ENVIRONMENTAL IMPACT STATEMENT ON IMPROVING THE REGULATORY PROCESS IN SOUTHWEST FLORIDA, LEE and COLLIER COUNTIES, FLORIDA

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PREPARED BY

U.S. ARMY CORPS OF ENGINEERS

JACKSONVILLE DISTRICT

(LEAD AGENCY)

U.S. FISH AND WILDLIFE SERVICE

U.S. ENVIRONMENTAL PROTECTION AGENCY

(COOPERATING AGENCIES)

The Jacksonville District of the U.S. Army Corps of Engineers (Corps) prepared this Environmental Impact Statement (EIS) to improve review of future applications to fill wetlands. A landowner who desires to fill wetlands on his/her property must apply to the Corps for a Department of the Army Permit (Permit) under Section 404 of the Clean Water Act. The Corps initiated the EIS out of concern whether the incremental (permit-by-permit) reviews were adequately addressing cumulative and secondary effects of the wetland fill in the rapidly growing Southwest Florida area. The northwest corner of the EIS study area is roughly defined by the cities of Ft Myers/Sanibel, the northeast by Lehigh Acres/Immokalee, the southwest by Naples and the southeast by Everglades City. The area contains a number of important resources including protected species, wetlands, marine and estuarine resources, habitat preserves, sanctuaries, other public and private conservation lands, and other important ecological resources. The environmental and cumulative effects of a project for which a permit is sought are currently analyzed on a case-by-case basis by the project manager. Each Corps project manager (the person reviewing the permit application) currently makes his or her own determination of what resources may be affected by the project, determines what criteria to apply, and what weight to apply to each criteria. To improve this procedure, the Corps proposes to use a set of standardized Permit Review Criteria with the determination of criteria to be based upon a Natural Resources Overlay Map that identifies the locations where a project has a probability to adversely affect one or more natural resources. Just as some areas have greater or lesser degrees of environmental importance, so does the review of applications require greater or lesser degrees of rigor. Neither the map nor the criteria establish the location of fill, quantity of fill, or any constraint on any piece of property. That decision can only be made after review of an application. The standardized maps and criteria are expected to more clearly identify natural resource concerns and thereby improve the Corps reviews. The Permit Review Criteria and Natural Resources Overlay map were developed based on five predictions of future landscapes (called Ensembles). The EIS discloses the potential effects on natural resources and other issues of these Ensembles. Each Ensemble predicted different locations of wetland fill, conversion of upland plant cover, and other permit review criteria, based on the expected actions or suggestions for actions that could or should be taken by the Corps (for wetland fill) and by landowners or City, County, State or Federal Agencies. During preparation of the EIS, the Corps initiated and hosted a group of community and agency representatives, the Alternatives Development Group, whose membership represented a range of views and expertise in the community. The Alternatives Development Group prepared documents that the Corps used to prepare the Ensembles, but had no part in preparation of the proposed action or environmental analysis.

For more information, feel free to contact Bob Barron, Regulatory Division, U.S. Army Corps of Engineers, P.O. Box 4970, Jacksonville, Florida 32232-0019, telephone (904) 232-2203. Previously released documents are available at http://www.saj.usace.army.mil/permit/swfeis/contents.htm.

US Army Corps of Engineers®
Jacksonville District

SUMMARY

ENVIRONMENTAL IMPACT STATEMENT
On
Improving the Regulatory Process in
Southwest Florida
Lee and Collier Counties, Florida

1. Purpose and Need.

The Jacksonville District of the U.S. Army Corps of Engineers (Corps) prepared this Environmental Impact Statement (EIS) to improve review of future applications to fill wetlands.

Corps Permits. A landowner who desires to fill wetlands on his/her property must apply to the Corps for a Department of the Army Permit (Permit) under Section 404 of the Clean Water Act. The Corps decision whether to issue a Permit considers the benefit and detriments of the proposed fill on many factors, including wetland ecological values and functions, fish and wildlife habitat, water quality, natural resource conservation, economics, aesthetics, historic properties, flood hazards, land use, navigation, shore erosion, recreation, water supply and conservation, energy needs, public safety, food and fiber production, mineral needs, and property ownership. The applicant must demonstrate in the application that a non-wetland alternative is not available and that the proposed fill is the practicable alternative project design with the least damaging environmental effect. The Corps must also consider the effects of the proposed fill on species listed under the Endangered Species Act.

Problem to Be Addressed: The Corps initiated the EIS out of concern whether the incremental (permit-by-permit) reviews were adequately addressing cumulative and secondary effects of the wetland fill in the rapidly growing Southwest Florida area. The northwest corner of the EIS study area is roughly defined by the cities of Ft Myers/Sanibel, the northeast by Lehigh Acres/Immokalee, the southwest by Naples and the southeast by Everglades City. The area contains a number of important resources including protected species, wetlands, marine and estuarine resources, habitat preserves, sanctuaries, other public and private conservation lands, and other important ecological resources. Approximately 38% of the historic plant cover has been converted to agriculture, urban, suburban, and other economic activities. Ten species listed as Endangered or Threatened are found in the study area, plus sea turtles who nest on its beaches and the Florida manatee found it its open waters. Thirteen of the thirty seven waterbodies in the study area are listed by the State of Florida as partially or not meeting water quality standards.

2. Major Findings and Conclusions

A decision on an application for an individual permit is made after review of site-specific and project-specific information submitted by the landowner or provided by other sources. The information that is gathered is based on the understanding of what natural resource and other issues are applicable to the project. The evaluation considers and weighs the extent of adverse or beneficial effects on these issues. The decision authorizes the location and quantity of wetland fill and includes appropriate conditions .

The EIS discloses five sets of predicted futures (Ensembles). Each future maps different location and quantity of wetland fill. Also, each future includes legends that suggest various conditions or constraints applied to the permit decisions. Any location on the map therefore has an associated: location of fill (present or not), quantity of fill, and some condition or constraint. These attributes are collectively called criteria. Therefore, there are five combinations of various criteria. Each map assumes all future permit decisions followed the suggested criteria. The EIS then compares the effects of each future on wetland fill, wildlife habitat, and other factors. Summary of the criteria and effects are found in Table 3.

Existing Conditions (No Action Alternative): The Corps presently makes its determinations of the benefit and detriments of proposed fills on a case-by-case basis. The factors to be considered, and the weight to be afforded each factor, are presently left to the professional judgment of the program manager with oversight from Regulatory Division management. The "no action" alternative would be to continue evaluating permit applications in the same manner as before the EIS.

Proposed Action. The Corps proposes to use the information in this EIS in the review of future permits. The information will be used to identify the issues that may be relevant to the project site, provide a source of information on potential effects of the project on various issues, to provide a reference on the potential effects of the location and quantity of fill, and to describe potential effects of alternative permit conditions or constraints. The Corps is not proposing to decide, based on this EIS, to establish the location of fill, quantity of fill, or on any condition or constraint on any piece of property. That decision can only be made after review of an application.

The EIS provides a set of standardized natural resource criteria in reviewing permit applications in Southwest Florida. This set is called the Permit Review Criteria and is found at Appendix H of the EIS. Important natural resource issues are shown on the companion Natural Resources Overlay Map. The map is divided into anticipated future use areas where a project may have a high potential for adverse effect on the natural resource. The program manager (person reviewing the permit application) would evaluate each application using the criteria and evaluations suggested in the EIS applicable to the important resources found in that area. Just as some areas have greater or lesser degrees of environmental importance, so does the review of applications require greater or lesser degrees of rigor. As seen, some areas have no issues mapped. For these areas, the program manager would continue to use his/her discretion as to the appropriate reviews .

The Natural Resources Overlay Map implements the proposed action, and will be used to determine the applicable permit review criteria. The map was created by the Corps based on evaluation of the effects of five future landscapes (called Ensembles) that suggested different locations of development and different criteria for the permitting of those developments. The comparison of the Ensembles allowed for the identification of areas where projects may have the greater impacts to natural resources.

Other Alternatives Considered: The issue is how the Corps considers available information on the effects of alternative locations, quantities and conditions of natural resources when deciding whether to issue a permit. An infinite number of potential locations and quantities of fill and types of conditions and constraints are available to be applied. Although an infinite number of alternative criteria and natural resource maps could be developed, all would simply be variations of the proposed action. They are all just variations on the way the Corps reviewer can find the applicable information on the same natural resource factors. Rather than set up and knock down a number of such "strawman" alternatives, the Corps felt it was better to develop one easily used set of criteria and a natural resource map to reference the information in the EIS since it can be easily modified in response to public concerns and changing conditions. The choice is really between "piecemeal" review of cumulative impacts and review of cumulative impacts using standardized criteria and a reasonable forecast of future conditions. Therefore, only the "No Action" alternative and the Proposed Action have been considered.

Summary of Environmental Effects of the Proposed Action: Implementation of the Permit Review Criteria will have the following effects compared to the no-action continuation of piecemeal review: less likely to have fragmentation of habitat; reduced cost for application preparation in some geographic areas; greater predictability for the applicant; create dialog for exploration of solutions rather than surprising a future applicant when the natural resource reaches the point that "breaks the camel's back".

3. Determination of Future Conditions: A sizable part of this EIS has been concerned with analysis of land use patterns so as to determine the most likely future land use over the next 20+/- years. In conjunction with Corps wetland permits, such land use patterns have a tremendous cumulative environmental effect. For example, a permit to build a factory in an existing undisturbed area may have little environmental effect if the rest of the area remains undeveloped, but if the factory then results in extensive residential and commercial development, the cumulative environmental effect may be much greater.

To determine the anticipated "futures," the Corps initiated and hosted this group of community and agency representatives. The membership was balanced to represent the range of views of the community and to provide a mix of expertise for the development of alternatives. Through professionally facilitated meetings, the ADG defined 12 evaluation issues, agreed to 62 measurement factors, and then created and evaluated 28 alternatives. A final report of their work is found as an Appendix in the EIS. For the work of the ADG, the EIS study area was divided into sub-areas. Any individual ADG alternative only covered one of the four sub-areas. Several alternatives would apply to the same sub-area. The Corps used the ADG work to assemble the Ensembles which cover the entire study area. In turn, the Corps used the Ensembles to create the Natural Resources Overlay Map that is part of the proposed action.

The map accompanying the Ensemble depicts what the landscape may or may not look like in 20+/- years as a result of many individual decisions by the Corps, landowners, Counties, and others. Conversion of upland plant cover does not require a Corps Permit, but, based on previous permit applications, development of the uplands is sometimes impracticable without some wetland fill. Therefore both wetland and upland changes are shown by the Ensembles. Each Ensemble represented a possible future state:

Ensemble Q. Builds on the comprehensive plans and provides a larger acreage of development than the comprehensive plan.

Ensemble R. Represents the status quo and incorporates the Lee & Collier County Comprehensive Plans.

Ensemble S. Provides greater emphasis on listed species and their habitat, particularly wide-ranging species such as the Florida panther and Florida black bear. Contains restrictions on the clearing of native vegetation, preservation and restoration of habitat corridors and flowways, and increased regulatory and public awareness of the presence and extent of sensitive resources.

Ensemble T. Seeks to increase the area of preserves through restore, retrofit, and redevelopment of vacant lands within Lehigh Acres, greater protection afforded to isolated wetlands, and limitation on the extent of clearing & filling activities, within Golden Gate Estates and other areas. Agricultural activities would be limited to existing acreage with limited intensification therein.

Ensemble U. Proposes the largest area of preserve among the Ensembles through criteria that limit the conversion of natural vegetation to other land cover types. This criteria also seeks to increase the difficulty of placing fill in wetlands by strict application of the presumption that alternative non-wetland sites are available.

4. Issues Raised by the Public and Agencies. A number of issues were identified by the Alternatives Development Group and others. These include the following: property rights; water management; water quality; ecosystem function; wildlife habitat; listed species; regulatory efficiency and effectiveness; economic sustainability; local land use policy; avoidance of wetland impacts; mitigation;

cumulative/secondary impacts; restoration/retrofit; and public lands management/use. The Corps invited the assistance of the Alternatives Development Group (ADG), a group of community and agency representatives, for input in issues important to the community. Having obtained a preliminary look at issues important to the public, the Corps was able to develop its own Natural Resources Overlay Map and Permit Review Criteria, then proceed with public scoping of this EIS. This allowed the Corps to present a Draft EIS with a comprehensive review of the issues and in terms and terminology important to the community. The 189 day public comment period on the Draft EIS, including three public hearings, resulted in 1,098 pages (without enclosures) of additional input (plus 1,400+ letters from landowners in Lehigh Acres.)

5. Areas of Controversy. Decisions on permit applications and implementation of various other laws to protect environmental resources may be in conflict with certain plans for development and other land use changes. In addition, the question has been raised as to how much restriction on use of private property is justified by the public benefit of environmental protection. As long as there are strong and diverse viewpoints on these issues there will be a degree of controversy.

Comprehensive Plans. Although the Corps authority, based on federal laws, is independent of local authorities, one of the goals of this EIS is to better coordinate with local and State processes. For example, the Lee County Comprehensive Plan states "Permitted uses in Wetlands consist of very low density residential and recreational uses that will not adversely affect the ecological functions of wetlands" and, later, "...the county will not undertake an independent review of the impacts to wetlands..." Collier County's Area of Environmental Concern Overlay "...has no regulatory effect." Both Counties refer the landowner to state and federal permitting programs. Therefore, landowner will look to other parts of the County Plans for criteria on density, type of activity, etc., and, we hope, will be able to look at the EIS for criteria on wetlands and wetland related issues. The overlay map shows where the Permit Review Criteria issues overlap areas identified for development by the Comprehensive Plans. A potential conflict may occur if a project proposed in an area deemed appropriate by the Comprehensive Plan is determined by the Corps, after its review of the application, to have not addressed the natural resource degradation.

Lehigh Acres. Lehigh Acres was included in EIS study area because of its landscape importance for some natural resources. For example, Wood storks from Corkscrew Marsh forage in Lehigh Acres as well as other areas. If a lot owner fills a herbaceous marsh on his/her wetland, the population of this endangered species would decline. By including Lehigh Acres, the EIS can describe the past loss of marsh and present estimates of potential future loss of marsh for the rookery. The EIS presents Comprehensive Plan and four alternative maps (the 5 Ensembles) that incorporate ideas for changes in landscape and permit review criteria that may happen or were expressed as ideas to address a concern such as wildlife habitat loss. These ideas were addressing issues that affect the entire study area and the effort was not aimed at Lehigh or any other particular area. Although the Corps recognizes the Comprehensive Plan as the State and County preferred plan, the Plan does state "...the county will not undertake an independent review of the impacts to wetlands..." and refers the landowner to State and Federal permitting. The Corps, therefore, cannot simply defer to the Comprehensive Plan. Under the Clean Water Act, the Corps must make its independent decision whether to authorize lot owners to fill their wetlands. The EIS is not adding regulations. They already exist. The Corps is disclosing to the public the different impacts of alternative quantities of permitting. However, the Corps has always recognized in permit reviews that circumstances of single family lot owners are such that options such as purchasing other sites or changing site design are often not practicable alternatives to filling the wetlands on their lots. Based on public comments submitted, Lehigh Acres serves those that do not have alternative locations for homesites in the region. However, the continued authorization of wetland fill will contribute to wetland and habitat impacts such as disclosed in the EIS.

Property Value. There is no guarantee under the law that a landowner will be authorized to fill wetlands, if wetlands are on his/her property. None of the alternatives state that the Corps will or will not issue a permit. The EIS discloses the review criteria that will be used to assess potential impacts. The

EIS has not proposed to deny permits. That decision can only be made after a review of the individual circumstances of a lot owner based on information in his/her application. The Corps weighs the impacts to the environment and to the individual landowner. However, the EIS is disclosing what is the total environmental impact of prospective decisions to better understand the ecological context of the loss of the wetland on a single parcel.

Permitting cost. As public's concern for fate of remaining wetlands increases, additional administrative requirements have been added to the Nationwide Permits. Nationwide permits and General Permits are one method by which the Corps keeps permitting costs down. The Corps hopes to develop a General Permit written for Lehigh Acres and other areas in Southwest Florida to prevent permit cost burden.

Permitting uncertainty. For property with wetlands, permitting uncertainty already exists since there is no guarantee a permit will be issued. As the number of acres of wetlands in a region continue to be reduced, the general public's concern over the fate of the remaining ones typically increases. By preparing a 20 year estimate, the Corps is trying to identify problems and solutions particularly for those owners who will not be building until later. The EIS by itself is not pre-determining what the Corps permit decisions will be. The Corps is concerned with the apparent continued decline of wildlife populations, water quality, and other issues. If the Corps waits until the decline becomes critical some landowners may be surprised by a permit denial ("the straw that breaks the camels back"). Through this EIS the Corps is disclosing how much impact its program may have and has presented ideas for alternatives. The Corps hopes this results in public discussion of solutions. The Corps has not selected a plan of land acquisition or a plan to begin denying permits. The Corps has presented Draft Permit Review Criteria that identifies locations where projects have a greater potential to affect natural resource issues.

Vested Rights. The landowner, if he/she wishes to fill wetlands, must obtain a Corps permit in accordance with the Clean Water Act. A State or local permit or other development authorization does not override a federal law. The requirement for a Corps permit to place fill in wetlands was initiated by passage of Section 404 of the Clean Water Act of 1972. There are those who purchased lots before then that have been affected by this new law. Those who purchased after 1972 unfortunately may not have been aware of this. The law applies to all wetlands no matter when purchased.

Upland Activities. The EIS presents total projected impact, both resulting from Corps decisions and decisions of others, to provide context of Corps decisions. In some circumstances, the Corps will review the activities on uplands if they are a result of the wetland fill. For example, where wetland fill is the only way to provide access to an upland island, the Corps will typically include in its evaluation of effects the resulting impact on uplands. The EIS does not expand Corps permitting. However, if a change in activity on the upland, including agricultural activity, does not require wetland permit but adversely affects an endangered or threatened species, the landowner may have other obligations under the Endangered Species Act.

Property Rights. The Corps must and will ensure its actions that restrict use of property are just those that are authorized by law. However, the Corps will, within the limits of the law, fully consider the natural resource effects that may result if a requested wetland fill is authorized. Section 404 of the Clean Water Act is a restriction of the right of a landowner. But that restriction is limited to placement of fill in wetlands on the property. (The Endangered Species Act and other laws also are restrictions within designate limits). The Corps can and has asked questions related to these effects in permit reviews. The EIS reflects the Corps knowledge of location and assessment of natural resource effects prior to receipt of site-specific information. The permitting process is complicated and the Corps hopes the EIS will provide the landowner with better understanding of these effects in advance of application.

6. Implementation. The Corps decision whether or not to implement the Proposed Action will be made after considering comments submitted by the public on the EIS. If the proposed action is adopted, the Corps will use site-specific information provided by the applicant that addresses the issues raised by the permit review criteria. Only after full information is available would a permit decision be made. Again, the permit review criteria do **not** pre-determine a result. Depending on a complete review of all factors, a permit may or may not be granted, regardless of the Natural Resources Overlay Map and regardless of the Permit Review Criteria.

Anticipated Future Actions: The Corps may, in geographic areas with fewer concerns, consider initiating development of General Permits or other mechanisms to expedite the administrative processes, including ones for Golden Gate Estates and Lehigh Acres. A General Permit is a type of permit issued by the Jacksonville District of the U.S. Army Corps of Engineers that authorizes a group of construction activities within the State of Florida, Commonwealth of Puerto Rico, or the Territory of the U.S. Virgin Islands for five years. If a landowner's proposed project is for the construction listed by the General Permit and if the project design matches the special conditions described in the General Permit, then the landowner applies for and the Corps issues a letter verifying in advance that the landowner's plan matches the General Permit. (This letter of verification is commonly referred to as "issuing a General Permit"). The landowner is thereby assured he/she has met requirements of the Clean Water Act and does not have the administrative burden of the individual permit review. Nationwide Permits are similar except the permits are issued from Washington, DC, although landowners receive their verifications from Jacksonville. The General Permits would apply to certain areas, such as Lehigh Acres and Golden Gate Estates, and would include conditions to address the concerns described in the Permit Review Criteria. For example, in Lehigh Acres the Corps might pursue a General Permit that authorizes fill of the individual wetlands on single family lots but with a funding mechanism where a large area of replacement wetlands are provided since preserving wetlands on a single lot is often impracticable. This would prevent the decline of wildlife habitat and provide an administrative process to keep permitting costs low. All these possible actions are, however, speculative at this time and are **not** within the scope of this EIS.

Refinement. The information used is necessarily based on regional or statewide mapping programs. The Corps will use site-specific information provided by the applicant that either confirms or finds the issue raised by the EIS as not applicable. The evaluation factors used to analyze the effects are not elaborate. Their purpose is to present the relationship of an individual permit to the whole. As these are used, the Corps will periodically evaluate, in cooperation with other agencies, the accumulation of permit decisions to evaluate trends.

ENVIRONMENTAL IMPACT STATEMENT

IMPROVING THE REGULATORY PROCESS IN SOUTHWEST FLORIDA LEE AND COLLIER COUNTIES, FLORIDA

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1. PROJECT PURPOSE AND NEED

1.1 PROJECT LOCATION

The project area covers approximately 400,167 hectares (988,800 acres) in Lee County and portions of Collier County on the southwest coast of Florida (**Figure 1**). The geographic area is defined as follows: the north boundary being the south shore of the Caloosahatchee River from its mouth at San Carlos Bay to the Hendry County line, a distance of approximately 54 kilometers (km) (34 miles); the east boundary being the Hendry County line to the City of Immokalee, then south along State Road 29 to the Ten Thousand Islands Area at Chokoloskee Bay; the south boundary being the Ten Thousand Islands and Marco Island; the west boundary being the coastline along the Gulf of Mexico (USACE 1998).

This study area was further subdivided into four sub-areas (zooms) referred to as Zoom A, Zoom B (also referred to as the "Hub"), Zoom C, and Zoom D (**Figure 2**). Zoom A (798 square kilometers (sq. km) (308 square miles)) is bounded on the north by the Caloosahatchee River, on the west by the Gulf of Mexico, on the east by the Lee County-Hendry County line, and on the south by the northern boundary of the Estero-Imperial Integrated Watershed. Zoom B (the "Hub") is roughly defined as the Estero-Imperial Integrated Watershed as it occurs within Lee and Collier Counties. The Estero-Imperial Integrated Watershed does extend into Hendry County, but the Hendry County portion was not considered during this process. Zoom B covers approximately 795 sq. km (307 sq. mi.). Zoom C, which encompasses1,194 sq. km (461 sq. mi.) is roughly defined as the western portion of the Faka-Union Watershed. The western boundary is the Gulf of Mexico while the Faka-Union Canal, Miller Boulevard (part of the eastern portion of Golden Gate Estates), Winchester Strand, and Big Corkscrew Island form the eastern limits. Zoom D is defined on the south by Chokoloskee Bay, on the east by State Road 29, on the north by State Road 846, and on the west by Zoom C. Zoom D is the largest of the four areas, covering 1,246 sq. km (481 sq. mi.).

1.2 PROJECT NEED OR OPPORTUNITY

The State of Florida, and the study area in particular, has undergone rapid growth and development over the last twenty years. With this increased development has come a concomitant increase in the number, the scope, and the complexity of development permit applications submitted to local, County, State and Federal regulatory agencies. This situation has led to difficulty on the part of the Corps and these other agencies in, on a case-by-case basis, addressing their responsibilities under Federal and State law. Permit processing is taking longer and the environment may be receiving less protection than required by law. The subject EIS is designed to offer regulatory and planning-based remedies to these short-comings, by seeking an effective balance between natural systems and economic stability through the examination of natural and social interactions that occur in the study area.

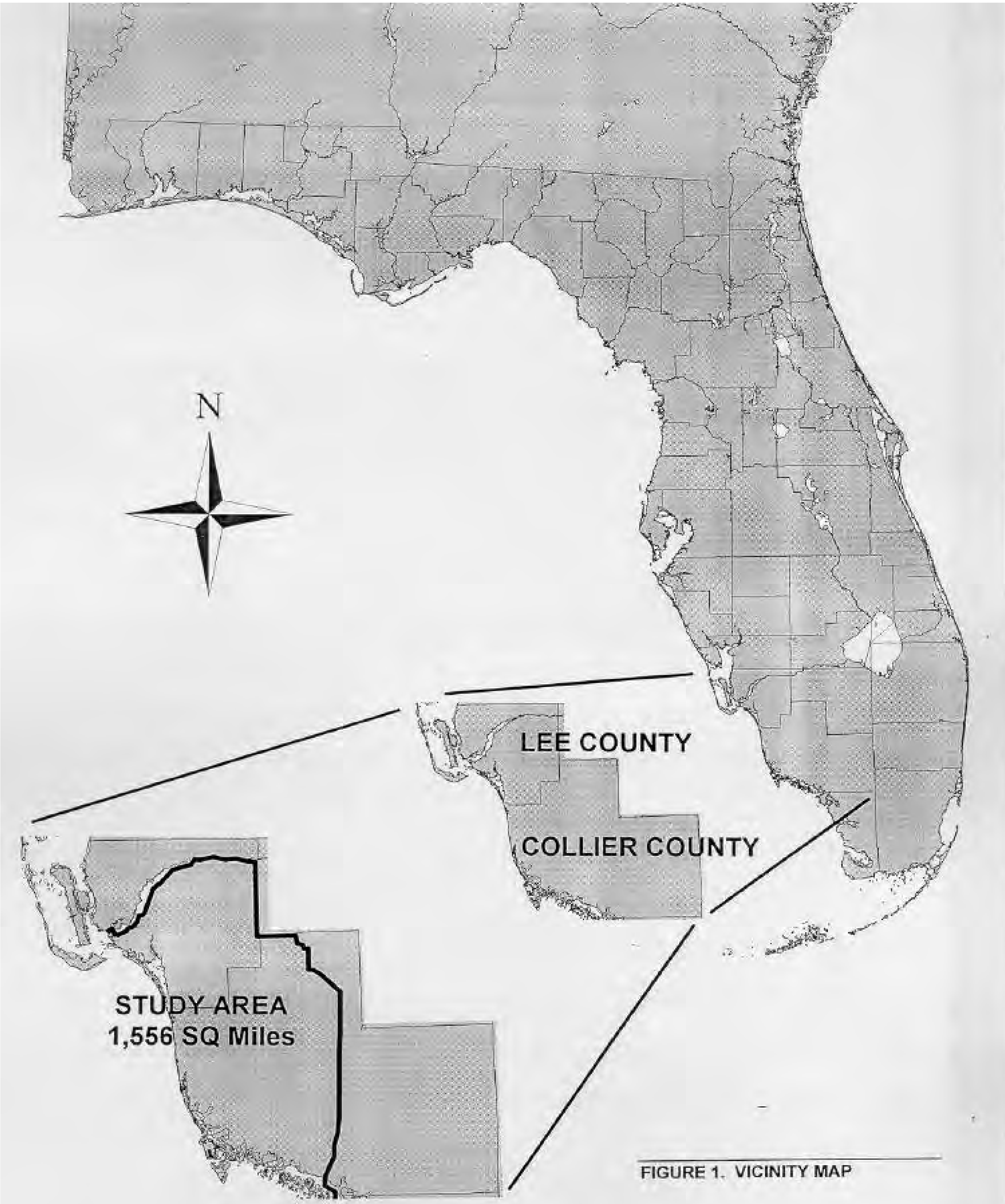


FIGURE 1. VICINITY MAP

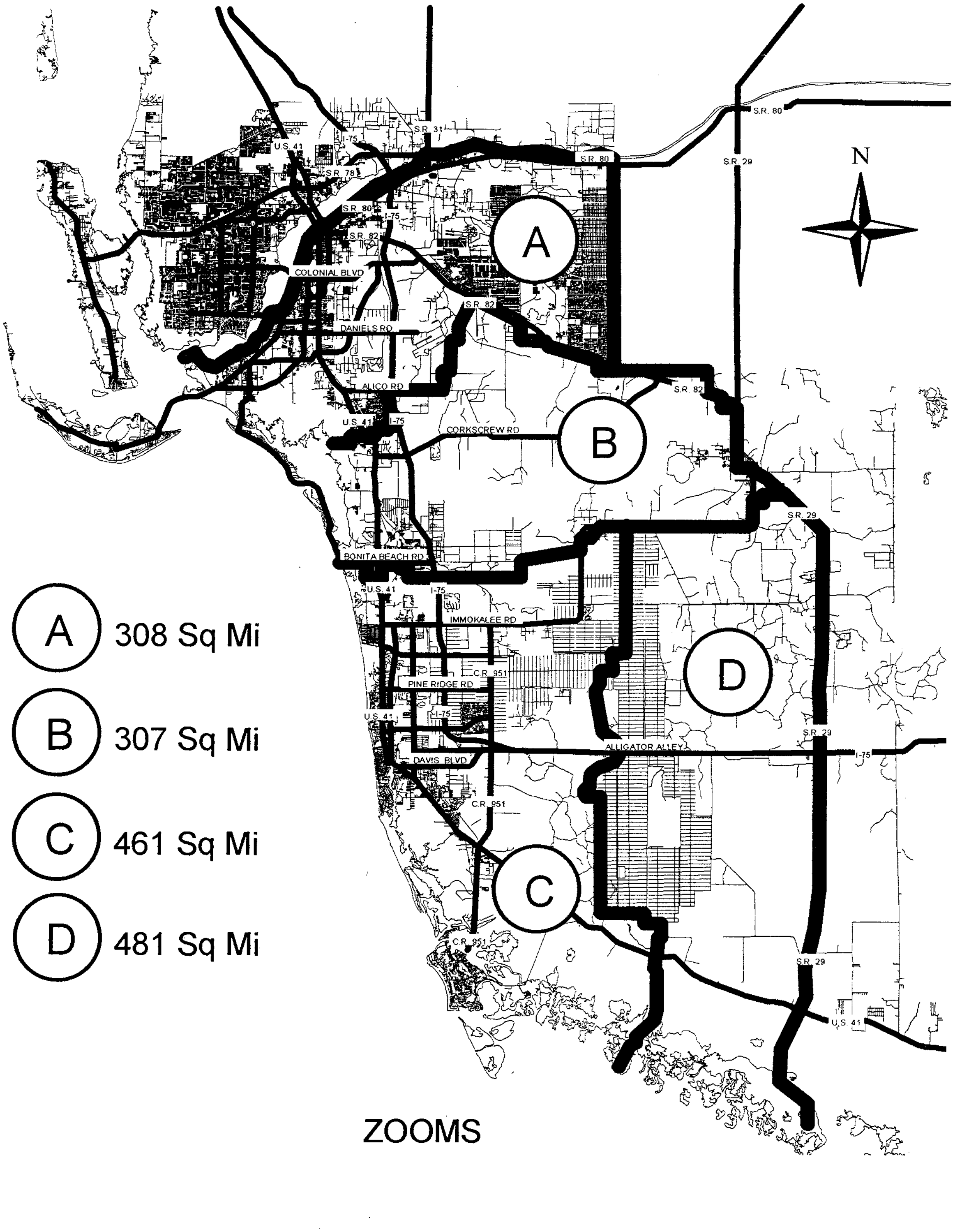


FIGURE 2. ZOOM AREAS

1.3 AGENCY GOAL OR OBJECTIVE

The purpose of this effort is to establish a better foundation of information and knowledge of existing conditions and identification of future alternatives for balancing the demands of growth and conservation. The goal of this effort is a more effective, timely, streamlined, cost-conscious, objective, productive, and predictable environmental permitting process for projects within the study area. The objective is to implement permit review criteria (keyed to a map) that provide specific questions to ask and answer during the review of an application. The purpose of these measures is to facilitate efficient, timely, and appropriate planning and permitting while affording an appropriate level of review to the cumulative effects on natural resources.

This document presents several potential future landscapes, each represent the potential outcomes of future decisions on permit applications. This document reports the impacts and benefits associated with the various future outcomes. The information presented in this EIS was used to develop the permit review criteria, and an accompanying landscape map, that will be used, on individual applications, to contribute to the evaluation of the cumulative effect of the individual decision from a regional landscape perspective.

1.4 RELATED ENVIRONMENTAL DOCUMENTS

The following is a list of related documents:

1.4.1 NATIONWIDE PERMITS

Certain minor activities requiring a permit from the Corps have been determined to qualify for authorization by one or more Nationwide Permits under the Corps regulatory permit program. The Nationwide Permits are issued for a period of 5 years in accordance with Section 404(e) of the Clean Water Act. In addition, activities requiring a permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 may be authorized by certain Nationwide Permits. The Nationwide Permits are issued by the Chief of Engineers for application throughout the United States.

Since the Nationwide Permits are valid for a period of 5 years, the Chief of Engineers must periodically reissue them. These actions are announced in the Federal Register (applicable announcement on December 13, 1996) and become part of the Code of Federal Regulations (33 CFR 330 and its Appendix A). The Nationwide Permit re-issuance is conducted in compliance with the National Environmental Policy Act (an Environmental Assessment is prepared by the Chief of Engineers). In addition, the Nationwide Permits comply with other applicable environmental requirements.

1.4.2 INDIVIDUAL PERMITS

Activities requiring an individual Department of the Army permit from the U.S. Army Corps of Engineers, would be evaluated on a case-by-case basis. These individual permit actions would normally require preparation of an Environmental Assessment or an Environmental Impact Statement (if there would be a significant impact on the human environment). A number of permit actions and associated environmental documents have been prepared for activities in the study area.

1.4.3 SOUTHWEST FLORIDA FEASIBILITY STUDY

The study area of the document you are reading is within the geographic boundary of two other documents in preparation, a Feasibility Report and EIS, to re-examine the Central and Southern Florida project and what might be done to mitigate the impacts or enhance the benefits of that project.

1.4.4 CRITICAL PROJECTS

Section 528 of the Water Resources Development Act of 1996 (WRDA 96) authorizes the Secretary of the Army to develop specific water quality related projects features which are essential to Everglades restoration. The section authorizes an appropriation of $75 million over three fiscal years for the construction of projects determined by the Secretary to be critical to the restoration of the Everglades.

A number of these "critical projects" are being pursued by the Corps. At least three of which would occur in the study area: Southern Golden Gate Estates, Lake Trafford, and Southern Corkscrew Regional Ecosystem Watershed (CREW). An Environmental Assessment has been completed for Lake Trafford (September 1999) and CREW (August 1999). A final Fish and Wildlife Coordination Act Report (CAR) was completed for CREW in October 1998. An interim final CAR was prepared for Lake Trafford (September 1999). A supplemental CAR is being prepared by the U.S. Fish and Wildlife Service. The Southern Golden Gates Estates project is no longer a Critical Project but is being pursued under another authority (as part of the Comprehensive Everglades Restoration Plan).

1.4.5 TIERED DOCUMENTS

Based on the principle of "tiering" (40 CFR 1502.20 and 1508.28), this EIS takes a broader geographic or programmatic approach. Future and more specific actions would be evaluated by subsequent documents. This document does not complete evaluation of the following items which are not yet ripe for decision: any specific permit action by the Corps of Engineers (Sections 404(a) and 404(e) of the Clean Water Act); any specific determination of jeopardy or incidental take by the U.S. Fish and Wildlife Service on Federally listed species and designated critical habitat (Endangered Species Act); any denial or restriction for any specified area by the Environmental Protection Agency (Section 404(c) of the Clean Water Act); action under the Fish and Wildlife Coordination Act; or any other regulatory action. This document does disclose, in a general way, the potential future outcomes of such actions for the study area to better evaluate the cumulative impacts of such actions.

The information in this EIS will be used as a reference and background for future documents (EISs and Environmental Assessments) prepared pursuant to the National Environmental Policy Act for these more specific actions. We expect this EIS to be particularly useful for evaluating cumulative impacts on important resources in the study area.

1.5 DECISIONS TO BE MADE

The information presented in this Environmental Impact Statement will result in specific questions to be used in the review of applications in Southwest Florida. This document does not directly lead to a permit decision on any specific application or for any particular property.

1.6 SCOPING AND ISSUES

A Notice of Intent (NOI) to prepare a draft of this EIS appeared in the Federal Register on 12 January 1998. In addition, the NOI was mailed to interested and affected parties by letter dated 12 January 1998. A copy of the letter and NOI are in Appendix C. Two public meetings were held to receive comments. At public meetings held on 9 February 1998, more than 200 people (of whom 60 spoke) attended and provided comments regarding geographic area, specific issues, and the manner of the EIS process. The Corps also addressed a joint session of the Boards of County Commissioners of Lee and Collier Counties. In addition, there was a series of intensive working meetings by the ADG to help develop alternatives", evaluation factors, and assessment of the impacts.

1.6.1 ISSUES EVALUATED IN DETAIL

The following issues were identified during scoping, through the meetings of the Alternatives Development Group (ADG), and by the preparers of this Environmental Impact Statement to be relevant to the Proposed Action and appropriate for detailed evaluation:

a. Property Rights
b. Water Management
c. Water Quality
d. Ecosystem Function, Wildlife Habitat, and Listed Species
e. Regulatory Efficiency and Effectiveness
f. Economic Sustainability
g. Local Land Use Policy
h. Mitigation
i. Cumulative/Secondary Impacts
j. Restoration/Retrofit
k. Avoidance of Wetland Impacts
l. Public Lands Management/Use

The ADG is a group of resource experts, regulatory agency personnel, concerned citizens appointed by actions of the Lee County and Collier County Boards of County Commissioners as well as through actions of other agencies and entities, and development and business interests representing their respective industries/interests. Further detail regarding the ADG and its charge are discussed in Section 2 - Alternatives.

1.6.2 IMPACT MEASUREMENT

The following provides the factors that were considered in the evaluation of alternative futures that represent the cumulative effect of actions by landowners and city, County, State and Federal governments.

a. Property Rights
    1. Fair Market Value
    2. Vested Rights
    3. Reasonable Expectation For Use of Land and Return on Investment

b. Water Management
    1. Infrastructure Existence (Stormwater Utility/Maintain and Improve)
    2. Home Damage During Storm Events (Level of Flood Protection)
    3. Home Construction to Meet the One-Hundred Year Storm Event
    4. Flood Depth and Duration
    5. Historic Flow Patterns (Maintain and Improve)
    6. Adequate Water Storage (Balance Consumption with Hydroperiods)
    7. Groundwater Data Floors and Ceilings (Aquifer Zoning)

c. Water Quality
    1. Pollution Loading
    2. Freshwater Pulses
    3. Habitat Loss
    4. Groundwater Impacts

d. Ecosystem Function, Wildlife Habitat, and Listed Species
    1. Effects on Florida Game and Fresh Water Fish Commission's (FGFWFC) Strategic Habitat Conservation Area (SHCA) habitat planning objectives (GAPS)

2. Effects on the U.S. Fish and Wildlife Service's (USFWS) Priority I and II Florida Panther habitat (Florida Panther Habitat Preservation Plan).
3. Effects on Southwest Florida Regional Planning Council (RPC) Resources of Regional Significance
4. Effects on USFWS Multi-species Recovery Plans for South Florida and Recovery Plans for Federally listed species.
5. Effects on Occurrences of Listed Species
6. Effects on Occurrences of Rookeries
7. Effects on Loss of Native Plant Communities (Common and Rare)
8. Effects on Fragmentation and Connectivity of Plant and Animal Habitats
9. Effects on Loss of Seasonal Wetlands
10. Effects on Integrity of Flowways (Rivers, Sloughs, and Strands)
11. Effects on Wetlands of Importance to Critical Wildlife
12. Effects on Aquatic Resources

e. Regulatory Efficiency and Effectiveness
1. Permit Review Time and Level of Effort
2. Pre-identified Impact/Mitigation and Preserve Areas
3. USFWS/FFWCC General Concerns Addressed

f. Economic Sustainability
1. Job Creation
2. Home Affordability
3. Cost of Living
4. Property Tax Base
5. Cost to Implement
6. Increased Taxes
7. Environmental Justice

g. Local Land Use Policy
1. Significance of Conflicts with Local Land Use Plans and Regulations
2. Hurricane Preparedness (i.e., Evacuation Routes and Shelter Availability)

h. Mitigation
1. Total Acres Provided for Mitigation Opportunity
2. Total Wetland Function Improvement Opportunity Provided

i. Cumulative/Secondary Impacts
1. Impacts on Infant Mortality
2. Impacts on Road Needs
3. Impacts on Air Pollution Loading
4. Impacts on Water Pollution Loading
5. Impacts on Crime Rates
6. Impacts on Hurricane Vulnerability
7. EPA Index of Watershed Indicators
8. Impacts on Wetlands Only
9. Impacts on Hydrology
10. Amount of Lands in Public and Private Ownership in Protected Status

j. Restoration/Retrofit
1. Natural Functions Maintained in Natural Systems (i.e., Flowways)
2. Exotic Species Control (Percent and Size of Parcels Treated and Restored)
3. Percent of Residents Using Self-Supplied Infrastructure (i.e. Septic Tanks)
4. Percent of Agricultural Land Applying Best Management Practices (BMP)

5. Wildlife Habitat Restoration

k. Avoidance of Wetland Impacts
   1. Total Acres at Risk
   2. Total Wetland Acres by Functionality at Risk

l. Public Lands Management/Use
   1. Compatibility with Land Management Plans
   2. Degradation or Improvement of Resources on Public Lands

The means of evaluation within each impact issue was based upon analysis of local data and assessment of proposed changes against existing and proposed economic and resource protection goals.

1.6.3 ISSUES ELIMINATED FROM DETAIL ANALYSIS

The following issues were not considered during the detailed analysis as part of this Environmental Impact Statement. The ADG identified two issues that did not fit within the twelve previously listed issue categories; a holistic approach to management, and higher standards for data and information. The ADG concluded that these were goals to strive for in Southwest Florida, not issues that could be addressed in the development of alternatives (ADG 1998) for the purposes of this EIS.

1.7 PERMITS, LICENSES, AND ENTITLEMENTS

The proposed action, which is adoption of standardized Permit Review Criteria together with the Natural Resources Overlay Map, is a procedure the Corps uses to review applications for 404 wetlands fill permits. Therefore, the proposed action itself does not require any local, state, or federal permits.

2. ALTERNATIVE PREDICTIONS OF FUTURE CONDITIONS

The Corps is proposes to use a set of standardized Permit Review Criteria with the determination of criteria to be based upon a Natural Resources Overlay Map that identifies the locations where a project has a probability to adversely affect one or more natural resources. The Corps will determine, after consideration of comments submitted on this EIS, whether to implement the Permit Review Criteria or the alternative (no-action) continuation of current practice of identifying issues to be reviewed in a permit application. The criteria proposed are those natural resource issues that have the potential to be influenced by the results of a Corps permit decision. To discover this, the Corps compared five predictions of future conditions that could result from a combination of Corps and non-Corps decisions. These are called Ensembles. The five Ensembles (predicted futures) each have a map of the landscape as it might appear in 20+/- years. Each future includes legends that suggest ideas for various conditions or constraints applied to the permit and other decisions. These five Ensembles were in turn developed from what are called "alternatives" "developed by the Alternatives Development Group (ADG). The Corps initiated and hosted this group of community and agency representatives. The membership was balanced to represent the range of views of the community and to provide a mix of expertise. This section of the EIS (Section 2) describes the development of the Ensembles (predicted futures) that started with the ADG "alternatives" but ended with the actual Permit Review Criteria that the Corps proposes to implement.

2.1 EIS ENSEMBLES

Through professionally facilitated meetings, the ADG defined 12 evaluation issues, agreed to 62 measurement factors, and then created and evaluated 28 alternatives". A final report of their work is found as an Appendix. As described in Section 1.1, the EIS study area was divided into sub-areas. Any individual ADG alternative covered only one of the four sub-areas. Several alternatives would apply to the same sub-area.

The Corps used the ADG work to assemble five EIS alternatives (called "Ensembles") each of which cover the entire study area.

Each of the alternatives" are described by a map and a legend.

> Each map depicts what the landscape may or may not look like in 20+/- years. Many of the areas that are currently "native vegetation" but are predicted to be developed will require authorization by the Corps for wetland fill. Development could occur without wetland fill but based on previous permit decisions this is impracticable for some landowners. Most of the intensification of agricultural uses can occur without Corps permits. Therefore, the map represents a potential result of future individual decisions by the Corps, landowners, Counties, and others.
>
> Each legend describes site design considerations, type of activity, mitigation, and other criteria that are or are suggested to be applied by the Corps, landowner, Counties, or other decision-makers to future projects inside the area delineated.

The maps delineate areas of "development", "agriculture", and "preserves" to characterize the predicted or suggested activity. They are not proposals that the Corps designate land use. They are used to quantify the effects of changes to the Corps or other regulatory agency’s regulatory programs. For example, Ensemble S includes a legend "Development - Compensate Offsite for Wide Ranging Species". This legend (described at 2.3.4.2) suggests the Corps or other decision-makers require off-site compensatory mitigation for future development in the area delineated. Therefore, Ensemble S is evaluated as if the future projects in this area were constructed with the criteria applied. For the evaluation factor related to wildlife, Ensemble S would be considered to have less adverse impact then another alternative that did not have the explicit criteria. However, for the evaluation factor related to economic sustainability, Ensemble S would be considered to have an adverse effect (higher costs). For each alternative, the EIS presents estimates of acres of wetland fill, area of habitat lost, change in water quality, etc. The reader can then see the tradeoffs between the various evaluation factors resulting from a change in criteria.

Four of the ADG alternatives" (one for each sub-area) and one of the EIS alternatives (Ensemble R) represent the current County Comprehensive Plans (that is, if all decisions matched these plans and these plans were not amended in the next twenty years). The remaining alternatives include ideas that the ADG members collectively or individually presented which they felt might occur or would like to see occur. The Corps may or may not receive applications that all mirror any single one of the maps.

Presentation of the five maps is simply a technique to identify the five different quantities of wetland fill that the Corps may be asked to authorize through permit applications in the next 20+ years. The five sets of legends provide ideas for criteria that could be adopted by the Corps and other decision-makers in the projects requiring wetland fill. The evaluation section of the EIS (Section 4) compares potential impacts and benefits if the fill is authorized and/or the criteria applied.

Some of the criteria found in the Ensembles are outside the jurisdiction of the Corps to implement. Much of the landscape could change (that on uplands) without Corps involvement. However, this EIS presents the larger picture to better place the Corps role in context with other Federal, State, local, and individual landowner actions. For example, the Lee County Comprehensive Plan states "Permitted uses in Wetlands consist of very low density residential and recreational uses that will not adversely affect the ecological functions of wetlands" and, later, "...the county will not undertake an independent review of the impacts to wetlands..." Collier County's Area of Environmental Concern Overlay "...has no regulatory effect." Both Counties refer the landowner to State and Federal permitting programs. Therefore, the landowner will look to other parts of the County Plans for criteria on density, type of activity, etc., and will be able to look at the EIS and Federal laws for criteria on wetlands.

2.1.1 IDENTIFICATION OF CRITERIA IN ADG ALTERNATIVES.

Each legend represents suggested review criteria. Each alternative map has from three to six legends. In order to identify all of the suggested criteria, a coding system was applied as described in Chapter VII of the Final Report from the Alternatives Development Group" (Appendix D). Each legend was then categorized into "families" and "subfamilies." A "family" is the general land cover characteristic of the legend. A "subfamily" is the narrative criteria applied to the legend. For example, the legends **Urban & Industrial** and **Develop (Compensate off-site for wide ranging species)** all envision that Corps Permits and/or other decisions will result in urban and/or suburban land cover. These legends are assigned to the same "Development" family. However, the **Develop (Compensate off-site...)** legend in ADG Alternative B2A envisions that the Corps' Permit decision will include off-site compensation. This criteria is not explicitly described by the **Urban & Industrial** legend of ADG Alternative B1A. Therefore, the two legends are assigned to different subfamilies within the "Development" family. Numerical codes are assigned to ease subsequent analysis. In this example, all three legends are coded family number 100 (Development). The **Urban** and **Industrial** legends are coded subfamily number 110 and the **Develop (Compensate off-site...)** is assigned subfamily number 130. The result is analogous to having a set of building blocks, each piece representing a unique subfamily code. Each of the alternatives" can then be depicted as assemblies of these building blocks.

2.1.2 OVERLAY OF ADG ALTERNATIVES

Using this coding scheme, the alternative maps were then overlaid to find which geographic locations were mapped with similar legends. The results are presented by figure VII-1 of the Final Report from the Alternatives Development Group (Appendix D), repeated here as **Figure 3A**. For 67% of the study area, the alternatives" mapped the same general land cover characteristic (family). These are the areas with crosshatching. Within any single crosshatch area, however, the alternatives" presented different descriptive language or criteria (subfamilies). Fundamentally, the alternatives do not vary the land cover type but vary in the review criteria to be applied. For 25% of the study area, the alternatives mapped a combination of two land covers. For example, in some locations the two might be Development and Preserve, or Preserve and Agriculture, etc. These are the areas in gray. For the remaining 8% of the study area, shown in white, the alternatives" map more than two covers.

2.1.3 DEVELOPMENT OF THE ENSEMBLES

Each "Ensemble" comprises four of the alternatives" created by the ADG. The ADG subdivided the study area into four pieces (called "Zoom A", "Zoom B" or "The Hub", "Zoom C", and "Zoom D") and created several alternatives for each. Each Ensemble selects one alternative from Zoom A, one from Zoom B, one from Zoom C, and one from Zoom D so that the Ensemble covers the entire study area. Alternatives with similar characteristics were placed in the same Ensemble. For example, Ensemble R consists of the alternative in Zooms A that represents the Lee County Comprehensive Plan, the alternatives each from Zoom B, C, and D that represent the Lee County and Collier County Comprehensive Plans. The other Ensembles were assembled based on a combination of: the similarity in the proportion of acreages mapped for land cover types (for example: alternatives within each Zoom that map the largest number of acres for the Development family are placed in Ensemble Q); the similarity of the suggested criteria (for example, the alternatives within each Zoom whose legends describe similar criteria to maintain the low density mix of uses within the Rural family are placed in Ensemble S); and the similarity of the individual alternative maps when joined to their neighbors.

2.1.4 CRITERIA ELIMINATED FROM EVALUATION

The subfamily coding system was used to ensure that all criteria found in the entire set of alternatives were represented in the Ensembles. For example, one of the alternatives" not assembled into an Ensemble describes criteria for Golden Gate Estates, but those criteria are duplicated in another alternative that was incorporated into Ensemble S.

2.1.5 USE OF ENSEMBLES

The evaluations in this EIS are presented by comparing five Ensembles, labeled Q, R, S, T, and U.

2.2 IMPLEMENTATION

The Corps anticipates that distribution and use of the EIS will enable a reduction in process time in some geographic areas and to more quickly focus efforts on relevant issues on complex projects. The following are the anticipated uses of this EIS.

First, the EIS places information in one document so that the public and reviewers are better informed of some of the tradeoffs between various environmental and other issues relevant to future reviews of permit applications. In particular, this will assist the permit reviewer to understand the terminology and interrelationships of the issues.

Second, the EIS discloses estimates of the collective effect of prospective decisions. The Ensembles presented by this EIS describe several "futures" that might result from a combination of actions by many landowners and, for those subset of projects that involve fill in wetlands, actions by the Corps. A landowner submits an application to the Corps requesting authorization to place fill in wetlands in order to construct some project on some parcel of land. The Corps considers the characteristics of the parcel and the benefits and impacts ascribed to the proposed project to decide whether or not to issue a Department of the Army Permit (Permit). The Permit, if issued, authorizes the placement of fill. The parcel's "land cover type" changes from wetland to something else (for example, residential). For any single parcel that includes wetlands, a prediction of the future (say twenty years) land cover type depends on the combination of: (1) whether the landowner proposes to fill the wetlands; and (2) what the Corps decides after considering the project specific information. All of the landowners in the study area could possibly construct all of their projects in such a way that would result in a land cover type map that exactly matches Ensemble R. However, it is not unlikely that some of the landowners' applications and the Corps' permit decisions will not exactly match any one particular Ensemble. The Ensembles do not represent all the possible combinations of projects and permits but instead represent a range of possibilities. Each Ensemble represents the collective total of all the projects, including the subset of those with permit decisions rendered by the Corps. The accompanying evaluation of those Ensembles present the collective total benefits and impacts. The Corps permit reviewer can then better give appropriate weight to the project's incremental contribution to the cumulative total effect compared to the individual impact and/or benefit of the proposed project.

Third, the EIS lists the concerns that landowners can anticipate arising during application reviews. The Corps has direct jurisdiction over a subset of the evaluation factors presented in the EIS. However, the Corps permit decision does consider the effects of its decision on many of the other factors. No single application will see all of the EIS factors applied in its review. However, the evaluation results reported for some factors are particularly worrisome. For example, the magnitude of habitat loss for many of the wildlife listed under the Endangered Species Act will, if the loss occurs, greatly reduce the potential for recovery of the species. Factors such as these are picked out and listed in the Draft Permit Review Criteria in the Appendix. If adopted, this document will be used by the Corps to formally focus review effort on projects that affect these factors. It must be noted that the Corps can review these issues now under current law but through proposed used of the Permit Review Criteria existing manpower will be more consistently applied and applied only on applications needing that review.

Fourth, the EIS will facilitate, in geographic areas with fewer concerns, future development of General Permits or other mechanisms to expedite the Corps' administrative processes. The Overlay of Alternatives Map (Section 2.1.2) describes many of the geographic areas as having similar fundamental land cover characterization. The Corps intends to use the information in the EIS in developing several General Permits that cover this area, including ones for Golden Gate Estates and Lehigh Acres. The General Permits would include conditions or provisions to address the concerns described in the Permit Review Criteria. An example would be criteria for project design that, if implemented across many projects, would preserve habitat. Development of future General Permits is not part of the proposed action and appropriate NEPA analysis will be done if an when the Corps makes such a proposal.

2.2.1 USE OF THE "OVERLAY OF ALTERNATIVES" MAP

The Ensembles propose the same land cover type for 67% of the study area. For example, the alternatives" created by the ADG variously use legends such as "urban," "industrial," or "development" on 14% of the study area to indicate that the land cover will be commercial, retail, residential and other types of urban or suburban development. These areas of similarity are mapped with cross-hatching on **Figure 3a**. The remaining cross-hatching represents development within the Lehigh Acres, Golden Gate Estates, and rural areas (8.8%), agricultural areas (5.4%) and preservation areas (38.8%). (This figure is also found in Chapter VII of the Final Report from the Alternatives Development Group.)

2.2.1.1 Sixty-Seven Percent of Overlay Map

Within the 67% crosshatched area, the Corps still will review certain details of the development's design to understand the impacts and benefits to various issues as required under Federal Law.

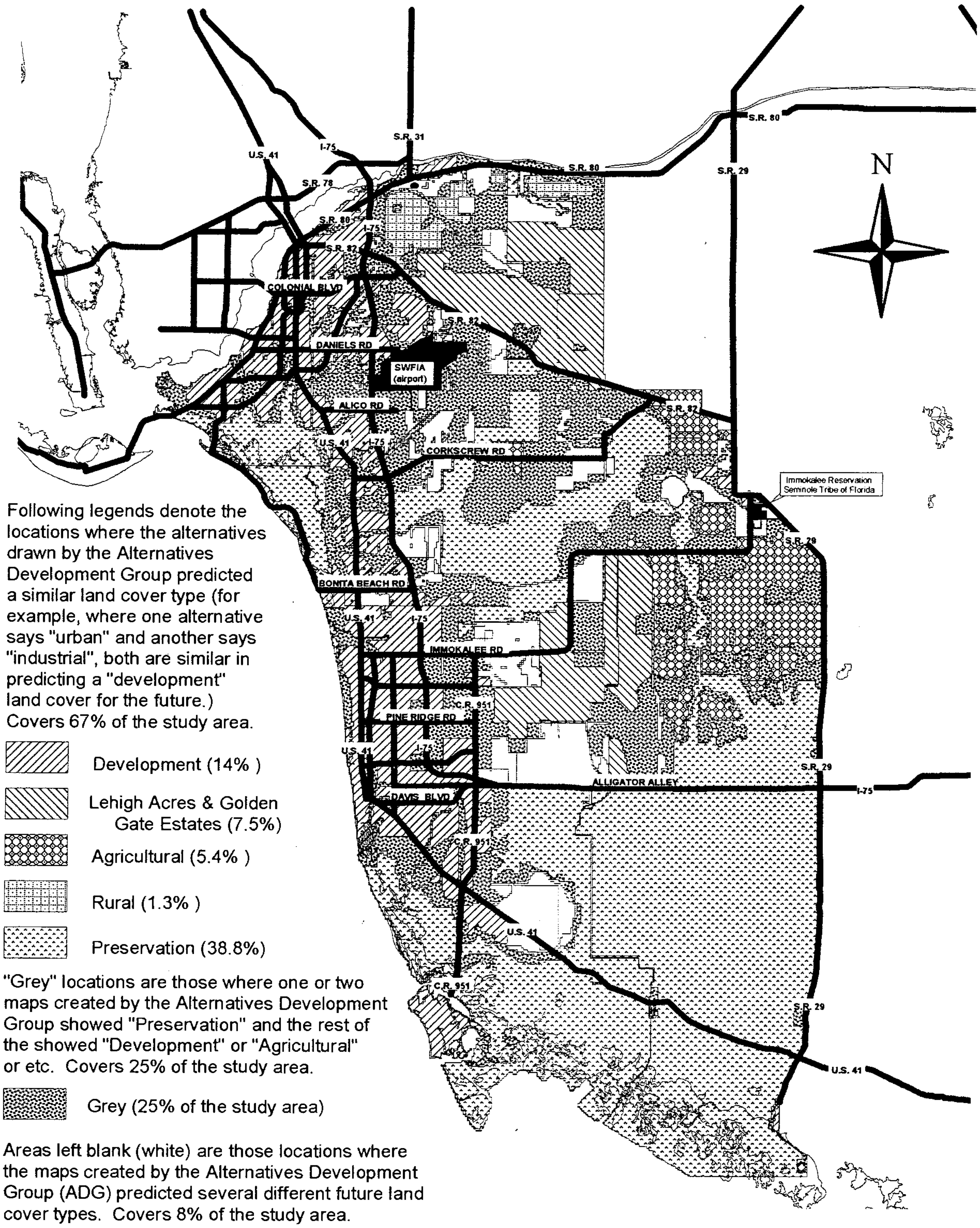
2.2.1.2 Thirty-Three Percent of Overlay Map

For the remaining 33% crosshatched portion of the study area, the Ensembles do not agree on the land cover types. For 25% of the study area, the difference is between two land cover types, for example, one Ensemble maps "preserve" and the others "development." This 25% is shown in gray on **Figure 3a**. For the remaining 8%, shown in white on **Figure 3a**, there are three or more land cover types mapped.

2.2.1.3 Twenty-Five Percent of Overlay Map

For the 25% (gray) area, the fundamental disagreement is on the appropriate geographic boundary between two adjacent land cover types, and commonly this is between "preserve" and some other land cover type. The quantity and location of native vegetation that is or is not preserved influenced many of the evaluation factors(presented in Chapter 4), particularly those related to wetland functions and fish and wildlife habitat. The focus of the Draft Permit Review Criteria in the Appendix has most of its questions related to wildlife reflecting this.

INSERT FIGURE 3a OVERLAY OF ALTERNATIVES MAP



OVERLAY OF ALTERNATIVES

FIGURE 3A. OVERLAY OF ALTERNATIVES

2.2.1.4 Eight Percent of Overlay Map

For the 8% (white) area, review of permit applications will be challenging. The evaluations in this EIS ascribe benefits to the local economy from expansion of development but the evaluations also show serious incremental impacts to natural resources. There is not a defined "threshold" number of acres of preserve or development where unequivocally a certain number of these acres are considered to be the ideal balance between natural resources and economic development. This EIS presents multiple evaluation factors and expresses each as relatively simple indices (such as percent of study area) that could be used to compare the many benefits and impacts.

2.2.2 THE PROPOSED ACTION: PERMIT REVIEW CRITERIA"

The Permit Review Criteria and associated map is found at Appendix H. This document will be used by Corps Project Managers to base the level of effort in reviewing a applications for Department of the Army Permit under Section 404 of the Clean Water Act on the potential cumulative direct and indirect effects.

The Corps' decision whether to issue or deny a Permit is based on site and project specific information. The information is gathered to support the evaluation and weighing of the impacts and benefits of the proposed project on many factors, including but not limited to wetlands, wildlife, endangered species, and water quality. The decision will consider both the direct and immediate effects and the indirect (cumulative and secondary) effects of the proposal.

The Corps will use this document to focus effort on those factors relevant to the review of the individual projects. In geographic areas where there are few concerns the Corps may at some time in the future be able to reduce the processing time through administrative mechanisms such as General Permits.

The document lists many issues. Each issue has its own map. For example, a particular species has a map showing areas with a high probability that species habitat is present and a high potential that the loss of that habitat will adversely affect the species.

The number of issues applicable to a particular project will depend on how many of the individual maps intersect the project location in addition to other information. A location with a larger number of issues will receive a greater rigor of review. However, the maps do not predetermine the Corps permit decision. The maps are necessarily based on regional or statewide mapping programs. The applicant can submit and the Corps will use site-specific information to confirm the map (for example, whether habitat is actually present) or find the issue is not applicable due to the nature of the project.

The list of issues is a subset of the factors evaluated in the EIS. The five maps in the alternatives section of the EIS delineate areas of "development", "agriculture", and "preserves" based on various ideas of how the land in the study area may be or should be distributed in 20+ years. These maps represent the potential result of many individual decisions by the landowners, Counties, Corps, and others. One map represents the County Comprehensive Plans, that is, if all individual decisions collectively matched these plans and these plans were not amended in the next twenty years. These maps were used to prepare five estimates of acres of wetland fill, area of habitat lost, change in water quality, and other factors. Many of the ideas presented in the alternative maps to the Comprehensive Plan are ones beyond the Corps authority to implement. For example, if a project is designed to not require any fill in wetland or any construction in navigable waters, then the landowner's decision to build that project would not undergo a Corps permit review. However, the EIS presented, by comparing the evaluations of the five Ensembles, the difference potential effect of all projects to better understand the influence of the portion requiring wetland fill. The issues selected have the greater potential for degradation or improvement resulting from a Corps permit decision.

The narrative accompanying each issue is divided into four paragraphs: a description of the concern; the site-specific characteristics idetifying the applicability of the issue to the project; a description of how the map was drawn; and information on assessment of the effect of the project. The map descriptions include references to the Florida Department of Transportation Land Use, Cover and Forms Classification System (FLUCFCS). This was used since is often used by applicants describing their project sites and is thought to be ease the convenience of future revisions of these maps with updated information.

The Permit Review Criteria are independent of the Comprehensive Plan. For example, the landowner would present a proposed project to either Collier County or Lee County. The County's review is based on the policies and criteria described in the County's Comprehensive Plan and other implementing ordinances, some of which (such as density) are keyed to the Future Land Use Map. Both Collier County and Lee County require that appropriate State and Federal permits be obtained either before issuance of the County Development Order or commencement of construction. If the proposed project involves fill in wetlands, the landowner also submits a permit application to the State under the joint application process with the Corps. The Corps' review is based on the policies published in the Code of Federal Regulations including the Guidelines for Specification of Disposal Sites for Dredged or Fill Material (404(b)(1) Guidelines) issued by the U.S. Environmental Protection Agency under Section 404(b)(1), 40CFR230. The Project Review Criteria has been developed consistent with the 404(b)(1) Guidelines, particularly Subpart B. The Permit Review Criteria acting in concert with the Comprehensive Plan, will assist all levels of government to support the Clean Water Act and Endangered Species Act.

2.2.3 ADDITIONAL ANALYSIS.

The evaluation factors used to analyze the effects presented in this EIS are not elaborate. Their purpose is to present the differences between the Ensembles. They are incorporated into the Permit Review Criteria to ensure this information is used in review of permit applications. The Corps recognizes that this EIS represents just one step in the development of an appropriate analysis that can appropriately describe the many ecological relationships and other issues across the landscape. The Corps is committed to, after the publication of this EIS, working with the U.S. Fish and Wildlife Service and other agencies to develop more detailed analysis tools to be ultimately incorporated into the Corps' decision processes. For example, there are fairly specific guidelines for protection of bald eagle nests from construction and other activities in the vicinity of the nest. There is no similar document (with such specificity) for many of the other evaluation factors. Once the detailed analysis tools are available to be used in project development and design, then these can be applied not only to review of applications but also to a re-evaluation of the predicted total change in the landscape to determine whether, and to what extent, there are adverse effects as defined by the Endangered Species Act.

2.2.4 PRESUMPTION

The many individual maps related to natural resource questions are overlaid on the figure in the Permit Review Criteria (repeated as Figure 3c on the following page). The area shaded represent areas with high potential value for wildlife and other wetland functions compared to the remainder of the area. Those projects requiring a Corps permit will undergo more rigorous review then in others. In addition, if site specific information confirm the presence and value of the natural resource, the Corps will presume alternative locations are available in areas of less value and expect an analysis over a large geographic area to determine whether any are practicable

2.2.5 ILLUSTRATIONS

Several hypothetical applications follow that illustrate the use of the two maps. The project sites are marked on **Figures 3b** and **3c**.

2.2.5.1 Illustration “G”

The landowner for site "G" proposes to clear and fill wetlands to construct canals and dikes for agriculture. Some alternatives map this location as agriculture, some as preserve. This is part of the 25% of the study area that is "gray." The project is located within the gray area of the Natural Resources Overlay Map. Individual natural resource maps affected are those for the Florida panther and Audubon's caracara. The site is near areas mapped for four other species.

2.2.5.2 Illustration “L”

The landowner for site "L" proposes to clear and fill wetlands to construct infrastructure for a residential development. All alternatives" map this location for development but some map a wide preserve on either shore of the river. This is part of the 67% of the study area that is cross-hatched. The project is located within the gray area of the Natural Resources Overlay Map. The individual natural resource map affected is for the Scrub jay. The site is near areas mapped for four other issues, one of which is potential habitat connection along the shoreline.

2.2.5.3 Illustration “J”

The landowner for site "J" proposes to clear and fill wetlands to construct homes. Some of the Ensembles map this location as residential development of this nature and other Ensembles map the remnant of the Picayune Strand as preserve. This is within the 25% of the study area that is "gray." The project located within the gray area of the Natural Resource Overaly Map. The individual natural resource maps affected are for the Florida panther, Red cockaded woodpecker, Flowway, Habitat connection, Herbaceous marsh, and is an area with high percentage of wetland.

2.2.5.4 Illustration “K”

The landowner for site "K" proposes to clear and fill wetlands to construct homes. All of the Ensembles map this location for residential development and therefore it is part of the 67% of the study area that is cross-hatched. This project is outside the gray area of the Natural Resource Overlay Map. The project site is near areas mapped as Herbaceous marsh.

2.2.5.5 Illustration “H”

The landowner for site "H" proposes to clear and fill wetlands to construct a residential development. One of the Ensembles maps this location for residential development but others map it as agriculture or preserve. This area is within the 8.4% of the study area that is shown as "white". The project is located within the gray area of the Natural Resources Overlay Map. The individual natural resource maps affected are for the Florida panther, Red cockaded woodpecker, Flowway, Habitat Connection, and is in an area with a high percentage of wetland.

2.2.6 Result

The Corps will prioritize its attention to projects that affect natural resources that have a high potential for adverse impact from the cumulative impacts of future individual permit decisions as described by the evaluations in this EIS. Potential cumulative impacts will influence the individual permit decision. This EIS does not replace consideration of individual circumstances unique to the site. In addition, others besides the Corps are encouraged to use this document since it represents visions presented by representatives of the community.

2.3 DESCRIPTION OF ENSEMBLES.

2.3.1 ALTERNATIVE FUTURES CONSIDERED

As detailed in the previous section, the Corps developed five of alternative "Ensembles" in an effort to streamline the presentation of the mass of information from the many alternatives developed by the ADG

(Appendix D). **Table 1** shows the relationship between the Ensembles and the alternatives" developed by the ADG. **Table 2** provides the expected land use acreages within the study area for each of the Ensembles. These Ensembles differ in their specific levels of preservation and protection of resources, as well as the development potential (see **Figure 4** comparing the expected land use distribution under the various Ensembles, and **Figures 5 through 9** which are maps depicting typical land use patterns expected under the various Ensembles).

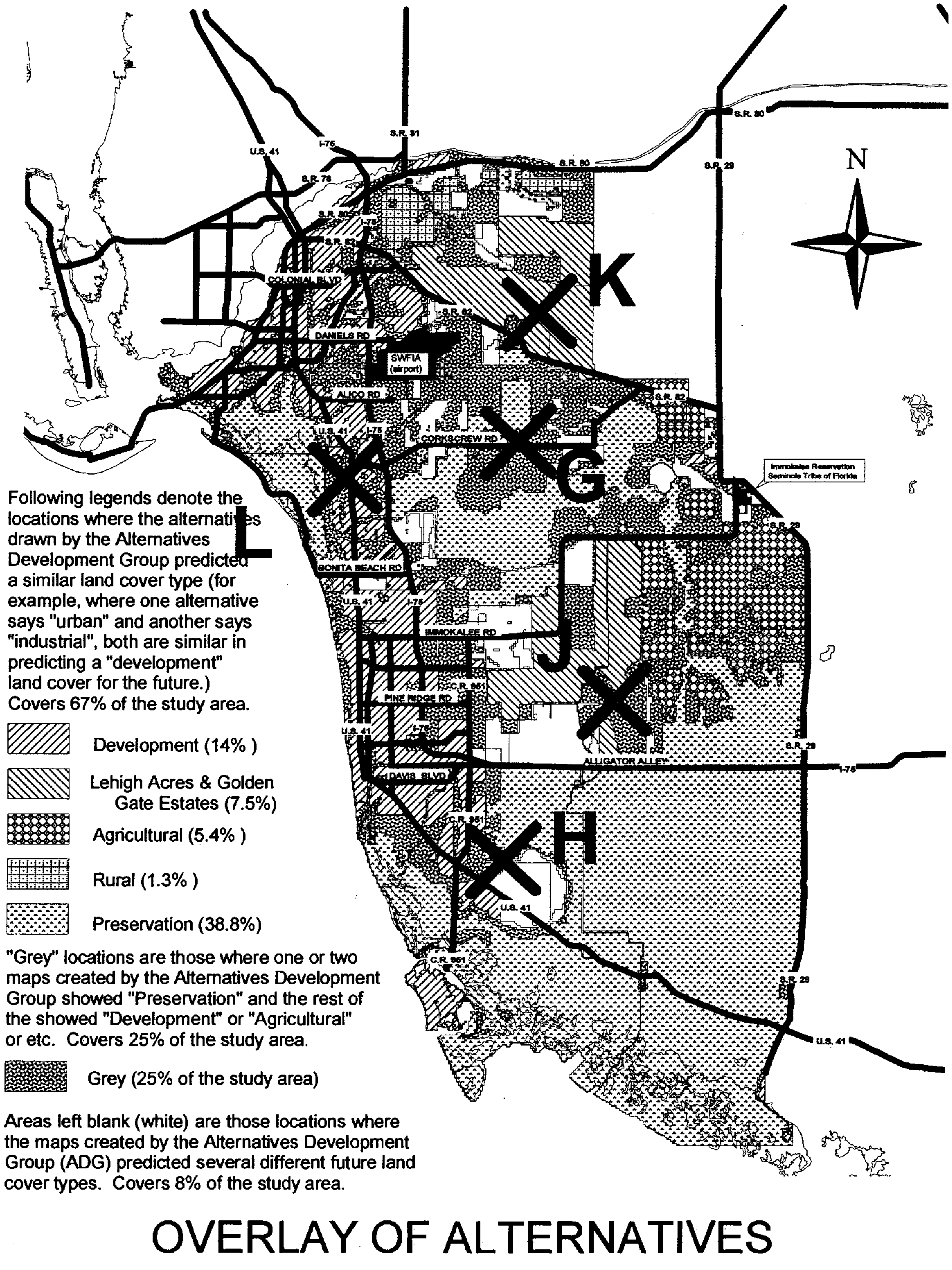


FIGURE 3B. SITE LOCATIONS FOR ILLUSTRATIONS ON OVERLAY MAP

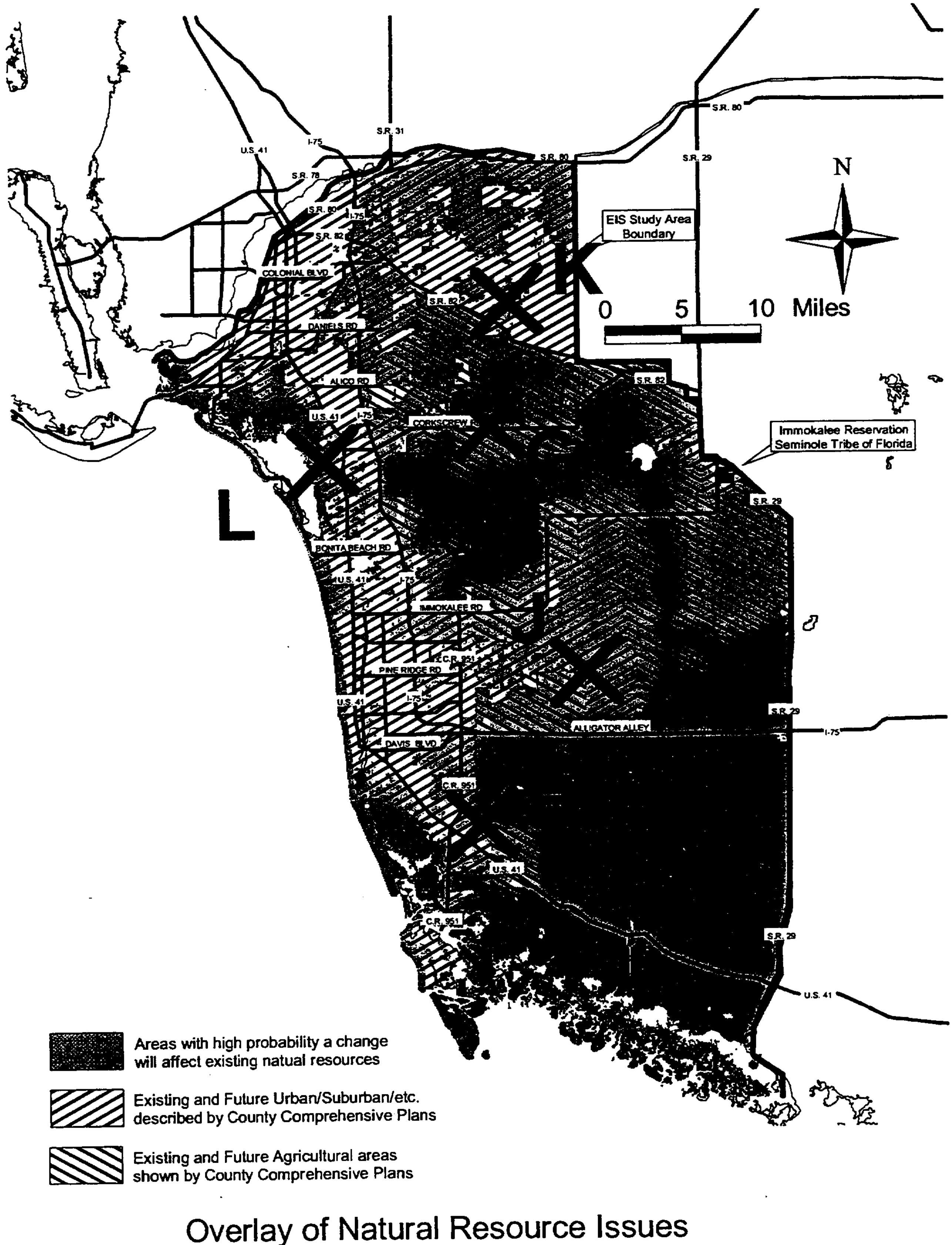


FIGURE 3c. SITE LOCATIONS FOR ILLUSTRATIONS OF NATURAL RESOURCES OVERLAY MAP

TABLE 1: RELATIONSHIP BETWEEN THE ALTERNATIVE ENSEMBLES AND THE 28 ADG ALTERNATIVES (zoom = sub-area)

Ensemble ↓ Zoom→	ADG Alternatives A	B	C	D
Q	4	4A	4	4
R	Status Quo	Status Quo	Status Quo	Status Quo
S	2	2A	2	2
T	3A	2B	3A	3
U	5	3B	1A	1A

TABLE 2: EXPECTED LAND USE FOR SOUTHWEST FLORIDA STUDY AREA FOR ALTERNATIVE ENSEMBLES (IN THOUSANDS OF ACRES)

EXPECTED LAND USE	Q	R	S	T	U
Lehigh (re-development)[1]	46	0	0	0	0
Lehigh (water storage area)[2]	10	0	0	0	0
Lehigh Acres (zone limitations)[3]	0	0	36	0	0
Lehigh (restore/fix)[4]	0	0	0	34	0
Lehigh (restore/fix & zone limitations)	0	0	0	0	34
Lehigh (greenway)	0	0	15	0	0
Golden Gate (development criteria)[5]	0	0	55	51	54
Other Development	346	363	213	253	223
TOTAL DEVELOPMENT	404	363	320	339	312
Agriculture (end go preserve)[6]	0	0	0	54	0
Agriculture (limited intensity)[7]	0	0	97	0	0
Agriculture (zone limitations)	0	0	0	0	28
Rural (low density)[8]	0	0	61	0	0
Other Agriculture/Mining	140	181	0	77	124
TOTAL AGRICULTURE & MINING	140	181	158	130	152
PRESERVATION[9]	447	468	518	518	532
Undecided	5	0	0	8	0
GRAND TOTAL	996	995	996	995	996

[1] re-development = redistribute/reassign densities and cluster people to central area of Lehigh Acres
[2] water storage area = part of re-development, regional water storage facility near Harnes Marsh
[3] zone limitations = limitations to activities in certain specified areas or zones to protect natural resources
[4] restore/fix = acquire, restore, & fix, then place in preservation status
[5] development criteria = allow planned development meeting development criteria: zone 1 limitations = avoid, minimize, and mitigate wetland impacts and address protected species impacts; zone 2 limitations = limited fill, not impede sheet flow, and eliminate exotics plus zone 1 criteria
[6] end go preserve = abandoned agriculture goes to preserve and does not convert to development
[7] limited intensity = no changes that require additional loss of natural habitat
[8] low density = low density rural development such as ranchettes and plant growing nurseries (single family)
[9] preservation = areas that now or will soon be owned by government or private entities to protect natural resources

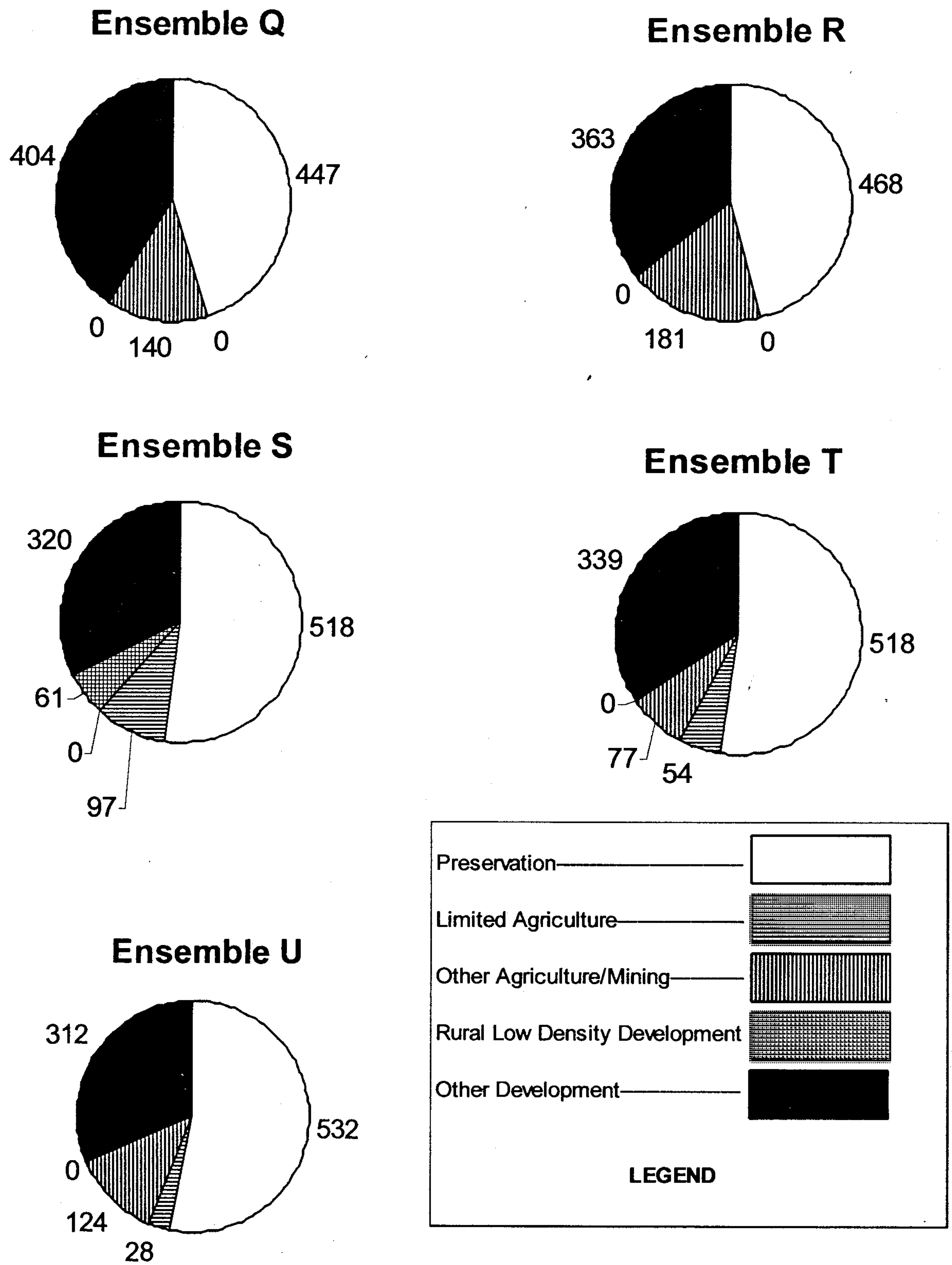


FIGURE 4. COMPARISON OF EXPECTED LAND USE UNDER THE ALTERNATIVE ENSEMBLES

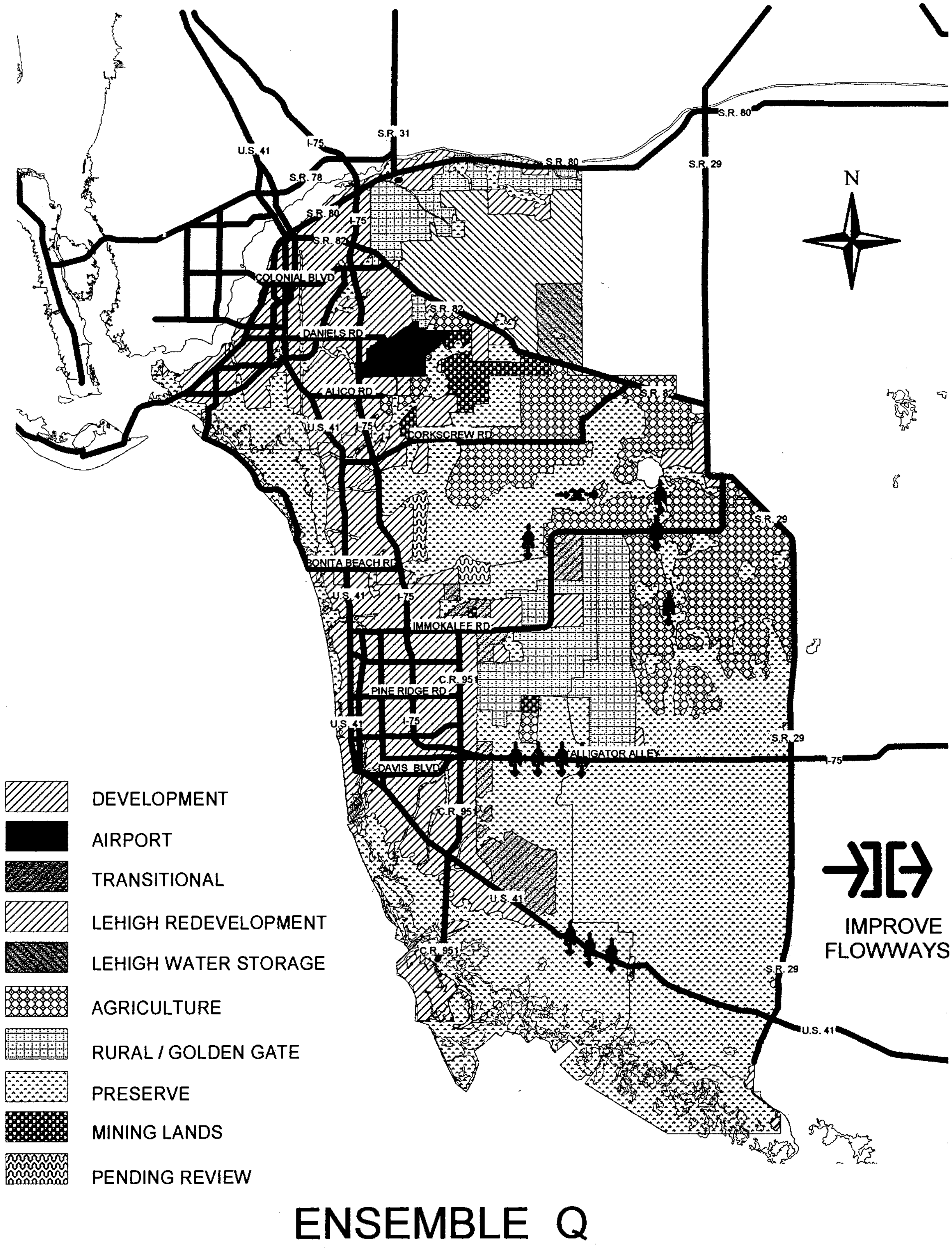


FIGURE 5. ENSEMBLE Q

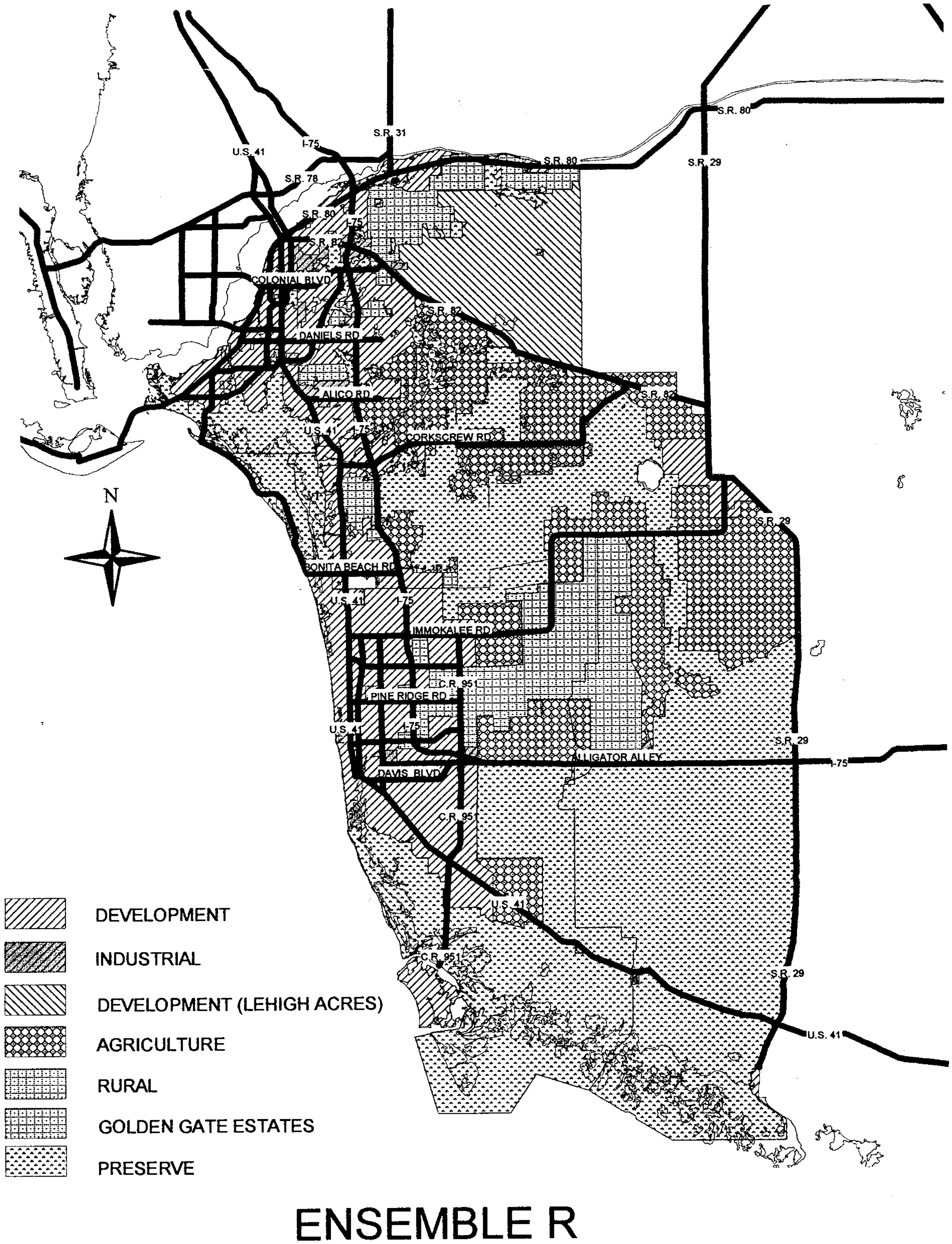


FIGURE 6. ENSEMBLE R

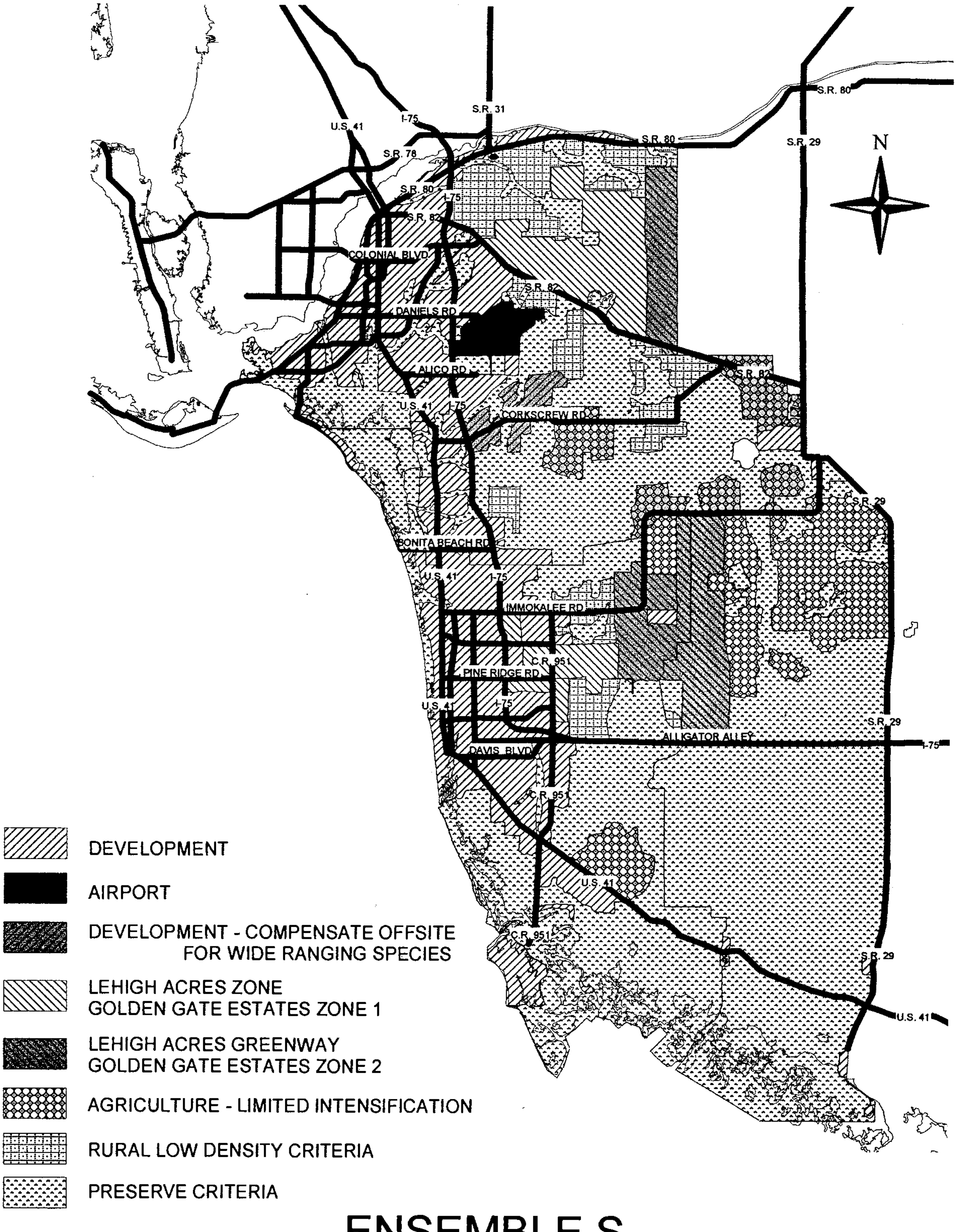


FIGURE 7. ENSEMBLE S

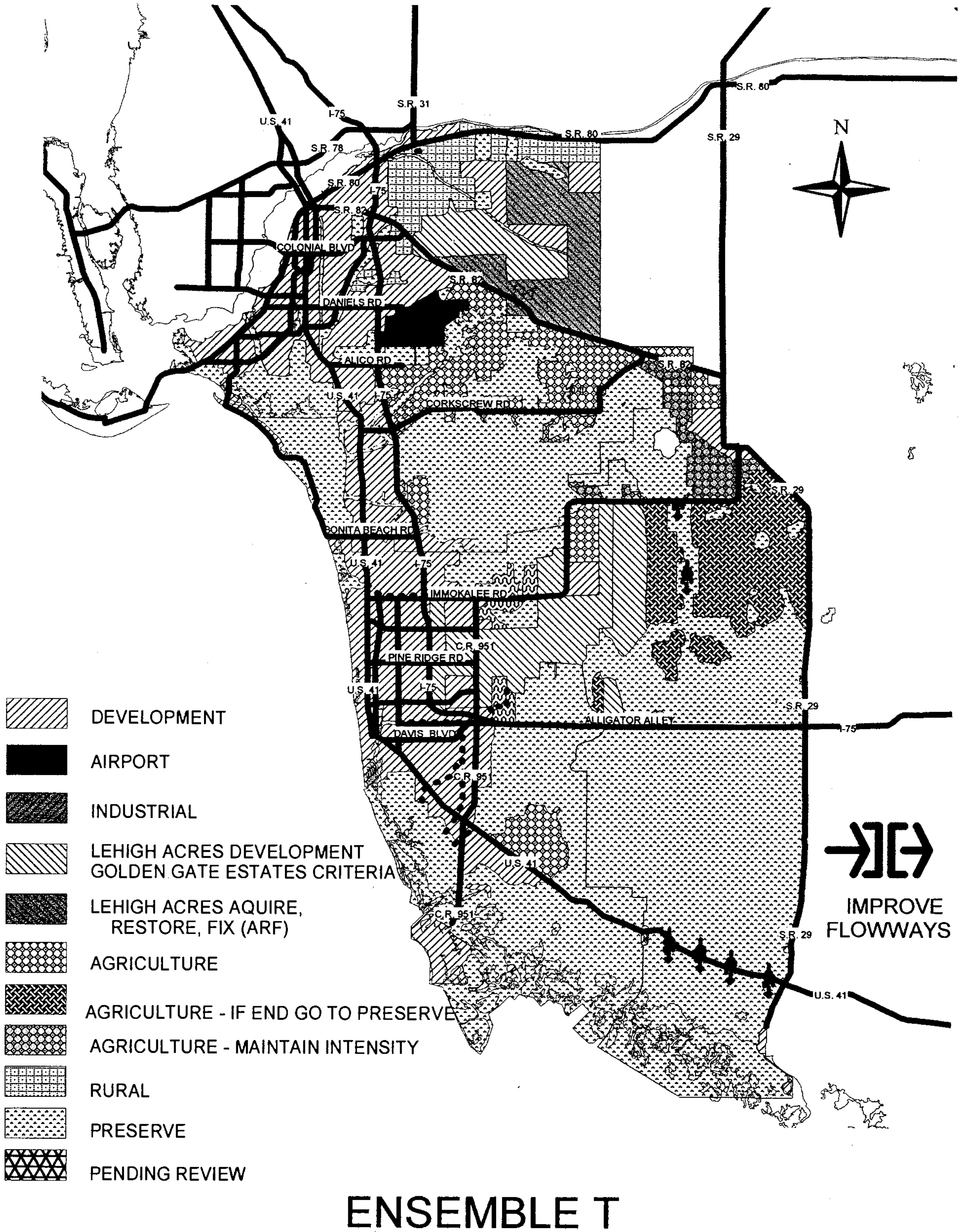
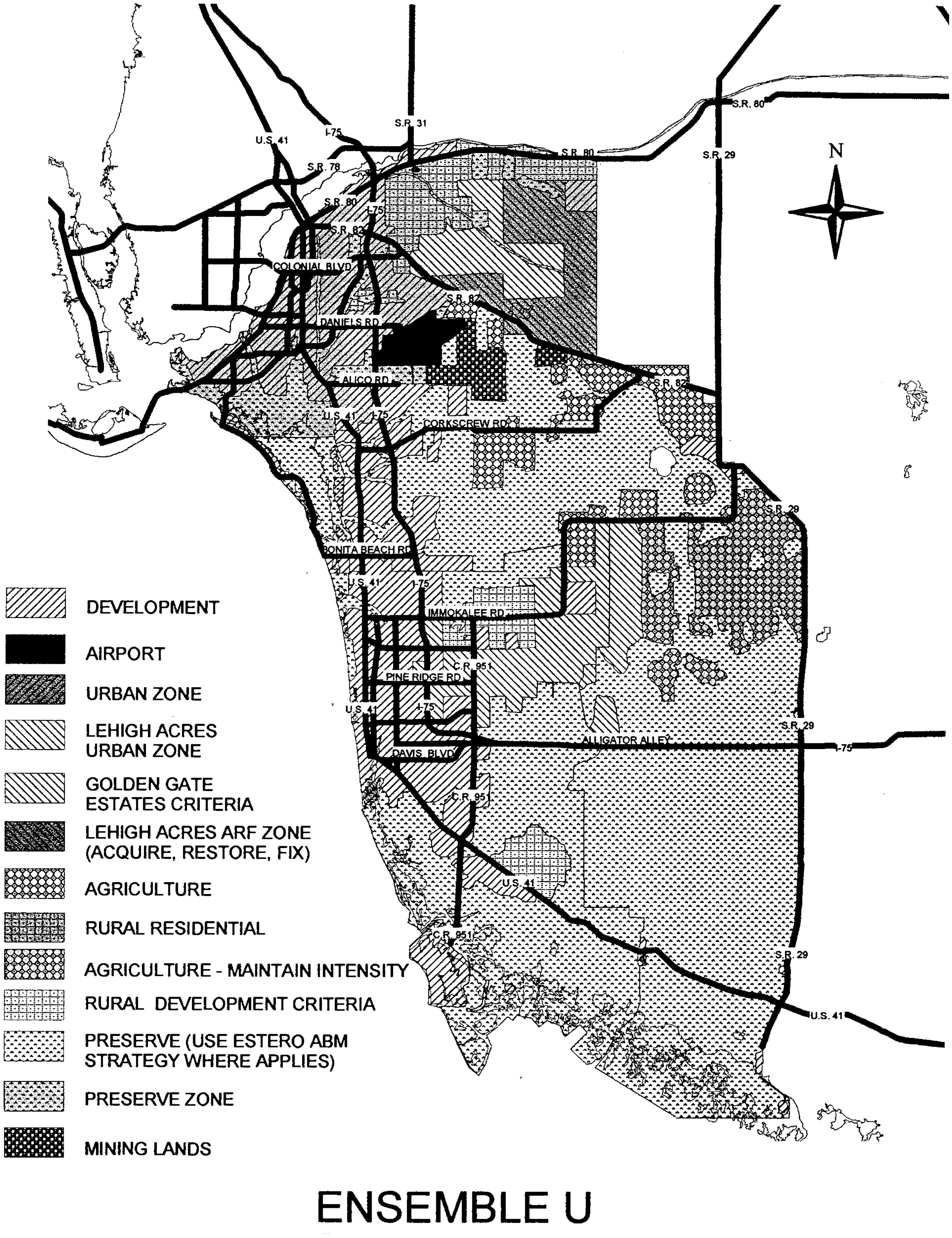


FIGURE 8. ENSEMBLE T



INSERT FIGURE 9. ENSEMBLE U

2.3.2 ENSEMBLE Q

This grouping of alternatives builds on the Comprehensive Plans and provides a larger acreage of development than the comprehensive plan. The Ensemble also suggests the establishment of new flowways or restoration of historic flowways. The alternatives used to assemble this Ensemble are: Zoom A, Alternative 4; Zoom B, Alternative 4A; Zoom C, Alternative 4; and Zoom D, Alternative 4.

2.3.2.1 Legend: Development Within the Urban areas, flowways improvements were shown in various locations and connected to the Preservation areas. Some of these are as described in the South Lee Watershed Plan presented by the South Florida Water Management District. The western end of Golden Gate Estates was included in the Urban designation. An increase in density within Golden Gate City is also proposed.

2.3.2.2 Legend: Development (Transition) Those lands currently in agriculture that will likely change to the Urban designation.

2.3.2.3 Legend: Lehigh Redevelopment Suggests Lee County should consider redevelopment alternatives, particularly for the Greenbriar Area, to restore flowways.

2.3.2.4 Legend: Lehigh Water Storage An area in southeast Lehigh Acres was identified as potential use for water storage.

2.3.2.5 Legend: Agriculture The definition for Agriculture is the same as the Comprehensive Plan.

2.3.2.6 Legend: Rural The definition is the same as the Comprehensive Plan.

2.3.2.7 Legend: Golden Gate Estates The remainder of Golden Gate Estates would retain the same Rural Residential designation as found in the Comprehensive Plan.

2.3.2.8 Legend: Preserve Flowways are proposed through the urbanized areas and, within Preservation Lands, removal or culverting of various roads to restore flowways, for example, culverts under I-75 and Tamiami Trail to improve sheetflow of surface waters. Preservation Lands include lands surrounding Ten Mile Canal and certain flowways leading to Six Mile Cypress Slough and others leading to the Caloosahatchee River. Of the Ensembles, this one proposes the narrowest footprint for Preservation Lands within Camp Keais Strand, restricting it to areas not currently under agriculture, but proposes culverts in the Strand to improve flows.

2.3.2.9 Legend: Mining Lands Mining lands are shown separate from Agriculture".

2.3.2.10 Legend: Pending Review Two areas are designated Pending Review as the group preparing the alternative could not agree whether to designate the location as development or preservation.

2.3.3 ENSEMBLE R

This grouping of alternatives represents the “status quo” and incorporates the Lee County and Collier County Comprehensive Plans, including the implementing policies and procedures for approval of projects. The alternatives used to assemble this Ensemble are: Zoom A, Alternative 1; Zoom B, Alternative 1; Zoom C, Alternative 1; Zoom D, Alternative 1.

2.3.3.1 Lee County Comprehensive Plan (Ordinance 89-02 with amendments)

Chapter II (Future Land Use) of the Lee County Comprehensive Plan states the first goal is “To maintain and enforce a Future Land Use Map showing the proposed distribution, location, and extent of future land uses by type, density, and intensity...” Under this first goal are listed approximately 22 categories. Other goals in this chapter and other chapters in the Ordinance provide specific policies for evaluation of proposed development designs or rezoning. Chapter XIII (Procedures and Administration) states “...all development and all actions taken in regard to development orders shall be consistent with the plan...” The Ordinance also provides for a Year 2010 Overlay which divides the County into 105 sub-districts. Within each district is assigned an acreage for each land designation within that district. The number of acres are those proposed for the year 2010. No development orders will be issued which exceed these acreage numbers. This overlay is being replaced by a Year 2020 Overlay which divides Lee County into 20 Planning Communities. Therefore, the Future Land Use Map shows “build-out” acres for each designation, but the acres projected for the year 2020 will be something less. The Ordinance itself states “With the exception of Cape Coral and Lehigh Acres, the County’s urban areas will be built out by 2020.” Due to the difficulty of mapping these 2020 projections, the alternative was created using the “build-out” map. It appears the evaluations were generally performed using “build-out” although at least one sub-group discussed the 2020 overlays while preparing their evaluations.

2.3.3.2 Collier County Future Land Use Element of the Growth Management Plan (Ordinance 97-67)

The Collier County Ordinance states the goal is “To guide land use decision-making...” and provides several objectives and policies. The ordinance also defines approximately twelve land use designations that “...generally indicate the types of land uses for which zoning may be requested.” For each designation, the ordinance describes the uses and standards to be applied and shows the properties affected on the Future Land Use Map. Note that Ordinance 97-67 is the amendment of the current Future Land Use Element and is not in effect (as of May 11, 1998) while concerns raised by the Florida Department of Community Affairs(DCA) are resolved. The Land Development Code (Ordinance 91-102) implements applicable portions of the Growth Management Plan. Article 2, Zoning, includes, among other things, a requirement for open space and for special requirements in areas of environmental sensitivity designated as Special Treatment Overlay District. Article 3, Development Requirements, includes, among other things, a requirement for an Environmental Impact Statement for certain projects, and various requirements for protection of natural vegetation and endangered species.

2.3.3.3 Land Use Legends

The Ensemble uses five land use legends: Agricultural; Industrial; Preserve; Rural; and Urban. The Lee County Future Land Use Map shows 22 land use designations and the Collier County Future Land Use Map shows 12. These 34 designations were collapsed into five simply to ease the preparation of other alternatives and for convenience in evaluation. Agricultural represents Density Reduction/Groundwater Resource (Lee) and Agricultural/Rural Mixed (Collier). Industrial represents Industrial Development, Industrial Interchange, Industrial Resource (Lee) and Industrial District (Collier). Preserve represents Wetlands, portions of Density Reduction Groundwater Resource (Lee), and Agricultural/Rural Mixed Use District (Collier) that currently are or are proposed to be preserved and managed to maintain natural resource values. Rural represents Rural, Rural Community (Lee), Estates Designation, and Rural Settlement Area District (Collier). Urban represents Central Urban, Suburban, Outlying Suburban, Urban Community, University Community, the various Interstate Highway Interchange areas (except for the Industrial and the Industrial Commercial types), Public Facilities (other than certain parks that were placed in the preserve legend). New Community, and the various Airport areas (Lee), Urban and Commercial sub-districts under the Urban Designation (except for the Industrial District), Urban Residential Sub-district, and Mixed Use Activity Center Sub-District (Collier).

2.3.4 ENSEMBLE S

This grouping of alternatives represents the Ensemble that provides greater emphasis on listed species and their habitat, particularly wide-ranging species such as the Florida panther and the Florida black bear. Other foci of this Ensemble are restrictions on the clearing of native vegetation, preservation and restoration of habitat corridors and flowways, and increased regulatory and public awareness of the presence and extent of sensitive resources. The alternatives used to assemble this Ensemble are: Zoom A, Alternative 2; Zoom B, Alternative 2A; Zoom C, Alternative 2; and Zoom D, Alternative 2A. In some cases, some particular criteria were proposed for one alternative, but not explicitly repeated in others. Therefore some of the narratives below note to which portion of the study area the criteria applies (each portion labeled either Zoom A, B, C, or D).

2.3.4.1 Legend: Development Within Zoom A, flowway improvements are proposed. Within Zoom C, the Ensemble proposes encouraging planting of emergent and shoreline planting in stormwater retention lakes and continuation of the Corps standards for wetland protection. The alternative also adopts what are called "Urban Zone" criteria that requires project designs will: restore flowways; retrofit residential septic systems and package treatment plants; provide adequate hurricane shelters and evacuation times; restore or retrofit buffer zones around wetlands, flowways, natural streams, rivers and creeks; and, meet Pollution Load Reduction Goals when set.

2.3.4.2 Legend: Development - Compensate for Wide Ranging Species An area is mapped for Development with a requirement for off-site compensatory mitigation for wide-ranging species.

2.3.4.3 Legends: Lehigh Acres Zone and Lehigh Acres Greenway Allows development but proposes criteria that includes: identify existing wetlands, location of historic flowways, and potential water storage areas (per pre-Townsend Canal); identify development concentrations; identify xeric oak scrubs; transfer development rights from important resource areas (existing wetlands, xeric scrub) to development clusters; redistribute/reassign densities for a more balanced community that includes an appropriate mix of uses (i.e., mix of single-family, multifamily, etc.); geographically cluster people to central area of Lehigh Acres where highest land and least amount of wetland are located and move development away from the eastern and southeastern areas of Lehigh Acres; adjacent rural lands should have opportunities to be included in Lehigh Acres planning process to prevent urban sprawl in unregulated areas; abandon major infrastructure plans that promoted growth inconsistent with these criteria; where zones vacated, abandon/retrofit infrastructure (canals, roads); create regional stormwater management facilities to benefit Caloosahatchee/Orange Rivers, water quality restoration and protect Hickey and Bedman Creek watersheds. Since the projected growth is generally in an "L" pattern for near future, try to develop a "greenway" approximately 2 miles wide that extends north from State Road 82 along the County line on the east side of Lehigh Acres and connect north to Greenbriar Swamp and Hickey Creek, Bedman Creek watersheds (which include wetlands, scrubs and water storage); and a potential appropriate location for a regional water storage facility is adjacent to existing Harnes Marsh.

2.3.4.4 Legend: Golden Gate Estates - Zone 1 Zone 1 is the more densely developed western Golden Gate Estates. Criteria proposed include: avoid/minimize and mitigate wetland impacts; culverting entrance roads; address listed species concerns; development of an educational pamphlet on resource issues; and, implementation of a Florida Yards and Neighborhood program.

2.3.4.5 Legend: Golden Gate Estates - Zone 2 Zone 2 is the eastern portion of Golden Gate Estates toward Picayune Strand. Criteria proposed include: no more than 10% fill; no more than 50% fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. Zone 2 would also be designated a receiving area for mitigation.

2.3.4.6 Legend: Agriculture - Limited Intensification

The Ensemble "assumes limited intensification of use, that is, no changes that require additional loss of native habitat, no changes (such as intensification of citrus) that would lower hydrology. For example, range and improved range stay the same, vegetable crops change or go to fallow field and back again. No golf course or ranchette development, as these are not associated with true agriculture." The Ensemble assumes rotation of crops but no additional clearing.

2.3.4.7 Legend: Rural Low Density Criteria - Zoom A

In Rural Residential, the alternative adds development of greater planning detail to identify existing flowways, forested habitats, and seasonal wetlands that are large or contiguous to one another. This information would then be used to protect these areas in a connected landscape as the area develops. Within Zoom C, two areas of rural are mapped immediately adjacent to Golden Gates Estates, one area north of Golden Gate Estates and one area south. For the north area, the criteria include: avoid and minimize impacts to wetlands; protect nesting areas; mitigate wide-ranging species including mangrove fox squirrels, off-site; and, maintain or improve hydrology (for example, weirs in Cocohatchee Canal). For the south area, the criteria include: avoid and minimize impacts to wetlands; protect red-cockaded woodpecker habitat or mitigate off-site when their viability is affected; mitigating off-site for wide-ranging species (black bear); and maintain or improve hydrology (for example, the depth of the I-75 canal). For both north and south areas, the alternative also adopts the Buffer Transition Zone criteria that requires project designs will: result in no net loss of wetland acreage and function; result in no net loss in historical water table height and recharge area; not alter water sheet flow characteristics; contribute to the restoration of historic flowways; preserve buffer zones around wetlands, flowways, natural streams, rivers, and creeks; not impact water quality; not contribute to hurricane shelter deficit nor increase evacuation times; and implement the principals adopted by the Estero Bay Agency on Bay Management (copy enclosed in Appendix F).

2.3.4.8 Legend: Preserve Criteria

Within Zoom A, the area of Preservation Lands was drawn to emphasize connections between the Rural Residential and Airport preservation areas to the Six Mile Cypress Slough and between the Slough and Estero Bay. Preservation Lands were also drawn in wetland areas in the Rural areas between Lehigh Acres and the Caloosahatchee River. Within Zoom B, the mapping of Preserve used the Land Conservation/Preservation Strategy Map adopted by the Estero Bay Agency on Bay Management (copy enclosed in Appendix F), added connections to the boundary of the CREW for long range species, and proposes riparian corridors through the urban areas. Within Zooms C and D, the Ensemble proposes expansion of preserves beyond that mapped by the Comprehensive Plan and provides the following criteria for project design and review: no public utilities; no new or expanded transportation; no well-field expansion; restoration or retrofit of certain areas with hydrologic problems (the retrofits listed are: add culverts under Tamiami Trail; "fix" I-75 canal plugs; protect Rookery Bay watershed; "fix" District 6 drainage basin works; "fix" Cocohatchee Canal; restore Clam Bay; and "fix" Golden Gate Canal to protect Naples Bay); and use as mitigation receiving areas only those portions of Preservation Lands that are currently not in public ownership.

2.3.4.9 Mining:

Mining is not identified separately as a category but is classified as either Rural or Preserve depending on the ultimate use.

2.3.5 ENSEMBLE T

This Ensemble seeks to increase the area of preserves through restore, retrofit, and redevelopment of vacant lands within Lehigh Acres, greater protection afforded to isolated wetlands, and limitation on the extent of clearing and filling activities, within Golden Gate Estates and other areas. Agricultural activities are proposed to be limited to existing acreage with limited intensification therein. Flowways and connectivity of habitat would be improved and/or restored. The alternatives used to assemble this Ensemble are as follows. The alternatives used to assemble this Ensemble are: Zoom A, Alternative 3A; Zoom B, Alternative 2B; Zoom C, Alternative 3A; and Zoom D, Alternative 3. In some cases, some particular criteria was proposed for one alternative, but not explicitly repeated in others. Therefore some of the narratives below note to which portion of the study area the criteria applies to (each portion labeled either Zoom A, B, C, or D).

2.3.5.1 Legend: Development Within Zoom D, the Ensemble proposes flowway improvements along the Cocohatchee Canal, Golden Gate Canal, and sloughs in eastern Naples, coordinated with improvements within Preservation Lands.

2.3.5.2 Legend: Lehigh Acres Development and Lehigh Acres - Acquire, Restore, Fix (ARF) Within Lehigh Acres, this Ensemble proposes an Acquire, Restore, Fix (ARF), similar to the Restoration, Retrofit, and Redevelopment (3 R's) approach proposed for another alternative, to remove roads and canals in vacant areas to restore hydrology and preserve wildlife habitat.

2.3.5.3 Legend: Agriculture and Agriculture - Maintain Intensity Areas would remain agricultural" but also delineated a sub-area where there would be no intensification in activity.

2.3.5.4 Legend: Agriculture - If End go to Preserve Current agriculture would continue with limited intensification but if agriculture ceases, then the lands would be placed in preservation.

2.3.5.5 Legend: Golden Gate Estates Criteria Within Zoom C, permitting would continue under the current processes but with additional protection afforded isolated wetlands by the following criteria: no General Permits; determination of wetland jurisdiction prior to Collier County permitting; reconnection of wetlands along historic flowways; and, limitations on the clearing of residential lots. Within Zoom D, criteria are: no more than 10% fill; no more than 50% fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. This area would also be designated a receiving area for mitigation.

2.3.5.7 Legend: Rural No particular criteria noted.

2.3.5.8 Legend: Preserve Within Zoom A, the areas mapped Preserve provided filter marshes along Ten Mile Canal and the canals leading from Lehigh Acres. In addition, lands south of the Airport are proposed to be preserved. Within Zoom B, the areas mapped Preserve were based on an assembly of several items: the preserves shown in the Comprehensive Plan, all proposed acquisitions; the Strategic Habitat Conservation Area mapping for the Florida Panther; and, the Priority 1 and 2 areas of the Florida Panther Habitat Preservation Plan. It was found that all mapped eagle nests, rookeries, rare native plant communities, seasonal wetlands and flowways, and various coastal resources of interest were encompassed within these areas. Within Zoom D, the Ensemble proposes culverts within Camp Keais Strand and across Tamiami Trail to improve flowways.

2.3.5.9 Legend: Pending Review The group preparing the alternative could not agree whether to designate the location as development or preservation.

2.3.5.10 Mining: Mining is considered in the Agricultural category to the extent consistent with the Comprehensive Plan.

2.3.6 ENSEMBLE U

This Ensemble proposes the largest area of preserve among the Ensembles through criteria that limit the conversion of natural vegetation to other land cover types. This criteria also seeks to increase the difficulty of placing fill in wetlands by "strict" application of the presumption, under the EPA Section 404(b)(1) guidelines, that alternative non-wetland sites are available. The alternatives used to assemble this Ensemble are: Zoom A, Alternative 5; Zoom B, Alternative 3B; Zoom C, Alternative 1A; and Zoom D, Alternative 1A. In some cases, some particular criteria was proposed for one alternative, but not explicitly repeated in others. Therefore some of the narratives below note to which portion of the study area the criteria applies to (each portion labeled either Zoom A, B, C, or D).

2.3.6.1 Legend: Development Flowways are included through the urban areas.

2.3.6.2 Legend: Development: Urban Zone and Lehigh Acres Urban Zone For the Urban Zone within Zoom A, the alternative proposes "…a presumption that alternatives exist to locating dredge and fill activities in creeks, rivers, other historic flowways and adjacent wetlands; and to locating dredge and fill activities in isolated wetlands identified as important to wading birds, other species of concern, water quality, groundwater recharge or flood control." The proposal also describes numerous criteria for the Corps to apply during permit review. For example, certain limits to the use of Nationwide and General Permits, promotion of the restoration of flowways, and restoration of buffer zones. The proposal states the vision is, in part, to "..direct development into this zone...while maintaining watershed integrity within the zone."

2.3.6.3 Legend: Lehigh Acres ARF Zone For the Acquire, Restore, Fix (ARF) Zone within Lehigh Acres, the alternative proposes that the "Corps strictly applies the Section 404(b)(1) Guidelines, including: (1) a strong presumption that practicable alternatives exist outside of the ARF Zone to dredge and fill activities (except restoration/retrofit activities)..." The proposal also describes numerous criteria for the Corps to apply during permit review. For example, certain limits to the use of Nationwide and General Permits, application of the criteria of the Big Cypress Area of Critical State Concern regulations, and restoration of flowways. The proposal states the vision is, in part, to "...protect and restore critical resources..." The complete set of criteria is enclosed in Appendix F.

2.3.6.4 Legend: Golden Gate Estates Criteria A flowway program is suggested though without details. Within the more densely developed western Golden Gate Estates, criteria proposed include: avoid/minimize and mitigate wetland impacts; culverting entrance roads; address listed species concerns; development of an educational pamphlet on resource issues; and, implementation of a Florida Yards and Neighborhood program. Within the eastern portion of Golden Gate Estates (toward Picayune Strand), criteria proposed include: no more than 10% fill; no more than 50% fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and, culverting entrance roads. The eastern portion would also be designated a receiving area for mitigation.

2.3.6.5 Legend: Agriculture and Agriculture - Maintain Intensity Some portions of the areas mapped Agriculture propose additional criteria that current agricultural activities would continue but intensification would be limited.

2.3.6.6 Legend: Rural Residential Zone Within Zoom A, the proposal provides criteria for an Agricultural Zone and a Buffer Zone. These would be applied to the Rural Residential designation of this alternative. The proposal provides "...a strong presumption that alternatives exist outside.." either the Buffer Zone or Agricultural Zone and includes numerous criteria for the Corps to apply during permit review. The proposal states the vision is, in part, that agricultural "…should remain in agricultural use, compatible with conservation purposes..." and to "...discourage urban expansion in and through..." the Buffer Zone. The complete set of criteria is enclosed in Appendix F.

2.3.6.7 Legend: Rural Development Criteria. Criteria proposed are: one residential unit per five acres (overall); clustering; preserve 50% of the land area in natural state; maintain corridors, flowways with connectivity outside project boundaries; and 100% wetland preservation/restoration.

2.3.6.8 Legend: Preserve Within Zoom A, this Ensemble proposes denial of all permits in the areas mapped Preserve. The proposal states the vision is, in part, that these areas would be "...off limits to future development activity." The complete set of criteria is enclosed in Appendix F. Within Zoom B, the areas designated Preserve were based on the Land Conservation/Preservation Strategy Map adopted by the Estero Bay Agency on Bay Management. Included are flowways through the urban areas and within existing agricultural areas. Within Zoom D, areas mapped as Preserve include historic flowways within Golden Gate Estates and along Camp Keais Strand.

2.3.6.9 Legend: Mining Lands Mining lands are mapped with no comment.

2.4 ALTERNATIVE FUTURES NOT WITHIN JURISDICTION OF LEAD AGENCY

The charge to the ADG specifically set forth the goals for the development of alternatives which protect natural environmental values, provide for sustainable economic growth, manage appropriate changes in water flows and quality, and respect public involvement and private rights. Some of the specific aspects set forth in a particular alternative will not be within the jurisdiction of the Corps. First, the Corps has jurisdiction over the placement of fill in wetlands and other Waters of the United States. Wetlands cover a portion of the study. Only those projects that are dependent upon the filling of wetlands will be reviewed by the Corps. Second, the Corps only reviews activities proposed by and to be performed by the landowner. The Ensembles describe a range of possible activities that may or may not be proposed by the landowners. However, the analysis of the cumulative benefits and impacts presented by the Ensembles are within the purview of the Corps because the Corps must consider the cumulative impacts of its decision to issue a permit. Even though the permits that will be issued are only a subset of all the activities that will occur in the study area, the activities authorized by these permits will contribute to the cumulative total.

2.5 COMPARISON OF CRITERIA

Table 3 summarizes the issues found in the Permit Review Criteria that the Corps proposes to implement, lists the criteria suggested by the Ensembles and compares the evaluation factors that were considered in the development of the Proposed Action (standardized identification of issues by use of the Permit Review Criteria).

2.6 MITIGATION

Unavoidable impacts proposed in applications for a Federal dredge and fill permit will be evaluated on a case-by-case basis, and compensatory, project-specific mitigation for wetland acreage and function will be addressed at that time.

2.7 AUTHORITIES TO IMPLEMENT

The U.S. Army Corps of Engineers [U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency] will exercise its [their] authority as described below.

2.7.1 U.S. ARMY CORPS OF ENGINEERS

Pursuant to Section 404 of the Clean Water Act, the Corps of Engineers has regulatory authority to permit the discharge of dredged or fill material into wetlands and other waters of the United States at specified disposal sites. The Corps conducts a public interest review of the probable impact of the proposed activity and its intended use. The review covers nineteen (19) factors, including effects upon conservation, fish and wildlife values, recreation, water quality, and cultural values. The guidelines pursuant to Section 404(b) of the Act require that impacts to the aquatic environment be avoided and minimized to the extent practicable. Also, unavoidable impacts are to be compensated (mitigated) to the extent practicable. A permit is typically issued provided that the proposed use is not contrary to the public interest, and is in compliance with the guidelines promulgated by the EPA pursuant to Section 404(b) of the Clean Water Act.

In determining whether to issue a permit, the Corps must also comply with other requirements including, but not limited to, the Section 7 of the Endangered Species Act of 1973 (50CFR part 402), the National Environmental Policy Act of 1969, the Coastal Zone Management Act, Sections 401, 404, and 404b(1) of the Clean Water Act of 1977, Section 10 of the Rivers and Harbors Act of 1899, Fish and Wildlife Coordination Act, and other applicable Federal laws. Modifying land for new uses also involves zoning, land use planning, water management, and other regulatory/planning requirements at the local, regional, State, and Federal level.

The Administrator of the EPA has the authority to prohibit the specification of any defined area, and to deny the use of any such defined area, for the placement or excavation of fill material. This veto authority can be exercised (only after notice and opportunity for public input and review) where the discharge of materials will have an unacceptable adverse effect on potable water supplies, fishery areas, wildlife areas, or recreational areas.

Memoranda of Agreement between the Department of the Army and the Department of the Interior (USFWS), the Department of Commerce (National Marine Fisheries Service), and the EPA allow the "elevation" of the decision to issue a permit above the District level pursuant to Section 404(q) of the Clean Water Act. These decisions to elevate are typically the result of: insufficient interagency coordination (procedural failure or failure to resolve concerns raised by the commenting agency(s)); significant new information being developed that did not previously exist; or the project raising environmental issues of national importance requiring policy level review. The permit decision is first elevated to the Division level, and if not resolved there, the commenting agency has the option to further elevate the decision to the national level, where the office of the Secretary of the Army would review the record, and Corps Headquarters would issue guidance to the District Engineer as to the disposition of the permit application.

2.7.2 U.S. FISH AND WILDLIFE SERVICE

Section 7 of the Endangered Species Act (16 U.S.C. 1531 *et seq*.) (ESA) outlines the procedures for Federal interagency cooperation to conserve Federally listed species and designated critical habitats. Section 7(a)(1) directs all Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of species listed pursuant to the ESA. Section 7(a)(2) requires that each Federal agency, in consultation with the Secretary (Secretary of the Interior/Secretary of Commerce) shall ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat.

Consultation with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (Services) in accordance with Section 7 of the ESA was not completed for any alternative presented in this DEIS. (The term "Services" is used to generically refer to both agencies together. This is not meant to imply that all actions discussed herein are taken by the Services jointly.) Actions proposed within the framework of this EIS will undergo consultation, either formal or informal, as appropriate.

The Corps will prepare biological assessments for "major construction activities" which may significantly affect the quality of the human environment as referred to in the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq*.). Major construction activities include dams, buildings, pipelines, roads, water resource developments, channel improvements, and other such projects that modify the physical environment and that constitute major Federal actions.

Although a biological assessment may not be required for all projects proposed within the framework of this EIS, formal consultation cannot be initiated until an assessment of effects is completed. The Corps may submit a biological assessment, or some other form of biological evaluation, early to benefit from the informal consultation process. The Corps may also request early consultations with the Services to reduce the conflicts between listed species or critical habitat and Proposed Actions. Early consultation is an optional process that occurs before a prospective applicant files an application for a Federal permit. To qualify, a prospective applicant must provide the Corps, in writing: (1) a definite proposal outlining the action and its effects; and (2) intent to implement the proposal, if authorized.

A biological evaluation will be completed if listed species or critical habitat may be present in the action area. The Corps may designate the applicant or a non-Federal representative (often a consultant) to prepare the evaluation, although the Corps is responsible for the content of the evaluation and for the findings of effect. The evaluation ensures the Corps involvement and increases the chances for resolution during informal consultation.

The evaluation will address all listed and proposed species found in the action area, not just those listed and proposed species likely to be affected, to help make the determination of whether the proposed actions are likely to adversely affect listed species and critical habitat. Because proposed species will be addressed, the evaluation will help determine the need for conference as well as formal consultation. The evaluation should include a detailed description of all aspects of the proposed action; the results of surveys to determine the presence of listed species or their habitat; an analysis of the likely effects of the proposed action on the species or critical habitat based on biological studies, review of the literature, and views of species experts. The evaluation should also describe any known unrelated non-Federal activities, or cumulative effects, which are reasonably certain to occur and that are likely to affect listed species or critical habitat.

If, after review of the biological evaluation, the Corps determines that a proposed project has no likelihood of adverse effect, the Corps will request written concurrence from the Services. The Services' letters of concurrence, based on review of all biological information, completes informal consultation. Although not required, the Corps may also request written concurrence from the Services if a proposed action will have no effect on listed species or critical habitat. If the Corps determines that a proposed action may adversely affect listed species or critical habitat, the Corps will initiate formal consultation through a written request to the Services. The Services may meet or communicate with the Corps and applicant to gather additional information necessary to conduct the consultation. With early coordination and cooperation, the Services ensure the Biological Opinion, including an Incidental Take statement, is prepared and delivered within 135 days of initiation of formal consultation.

2.7.3 U.S. ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) has the authority to administer the Clean Water Act (CWA) statutes and regulations, except for State water quality certification (Section 401) which is administered by the Florida Department of Environmental Protection.

The Clean Water Act (CWA) Section 404 dredge and fill program has not been delegated to the Florida Department of Environmental Protection and is administered by the Army Corps of Engineers. The EPA's role in the CWA Section 404 process is to provide independent comments on proposed permit applications to ensure the CWA Section 404(b)(1) Guidelines are met. In addition, the EPA has the authority to elevate permit objections under the CWA Section 404(q) process for projects that involve aquatic resources of national importance. In addition, under the CWA Section 404(c) "veto authority" the EPA must determine whether the proposed discharge of dredged or fill material will have an unacceptable adverse effect on either municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. The veto authority may be used before, during or after the Army Corps' action on a permit application. The EPA may also exercise this authority in the absence of a permit application. The EPA is the only Federal agency that has the regulatory authority to veto a proposed project and to that end, the EPA has the final decision but also the burden of proof.

2.7.4 FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Section 401 of the CWA requires any applicant for a Federal permit that may result in a discharge of a pollutant into waters of the United States to obtain a certification in which the discharge originates. This certification must pertain not only to the construction of a facility, but also to the subsequent operation of the facility. In Florida, issuance of a State stormwater permit in accordance with Chapter 62-25, Florida Administrative Code (F.A.C.), or an Environmental Resource Permit (ERP) in accordance with Part IV of Chapter 373, Florida Statutes constitutes State water quality certification. Alternatively, a No-Permit-Required letter from the State signifies compliance with State water quality certification procedures.

Authorization for use of Sovereign submerged lands (under Chapter 18-21, F.A.C.) are reviewed concurrent with the ERP application and one cannot be issued without the other. "Sovereign submerged lands" means those lands including but not limited to, tidal lands, islands, sand bars, shallow banks, and lands waterward of the ordinary or mean high water line, beneath navigable fresh water or beneath tidally-influenced waters, which the State of Florida acquired title on March 3, 1845, by virtue of statehood, and which have not been heretofore conveyed or alienated. Authorization for use of Sovereign submerged lands can be issued by the State permitting agency or through an action of the Governor and Cabinet sitting as the Board of Trustees of the Internal Improvement Trust Fund.

Section 307 of the Coastal Zone Management Act of 1972 requires agencies conducting development projects which directly affect a states coastal zone to comply to the maximum extent practicable with the state's approved coastal zone management program. The Act also requires any non-Federal applicant for a Federal permit to conduct an activity affecting land or water uses in the state's coastal zone to furnish a certification that the proposed activity will comply with the state's coastal zone management program. The issuance of an ERP constitutes compliance with the State of Florida coastal zone management program under Section 380.23(3) (c), Florida Statutes.

2.7.5 SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Section 401 of the CWA requires any applicant for a Federal permit that may result in a discharge of a pollutant into waters of the United States to obtain a certification in which the discharge originates. This certification must pertain not only to the construction of a facility, but also to the subsequent operation of the facility. In Florida, issuance of a State stormwater permit in accordance with Chapter 62-25, Florida Administrative Code (F.A.C.), or an Environmental Resource Permit (ERP) in accordance with Part IV of Chapter 373, Florida Statutes constitutes State water quality certification. Alternatively, a No-Permit-Required letter from the State signifies compliance with State water quality certification procedures.

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2.7.6 LOCAL GOVERNMENT

Chapter 163, Florida Statutes, requires local governments to prepare, adopt, and implement comprehensive plans that encourage the most appropriate use of land and natural resources in a manner consistent with the public interest. All public and private development is required by this statute to conform with the area's local government comprehensive plan adopted pursuant to the statute. Lee County's Comprehensive Plan is found at Ordinance 89-02 with amendments. Collier County's Future Land Use Element of the Growth Management Plan is found at Ordinance 97-67.

Table 3. Summary of Criteria and Evaluation Factors

Permit Review Criteria
Natural Resource Issues
Audubon's crested caracara
Bald eagle
Management of preserves.
Public acquisition program
Flowways
Habitat fragmentation
Isolated and seasonal wetlands
Florida panther
Shorebird nesting, foraging and resting areas
Red cockaded woodpecker
Florida scrub-jay
Coastal Forests
Strategic Habitat Conservation Area lands
Wading bird rookeries
Existing Urban/Suburban Infrastructure
Water Quality

Note, even if criteria are not listed in the Permit Review Criteria, the Corps will still review appropriate site-specific information applicable to issues within the Corps jurisdiction in a permit decision.

Ensembles

Legends	Criteria	Q	R	S	T	U		Natural Resource Issue (but not necessarily same criteria language) also found in the Permit Review Criteria (PRC)
The same Legend or Criteria may be found in different Ensembles, but the location and acres to which is applied will be different.								
There are more than one Legend or Criteria in a single Ensemble since each apply to different geographic area.								
Urban, Industrial, Transition, Airport, Development	Status Quo	X	X	X	X			X
Development (w/ Flowways &tc)	Flowway Improvements	X		X	X	X		X
Off-site Compensation	Compensate off-site for wide ranging species			X				X
Urban & Industrial	Criteria for Urban (package of several criteria)							
	Encourage emergent and shoreline planting in retention lakes			X				X
	Restore Flowways			X				X
	Retrofit Septic Systems and package treatment plants			X				
	Provide adequate hurricane shelters and evacuation routes			X				

Legends	Criteria	Q	R	S	T	U		(PRC)
	Large buffer zones around wetlands, flowways, streams, rivers			X				X
	Set and meet Pollution Load Reduction Goals (PLRGs)			X				
Urban Zone (including Lehigh Acres outside of ARF Zone)	Package of several criteria below and also at "Zone Criteria" legend							
	Direct development into this zone in lieu of urban expansion					X		
	Maintain watershed integrity					X		
	Plan carefully for future growth					X		
	Presume alternatives to filling creeks, rivers, wetlands, etc.					X		X
	Less l kely are practicable alternative locations outside urban zone					X		X
	Mitigation focuses on maintaining watershed integrity including:					X		
	Groundwater and surface water supply					X		
	Surface water levels					X		
	Flood retention					X		
	Water quality					X		
	Fresh/salt water balance					X		
	Wading bird and fisheries production					X		
	Encourage clustering, Transfer Development Rights, etc. land use					X		
Urban (Lehigh)	Status Quo		X		X			X
Acquire/Restore/Fix, Restore/Retrofit/Redevelop	Lehigh - Redevelopment	X			X			
Lehigh Acres	Lehigh Acres Zone (package of several criteria)							
	Map wetlands, flowways, xeric oak, development concentration			X				
	Reassign densities and development rights to cluster residences			X				
	In vacated zones, abandon/retrofit infrastructure (canals, roads)			X				
	Create regional stormwater management facilities			X				
	Potential regional water storage facility near Harnes Marsh			X				
Greenway	Lehigh Greenway			X				
Water Storage	Lehigh - Water Storage	X						
Acquire, Restore, Fix (ARF) Zone	Package of several criteria below and also at "Zone Criteria" legend							
	Acquire and restore areas with wildlife and water resources					X		
	Place restored ARF Zone areas into Preservation status					X		
	Develop if adjacent other & if compatible w/ resource conservation					X		
Legends	**Criteria**	**Q**	**R**	**S**	**T**	**U**		(PRC)

Golden Gates Estates, Rural Residential	Status Quo	X	X			X		X
Golden Gates Estates Zone 1	Zone 1 Criteria (package of several criteria)							
	Avoid/minimize and mitigate wetland impacts			X	X	X		X
	Culvert entrance roads			X	X	X		
	Address listed species on or off-site			X	X	X		X
	Develop educational pamphlet on natural resource issues			X	X	X		
	Florida Yards and Neighborhoods program			X	X	X		
Golden Gates Estates Zone 2	Zone 2 Criteria (package of several criteria)							
	No more than 10% fill. No more than 50% impervious.			X	X	X		
	Fill not impede sheetflow			X	X	X		
	Eliminate exotics			X	X	X		
	Develop educational pamphlet on natural resource issues			X	X	X		
	Florida Yards and Neighborhoods program			X	X	X		
	Culvert Entrance Roads			X	X	X		
Golden Gate Estates	Protect isolated wetlands							X
	No general permits				X			
	Determine wetland jurisdiction prior to County permitting				X			
	Reconnect wetlands along historic flowways				X			X
	Limitation on clearing of the lot				X			
Agricultural	Status Quo	X	X		X	X		X
Mining	Mining Lands (no special criteria noted)	X				X		
Agricultural - Maintain Intensity	No intensification in activity				X	X		
Agriculture (Limited Intensification)	Limited Intensification (no loss of habitat)			X				
Agricultural - Go To Preserve	If Agriculture ends then goes to preserve				X			
Agricultural	Criteria for Agriculture (package of several criteria)							
	No changes that would lower hydrology			X				
	No uses not associated with agriculture (golf courses, ranchettes)			X				
Rural Residential (Agricultural and Buffer Zones)	Package of several criteria below and also at "Zone Criteria" legend							
	Agricultural lands not converted to non-agricultural development					X		
	Discourage Urban expansion into this area.					X		
	Activities compat ble with wildlife and water resource conservation					X		X
Rural Residential	Status Quo	X	X		X			X
Rural	Rural Low Density Mix (package of criteria)							
Legends	**Criteria**	**Q**	**R**	**S**	**T**	**U**		(PRC)
	Avoid and minimize impacts to wetlands			X				X

	Protect nesting areas (e.g., sandhill crane)			X				X
	Mitigate wide ranging species off-site, min 1:1, incl. fox squirrels			X				X
	Maintain or improve hydrology			X				
	Protect RCW habitat. If viability affected, go off-site 1:1			X				X
	No net loss in water table and recharge area			X				
	No net loss in area and function of wetlands			X				X
	Larger buffer zones around wetlands, flowways, streams, rivers			X				X
	Do not contr bute to hurricane shelter deficit or increase travel time			X				
	Implement Estero Bay ABM adopted principles			X				
Rural	Rural Criteria (low density uses/connect wetlands)							
	Assumes lower density uses (ranchettes, nurseries, etc.)			X				
	Protect flowways, seasonal wetlands, forest and their connections			X				X
	Use Estero Bay ABM map as acquisition map			X				
Rural Development Criteria	Rural (package of criteria including clustering)							
	One residential unit per five acres overall					X		
	Clustering					X		
	Preserve 50% of the land area in natural state					X		
	Maintain corridors, flowways with connect outside project bounds					X		X
	100% wetland preservation/restoration					X		
Preservation/Conservation	Status Quo		X	X	X	X		X
Preservation Lands	Flowway Improvements	X			X	X		X
Preservation Lands	Preserve (package of criteria)							
	Filter marshes (Ten Mile Canal and from Lehigh Acres)				X			
	Preserve proposed acquisitions				X			X
	Preserve Strategic Habitat Conservation Area for Florida Panther				X			
	Preserve Florida panther Priority 1 and 2 designated lands				X			
	Preserve eagle nests				X			X
	Preserve rookeries				X			X
	Preserve rare native plant communities				X			X
	Preserve seasonal wetlands and flowways				X			X
	Preserve coastal resources				X			X
Legends	**Criteria**	**Q**	**R**	**S**	**T**	**U**		(PRC)
Preserve (Existing & Proposed)	ABM Conservation/Preservation Strategy Map			X		X		
Preservation Lands	Criteria for Preserve (package of several criteria)							

	No public utilities			X				
	No new or expanded transportation			X				
	No well-field expansion			X				
	Restore/Retrofit areas with hydrologic problems			X				
	Use as mitigation receiving area			X				
	Managed for wetlands and wildlife protection			X				X
Preservation/Conservation	Culverts under Tamiami and I-75	X						
Preservation Zone	Denial of all dredge/fill permits in existing preserved lands because:							
	Contrary to conservation purposes of these lands					X		
	Adverse effects wildlife & water resources, including downstream					X		
	Adverse effect Federally listed threatened and endangered species					X		
	Practicable alternatives exist elsewhere					X		
Zone Legends	(Referenced by the Zone criteria packages)							
	Strictly apply 404(b)(1) guidelines including					X		
	Presumption practicable alternative site exist elsewhere					X		X (status quo)
	Presumption new dredge/fill results in degradation to wetlands					X		
	Heightened levels of compensatory mitigation for wetland loss					X		
	No net loss in area and function of wetlands					X		X (status quo)
	Consider only single and complete projects, including all phases					X		
	Presume new dredge/fill adversely affect listed species					X		
	Eliminate use of Nationwide and General Permits					X		
	Reduce potential for additional secondary development					X		
	Presumption against new road and utility construction					X		
	Implement principles of Estero Bay ABM					X		
	Maintain water tables and recharge areas					X		
	Promote restoration of flowways					X		X
	Buffer zones around wetlands, flowways, streams, rivers					X		X
	Buffer zones around eagle's nests and colonial bird rookeries					X		X
	No adverse impacts on water quality					X		X
Legends	**Criteria**	**Q**	**R**	**S**	**T**	**U**		(PRC)
	Not contr bute to hurricane shelter deficit or increased evacuation times					X		
	Apply Big Cypress Area of Critical State Concern standards					X		

	Target aggressive acquisition/compensation and restoration					X		
	Scrutinize activities claimed exempt as prior converted cropland					X		
	Encourage best management practices to reduce resource impacts					X		

Evaluation Factors

Evaluation Factor.	Measurement.	Q	R	S	T	U	What influenced evaluation.	Conclusion/Comparison.
Avoidance of wetland impact	Estimate of percent of total area of wetland that is predicted tol be filled.	6.6%	7.0%	5.6%	5.8%	5.5%	How flex ble is typical configuration of site design for the land use compared to distr bution/shape of wetlands in the area that land use is mapped.	Ensemble with less impact better satisfy requirement for avoidance.
Loss of uplands adjacent to wetlands	Portion of study area that may be preserved for natural resource benefits.	38%	38%	42%	42%	43%	Existing preserves total 27%. Native vegetation (upland and wetland) occupy 58% of the study area.	Uplands outside of preserves have higher probability to be impacted.
Availability of compensatory mitigation	Percent of total wetlands in study area that are within areas that are not now preserved but are suggested to be preserved ("new preserves").	17%	19%	22%	23%	24%	Typical compensation is to restore degraded wetlands and preserve in perpetuity.	Larger percentage provides greater selection of wetlands that could be restored.
Acreage ratio	Acres of wetlands in suggested"new preserves" divided by acres that mayl be filled.	2.6:1	2.7:1	4.0:1	3.9:1	4.4:1	Some wetlands in "new preserves" will not be suitable for compensatory mitigation.	Larger ratio provides greater choice in lands to be acquired and restored.
Availability of replacement of wetland function	Wetlands in suggested "new preserves" were converted to a scored high, medium, and low for their potential quantity of "units of restoration" and wetlands predicted to be filled were converted to a scored for the "units of impact". Ratio is the "units of restoration" divided by "units of impact".	1.8	1.8	2.8	2.8	3.3	Wetlands adjacent to existing development, canals, etc. Converted to a scored "low".	Higher ratio indicate greater assurance that ecosystmem benefits would be replaced.
Florida Panther	Percent of Priority 1 and 2 lands (within study area) within suggested preserves.	56%	62%	70%	71%	72%	Existing public preserves with panther use.	Higher percentage on public lands provide greater assurance of preserving population.
Florida Panther	Percentage of lands in agriculture" and whether criteria for non-intensification of use suggested.	26%, No criteria	35%, No criteria	18%, Criteri a	25%, Criteri a	19%, Criteri a	Low-intensity agriculture retains clear areas for prey and travel for panther.	Greater area of low-intensity agriculture increases assurance of conservation of the species.
Evaluation Factor.	**Measurement.**	**Q**	**R**	**S**	**T**	**U**	**What influenced evaluation.**	**Conclusion/Comparison.**
Scrub Jay	Number of families within suggested areas of preserves.	6	6	11	8	6	26 known families within study area.	Higher number within suggested preserves increase assurance of preservation of species.
Red cockaded	Number of known clusters located	10	2	13	12	18	40 known groups in study area.	Higher number of groups in

woodpeckers	within suggested preserves.						Existing sites in old growth pine.	preserves increases assurance of preservation of the species.
Bald Eagle	Number of nests located within suggested preserves.	18	18	20	19	18	74 known nests in study area. Concern also with adjacent lands.	Higher number of nests in contiguous preserve provides more assurance of preservation of the species.
Woodstork	Maintenance of existing seasonal wetlands is suggested, especially short hydroperiod wetlands.						Species already nesting elsewhere due to loss of wetlands. Needs marshes providing prey base throughout year.	Maintenance/restoration of short hydroperiod wetlands restores historic nesting productivity and foraging habitat availability.
Audubon's crested caracara	Proposed continuation of low intensity agriculture"	140,000 acres agriculture, no criteria.	181,000 acres agriculture, no criteria.	97,000 acres agriculture w/ limited intensification.	130,000 acres agriculture, 54,000 with no intensification.	152,000 acres agriculture, some with limited intensification.	Study area fringe of 10 county area where population is found.	Continuation of low intensity agriculture and greater area of preservation of seasonal wetlands better provide opportunities to maintain or expand population.
Piping Plover	Affect on beaches and tidal flats directly or by water quality change.						Barrier beaches and tidal flats used as wintering sites.	Could be affected by water quality. Increased coastal development degrades habitat.
Snail Kite	Suggested preservation of seasonal wetlands.						Feed only on apple snails, only found in seasonal wetlands.	Greater number of seasonal wetlands within contiguous preserves increases probability of maintenance of species.
West Indian Manatee	Affected by coastal development and seagrass loss.						Boating mortality, loss of seagrass from prop dredging and decline in water quality.	Increased coastal development degrades habitat.
American Crocodile	Changes in timing and quantity of freshwater (see Flowways factor). Fill affects foraging habitat						Changes in freshwater flows and dredge/fill affect estuarine resources.	Maintenance of flowways reduce potential changes in hydropatterns, increasing potential for preservation of the species. Increased coastal development degrades habitat.
Eastern Indigo Snake	Native Habitat							More fragmentation and reduction in habitat impacts species.
Sea Turtles (Loggerhead, Green, Hawksbill, and Kemp's Ridley)	Effects on beaches.						Effects include artificial lighting, beach renourishment, human presence, exotic vegetation, and dredge/fill.	More coastal development degrades habitat.

Evaluation Factor.	Measurement.	Q	R	S	T	U	What influenced evaluation.	Conclusion/Comparison.
Multi-Species Recovery Plan (MSRP)	BPJ assessment of how suggested Ensemble provides specific implementation of the MSRP. Converted to a score from 4 (best) to 24.	17	23	6	13	9	Whether landuse/criteria included that explicitly supported the MSRP.	Those with mapping of preserves or, for all land types, resource protection criteria such as found in the MSRP enhanced its implementation.

Strategic Habitat Conservation Area (SHCA)	Percentage of the total area of SHCA in the study area that will be in the suggested preserve areas.	56%	56%	65%	69%	69%	8.2% of SHCA in State is within study area.	Insufficient preserves to protect minimum viable population.
Wading Bird Rookeries	Number rookeries found within the suggested preserve areas.	17	13	17	18	17	Not measured is effect on foraging range up to 15 kilometers (30 kilometers for Woodstorks). Total 25 sites.	Higher number of rookeries and foraging range in preserves provide more assurance of preservation of species.
Seasonal wetlands	Percent of total area that will be found within suggested preserves.	70%	73%	76%	75%	86%	Seasonal wetlands not evenly distr buted across landscape.	14% to 30% of historic impacted habitat not located in preserves.
Connectivity provided between major habitat areas	BPJ assessment of number of connections explicitly provided by the Ensemble. Converted to a score 4 (best) to 24.	21	18	6	10	8	Wider the connection Converted to a scored lower (better).	Wider and more numerous connections provide better wildlife habitat and reduce disturbance from adjoining land uses.
Flowways	Similar to Connectivity, since most connections follow natural flowways. Converted to a score 4 (best) to 24.	18	23	5	6	8	Routing flows through contiguous natural areas Converted to a scored lower (better).	Wider flowways of natural vegetation preserve ability to store floodwaters, prevent downstream pulse flows, and increase habitat value.
Regional significant natural resources. Plans and goals of the Southwest Florida Regional Planning Council	Assessment of how the Ensemble specifically provides implementation of plans and goals. Converted to a score 4 (best) to 24.	20	17	4	6	7	Comparison of mapping or criteria to the goals.	Explicit inclusion of maps or criteria better support resource protection goals.
High priority wetlands important to wetland dependent species	Percentage of all wetlands and uplands that would be within preserve areas suggested by the Ensembles.	79% wetland / 37% upland	79% wetland / 38% upland	82% wetland / 46% upland	86% wetland / 77% upland	87% wetland / 49% upland	37% of study area is important wetland and 19% of study area is important upland.	Percentages of upland lower than wetland indicate lower wetland habitat buffer support.
Shoreline	Assessment how suggested Ensemble affects fringe's ability to provide aquatic nursery and foraging habitat. Converted to a score 4 (best) to 24.	20	21	7	7	8	Reduction in area of mangrove, saltmarsh, or, landward of the fringe, pineland and hardwood hammock plant communities.	No direct affect on mangrove or salt marsh, but higher score reflects higher potential for indirect effect on estuaries landward of the coastal fringe.
Historic Properties	Site specific.						Site specific.	Addressed in specific application.
Property Rights	Assessment of how Ensemble's suggestions reduce rights. Converted to a score 48 (least effect) to 0 (greatest reduction).	45	47	18	21	12	Affect on fair market value of property, reasonable expectation for use of land and return on investment, and vested rights.	
Evaluation Factor.	**Measurement.**	**Q**	**R**	**S**	**T**	**U**	**What influenced evaluation.**	**Conclusion/Comparison.**
Difference from Comprehensive Plans	Assessment of how different the Ensembles are from the Plans. Converted to a score 16 (most agreement) to 0 (greatest difference).	14	16	7	7	5	Additional criteria or restrictions lowered Converted to a score.	Large difference between Ensembles.

Economic Sustainability: Job Creation	Assessment of effect of suggestions in Ensembles on creation or elimination of jobs. Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability)	13	13	6	5	4	One influcence is restrictions on intensification of agriculture prevents year round jobs from citrus.	Restrictions on area or type of land use restrict opportunity for job creation.
Economic Sustainability: Home affordability	Assessment of change in cost of homes from suggestions in Ensembles. Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability).	11	11	6	6	4	One is restrictions on density (number of homes per acre).	More restrictions increases cost per unit of homes.
Economic Sustainability: Cost of living	Assessment of change in costs resulting from suggestions in Ensembles. Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability).	10	10	7	7	7	Restrictions add to costs. Costs passed to consumers.	More restrictive criteria increases cost of living.
Economic Sustainability: Property tax base	Area of development suggested by Ensembles. Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability).	13	14	7	6	5	Number of acres and type of land use.	Restrictions on use of land (intensification of agriculture) or area of development reduces tax base.
Economic Sustainability: Cost to implement	Cost to acquire preserves and peform restoration suggested by Ensembles. Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability).	12	13	5	6	3	Area of suggested "new preserves".	Larger "new preserves" adds costs passed to local goods and services.
Economic Sustainability: Increased taxes	"Cost to implement" divided by "Property Tax Base". Converted to a score 16 (positive influence) to 0 (less protective of economic sustainability).	12	13	6	6	4	Preserves must be supported by property tax base.	Higher area of preserves at same time as smaller area of development increases taxes.
Aesthetics	Poss ble socio-economic influence						Areas of preserve.	Many persons attracted to area for presence of natural areas.
Management of Public Lands	Narrative assessement of effect on management of verious locations of development suggested by the Ensembles.	Greatest area of develop ment.	Greate st area of agricult ure", prefera ble to urban	Increa ses area of preser ve adj to public lands.	Less urban adjace nt to Corksc rew Marsh.	More restrict ive criteria .	Considered (1) compatability of the surrounding land use with the land management plans and (2) whether change in land use degrade or improve natural resources on public land.	Management least effected when public lands surrounded by low intensity activities and by expansion of contiguous preserves.

Evaluation Factor.	**Measurement.**	**Q**	**R**	**S**	**T**	**U**	**What influenced evaluation.**	**Conclusion/Comparison.**
Water Quality: Pollution Loading	Assessment of Ensembles. Converted to a score 3/+ (least l kely to affect water quality) to	13/0	15/0	6/0	9/+	6/+	Type of land use and type of treatment of the runoff.	Reduction in area of urban or criteria to provide treatment reduced likelihood of impact.

	15/0 (more l kely an impact).							
Water Quality: Freshwater pulses	Assessment of Ensembles. Converted to a score 3/+ (least l kely to affect water quality) to 15/0 (more l kely an impact).	12/0	13/0	7/0	6/+	6/+	Area of new impervious surface and acres of wetland preservation.	Increase in urban with decrease in wetland areas (that provide peak storage) increases pulses.
Water Quality: Habitat Loss	Assessment. Converted to a score 3/+ (least likely to affect water quality) to 15/0 (more likely an impact).	13/0	12/0	6/+	7/+	4/+	Quantity of wetlands.	Higher quantity of natural vegetation preserved maintains capability to assimilate pollutants.
Water Quality: Groundwater impact	Assessment. Converted to a score 3/+ (least likely to affect water quality) to 15/0 (more likely an impact).	11/+	11/+	5/0	7/0	6/0	Protection of Surficial Aquifer System.	Protection of lands surrounding wellfields either by criteria or placing in preserve reduces likelihood of impact.
Hurricane Preparedness	Assessment of suggestions in Ensembles.	Increase in urban area.					Increase in population offset by increase in roads and shelters.	None were considered to have change preparedness.
Water Management. (7 factors: infrastructure, home damage, home construction, flood depth, historic flow patterns, water storage, and aquifier zoning.)	Assessment whether seven factors were "addressed" by suggestions in Ensembles. Converted to a scored a "+". Converted to a score is the number of +'s. Higher the Converted to a score, the less potential for impact.	6	14	17	13	14.5	Provision for funding infrastructure. Criteria to prevent home construction in floodplain. Preservation of flowways. Preservation of wetlands (store water and preserve groundwater levels).	R provides criteria for homes within floodplain and funds infrastructure. S, T, and U provide wetland preserves and flowways.
Cumulative impacts: Social factors. (4 factors: Infant mortality, Road needs, Crime rates, Hurricane vulnerability)	Assessment of the cumulative effect for each of the individual factors of the suggestions in the Ensembles. Lower the Converted to a score, the less likely will be a degradation.	46	65	36	40	42	Area of urban development. For Hurricane vulnerability, presence of flowways.	Increase in urbanziation has cumulative impacts, but flooding from hurricane addressed by presence of flowways.
Cumulative Impacts: Environmental factors. (6 factors)	Assessment of the cumulative effect for each of the individual factors by the suggestions in the Ensembles. Lower the Converted to a score, the less likely will be a degradation.	104	113	72	69	71	Area of development and contiguous preserves. Presence of flowways.	Greater development increases of air and water pollution (and vulnerability of watershed) while increases in contiguous preserves reduces impacts to wetlands, hydrology, and preserves.

3. AFFECTED ENVIRONMENT

The Affected Environment section succinctly describes the existing environmental resources of the areas that would be affected if any of the alternatives were implemented. This section describes only those environmental resources that are relevant to the decision to be made. It does not describe the entire existing environment, but only those environmental resources that would affect or that would be affected by the alternatives if they were implemented. This section, in conjunction with the description of the "status quo" alternative, forms the baseline conditions for determining the environmental impacts of the Proposed Action and reasonable alternatives.

3.1 GENERAL ENVIRONMENTAL SETTING

The Southwest Florida Environmental Impact Statement study area is comprised of temperate and sub-tropical habitat in portions of Lee and Collier Counties. The major features include the Fakahatchee Strand State Preserve, the Florida Panther National Wildlife Refuge, the Ten Thousand Islands National Wildlife Refuge, the Big Cypress National Preserve, the Corkscrew Regional Ecosystem Watershed, the Rookery Bay and Estero Bay Aquatic Preserves, the Corkscrew Swamp Sanctuary, and the Picayune Strand State Forest. The interior parts of the study area show remnants of prehistoric shoreline, forming sand ridges, interspersed with large wetland strands. The coastal areas along the Gulf of Mexico are cut by islands, bays, and lagoons, and include portions of the largest mangrove ecosystem in the continental United States (**Figures 10a-e**, Map of Environmental Resources).

3.2 BIOLOGICAL RESOURCES

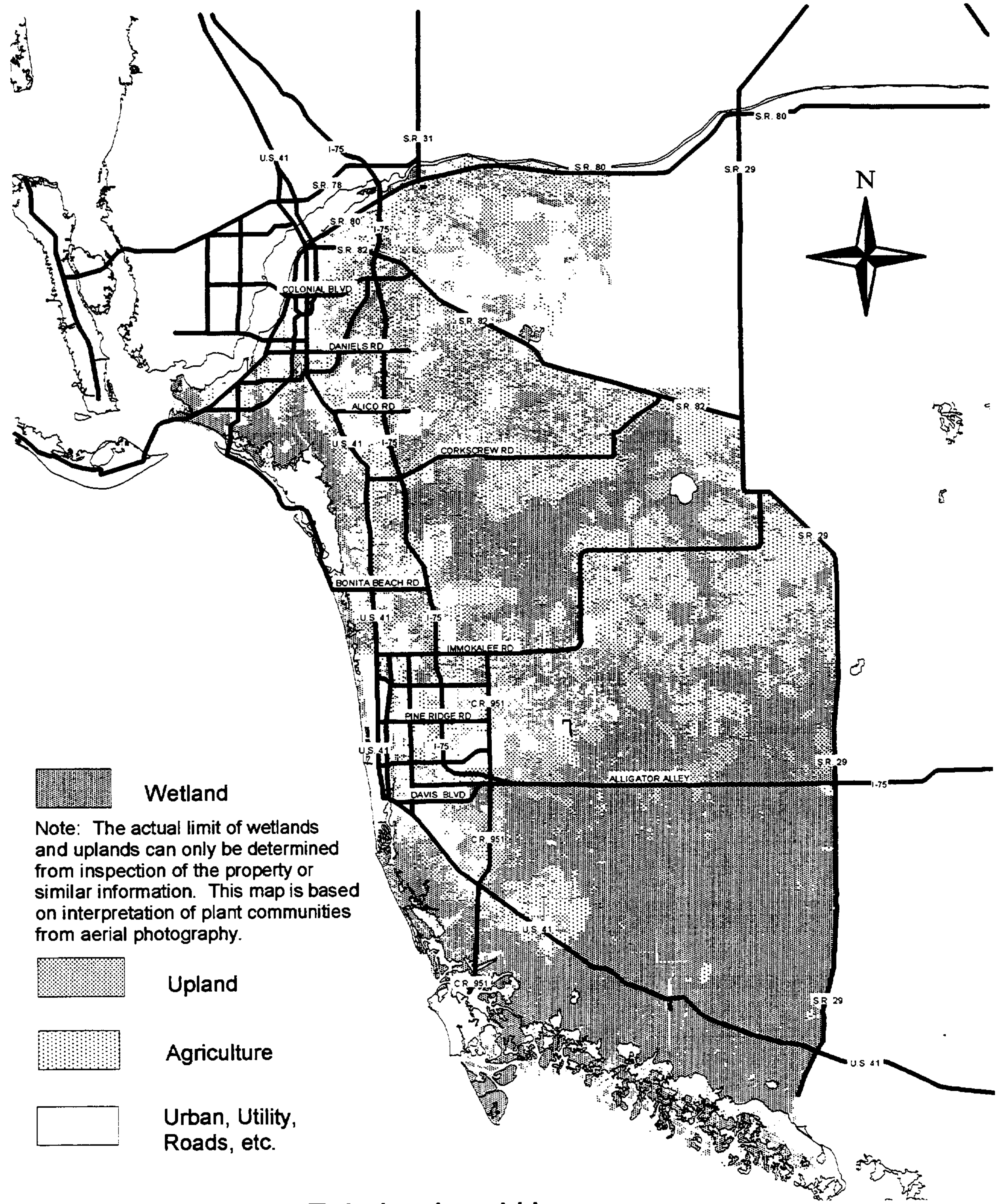
Southwest Florida features floral assemblages characteristic of both temperate and subtropical systems, as well as influences from the Caribbean. The coastal climatic influences, as well as the sheltered habitat afforded by the relatively remote sloughs and cypress strands of the region, provide suitable habitat for several tropical plant species that are rarely seen elsewhere in Florida (Ward 1979). In terms of supporting wide-ranging species (e.g., Florida panther, Florida black bear, and wood stork), the Southwest Florida area likely represents the most important region of Florida (Cox et al. 1994).

3.3 THREATENED AND ENDANGERED SPECIES

3.3.1 FAUNA

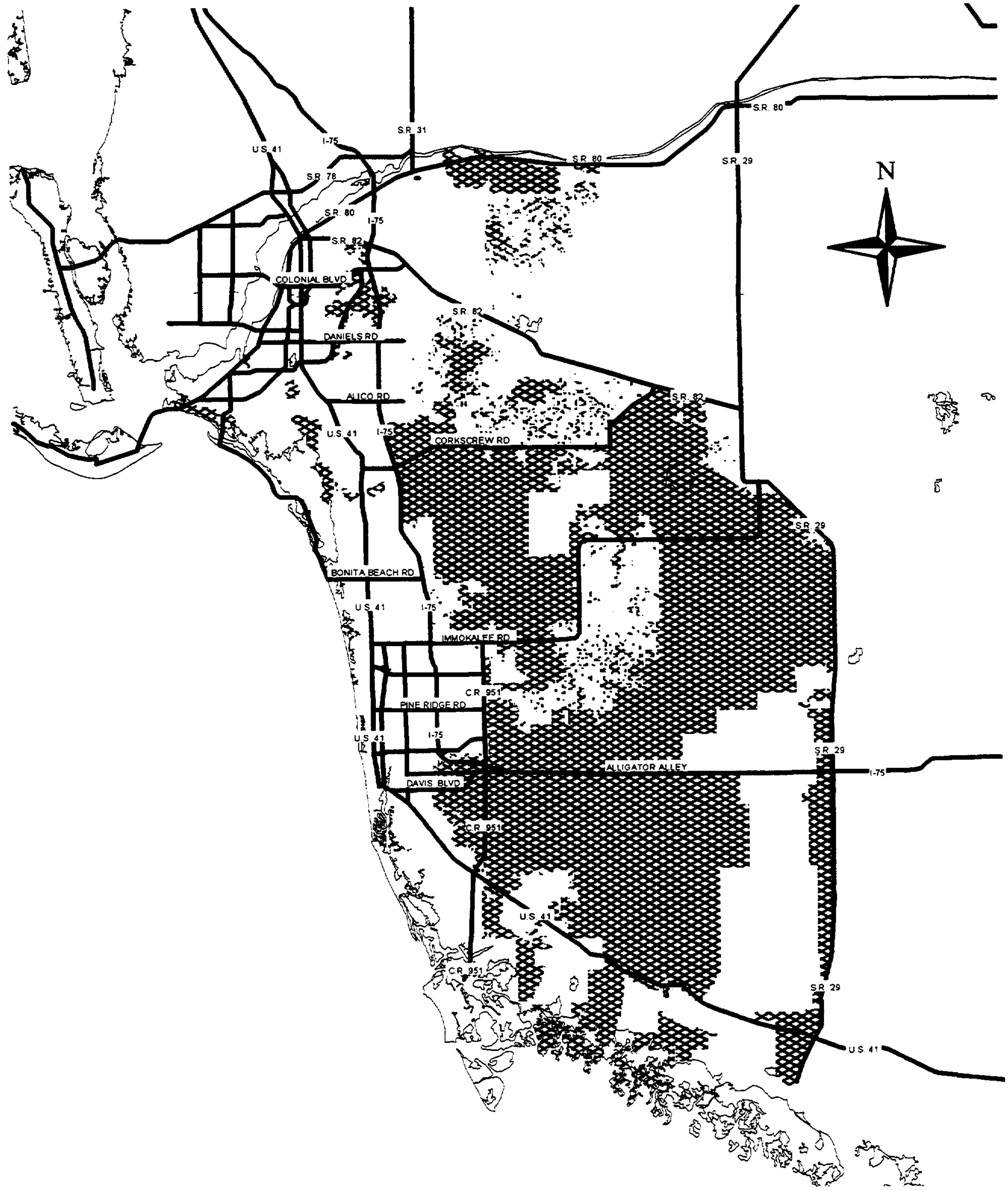
Twenty-three faunal species which are known to occur in Lee and Collier Counties are currently listed as threatened or endangered by the United States Fish and Wildlife Service (USFWS). Forty-five faunal species known to occur in these counties are currently listed as threatened, endangered, or as species of special concern by the Florida Fish and Wildlife Conservation Commission (FFWCC) (**Table 4**).

The Corps, through consultation with the USFWS, has determined that seventeen listed faunal species which occur in the study area could be affected by the proposed project. These species include the American crocodile, Eastern indigo snake, Florida scrub-jay, bald eagle, wood stork, red-cockaded woodpecker, piping plover, Audubon’s crested caracara, Everglades snail kite, Florida panther, mountain lion, West Indian manatee, and the Loggerhead, Hawksbill, Green, Leatherback, and Kemp's Ridley Sea Turtles.



Existing Land Use
Simplified based on 1995 Aerial Mapping

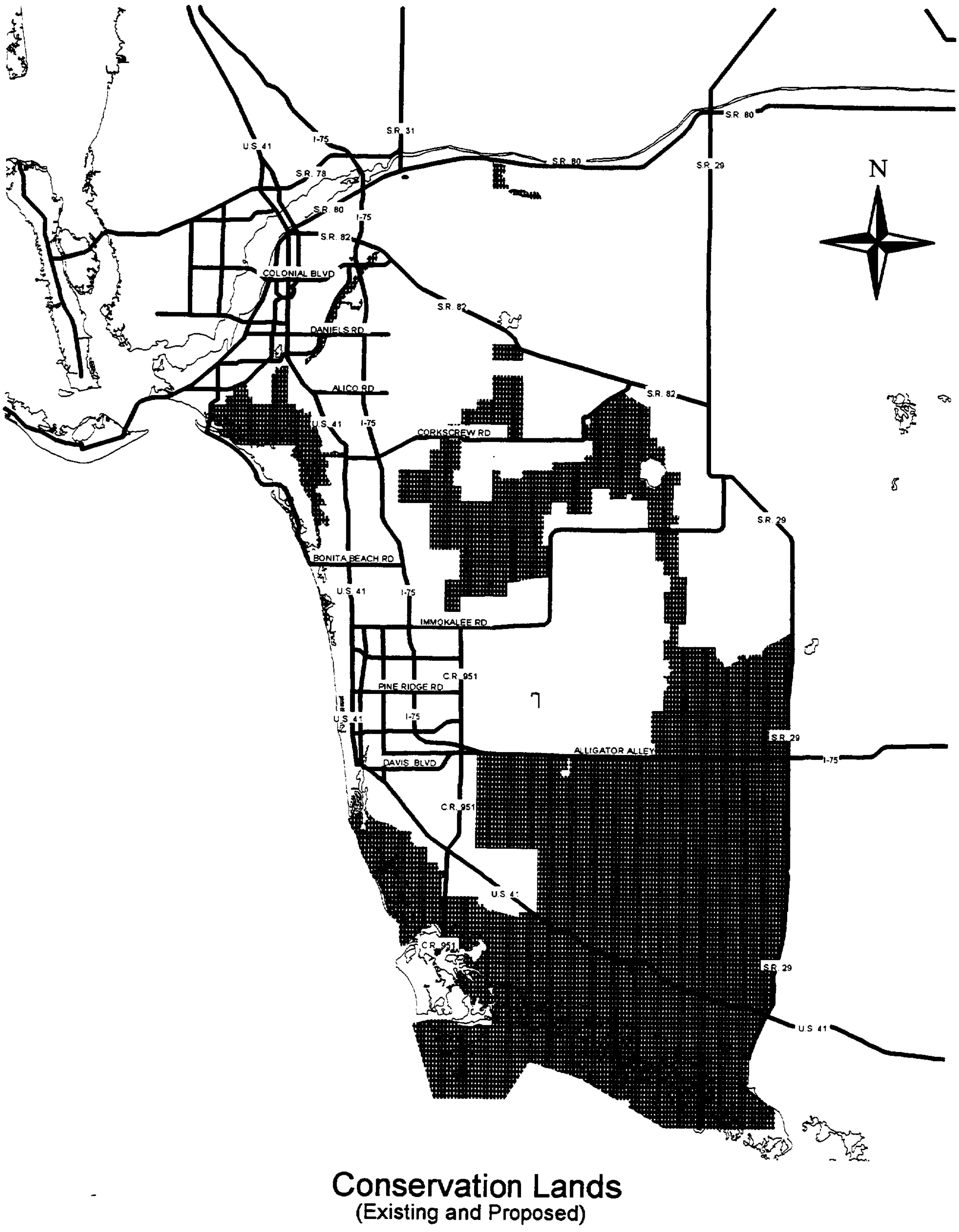
FIGURE 10a. MAP OF ENVIRONMENTAL RESOURCES - EXISTING LAND USE



Strategic Habitat Conservation Areas

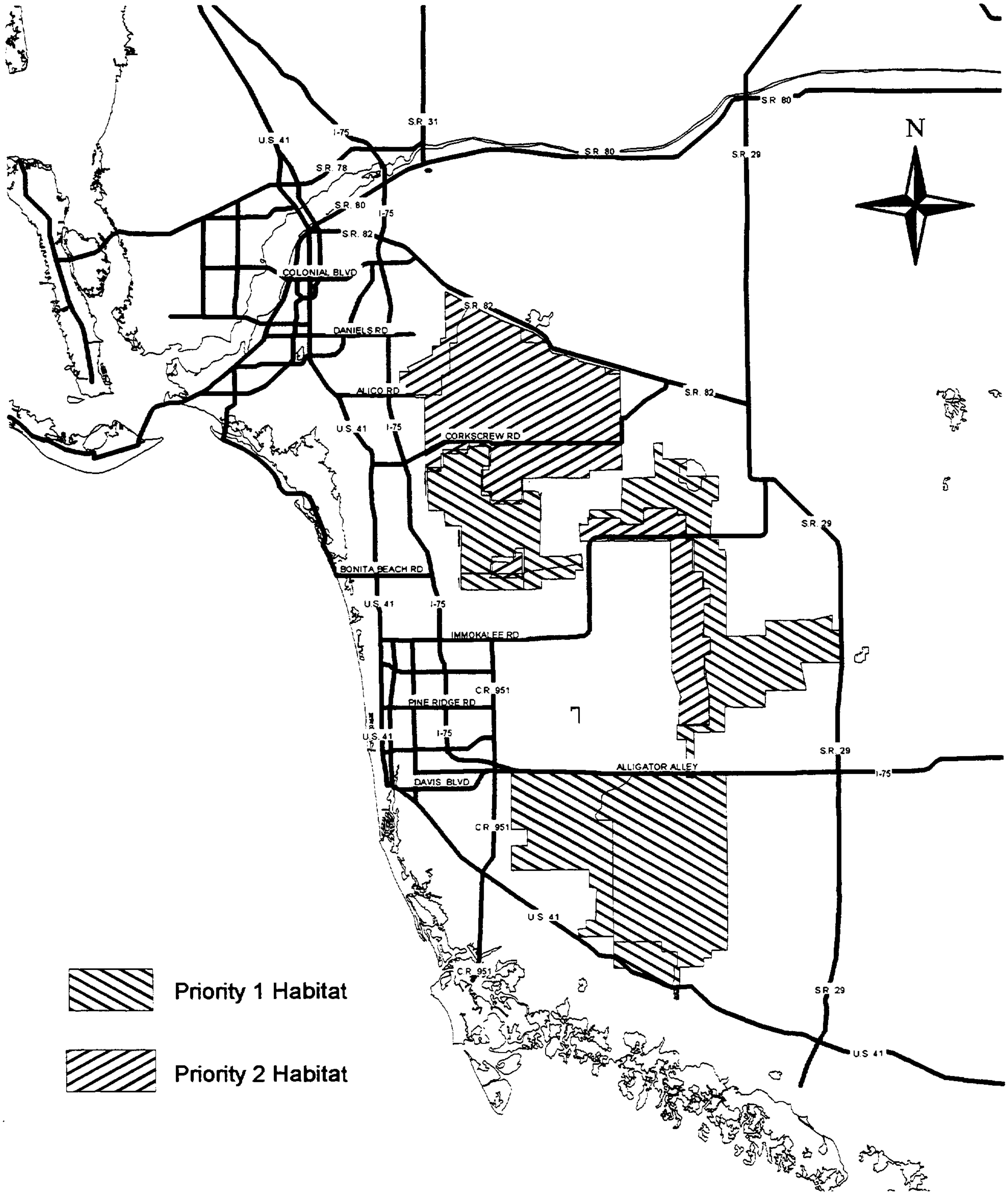
from Florida Game and Fresh Water Fish Commission (1994)
Closing the Gaps in Florida's Wildlife Habitat Conservation System

FIGURE 10b. MAP OF ENVIRONMENTAL RESOURCES - STRATEGIC HABITAT CONSERVATION AREAS



Conservation Lands
(Existing and Proposed)

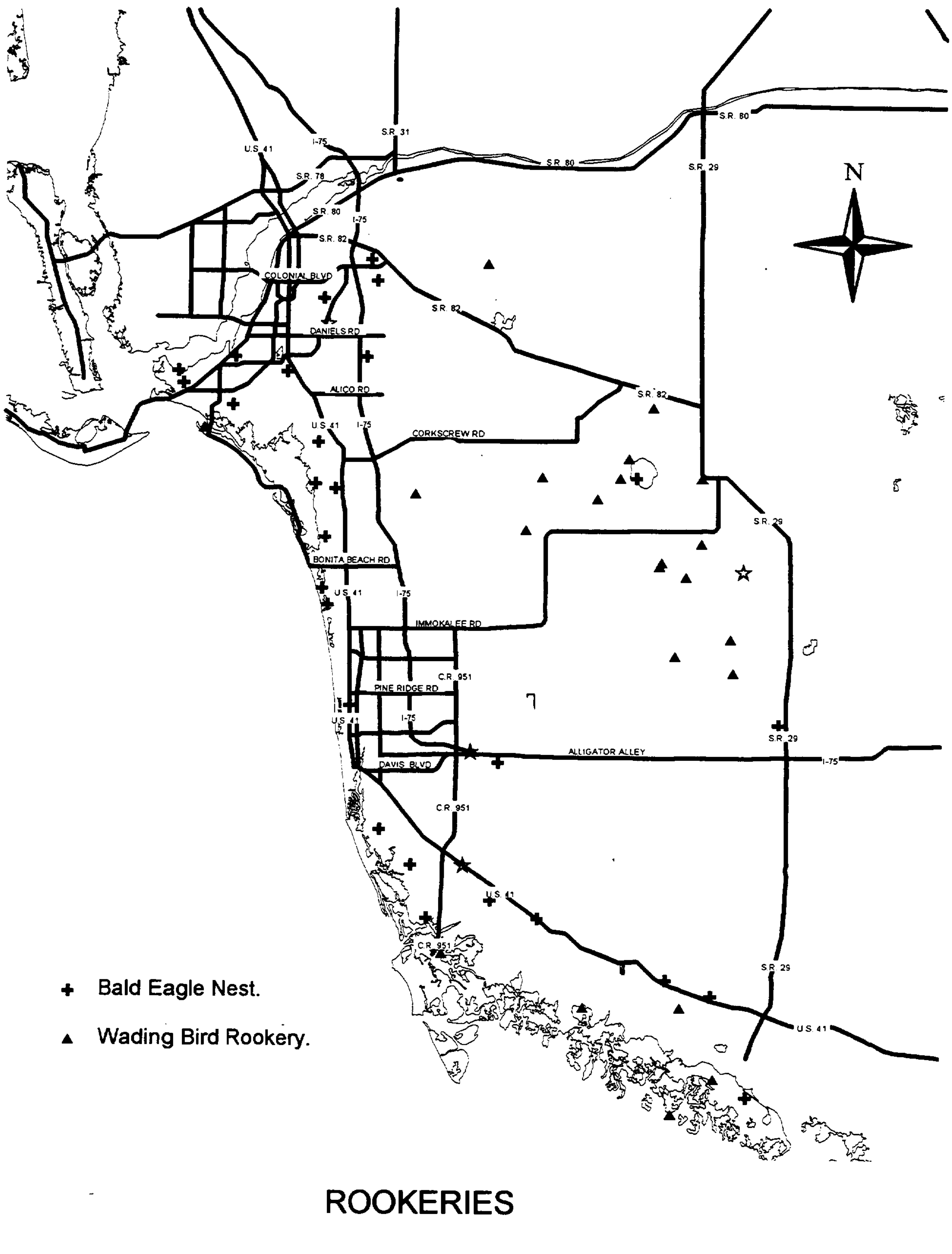
FIGURE 10c. MAP OF ENVIRONMENTAL RESOURCES - CONSERVATION LANDS



Florida Panther Priority 1 & 2 Habitat

from Florida Panther Interagency Committee
Panther Habitat Preservation Plan

FIGURE 10d. MAP OF ENVIRONMENTAL RESOURCES - PANTHER HABITAT PRESERVATION PLAN



+ Bald Eagle Nest.

▲ Wading Bird Rookery.

ROOKERIES

FIGURE 10e. MAP OF ENVIRONMENTAL RESOURCES - ROOKERIES AND NEST SITES

Table 4. Listed Faunal Species Occurring In Lee & Collier Counties, Florida
(USFWS & FFWCC, 1998)

Scientific Name	Common Name	Federal Status[1]	State Status[2]
AMPHIBIANS			
Rana capito	Gopher frog		SSC
REPTILES			
Alligator mississippiensis	American alligator	T (SA)	SSC
Caretta caretta	Loggerhead sea turtle	T	T
Chelonia mydas	Green sea turtle	E	E
Crocodylus acutus	American crocodile	E	E
Dermochelys coriacea	Leatherback sea turtle	E	E
Drymarchon corais couperi	Eastern indigo snake	T	T
Eretmochelys imbricata	Hawksbill sea turtle	E	E
Gopherus polyphemus	Gopher tortoise		SSC
Lepidochelys kempii	Kemp's ridley sea turtle	E	E
Pituophis melanoleucus mugitus	Florida pine snake		SSC
BIRDS			
Ajaia ajaja	Roseate spoonbill		SSC
Aphelocoma coerulescens	Florida scrub-jay	T	T
Aramus guarauna	Limpkin		SSC
Caracara plancus	Audubon's crested caracara	T	T
Charadrius alexandrinus tenuirostris	Southeastern snowy plover		T
Charadrius melodus	Piping plover	T	T
Egretta caerulea	Little blue heron		SSC
Egretta thula	Snowy egret		SSC
Egretta tricolor	Tricolored heron		SSC
Eudocimus albus	White ibis		SSC
Falco peregrinus tundrius	Arctic peregrine falcon		E
Falco sparverius paulus	Southeastern American kestrel		T
Grus canadensis pratensis	Florida sandhill crane		T
Haematopus palliatus	American oystercatcher		SSC
Haliaeetus leucocephalus	Bald eagle	T	T
Mycteria americana	Wood stork	E	E
Pelecanus occidentalis	Brown pelican		SSC
Picoides (= Dendrocopos) borealis	Red-cockaded woodpecker	E	T
Rhyncops niger	Black skimmer		SSC
Rostrhamus sociabilis plumbeus	Everglades snail kite	E	E
Speotyto cunicularia floridana	Florida burrowing owl		SSC
Sterna antillarum	Least tern		T
MAMMALS			
Balaena glacialis	Right whale	E	E
Balaenoptera borealis	Sei whale	E	E
Balaenoptera physalus	Finback whale	E	E
Blarina brevicauda shermanii	Sherman's short-tailed shrew		SSC
Felis concolor coryi	Florida panther	E	E
Felis concolor	Mountain lion	T (S/A)	E
Megaptera novaeangliae	Humpback whale	E	E
Mustela vison evergladensis	Everglades mink		T
Oryzomys palustris sanibelli	Sanibel Island rice rat		SSC
Physeter catodon	Sperm whale	E	E
Podomys floridanus	Florida mouse		SSC

Scientific Name	Common Name	Federal Status[1]	State Status[2]
Sciurus niger avicennia	Big Cypress fox squirrel		T
Trichechus manatus	West Indian manatee	E, CH	E
Ursus americanus floridanus	Florida black bear		T

[1]Federal Legal Status (US Fish and Wildlife Service)

E = Listed as an Endangered Species in the List of Endangered and Threatened Wildlife and Plants under he provisions of the Endangered Species Act. Defined as any species which is in danger of extinction throughout all or a significant portion of its range.

T = Listed as a Threatened Species. Defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

T/SA = Threatened due to similarity of appearance.

CH = Critical Habitat has been designated for this species in both coun ies

[2]State Legal Status (Florida Fish and Wildlife Conservation Commission)

E = Listed as an Endangered Species. Defined as a species, subspecies, or isolated population which is so rare or depleted in number or so restricted in range of habitat due to any man-made or natural factors that it is in immediate danger of extinction or extirpation from the state, or which may attain such a status within he immediate future.

T = Listed as a Threatened Species. Defined as a species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species within the foreseeable future.

SSC = Listed as a Species of Special Concern. Defined as a population which warrants special protection, recognition, or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species.

A description of each species reported by the USFWS and the FFWCC with the potential to be affected follows. For Federally listed species, the complete species account from the Multi-Species Recovery Plan is attached at Appendix G.

Gopher frog *Rana capito*

This medium-sized frog is a commensal of the gopher tortoise (*Gopherus polyphemus*) and is typically found in and around gopher tortoise burrows (Ashton and Ashton 1988).

The typical habitat is native, upland, xeric communities, particularly xeric oak scrub, although they are also found in pine flatwoods, sand pine scrub, and xeric hammocks (Godley 1992). The only documented occurrence of the gopher frog in the study area is in coastal Lee. and Collier counties.

The gopher frog is currently listed as a species of special concern by the FFWCC because of loss of upland habitat and wetland nesting habitat, typically ephemeral marshes located within a kilometer of the upland habitat.

American alligator *Alligator mississippiensis*

The American alligator's range extends across the southeastern states of Alabama, Arkansas, North and South Carolina, Florida, Georgia, Louisiana, Mississippi, Oklahoma, and Texas.

This reptile utilizes freshwater swamps and marshes as its primary habitat, but is also seen in rivers, lakes, and smaller bodies of water. Alligators have been shown to be an important part of the ecosystem, and are thus regarded by many as a "keystone" species. This role as a keystone species includes control of prey species and creation of peat through their nesting activities (University of Florida 1998).

Populations of the American alligator were severely affected in the early parts of this century due to hunting of the animal for its skin. In 1967, this species was listed as an endangered species which prohibited alligator hunting. As a result, the alligator has undergone a successful recovery. The alligator is hunted in Florida today under permit from the FFWCC.

The American alligator is currently listed as threatened by the USFWS, due to its similarity to the American crocodile (*Crocodylus acutus*). The American alligator is currently listed as a species of special concern by the FFWCC.

Loggerhead Sea Turtle *Caretta caretta*

The loggerhead turtle is the most common sea turtle species in South Florida (USFWS 1998). The total number of loggerhead sea turtle nests surveyed in South Florida account for over 90 percent of all nests reported State-wide (USFWS 1998).

The nesting and hatching season for loggerhead sea turtles in South Florida extends from mid-March through November, with the female laying an average of 110-120 eggs per nest, with multiple nestings (commonly 2-6 nests) spaced at two-week intervals (Dodd 1992).

Little is known regarding their behavior beyond the nesting beaches, although hatchlings are known to ride offshore drift lines in the Atlantic, and small juveniles are closely associated with floating mats of *Sargassum* in open ocean habitat (Ashton and Ashton 1991; Dodd 1992).

The diet of the loggerhead varies, but is primarily composed of mollusks, crustaceans, and horseshoe crabs (Dodd 1992).

The loggerhead is listed due to pressures on several levels, ranging from habitat alteration due to urbanization of coastal beaches, to pollution of the ocean, and human predation.

The loggerhead is listed as a threatened species under the Endangered Species Act of 1973, and is also listed as threatened by the FFWCC.

Green Sea Turtle *Chelonia mydas*

The only herbivorous sea turtle, the Green sea turtle is found throughout the tropic and subtropics, worldwide (Ehrhart and Witherington 1992). The green turtle, in Florida, nests primarily on the east coast, from Volusia County south to Dade County. The first recorded nesting in Southwest Florida occurred in 1994; prior to that there was only one recent nesting record on the west coast of Florida, occurring at Eglin Air Force Base in the Florida panhandle in 1987 (USFWS 1998; Ehrhart and Witherington 1992). However, the west coast of Florida does support important populations of immature green turtles (Ehrhart and Witherington 1992).

The green turtle is listed due to commercial exploitation (for meat, oil, and skins), habitat alteration due to urbanization of coastal beaches, and pollution of the ocean.

The green turtle is listed as a threatened species under the Endangered Species Act of 1973, except for the breeding populations in Florida and on the west coast of Mexico, which are listed as endangered. The green turtle is also listed as endangered by the FFWCC.

American Crocodile *Crocodylus acutus*

The American crocodile's range extends across southernmost Florida, Mexico, Central America, the Caribbean Islands, and northern South America.

This reptile utilizes coastal saltwater swamps and marshes as its primary habitat, but is also seen in saline lakes. The crocodile has also been known to range a few miles inland.

Populations of the American crocodile in Florida were likely relatively small historically, and the severely limited present distribution in Florida makes the population susceptible to catastrophic crash due to disease, or loss of habitat and individuals in a severe storm event (i.e., hurricanes) (Moler 1992). The species has been depleted elsewhere in its range due to hunting of the animal for its skin, and through loss of habitat.

The American crocodile occurs in low numbers within the study area. Crocodiles have been sighted as far north as Pine and Sanibel Islands and occur in the Rookery Bay, McIlvane Bay and Imperial River areas. Occurrence records within or adjacent to the study area include Estero Bay, Imperial River, Estero River, Shell Creek, Hendry Creek, Mullock Creek, the Marco Island area, and the Ten Thousand Islands National Wildlife Refuge. Although no successful reproduction has occurred on the Southwest coast, nesting has occurred.

The American crocodile is currently listed as an endangered species by both the USFWS and the FFWCC.

<u>Leatherback Sea Turtle</u> *<u>Dermochelys coriacea</u>*

The largest extant turtle species, the leatherback turtle can reach 2.4 meters (8 feet) in length and weigh up to 725 kilograms (1600 pounds) (Ashton and Ashton 1991).

Leatherback turtles nest during the Spring and Summer months, laying 80 or more eggs, which hatch 60-70 days later. The adult leatherback turtle is considered omnivorous, feeding on jellyfish, drift algae, seaweed, sea urchins, and squid.

Serious threats to the leatherback turtle on its nesting beaches include artificial lighting, beach nourishment, increased human presence, and exotic beach and dune vegetation (USFWS 1998).

The leatherback turtle is listed as endangered by both the USFWS and the FFWCC.

<u>Eastern Indigo Snake</u> *<u>Drymarchon corais couperi</u>*

The Eastern indigo snake is the largest non-venomous snake in North America. It is an isolated subspecies occurring in Southeastern Georgia and throughout peninsular Florida.

The Eastern indigo snake prefers drier habitats, but may be found in a variety of habitats from xeric sandhills, to cabbage palm hammocks, to hydric hardwood hammocks. Indigo snakes often forage adjacent to wetlands, particularly seasonal wetlands. Riparian systems (rivers, creeks, streams) represent important foraging habitats for the Eastern indigo snake, and wetland prey (including frogs) are a significant component of their diet.

Indigo snakes need relatively large areas of undeveloped land to maintain their population. The main reason for its decline is habitat loss due to development. Further, as habitats become fragmented by roads, indigo snakes become increasingly vulnerable to highway mortality as they move through their large territories (Schaefer and Junkin 1990).

The Eastern indigo snake occurs throughout the study area.

The Eastern indigo snake has been classified as a threatened species by the USFWS since 1978 and by the FFWCC since 1971.

<u>Hawksbill Sea Turtle</u> *<u>Eretmochelys imbricata</u>*

The hawksbill sea turtle is found throughout the tropic and subtropics, worldwide. The hawksbill turtle rarely appears in historical records in Florida, but nests have been noted along the east coast (from Volusia County south to Monroe County) since the early 1980’s (Meylan 1992). Stranding and museum records indicate the occurrence of the Hawksbill within the study area. The hawksbill is primarily associated with coral reefs, but also occupies other hard-bottom habitats (Meylan 1992).

The hawksbill turtle is listed due to commercial exploitation (for meat, oil, and skins), habitat alteration due to urbanization of coastal beaches, and pollution of the ocean, although exploitation for tortoiseshell is the principal cause for population decline worldwide (Meylan 1992).

The hawksbill turtle is listed as an endangered species under the Endangered Species Act of 1973. The hawksbill turtle is also listed as endangered by the FFWCC.

Gopher tortoise *Gopherus polyphemus*

The gopher tortoise is found throughout peninsular Florida, with the bulk of the population in central and northern portions. The south Florida population is scattered due to habitat loss and fragmentation, as well as urbanization (Diemer 1992).

Typical habitat for the gopher tortoise includes sand pine scrub, coastal strand, oak hammocks, oak scrub, dry prairies, pine flatwoods, palmetto prairies, pasture, fallow cropland, and disturbed upland habitats (Diemer 1992).

The population is threatened by fragmentation of habitat and urbanization, as well by conversion of habitat to agricultural use, changes in land management practices (i.e., suppression of fire), and by susceptibility to upper respiratory infections. Coastal populations in Southwest Florida have been greatly reduced by urban development. Few tortoise populations (with the exception of the Immokalee area) exist outside coastal or riverine dune ridges in the study area.

The gopher tortoise is listed as a species of special concern by the FFWCC.

Kemp's Ridley Sea Turtle *Lepidochelys kempii*

The Kemp's ridley sea turtle is found throughout the tropical and subtropical Atlantic, although adult ridleys are apparently limited to the Gulf of Mexico, worldwide (Ogren 1992). The majority of the turtle nest *en masse* at Rancho Nuevo, Tamaulipas, Mexico. A few nests have been noted recently in Texas, and one nest was documented in Pinellas County, Florida in 1989 (Ogren 1992).

The Kemp's ridley turtle is listed due to intensive egg collection, commercial exploitation (for meat, oil, and skins), and shrimp trawl mortality prior to the installation of Turtle Excluder Devices (TEDs).

The Kemp's ridley turtle is listed as an endangered species under the Endangered Species Act of 1973. The Kemp's ridley turtle is also listed as endangered by the FFWCC.

Florida pine snake *Pituophis melanoleucus mugitus*

Florida pine snakes, which were once common throughout the southeast, are typically found in open, sandy, pine-turkey oak woodlands and abandoned fields, as well as in sandhill, scrub, and longleaf pine forests (Tennant and Krysko 1997). The pine snake is listed by the FFWCC as a species of special concern, primarily due to loss and fragmentation of habitat, overcollecting, and road mortality (Franz 1992). The distribution of this species extends to Lee County only, and is not well-documented.

Limpkin *Aramus guarauna*

The limpkin is a heron-sized wading bird with a long neck, bill, and legs (Bryan 1996). They are typically found along the shallows of slow-moving freshwater rivers, marshes, and lakeshores. Nesting occurs in bulrush marshes, in the tops of cypress and cabbage palms, and amongst cypress knees (Bryan 1996).

The primary threat to the limpkin appears to be loss of its primary food source, the apple snail (*Pomacea paludosa*). The apple snail population is threatened by degradation of water quality, changes in hydroperiod and hydrology, pollution, and the proliferation of exotic plants, particularly water hyacinth (*Eichornia crassipes*), hydrilla (*Hydrilla verticillata*), and Brazilian elodea (*Egeria densa*).

The limpkin occurs throughout the study area, primarily in undeveloped areas.

The limpkin is listed as a species of special concern by the FFWCC.

Red-cockaded woodpecker *Picoides (=Dendrocopos) borealis*

The red-cockaded woodpecker is a territorial, non-migratory, year-round resident of mature pine forests in the Southeastern United States (Hovis 1996).

The red-cockaded woodpecker uses open upland and hydric pine forests, as well as mixed pine/cypress forests in Southwest Florida. The hydric pine flatwoods are of special importance to the red-cockaded woodpecker in the study area. Like the Florida scrub-jay, red-cockaded woodpeckers exhibit cooperative breeding where immature birds aid in the rearing of the young (Ehrlich et al. 1992).

Red-cockaded woodpeckers in Southwest Florida require an average of 200 to 500 acres of old pine forest to support foraging and nesting habitat. Territory size is larger in Southwest Florida than in other parts of the species' range due to available habitat.

The red-cockaded woodpecker appears to play a crucial role in the Southern pine forest ecosystem. A number of other birds use the nest cavities excavated by red-cockaded woodpeckers, such as bluebirds, and several other woodpecker species, including the downy, hairy, and red-bellied woodpecker (USFWS 1993). Larger woodpeckers may take over a red-cockaded woodpecker cavity, sometimes enlarging the hole enough to allow screech owls, wood ducks, and even raccoons to later move in. Flying squirrels, several species of reptiles and amphibians, and insects, primarily bees and wasps, also will use red-cockaded cavities (USFWS 1993).

In the study area, red-cockaded woodpeckers are documented in central Lee County within one mile west and east of Interstate 75; around the Southwest Florida International Airport; in the Corkscrew Regional Ecosystem Watershed (CREW) in both Lee and in Collier Counties; east of Naples; in Belle Meade; in Golden Gate Estates,including the Picayune Strand State Forest; and in the Big Cypress National Preserve.

The red-cockaded woodpecker rapidly declined as its pine habitat was altered for a variety of uses, primarily timber harvest and agriculture. The species was listed as endangered in March 1970 by the Department of the Interior. The red-cockaded woodpecker is listed as a threatened by the FFWCC and endangered by the USFWS.

Audubon's Crested Caracara *Caracara plancus*

The crested caracara is about the size of an osprey. The caracara is an opportunistic feeder; its diet includes both carrion and living prey. The living prey usually consist of small turtles, frogs, and lizards.

Adult caracara maintain large territories, usually with their mates. Pair bonds are strong, persisting until one of the mates dies. The nest is typically located in a cabbage palm. The breeding peak is from January to March, with the usual clutch being two or three eggs (Layne 1996).

The region of greatest abundance for this Florida population is a five-county area north and west of Lake Okeechobee (Layne 1996). Caracara occur in the following Florida counties: Glades, DeSoto, Highlands, Okeechobee, Osceola, Lee, Collier, Hendry, Charlotte, Hardee, and Polk Counties. Historically the Florida population was more widespread, but has diminished rapidly with expansion of development.

The crested caracara is a bird of open country. Dry prairies with wetter areas and scattered cabbage palm (*Sabal palmetto*) comprise their typical habitat. Caracara also occur in improved pasture lands and even in lightly wooded areas with more limited stretches of open grassland (Layne 1996). Adult caracara tend to spread thinly over a wide area, with each pair maintaining a large territory. Caracara have also been documented along the coastline, and have been attracted to the coastline during major fish kills.

The primary cause for the decline of the crested caracara has been habitat loss. Real estate development, citrus groves, tree plantations, improved pastures, and other agricultural uses are all competing for the same habitat. Less significant factors may include illegal killing and trapping; increased numbers of road kills due to a rising volume of traffic; slow recovery from population losses because of the caracara's low reproductive rate; and possible loss of genetic variability (due to the relatively small population), thus making the caracara more vulnerable to stresses than would otherwise be the case (USFWS 1991).

Most caracara occur on privately-owned lands in Florida. The only Federal land on which the bird might permanently reside is the Air Force's Avon Park bombing range in Polk and Highlands County. Without any significant areas of habitat under State or Federal protection, long-term survival of the Florida population will depend largely upon finding innovative means of preserving the extensive tracts of prairie habitat in private ownership (USFWS 1991). Caracaras are documented in the eastern portions of the study area, primarily in association with agricultural lands. Historically, caracaras were documented as far west as Colonial and Summerlin Boulevards in Ft Myers.

The Audubon’s crested caracara is listed as threatened by both the USFWS and the FFWCC.

<u>Little blue heron</u> *<u>Egretta caerulea</u>*
<u>Snowy egret</u> *<u>Egretta thula</u>*
<u>Tricolored heron</u> *<u>Egretta tricolor</u>*
<u>White ibis</u> *<u>Eudocimus albus</u>*

These wading birds forage in relatively shallow streams, lakes, ponds, rivers, cypress domes, mixed pine/cypress, hydric pine, and isolated wetlands in Southwest Florida. Wetlands within 15 km (9.3 miles) of rookeries are considered core foraging areas for wading birds (Cox et al. 1994). They also utilize estuaries, mangroves, and beaches in the study area. They feed on fish, frogs, crawfish, mice and insects.

Nesting occurs in flooded woodlands and on islands. Typical vegetation includes cypress, red maple, mangrove, willow, and buttonbush (Rodgers, Jr. 1996). Data collected in 1996 (FGFWFC) indicate that 25 wading bird rookeries occur within the EIS study area.

The primary threat to these wading birds is loss of foraging habitat, particularly seasonal and isolated wetlands, through habitat alteration, including filling and changes in hydrology. Exposure to pollution, pesticide residues, and disturbance of colony sites may also play a role (Rodgers, Jr. 1996).

These four wading bird species are listed as species of special concern by the FFWCC.

<u>Arctic peregrine falcon</u> *<u>Falco peregrinus tundrius</u>*

The peregrine falcon is the largest of the falcons found in Florida. Florida serves as an important wintering area and migratory route for this subspecies. Migrants can be found in Florida after the first fall cold front with some individuals remaining all winter. Florida's coastline (including the Marco Island and Ten Thousand Island areas) and inland lakes and marshes, both abundant with shorebirds and waterfowl, attract these spectacular hunters. Dry prairies, wet prairies, and agricultural environments also serve as suitable feeding areas. Abundant bird prey and high perching areas are a must for this species. The peregrine falcon is listed as endangered by the FFWCC and was recently delisted by the USFWS.

Southeastern American kestrel *Falco sparverius paulus*

The Southeastern American kestrel is the smallest of the falcons found in the United States. Florida also serves as an important wintering area for the similar American kestrel (*F. s. sparverius*). Both subspecies prefer open areas with scattered trees, as well as urban and cultivated habitats (Stys 1993). Typical food items consist of insects and small vertebrates, such as lizards and toads. Population decline appears to be due to man-induced changes including urbanization and changes in land use practices (e.g., suppression of fire). While clearing of timber and clearing for cattle has resulted in new foraging areas, it has also resulted in loss of suitable nest sites (Smallwood 1990 *in* Stys 1993). The Southeastern American kestrel is not well-documented in the study area but few comprehensive surveys have occurred. The Southeastern American kestrel is listed as threatened by the FFWCC.

Florida sandhill crane *Grus canadensis pratensis*

The Florida sandhill crane is one of Florida's largest birds, and is one of six recognized subspecies of sandhill crane. The sandhill crane utilizes open prairies, active or fallow cropland, and improved pastures for foraging, and herbaceous wetlands as nest sites. The cranes are opportunistic feeders, feeding on invertebrates, plants, seeds, berries, birds, and small mammals (Stys 1997).

Concentrations of cranes have been noted in the area surrounding the Southwest Florida International Airport, as well as agricultural areas within the study area (Arnold Committee 1996). The crane is at risk due to loss of wetlands from filling or ditching, degradation or loss of prairie and range habitats, and fragmentation of remaining habitat into patches too small or remote to be considered suitable for crane use (Stys 1997). Low fecundity is also a concern for the long-term fitness and recovery of the species. The Florida sandhill crane has been listed as threatened by the FFWCC since 1974.

Florida burrowing owl *Speotyto cunicularia floridana*

The Florida burrowing owl is listed as a species of special concern by the FFWCC. The Florida burrowing owl is typically found in open, well-drained treeless areas where the herbaceous ground cover is low or close-cropped, such as pastures and athletic fields (Millsap 1996). The primary prey items include insects, brown anoles, Cuban treefrogs, roadkill animals, songbirds, and small rodents. The primary threats to the species are from development and intensive cultivation (Millsap 1996).

Although the status of the owl population in the study area is unclear, owls are known to occur on mining lands and improved pasture, and in the area surrounding the Southwest Florida International Airport, Marco Island, and some areas of Lehigh Acres (Arnold Committee 1996).

Florida Scrub-Jay *Aphelocoma coerulescens*

The Florida scrub-jay was listed by the USFWS as threatened under the Endangered Species Act in 1987, primarily due to habitat loss, fragmentation, and degradation. The scrub-jay is also listed as threatened by the FFWCC. Scrub habitats associated with Florida's coastal islands, mainland coasts, and the Lake Wales Ridge are considered to be among the most threatened natural systems in the United States, with an estimated habitat loss of more than 80 percent relative to pre-settlement acreage (Fitzpatrick et al. 1991).

Florida scrub-jays are non-migratory and relatively sedentary, rarely traveling farther than 8-10 km (5-6 miles). Scrub-jays occupy territories on a continual (i.e., year-round) basis (Woolfenden and Fitzpatrick 1984; Fitzpatrick et al. 1991; Fitzpatrick et al. 1994). Territory size averages 9-10 ha (22 to 25 ac), with a minimum size of about 5 ha (12 ac). The availability of territories is a limiting factor for scrub-jay populations.

There are relatively few predators of adult Florida scrub-jays, but the most frequent predators are raptors such as Cooper's hawk (*A. cooperii*), sharp-shinned hawk (*Accipiter striatus*), merlin (*Falco columbarius*), and the Northern harrier (*Circus cyaneus*). Snakes, raccoons (*Procyon lotor*), and feral cats (*Felis cattus*) are also known to prey on nestlings and adults (Fitzpatrick et al. 1994).

The Florida scrub-jay has very narrow habitat requirements, being endemic to Florida's relict dune ecosystems and scrubs, which occur on well-drained, nutrient-poor, sandy soils (Myers 1990; Fitzpatrick et al. 1994). This relict oak-dominated scrub, or xeric oak scrub, is crucial habitat for the Florida scrub-jay. The phenotypic oak scrub is predominantly four species of evergreen, low-growing oaks (Chapman oak (*Quercus chapmanii*), sand live oak (*Q. geminata*), myrtle oak (*Q. myrtifolia*), and scrub oak (*Q. inopina*)), with or without the presence of rosemary (*Ceratiola ericoides*) and/or sand pine (*Pinus clausa*) or slash pine (*P. elliottii* var. *densa*) (Myers 1990). In optimal scrub-jay habitat, these oaks are one to three meters (3 to 10 feet) tall, with a mosaic of sandy openings comprising 25 to 50 percent of the total cover, and a pine (sand pine or slash pine) canopy of less than 20 percent (Woolfenden and Fitzpatrick 1990).

The predominant communities providing suitable scrub-jay habitat in Southwest Florida are oak scrub and scrubby flatwoods, the latter of which differs from scrub in that it has a sparse cover of slash pine. Portions of the EIS study area (the western two-thirds of Lee County, the northern portion of Collier County, and the Immokalee area) are mapped as containing suitable habitat types (USFWS 1998). This habitat, in addition to similar habitat in Charlotte, Glades, and Hendry Counties, acts as a "connector" between the larger habitat areas designated as the "Southern Gulf Coast sub-region" and the "Lake Wales Ridge sub-region." The Immokalee scrub-jay population has been designated by the USFWS and the FFWCC for special protection measures (Arnold Committee 1996). Scrub-jays have been reintroduced to oak scrubs at Rookery Bay National Estuarine Research Reserve.

The Southwest Florida area has experienced significant habitat fragmentation and loss due to development and urbanization (USFWS 1998). This loss of habitat, as well as degradation due to suppression of fire (necessary to maintain "optimal" habitat) has placed additional burdens on this populations.

<u>Bald Eagle</u> <u>*Haliaeetus leucocephalus*</u>

The bald eagle is the only eagle unique to North America. It ranges over most of the continent, from the northern reaches of Alaska and Canada down to northern Mexico.

The bald eagle occurs in various habitats near lakes, large rivers, and coastlines. In general, eagles need an environment of quiet isolation; tall, mature trees; clean waters; a source of prey; and prefer nesting within one-half mile (0.8 km) of water.

The bald eagle population was decimated in the 19th and early 20th centuries by habitat destruction, hunting, pesticide use and lead poisoning. In 1967, bald eagles were officially declared an endangered species. Due to this and other protective measures, the population has made a tremendous comeback, its populations greatly improving in numbers, productivity, and security in recent years. Its largest populations are currently found in Alaska and Florida (USFWS 1995).

Twenty-six active bald eagle nests are recorded within the study area, as of the 1996 winter census (FGFWFC 1996). In Lee and Collier counties, nesting eagles are mainly concentrated along coastal areas. Nests typically occur in pines and cypress within the study area but occasionally eagles nest in Australian pines.

The bald eagle is currently listed as a threatened species by both the USFWS and FFWCC.

<u>Wood Stork</u> <u>*Mycteria americana*</u>

The wood stork is the only stork occurring in the United States. In the U.S., the wood stork's range includes Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. However, the only states in which this bird is known to nest are Florida, Georgia, and South Carolina.

The wood stork is primarily associated with freshwater and estuarine habitats for nesting, roosting, and foraging. Wood storks typically construct their nests in medium to tall trees that occur in stands located either in swamps or on islands surrounded by relatively broad expanses of open water (Palmer 1962, Rodgers et al. 1996, Ogden 1991). Historically, wood storks in south Florida established breeding colonies primarily in large stands of bald cypress and red mangrove. The large, historic Everglades National Park nesting colonies were in estuarine zones. These estuarine zones are also an important feeding habitat for the nesting birds. In some years, the inland marshes of the Everglades have supported the majority (55 percent) of the U.S. population of wood storks (USFWS 1997).

During the non-breeding season or while foraging, wood storks occur in a wide variety of wetland habitats. Typical foraging sites for the wood stork include freshwater marshes and stock ponds, shallow, seasonally flooded roadside or agricultural ditches, narrow tidal creeks or shallow tidal pools, managed impoundments, and depressions in cypress heads and swamp sloughs. Because of their specialized feeding behavior, wood storks forage most effectively in shallow water areas with highly concentrated prey (Ogden et al. 1978, Browder 1984, Coulter 1987). In south Florida, low, dry season water levels are often necessary to concentrate fish to densities suitable for effective foraging by wood storks (Kahl 1964, Kushlan et al. 1975). As a result, wood storks will forage in many different shallow wetland depressions where fish become concentrated as a consequence of seasonal drying. Wetlands found within 30 km (18.6 miles) of rookeries are considered core foraging areas by the FFWCC (Cox et al. 1994). Four wood stork rookery sites were mapped within the EIS study area (all in Collier County) during the late 1980s (Runde et al. 1991). The largest wood stork rookery in the U.S. is located in the Corkscrew Swamp Sanctuary (Arnold Committee 1996). The extreme dependence of the wood stork on naturally functioning wetlands makes it an excellent indicator of the health of wetland ecosystems.

Until the last few decades, the wood stork was a common sight in Florida's wetlands. However, between the 1930s and 1960s, there was a serious decline in this species. One reason for the decline in population has been changes in the hydrologic regime in the Everglades, which affected its foraging habitat and food production (Mazzotti 1990).

The loss or degradation of wetlands in south Florida is one of the principal threats to the wood stork. Nearly half of the Everglades has been drained for agriculture and urban development (Davis and Ogden 1994). Everglades National Park has preserved only about one-fifth of the original extent of the Everglades and areas of remaining marsh outside of the Park have been dissected into impoundments of varying depths. From the mid-1970s to the mid-1980s, 105,000 ha of wetlands (including marine and estuarine offshore habitats) were lost in the State of Florida.

We do not have an estimate for the loss of freshwater wetlands in central and south Florida (Hefner et al. 1994) for this same period.

Traditional wetland nesting sites may be abandoned by storks once local or regional drainage schemes remove surface water from beneath the colony trees. Maintaining adequate water levels to protect nests from predation is a critical factor affecting production of a colony. The lowered water levels allow nest access by raccoons and other land-based predators. As a result of such drainage and predation, many storks have shifted colony sites from natural to managed or impounded wetlands.

The wood stork is currently listed as an endangered species by both the USFWS (1967) and the FFWCC. The original listing recognized the relationship between the declining wood stork population, the loss of suitable foraging habitat, and colony nesting failures, particularly in breeding colonies in south Florida where human actions have reduced wetlands areas by about 35 percent.

Everglades Snail Kite *Rostrhamus sociabilis plumbeus*

Although previously located in freshwater marshes over a considerable area of peninsular Florida, the range of the snail kite is currently more limited. This bird is now restricted to several impoundments on the headwaters of the St. John's River; the southwest side of Lake Okeechobee; the eastern and southern portions of Water Conservation Areas (WCA) 1, 2A and 3; the southern portion of WCA 2B; the western edge of WCA 3B; and the northern portion of Everglades National Park.

The snail kite inhabits relatively open freshwater marshes which support adequate populations of apple snail (*Pomacea paludosa*), upon which this bird feeds almost exclusively. Favorable areas consist of extensive shallow, open waters such as sloughs and flats, vegetated by sawgrass (*Cladium jamaicense*) and spikerushes (*Eleocharis* spp.). The areas are often interspersed with tree islands or small groups of scattered shrubs and trees which serve as perching and nesting sites. The water level must be sufficiently stable to prevent loss of the food supply through drying out of the surface.

In the study area, the snail kite has been noted in the area around the Southwest Florida International Airport mitigation lands, in canals and Harnes Marsh in Lehigh Acres (Arnold Committee 1996) and in agricultural retention areas in eastern Lee County.

The snail kite is threatened primarily by habitat loss and destruction. Widespread drainage has permanently lowered the water table in some areas. This drainage permitted development in areas that were once snail kite habitat. In addition to loss of habitat through drainage, large areas of marsh are heavily infested with water hyacinth which inhibits the snail kite's ability to see its prey (USFWS, May 1996).

Three (3) snail kite roosting areas were identified within the EIS study area, based upon FGFWFC (1996) data - one each in Zooms B (the Hub), C, and D. An additional four (4) roosting areas are located just east of Zoom D. Snail kite use of habitat in Southwest Florida may be linked to drought conditions in other areas. Birds may also be dispersing juveniles (Toland USFWS pers. comm. 1996).

The snail kite is currently listed as an endangered species by both the USFWS and FFWCC.

Sherman's short-tailed shrew *Blarina brevicauda shermanii*

The Sherman's short-tailed shrew is typically found in mesic forests and slash pine and palmetto flatwoods with dense herbaceous areas in Southwestern Florida. The primary threats to the shrew are habitat loss or disturbance, through changes in hydrology or land clearing activities, and predation by feral and domestic house cats (Layne 1992). Based upon current knowledge, Sherman's short-tailed shrew has one of the most restricted ranges of all Florida mammals (Layne 1992). The shrew has been collected along the Orange River and along Hickey Creek, located west and north of Lehigh Acres, respectively (Arnold Committee 1996).

The Sherman's short-tailed shrew is currently listed as a species of special concern by the FFWCC.

Florida panther *Felis concolor coryi*

A small population in South Florida, estimated to number between 30 and 50 adults (30 to 80 total individuals), represents the only known remaining wild population of an animal that once ranged throughout most of the southeastern United States from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida, and parts of South Carolina and Tennessee. The panther presently occupies a contiguous system of large private ranches and public conservation lands in Broward, Collier, Glades, Hendry, Lee, Miami-Dade, Monroe, and Palm Beach counties totaling more than 809,400 ha (2,000,000 ac). Population viability projections have concluded that under current demographic and genetic conditions, the panther would probably become extinct within two to four decades. A genetic management program was implemented with the release of eight female Texas cougars (*Puma concolor stanleyana*) into South Florida in 1995. The survival and recovery of the Florida panther is dependent upon: (1) protection and enhancement of the extant population, associated habitats, and prey resources; (2) improving genetic health and population viability; and (3) re-establishing at least two additional populations within the historic range (page 4-117, MSRP).

Environmental factors affecting the panther include: habitat loss and fragmentation, contaminants, prey availability, human-related disturbance and mortality, disease, and genetic erosion (Dunbar 1993).

<u>Genetic and Physiological</u>: Natural gene exchange between the Florida panther and three other subspecies ceased when the panther became geographically isolated, probably over a century ago (Seal et al. 1994).

<u>Disease</u>: Six of 20 free-ranging Florida panthers (30 percent) captured from Everglades NP, Big Cypress National Preserve, and adjacent lands between 1986 and 1988 tested positive for feline immunodeficiency virus (FIV) (Barr et al. 1989). Five out of 19 panthers (26.3 percent) examined in 1992 (Roelke and Glass 1992) and one of 23 examined between July 1, 1996 and June 30, 1997 (Taylor 1997) tested positive for FIV. FIV has a long incubation period but leads to non-specific immunosuppression and death in domestic cats (Roelke 1991). Its significance to the panther is not known. Other diseases, such as feline infectious peritonitis (FIP), feline leukemia virus (FeLV), *Cytauxzoon felis*, and *Bartonella henselae*, are present in varying degrees (Roelke 1991, Roelke and Glass 1992, Dunbar 1993).

<u>Mortality from shooting</u>: Six Florida panther shootings, five fatal and one non-fatal, occurred between 1978 and 1986--an average of one every 2 years.

<u>Highways</u>: Panthers consistently use large areas with few major highways (Maehr and Cox 1995). Belden and Hagedorn (1993) observed that Texas cougars, used in a population reintroduction study, established home ranges in an area with one-half the road density of the region in which the study was conducted. In particular, the study animals tended to avoid crossing more heavily traveled roads (e.g. primary and secondary hard-surface highways, and light-duty roads) in favor of more lightly traveled roads. Of 26 puma home ranges examined by Van Dyke et al. (1986), 22 (85 percent) included unimproved dirt roads, 15 (58 percent), included improved dirt roads, but only 6 (23 percent) included hard-surfaced roads. Female panthers rarely establish home ranges bisected by highways and maternal dens are located at distances one kilometer or greater away from highways (Maehr 1996). Florida panther road mortality (n=24) between 1978 and June 30, 1998 averaged 1.2 panthers per year and was almost evenly divided between males (n=13) and females (n=11). Vehicle collisions resulting in the death of sub-adult panthers (0 to 3 years) of both sexes exceeds sub-adult mortality due to intraspecific aggression (23.4 versus 10.9 percent) and equals all other forms of sub-adult mortality combined (Land and Taylor 1998). Although the relative significance of highway deaths to other sources of mortality is not entirely known, it has been the most often documented source of mortality (Maehr 1989, Maehr et al. 1991b). Florida panther road mortality and injury (n=30) between 1978 and June 30, 1998 was greatest in Collier County (76.7 percent), followed by Hendry County (10.0 percent), and Lee County (10.0 percent). During the same period panther mortality and injury was greatest on S.R. 29 (33.3 percent) and Alligator Alley (16.7 percent) in Collier County (Land and Taylor 1998). Nighttime speed limits were reduced on S.R. 29 and Alligator Alley in 1984 in an effort to minimize panther/vehicle collisions. Wildlife underpasses, first used by panthers in 1989 (Maehr 1992a), have greatly reduced risks in these problem areas (Foster and Humphrey 1995).

<u>Urbanization</u>: Continued expansion of the urbanized east coast, increasing growth on the west coast, and the spread of agricultural development in the interior have placed increasing pressures on forested tracts in Collier, Glades, Hendry, and Highlands counties (Maehr 1990b, Maehr 1992a, Maehr et al. 1991a).

Agriculture: Over 83 percent of the 648,000 ha of agricultural land in southwest Florida; i.e., Charlotte, Collier, Glades, Hendry, Lee and Sarasota counties, is categorized as rangeland. Between 1986 and 1990, row crop acreage increased by 3,640 ha or 21 percent, sugarcane increased by 6,475 ha or 21 percent, citrus increased by 21,850 ha or 75 percent, and rangeland - much of it suitable for panther occupation - decreased by 64,750 ha or 10 percent. Rangeland losses were about evenly divided between agricultural development (citrus, row crops, sugarcane) and urban development (Townsend 1991). (MSRP 4-125-7)

The only known remaining breeding panther population is centered in and around the Big Cypress Swamp and Everglades area of South Florida. Native landscapes within the Big Cypress Swamp region are dominated by pine, cypress, and freshwater marshes, interspersed with mixed-swamp forests, hammock forests, and prairies (Duever et al. 1979). Tracking data from radio-collared members of this population indicate that its epicenter is in Collier and Hendry Counties. Collared panthers have also been documented in Broward, Dade, Glades, Hardee, Highlands, Lee, Monroe, and Palm Beach Counties. There are still large areas of privately-owned land in Charlotte, Collier, Hendry, Lee, and Glades Counties where uncollared individuals may reside (Maehr 1992a). Lands under private ownership account for approximately 53% of the occupied panther range in South Florida (Logan et al. 1993). The greatest concentration of unprotected, occupied panther habitat is found on private land in eastern Collier County and southern Hendry County (Maehr 1992a). For the most part, privately owned lands are higher in elevation, better drained, have a higher percentage of hardwood hammocks and pine flatwoods, and are higher in natural productivity than public lands south of Interstate 75. Private lands contain some of the most productive panther habitat in South Florida, primarily due to habitat and general land management practices. However, better soils and drainage make this land more suitable for intensive agriculture and urban growth than public lands (Maehr 1992b).

Historically, the Florida panther population was tied to the population of its primary prey, the white-tailed deer (*Odocoileus virginianus*). As deer populations varied due to disease and to changes in land cover and land management practices, the panther took advantage of a human-introduced alternative to the deer - the feral hog (*Sus scrofa*) (Maehr 1992b). Food habit studies of panthers in Southwest Florida indicate that the feral hog was the most commonly taken prey followed by white-tailed deer, raccoon, and nine-banded armadillo (*Dasypus novemcinctus*). Although domestic cattle are readily available, they are rarely taken as prey items (Maehr 1990 *in* USFWS 1998).

The typical home range size for a female panther is 195 km^2 (75 square miles) (Logan et al. 1993). Female home range size has been positively correlated with higher percentages of dry prairie, shrub swamp, and shrub and brush, with the larger home ranges containing greater amounts of these cover types (Maehr 1992a). Similarly, female panther home range size is inversely related to habitat quality and may also influence reproductive success (Maehr 1992a). Male Florida panthers use more cover types and have larger home ranges than females. The average home range size for a male is approximately 518 km^2 (200 square miles) (Logan et al. 1993). The home range size of male panthers is influenced by the percentages of hardwood hammock, hardwood swamp, water, grass and agricultural land, barren land, and scrub and brush in the landscape. Smaller male home ranges have greater percentages of hardwood hammocks and hardwood swamp, while larger home ranges have greater percentages of water, grass and agricultural land, barren land, and shrub and brush. Dispersing males may wander widely through non-forested and disturbed areas (Maehr 1992b). Portions of Lee County are typically used by young, dispersing cats prior to establishment of a permanent territory. However, breeding cats are documented in the Corkscrew Marsh. These cats follow the forested areas along I-75 north from the CREW (Arnold Committee 1996).

Everglades mink *Mustela vison evergladensis*

The Everglades mink was first described as a subspecies in 1948 (Humphrey 1992). Its primary habitat is shallow wetlands of all types, although swamp forests are utilized more than most due to more stable hydroperiods. The diet of the mink consists of insects, crayfish, small mammals, and fish.

The primary threats to the species are from habitat degradation/alteration (draining of wetlands) and from conversion of habitat to citrus culture.

The Everglades mink is documented in the Big Cypress Preserve just east of the study area, and has been noted as far west as the Rookery Bay National Estuarine Research Reserve in Collier County and the Estero Bay Buffer Preserve in Lee County.

The Everglades mink is listed a threatened species by the FFWCC.

Big Cypress fox squirrel *Sciurus niger avicennia*

The Big Cypress fox squirrel is a distinct subspecies of fox squirrel with a range restriction to Southwestern Florida. Habitat use by the Big Cypress fox squirrel is complex and poorly understood. They are found in a variety of forested communities, especially open pinelands, with the exception of dense mixed cypress-hardwood strands. This may be due to avoidance of gray squirrels (*Sciurus carolinensis*), which densely occupy the mixed cypress-hardwood community (Humphrey 1992).

The cones of the South Florida slash pine (*Pinus elliottii* var. *densa*) seem to be a favorite food item, although cypress (*Taxodium* spp.) cones, cabbage palm (*Sabal palmetto*) fruits, and acorns are also utilized. The Big Cypress fox squirrel nests in pines, constructing nests of grapevine and cabbage palm thatch, but also utilizes cypress, bromeliads and exotic trees such as melaleuca (*Melaleuca quinquenervia*).

The primary threat to the species is habitat destruction. Large-scale development west of the Big Cypress National Preserve, conversion of pinelands to agriculture, and road construction are considered serious threats.

The Big Cypress fox squirrel is documented in pinelands, mixed pine-cypress, open cypress domes and mixed forested areas in the study area.

The Big Cypress fox squirrel is listed as a threatened species by the FFWCC, and is proposed as a candidate species for listing by the USFWS.

Florida black bear *Ursus americanus floridanus*

The Florida black bear is the largest extant land mammal in Florida (Maehr 1992c). Several fragmented sub-populations exist throughout the State, most notably around the Ocala National Forest, the Apalachicola National Forest, and in Southwest Florida. Large, undeveloped wooded tracts are the bear’s preferred habitat. In Southwest Florida, the black bear also utilizes mangrove forests.

The black bear is omnivorous, feeding primarily on succulent vegetation (tubers, bulbs, berries, nuts, young shoots) and colonial insects. The berries of the saw palmetto (*Serenoa repens*), cabbage palm, swamp tupelo (*Nyssa biflora*), and acorns are preferred foods in the fall. The honey bee (*Apis mellifera*) is the most frequently consumed insect, and nine-banded armadillos the most commonly consumed vertebrate (Maehr 1992c).

The primary threat to the black bear is loss of habitat through clearing and fragmentation of forested land for agricultural uses, urbanization, and other development. Loss of individuals due to vehicular collisions is also of concern in areas where highways bisect remaining bear habitat. There have been forty-seven (47) recorded roadkills within the study area, primarily in the southern portion (Zooms C and D).

The black bear occurs throughout the undeveloped and rural areas within the study area, and has been noted as far west as the Rookery Bay National Estuarine Research Reserve in Collier County and the Estero Bay Buffer Preserve in Lee County.

The black bear has been listed as a threatened species by the FFWCC since 1974.

West Indian Manatee *Trichechus manatus*

The West Indian manatee, is a large, plant-eating aquatic mammal that can be found in the shallow coastal waters, rivers, and springs of Florida. Florida is essentially the northern extent of the West Indian manatee's range, although some manatees occasionally are reported from as far north as Virginia and the Carolinas.

The West Indian manatee lives in freshwater, brackish, and marine habitats, and can move freely between salinity extremes. It can be found in both clear and muddy water. Water depths of at least 1 to 2 m (3 to 7 ft) are preferred, and flats and shallows are avoided unless they are adjacent to deeper water. During the summer months, manatees range throughout the coastal waters, estuaries, bays, and rivers of both coasts of Florida, and are usually found in small groups. During the winter, manatees tend to congregate in warm springs, and outfall canals associated with electric power generation facilities.

Over the past centuries, the principal sources of manatee mortality have been opportunistic hunting by man and deaths associated with unusually cold winters. Today, poaching is rare, but high mortality rates from human-related sources threaten the future of the species. The largest single mortality factor is collision with boats and barges. Manatees also are killed in flood gates and canal locks, by entanglement or ingestion of fishing gear, and through loss of habitat and pollution (FP&L 1989).

Lee and Collier counties have the second and third highest manatee mortality related to watercraft in the State. In 1996, 158 manatees died in Southwest Florida as a result of complications related to a red tide outbreak in Lee and Collier Counties.

The West Indian manatee is currently listed as an endangered species by both the USFWS and FFWCC.

3.4 FISH AND WILDLIFE RESOURCES

Fish and wildlife species are still abundant and widespread throughout the study area, although the distribution and numbers of species has been changed as a result of development and general urbanization of the coastal areas. The southwest region of Florida has a rich diversity of native animal life, including species that are endemic to the region, and sub-tropical species found nowhere else in the United States, augmented seasonally by migratory patterns of many different birds and fish species. The species for which Southwest Florida is known include the alligator, the West Indian manatee, the wood stork, the Florida panther, the tarpon (*Megalops atlanticus*), and the pink shrimp (*Penaeus duorarum*) (SWFRPC 1995).

3.5 WATER QUALITY

3.5.1. INTRODUCTION

This section provides descriptions of the methodology, terminology, and rationale used to characterize the affected environment of surface and ground water quality within the study area. The status of historical and current water quality conditions for the study area are described by means of water quality parameters, Florida State water classifications, water quality indices, and exceedences of Florida State water quality criteria. Data are inconclusive with respect to water quality trends for many watersheds discussed in the following sections.

3.5.2. SURFACE WATERS

This section describes surface water quality as defined by physical and biological parameters, flow characteristics, pollutants, nutrients and, if known, biological indicators. The descriptions of water quality are largely based on STORET data summaries for individual watersheds within the larger study area watersheds. STORET is an Environmental Protection Agency (EPA) database of water quality information collected by numerous agencies. Other water quality studies were consulted as well (CDM, Inc. 1995; Gibson 1997). Geography, topography, rainfall, evaporation, and man-made alterations within the watershed, such as hydrographic modifications (drainage canals, dams), development, and agriculture, affect the quality of water. The EPA and FDEP use STORET data to assess water quality trends in watersheds by condensing certain parameters into one of two indices, thereby facilitating year to year comparisons. Non-point source pollution, contaminant information, and exceedences of water quality standards are also evaluated for trend determination. In the following sections, water quality of rivers, creeks, bays, canals, and swamps will be discussed for the three watersheds of interest to this study.

For purposes of historical descriptions, the study area watersheds have been identified as the Caloosahatchee, the Estero-Imperial Integrated, and the Big Cypress/West Collier, and Southern Big Cypress Swamp with various associated watershed basins as indicated in **Figure 11** and **Table 5**. These four large watersheds have been divided into 10 drainage basins for the purposes of reporting water quality data. Additionally, the water quality data will be examined at a higher resolution after the release of this report. Introductory information on the physical setting, surrounding land use, natural habitats, and physical characteristics of the various watershed systems have been provided to better assess historic and current water quality within the study area.

Table 5. Watersheds And Receiving Waters Of The Study Area

WATERSHED	DRAINAGE BASIN	RECEIVING WATER BODY	ULTIMATE ENDPOINT
Caloosahatchee Watershed	Tidal Caloosahatchee Basin	Tidal Caloosahatchee River	San Carlos Bay
	West Caloosahatchee Basin	West Caloosahatchee River	West Caloosahatchee River
Estero-Imperial Watershed	Estero Bay Basin	Estero River, Spring Creek	Estero Bay
	Imperial River Basin	Imperial River	Estero Bay
Big Cypress/West Collier Watershed	Corkscrew-Cocohatchee River Basin	Cocohatchee River, Corkscrew Swamp	Wiggins Pass/Gulf of Mexico
	Golden Gate Canal Basin	Golden Gate Canal	Naples Bay
	District VI Basin	Lely Canal	Gulf of Mexico
	Faka-Union Canal Basin	Faka-Union Canal	Faka-Union Bay
	Henderson Creek Basin	Henderson Creek	Rookery Bay
	Collier-Seminole Basin	CR92 Canal	Gullivan Bay
Southern Big Cypress Swamp	Fakahatchee Strand Basin	Fakahatchee Strand	Ten-Thousand Islands

Caloosahatchee Watershed

The study area incorporates the southern portions of the Tidal Caloosahatchee and West Caloosahatchee watershed basins but does not include the waters of the Caloosahatchee River. The East Caloosahatchee River is not discussed although it drains into the study area.

The East and West portions of the freshwater segment of Caloosahatchee River have been restructured into a canal known as C-43. Drinking and irrigation water is obtained from the eastern portion of the canal, while the western portion is designated for wildlife and recreational use. There are about 60 tributaries of varying water quality with respect to FDEP indices within the Caloosahatchee River watershed.

Basin	Name
1	West Caloosahatchee
2	Tidal Caloosahatchee
3	Estero Bay
4	Cocohatchee-Corkscrew
5	Golden Gate
6	Faka Union Canal
7	Fakahatchee Strand
8	District VI
9	Henderson Creek
10	Collier-Seminole

Figure 11. USGS and SFWMD Watersheds and Basins within the Study Area.

Physical Description

To accommodate navigation, flood control, and land reclamation needs, the Caloosahatchee River has been radically altered from its natural state. One of the most dramatic changes was the dredging that connected the Caloosahatchee to Lake Okeechobee in 1881 in order to lower the water level of Lake Okeechobee. In 1882, the channelization of the lower reaches of the river began.

Due to intensive canal construction by 1910, shallow draft navigation from the Gulf of Mexico to the Atlantic Ocean was possible. Canal locks at Moore Haven were completed in 1918, and the locks at Ortoona were completed in 1937. The W. P. Franklin Lock was completed in 1969, preventing saline water from flowing upstream of Olga (Kimes and Crocker 1998).

In addition to the alteration of the main channel, many canals have been constructed along the banks of the river. These canals were constructed for both water supply and land reclamation in order to support the many agricultural communities along the river.

Land use within the Caloosahatchee watershed is dominated by rangeland and agriculture, particularly in the upper part of the basin (FDEP 1996a). The major urban areas that occur along the tidal Caloosahatchee watershed basin are Ft. Myers and, across the river, the large residential areas of Cape Coral and North Ft. Myers.

Flow and stage height in the Caloosahatchee River is controlled by a series of locks. Agricultural practices and navigation channels have for many years dictated the patterns of surface water drainage. Canal, lock, and spillway construction and dredging have been occurring since the late 1800s, altering the natural watercourse of the Caloosahatchee River. Today, three primary locks function to regulate water level, usage, and saltwater intrusion. One, at Moore Haven, regulates Lake Okeechobee waters. The Ortoona Lock delineates the east river basin from the west and controls water on the adjoining land areas. The Franklin Lock at Ft. Myers prevents saltwater intrusion from the tidal Caloosahatchee River segment from proceeding eastward. The pattern and period of flow of the Caloosahatchee River is highly variable, based on demand. River flows are negative (from west to east) for a majority of the year, possibly resulting from heavy irrigation usage or losses to groundwater and/or evapotranspiration (Drew and Schomer 1984).

Historical Description

Camp, Dresser and McKee (CDM), Inc. (1995) compared monitoring results of a 1993-94 study on the freshwater Caloosahatchee River with data from 1973-1980. CDM concluded that historical water quality differed from current water quality only with respect to small differences in nutrient concentrations. The report stated dissolved oxygen was historically low, as were suspended solids. Total phosphorus was comparable to other Florida water bodies, but nitrogen and chlorophyll a were generally high. Decreasing trends in total nitrogen were observed westward from Lake Okeechobee. Measurements of DO, pH, conductivity, and total phosphorus generally increased westward from Lake Okeechobee.

Historical information on the tidal Caloosahatchee from 1975-76 was available from Drew and Schomer (1984). Previous surveys indicated some aspects of water quality, such as DO, improved as one moved downstream away from the urbanized areas. Seasonal water quality fluctuations have also been observed, with DO decreasing in October and December and stabilizing in February. Salinity decreased, temperature decreased, and chlorophyll a decreased in the winter. During the 1970s, pollution was attributed to the following major sources: downstream flow from the Franklin Lock; Orange River inflow; the wastewater treatment plant (WWTP) effluent from the cities of Cape Coral and Fort Myers; and the residential development, Water Way Estates (Drew and Schomer 1984).

Freshwater Systems

The freshwater systems of the Caloosahatchee River are divided into the Eastern and Western Caloosahatchee. The Western Caloosahatchee begins at the point where Franklin Lock separates the tidally influenced waters from the upland waters. The Eastern Caloosahatchee begins at Ortoona Lock and extends to Lake Okeechobee (FDEP 1996a).

Water quality parameters are expressed as annual averages and include physical and biological parameters, nutrients, and contaminants. Sediment quality data, if available, are also briefly discussed. Known impaired usage of the basins is presented last. The majority of the current data discussion represent data collected from 1990 to 1995.

West Caloosahatchee Basin

Reductions in pH and increased suspended solids are partially responsible for an observed degrading trend for areas north of Townsend Canal (FDEP 1996a). Chlorophyll a levels are improving and most other parameters are holding steady. Other areas of the basin rate “good” on the FDEP’s WQI scale.

Physical water quality parameters throughout most of the basin are characterized by relatively neutral pH, DO readings mostly above 7.0 mg/L, good water clarity (i.e., low turbidity, low color, low TSS), and specific conductance between 500 and 700. No State screening levels for physical water quality are exceeded.

Biological oxygen demand is low (<2.3 mg/L) in the West Caloosahatchee and chlorophyll a ranges from 2-8 μg/L, an improvement over previous years. Nutrients generally do not exceed State screening levels, but at most basins are slightly higher than average for State waters. All waters in the West Caloosahatchee are rated “good” on the WQI scale.

Fecal and total coliform bacteria counts are low and do not exceed State standards. However, conventional pollutants and mercury are present (FDEP 1996a).

Approximately 41% of the West Caloosahatchee Basin are agricultural lands. Wetlands and pine forests make up 12% and 16%, respectively. The identified source of water quality degradation within this basin is agricultural runoff.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix). WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 41.4, 42.9, and 50; respectively.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990’s. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=70), total carbon (WQI=58.5), and fecal coliform (86.1). The level of confidence is much stronger with the 1990’s data, particularly with the recent addition of more water quality data.

Estuarine Systems

Tidal Caloosahatchee Basin

The tidal Caloosahatchee extends 28 miles from Franklin Lock to San Carlos Bay, and is so named because its waters are subject to tidal forces (Drew and Schomer 1984). Tributaries of the tidal Caloosahatchee include Billy Creek, Whiskey Creek, Orange River, Hickey Creek, Roberts Canal, and Daughtrey Creek.

Physical water quality of the tidal Caloosahatchee is represented by pH, DO, conductivity, and water clarity. pH ranges slightly above neutral at 7.3 – 7.8. Except for Deep Lagoon and Manuel Branch, the average DO of the tidal Caloosahatchee and its tributaries ranges from 6.5 to 7.4. The overall DO trend is stable. Conductivity is usually above 10,000 micromhos, which is typical for estuarine waters. The freshwater tributaries are lower in conductivity. Orange River is the lowest at 508 micromhos. Water clarity varies along the river and tributaries. Deep Lagoon color was highest at 130 PCUs. A low of 33 PCUs occurs in the lower tidal basin. TSS are generally low at 1-10 mg/L. The highest TSS occurs in

Manuel Branch. Turbidity is generally low, ranging between 1.3-6.3. The most turbid waters occur in Manuel Branch. Overall physical chemistry is stable (FDEP 1996a).

Measured values of key biological parameters indicate degraded water quality in parts of the tidal Caloosahatchee and tributaries. Biochemical oxygen demand (BOD), fecal coliform bacteria, and chlorophyll a levels exceeded State standards or screening levels at several locations. Fecal coliform bacteria were high in 1992 at Manuel Branch (2195 MPN/100 ml) and Billy Creek (1839 MPN/100 ml). The State screening level for fecal coliform bacteria is >190 MPN/100 ml (FDEP 1996a). Chlorophyll a was high (27 μg/L) in Deep Lagoon and Billy Creek (57 μg/L). Due to the poor biological parameters, the tidal Caloosahatchee only partially meets its designated use as a Class II water, suitable for shellfish harvesting (FDEP 1996a).

Nutrient measurements for total nitrogen and total phosphorus in the tidal Caloosahatchee were highest at or east of Ft. Myers. Total nitrogen levels were exceeded in the Caloosahatchee at a station adjacent to Ft. Myers with an average measurement of 1.64 mg/L in 1991. Total nitrogen exceedences (>1.22 mg/L) were also observed east of Ft. Myers in the Caloosahatchee, and at Billy Creek and Deep Lagoon. Averages for total phosphorus exceeded State standards (i.e., were >0.07) in most cases, with the exception of Orange River. The nutrient status as indicated by the TSI is “poor” for Deep Lagoon, “poor” for Billy Creek, and “fair” but close to “poor” for the tidal Caloosahatchee. The WQI for freshwater streams and rivers rated Orange River water quality “good” (FDEP 1996a).

Sources of water quality degradation include: wastewater inputs from Ft. Myers WWTPs, high nutrient waters from upriver, inputs from tributaries, and stormwater runoff from cities. Algal blooms occur frequently because of excess nutrients (FDEP 1996a).

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix). TSIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 63.5, 46.0, and 59.1; respectively.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990’s. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=75.2), total phosphorus (WQI=69.5), and fecal coliform (88.1). The level of confidence is much stronger with the 1990’s data, particularly with the recent addition of more water quality data.

3.5.2.2. Estero-Imperial Integrated Watershed

Introduction

The Estero-Imperial Integrated Watershed is comprised of the Estero Bay Watershed and northern portions of the Big Cypress Watershed. The Caloosahatchee River Watershed to the north, the Golden Gate Canal Watershed to the south, and the Gulf of Mexico to the west border the area. Interstate 75 runs north to south through the westernmost portion of the Estero-Imperial Integrated Watershed and divides the more developed coastal areas from the less developed interior. Most of the watershed lies in Lee County with a small percentage located in Hendry County. The Estero and Imperial Rivers, and Spring Creek, though small, are the major tributaries within the Estero-Imperial Integrated Watershed that drain into Estero Bay. Warm, slow moving, estuarine water bodies such as the Estero and Imperial Rivers have some naturally low water quality characteristics such as low DO. Therefore, these may be more susceptible to water quality impacts resulting from changes in land use (FDEP 1996a).

Physical Description

Population centers include the towns of Bonita Springs and Immokalee with 13,600 and 14,120 persons, respectively (U.S. Department of Commerce 1992). Bonita Springs is south of the Imperial River and above the Lee-Collier County border, and Immokalee is located along the eastern edge of the Estero-Imperial Integrated Watershed. Rapid growth is occurring in Bonita Springs where the population more than doubled from 1980 to 1990. Residential areas, cattle, and vegetable farms occupy the landscape and, except for the coastal areas, the population is low (FDEP 1996a).

The Estero and Imperial Rivers and Spring Creek provide minor freshwater flow into Estero Bay. The naturally low flow characteristics of these tributaries make Estero Bay notably susceptible to altered upland drainage water quality, volume, and seasonal inputs (Gissendanner 1983). The topography of the watershed is relatively level, thus accounting for the "sluggish" water movement in this part of the basin (FDEP 1996a).

The highest freshwater inflows into Estero Bay occur in September with great variation in volume observed over the course of the year (Kenner and Brown 1956; Drew and Schomer 1984). At one time, tidally induced flows in Estero Bay exceeded the amount of freshwater inflow (Jones 1980). Estero Bay tides are mixed and average about 0.54 m (1.75 ft) (Estevez et al. 1981), with velocities in the three major Bay-Gulf passes ranging from 0.64 m/s (ebb tide) to 1.52 m/s (flood tide). Flood tides can reach 1.07 m (3.5 ft) in height with volumes of 819 million cubic feet (measured for one pass in 1976) (Drew and Schomer 1984). The low freshwater inflow into Estero Bay allows for generally high saline conditions year-round (around 34 ppt in the dry season), yet is high enough to prevent hypersaline conditions. Salinity seldom falls below 10 ppt even in the wet season (Tabb et al. 1974). Saltwater intrusion into local aquifers has resulted from inadequate recharge of groundwater. This occurrence has been attributed to surface hydrology modifications such as drainage canal construction.

The construction of canals has increased surface water flow such that aquifers are not recharging, thereby allowing saltwater to infiltrate (Daltry and Burr 1998). The Ten Mile Canal was constructed about 1920 to drain a 70 square mile area for agricultural uses and directs this water into Mullock Creek, a tributary of Estero Bay. Generally, this watershed does not have the extensive drainage network of the surrounding areas, but the construction of roads and other berms has still significantly altered the hydrology of the area. These changes have resulted in extensive flooding along the Imperial River. In addition, where flows from the Imperial and Estero Rivers into Estero Bay were once approximately equal, the proportional flow from the Estero River is now much less than that of the Imperial River (Johnson Engineering, Inc. et al. 1998). Surface water from the more interior areas of Flint Pen Strand and Bird Rookery Swamp are drained into Estero Bay and the Wiggins Pass/Cocohatchee River Estuarine System through the Imperial River, Spring Creek, and the Cocohatchee Canal (SFWMD 1998a).

Historical Description

The Estero-Imperial Integrated Watershed was, and in many areas still is, typical of low, flat South Florida lands dominated by wetlands and characterized by slow, sheet-flow drainage patterns. In the past, the naturally dispersed water patterns served to distribute nutrients over broad areas of wetland vegetation. Thus, nutrient levels remained low in undrained areas of this watershed (Haag et al. 1996a). Seasonal fluctuations in flow due to rainfall created the necessary salinity regime in Estero Bay for good estuarine productivity. Estero Bay became the State's first aquatic preserve in 1966 (Alleman in CHNEP 1997). In 1983, the Estero Bay Aquatic Preserve Management Plan was implemented with emphasis placed on "enhancing the existing wilderness condition" (Gissendanner 1983). Increasing development in the 1960s led to changes in the natural river systems around Estero Bay (Alleman in CHNEP 1997). Changes in water quality and quantity have been observed. For example, the Imperial and Estero Rivers historically delivered less fresh water to Estero Bay. From 1940 to 1951, the maximum discharge from the Imperial River was 2,890 cubic feet. Low flows were common and no flows occurred on occasion. Periodic flooding has occurred (Kenner and Brown 1956).

Freshwater Systems

Currently, physical water quality in the coastal areas of the Estero and Imperial Basins is characterized by clear water with neutral pH (7.1 to 7.3) but relatively high conductivity values (>16,000 micromhos). DO is slightly lower in the Imperial Basin (4.9 mg/L compared to 5.7 mg/L) than in the Estero Basin. Estero and Imperial Basin water clarity is characterized by low turbidity at <5.0 NTU/NTUs, generally low suspended solids at <10 mg/L, above average Secchi disc depths of 0.9 m to 1.5 m, and low color at 43 to 55 PCUs. Chloride measurements are not available, but conductivity indicates high dissolved mineral content in the Estero and Imperial Rivers. Biological parameters of chlorophyll a and 5-day biochemical oxygen demand (BOD-5) are of slightly lower quality in the Imperial River than in the Estero River. To clarify, BOD in the Imperial River is higher (2.4 mg/L over 1.4 mg/L) than in the Estero River; chlorophyll a is higher in the Imperial (12 µg/L over 2 µg/L), but generally, the two systems are comparable with respect to water quality. Water from the Estero and Imperial Rivers has a "residency time in the Bay of at least several days during the wet season" (Clark 1987). The Estero and Imperial Rivers were evaluated by the FDEP as having "fair" water quality based on their nutrient status as determined by chlorophyll a, total nitrogen, and total phosphorus measurements.

Metals have been detected from limited sampling of the waters of the Estero-Imperial Integrated Watershed. In addition, elevated levels of cadmium, chromium, lead, mercury, and zinc have been found in the sediments of Estero Bay and River, Imperial River, and Spring Creek as recently as 1986 (Clark 1987). In general, analysis of metals, pesticides and PCBs is lacking for the Estero-Imperial Watershed, with metals having only been sampled six times (with the exception of iron) within the last 30 years.

The Imperial River is classified in terms of usage as a Class III water body, suitable for wildlife and recreation. Due to low DO, nonpoint pollution, and conventional pollutants, water quality only partially supports the Imperial River for this type of use (FDEP 1996a). Likewise, Estero River and Spring Creek are only in partial support of use; Spring Creek because of conventional pollutants and low DO, and Estero River for low DO and fecal coliform.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 52.5, 52.0, and 55.2; respectively.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=74.9), biological oxygen demand (BOD) (WQI=62.1), and fecal coliform (68.9). The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

Estuarine Systems

Estero Bay

Recent STORET data were not available, and data provided by Lee County were only recently acquired and will be evaluated; however, Estero Bay waters are described as shallow, turbid, and of "fair" quality (FDEP 1996a). Nutrients at levels that exceed screening levels tend to drive water-quality ratings down. Consequently, this water body only partially meets its Class III use designation (FDEP 1996a). Measurements were available for one station at Big Carlos Pass in the Bay and therefore may not be indicative of other areas of the Bay.

Water clarity, as indicated by turbidity, TSS, and color (8.5 NTU/NTUs, 28 mg/L, 25 PCUs, respectively) is low. Waters were well oxygenated with mean DO levels at 6.5 mg/L. Conductivity was 37800 micromhos (FDEP 1996a). Low chlorophyll a and low BOD were observed in the past. The mean for chlorophyll a was 8 mg/L, and the mean BOD was 1.6 mg/L.

Estero Bay phosphorus levels were above FDEP screening concentrations. Phosphorus screening levels are >0.07 mg/L and Estero Bay concentrations were 0.10 mg/L. Total nitrogen measured 0.81 mg/L, which is considered low for estuaries. Historical water quality has been described by FDEP as fair based on these parameters.

Estero Bay has not had a problem with high bacterial counts as indicated by the low total and fecal coliform analyses. Some contamination by cadmium, chromium, lead, mercury, and zinc in Estero Bay sediments has been observed. Concentrations of pesticides and PCBs were below minimum detection limits (Clark 1987).

Nutrient inputs from agricultural runoff (fertilizers) are cited as the source of high phosphorus. Habitat alteration through possible destruction of forests and wetlands, water flow changes, and pollution are listed as other impairments to use (CHNEP 1997).

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). TSIs were calculated by decade (1970-1979 and 1990-1998) and approximate 23.8 and 64.3, respectively, for the Estero/Imperial coastal area. Insufficient data for the period 1980-1989 precluded calculation of a TSI for that decade.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameters most responsible for these degraded water quality conditions includes total phosphorous and chlorophyll a. The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

3.5.2.3 Big Cypress/West Collier Watershed

Physical Description

The Big Cypress/West Collier Watershed portion of the study area is situated in Big Cypress preserve, an area of low flat lands of cypress trees, pine forests, and wet and dry prairies. Agriculture and urban are the main types of human land use; however, it should be noted that lands that are zoned as agricultural may in actuality be swamp. Major urban areas situated along the coastal area of the watershed are Naples, East Naples, North Naples, Naples Park, Marco Island, and Golden Gate. The single most conspicuous feature of the area is the expansive system of roads and canals constructed during the 1960s for the Golden Gate Estates (GGE) land development project. The Golden Gate Estate canals channel drainage from approximately 200,000 acres into the Gordon River, Naples Bay, and the Faka Union Bay (U.S. COE, 1980). Impacts from the Golden Gate Canal include overdrainage of surface waters, lowering of groundwater levels, altered traditional drainage patterns, reduction of habitats, and declines in agriculture potential (U.S. COE, 1980). Thus, the existing condition of water quality in the rivers and bays is undoubtedly linked to the major hydrological changes that have occurred in the past. Historically, the Big Cypress Basin was dominated by sheet flow, but several land reclamation projects starting at the beginning of the century have dramatically changed the hydrology. The majority of Collier County inside of the study area has been drained through the construction of canal networks. The construction of GGE has dramatically lowered the groundwater table and changed salinity regimes of coastal areas of the Big Cypress/West Collier watershed.

Cocohatchee River, Naples Bay, Gordon River, Blackwater River, Faka Union Bay, Fakahatchee Bay, Marco Bay, and Rookery Bay are the major natural water bodies within the study area. Barron Canal, Golden Gate Canal, Cocohatchee River Canal, Faka-Union Canal, Gordon River Canal, and Henderson Creek Canal are the major artificial drainage systems within this watershed. Flow direction and areas drained by canals are dependent upon rainfall amount. For example, the Cocohatchee River Canal drains an area southwest of Lake Trafford during dry periods and may have no flow during very dry years. During the rainy season, the Cocohatchee River Canal along with Henderson Creek Canal serves to collect excess drainage from the Golden Gate Estates area.

Faka-Union Canal collects drainage from a series of smaller canals and discharges into the Ten Thousands Islands area. The Golden Gate Canal and Gordon River drain into Naples Bay, the periphery of which is lined with an extensive network of finger canals and residential developments. The Barron River Canal, built as a source of fill to make roads, drains strands and sloughs of the Big Cypress National Preserve (Drew and Schomer 1984).

Historical Description
No pre-canal water quality data exist to describe the original water quality within the Big Cypress/West Collier Watershed. However, there are some basic factors to consider related to the channelization of wetlands. Canal construction, which began in the 1920s, undoubtedly led to increased drainage of freshwater from wetlands into the estuaries and a subsequent increase in dissolved minerals. Possible changes in salinity, sedimentation, turbidity, and nutrients likely resulted. In lieu of more detailed pre-canal water quality descriptions, STORET data from the 1980s provides a historical description of post-canal water quality of the Golden Gate Watershed for comparison with the present day. Physical water quality was characterized by neutral pHs, DO levels that were on the annual median (>5.0) at stations sampled in Naples Bay, Barron River Canal, Blackwater River, Gordon River, and Gordon River Canal, and conductivity above >1275 in some of the freshwater bodies (Cocohatchee River, Blackwater River). BOD and chlorophyll a were high in the Gordon River Canal and in the Blackwater River. Fecal coliform counts were high (>190 MPN/100 ml) in the Gordon River. Water quality in the Faka-Union canal was excellent, rating a very low 16 on the WQI scale. Naples Bay rated "fair" in terms of nutrient conditions according to the FDEP TSI with a 53. In general, the areas along the Blackwater River have the worst water quality.

Freshwater Systems

Corkscrew Swamp
Portions of Corkscrew Swamp are described as pristine due to its status as a National Audubon Society sanctuary. The Corkscrew Swamp Regional Ecosystem Watershed is a South Florida Water Management District (SFWMD) project that encompasses the sanctuary with goals to restore hydrologic conditions in impacted areas (Bird Rookery Swamp) and maintain flows and water quality in undisturbed areas of Corkscrew Swamp (SFWMD 1998a). Lake Trafford, north of Corkscrew Swamp is of historically good to fair water quality that fully supports use designation as a Class III water.

Cocohatchee River
Current physical water quality of the Cocohatchee River is characterized relative to typical State waters by low turbidity (2.9-3.5 NTU/NTUs), low TSS (2 –10 mg/L), higher than annual median color (85 –100 PCUs), neutral pH, variable DO (3.2 to 7.0 mg/L), and variable conductivity (675 – 2,650 micromhos (FDEP 1996a). The low DO results from excessive aquatic vegetation in the canals using up more oxygen than what is produced through photosynthesis (Kirby et al. 1988).

Chlorophyll a levels were well below screening levels with a mean concentration of 5 µg/L. BOD was, at one location, higher than average for typical Florida waters, but just shy of exceeding State criteria. BOD averaged between 1.6 and 2.0 for two stations in the Cocohatchee River. Total coliform bacteria levels were higher than average for State waters, and fecal coliform counts exceeded State standards with 2,650 MPN/100 ml.

Nutrient levels are lower than average, with phosphorus and nitrogen levels below State screening levels. Low DO (5.1 mg/L) and high fecal coliform counts (381 MPN/100 ml), averaged from two locations, drive the WQI rating for the Cocohatchee River down. The Cocohatchee River is a Class II water, suitable for shellfish harvesting, which partially meets its designated use.

Cocohatchee River Canal
According to STORET data, the Cocohatchee River Canal has not been sampled since 1988; therefore, a current account of water quality is not possible. Historical data collected from 1980 to 1988 provide the basis of the following description. The Cocohatchee River Canal is about 13 miles long and less than 5 feet deep with better water quality than its natural counterpart. Compared to other State waters, physical water quality is better than average for most State waters.

Biological data for the Cocohatchee River Canal are absent from STORET for 1980-1988. Therefore, no BOD, coliform, or chlorophyll a information is presented.

Nutrients are present in amounts higher than average for most estuaries, but do not exceed screening levels. Total nitrogen measured between 0.99 and 1.08 for two stations, and total phosphorus measured 0.03 for both stations.

No contaminants have been recently detected according to STORET data. However, the database compiled for this study indicates copper and zinc exceeded State standards in 23% and 14% of samples respectively from 1990-1998). Water quality is exhibiting a stable trend and fully supports designated use for a Class III water body (FDEP 1996a). Sediment quality information is not available for the Cocohatchee River Canal.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 48.6, 62.7, and 74.1 for the Corkscrew/Cocohatchee Basin. The data, though limited, indicate a degrading trend.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameters most responsible for these degraded water quality conditions include turbidity (WQI=92.5), biological oxygen demand (WQI=94), and fecal coliform (81.0). The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

Golden Gate Canal

Current water-quality data were not available for the Golden Gate Canal from the STORET database. However, historical STORET water quality data from 1980-1989 are available. Physical water quality in the 1980s was characterized by relatively low turbidity (3.5-4.3 NTUs), low TSS (2-3 mg/L), higher color content than average (50-99 PCUs), neutral pH, and low to moderate levels of DO (4.8-6.0 mg/L). Conductivity was higher than average for typical State waters (572-650 micromhos).

BOD exceeded State standards with an average of 2.4 mg/L at one canal sample location. The State standard is 2.3 mg/L. One location was sampled for chlorophyll a and was higher than average for typical State waters with 19 μg/L. Fecal coliform bacteria were lower than average (55 MPN/100 ml).

Total nitrogen and total phosphorus were below the screening level and overall were lower than average for other State waters. Total nitrogen ranged from 0.81-1.07 and total phosphorus ranged from 0.02-0.03 for three locations along the Golden Gate Canal. The WQI for the Golden Gate Canal ranged from 36 to 40, an indication of "good" water quality (FDEP 1996a). Sediment quality information was not available.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 55.5, 59.4, and 60.0, respectively for the Golden Gates Canal Basin. Though limited, the data indicate a stable trend.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=65.5), biological oxygen demand (WQI=76.4), and fecal coliform (WQI=79.9). The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

Henderson Creek/Blackwater River

Henderson Creek appears to be of good water quality until it intersects Blackwater River, which is of historically fair to poor water quality, depending on which index is applied. The TSI rated Blackwater River a 61, which is "poor", while the WQI rated the river a 46, which is "fair", and close to "good". Low

DO (3.5 mg/L) and high BOD (2.8) drive the index down. Because of these factors, the FDEP states that Blackwater River only partially meets its use designation. However, the overall status (derived from a combination of indices, contaminant information, nonpoint source assessments, and expert opinion) of the Blackwater River is represented as “poor” in the 1996 305b report (FDEP 1996a).

Fecal coliform bacteria counts from STORET data were 3 MPN/100 ml, averaged over five observations. The study area database compiled for this report indicates average fecal coliform levels from 1980 to 1990 was closer to 111 MPN/100 ml. No total coliform counts were available from STORET records for this period, but data summarized for **Table 13** (Appendix E) indicate high total coliform levels in Henderson Creek, averaging 1830 MPN/100 mls. Chlorophyll a levels measured 40 µg/L, which is higher than 90% of similar State waters; however, total nitrogen and total phosphorus levels remained low at 0.98 mg/L and 0.03 mg/L, respectively.

Sediment quality data was not available, and the literature provided very little historical or current water quality data for the District VI Basin.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 67.3, 73.1, and 56.7, respectively for the Henderson Creek Basin. The WQIs for the periods before the 1990s is suspect due to the lack of data available.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990’s. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=65.7), biological oxygen demand (WQI=81.4), and fecal coliform (70.5). The level of confidence is much stronger with the 1990’s data, particularly with the recent addition of more water quality data.

Faka Union Canal

No current data were available for Faka Union Canal. Historical water-quality data from two stations from 1980 to 1989 indicate exceptional physical water quality. Turbidity measured less than 1 NTU, better than 90% of State waters, and color was low, between 10 and 30 PCUs. The DO was high (6.4 mg/L), and at one station it was above saturation (9.9). Conductivity was between 600 and 700, which is above average.

Nutrient levels, bacterial contaminants, and BOD were all well below screening levels. Total nitrogen ranged from 0.51-0.73 mg/L and total phosphorus measured 0.01 mg/L. The WQI rated Faka-Union Canal a 17, an indication of “good” water quality.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix). The WQIs for Faka Union Canal Basin for 1970-1979, 1980-1989, and 1990-1998 were 60.6, 21.9, and 51.3, respectively.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990’s. Water quality parameters most responsible for these degraded water quality conditions include dissolved oxygen (WQI=68.1), and biological oxygen demand (91.0). The level of confidence is much stronger with the 1990’s data, particularly with the recent addition of more water quality data.

Collier-Seminole Basin

The Collier-Seminole Basin drains primarily cypress wetlands ultimately into Gullivan Bay. The basin exists within the boundaries of the Collier-Seminole State Park.

The literature provided very little historical or current water quality data for the Collier-Seminole Basin. Sediment quality information was not available.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). The WQI for 1990-1998 was 57.4 for the Collier-Seminole Basin. No data were available for the previous two decades.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameters most responsible for these degraded water quality conditions include total phosphorous (WQI=80.5), and biological oxygen demand (WQI=81.2) and coliforms (WQI=76.2). The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

Estuarine Systems

Naples Bay

Current water quality information is not available for Naples Bay. STORET data from 1989 are used to describe water quality. Water clarity is characterized by near average turbidity (3.6-4.5 NTU/NTUs), and slightly better than average color (40-80). No information on TSS was available from STORET for Naples Bay. Low DO was observed at two sample locations in the Bay. Average DO ranged from 4.5 to 6.0 mg/L. Chlorophyll a was low, measuring 6-7 μg/L, while total nitrogen levels exceeded screening levels (1.31 mg/L), as did total phosphorus (0.10 mg/L). Sediment quality information was not available.

Historically, the major sources of freshwater to Naples Bay were the Gordon River, Haldeman Creek, Rock Creek, and direct run-off from the city of Naples, providing a combined discharge of approximately 100 cubic feet per second (cfs). The construction of Golden Gate Canal has considerably increased the flow of freshwater into the Bay in the wet season to as much as 1,500 cfs. In contrast, during the dry season in April, discharge to the Bay drops to near zero (Simpson et al. 1979).

Rookery Bay

Current water quality data are not available through STORET. Under the National Oceanic Atmospheric Association (NOAA) National Estuarine Reserve Research (NERR) National Monitoring Program, automated data collectors deployed throughout Rookery Bay will soon make continuously collected water quality data available on the Internet. In addition to being part of the NERR program, Rookery Bay is designated by the State of Florida as an aquatic preserve, and as a National Audubon Society Wildlife Sanctuary.

Rookery Bay has been described as a "transitional" estuary in terms of its location between the high-energy (erosional forces) coastline to the north and the lower energy. Physical water quality is characterized by large fluctuations in salinity and low flushing due to the small size of the adjacent upstream watershed. Freshwater arrives into Rookery Bay via Henderson Creek to the west and Stopper Creek to the northwest. Tidal exchange is low due to the presence of oyster bars and low flushing of the shallow creeks that feed into the Bay. Hypersaline conditions can result during periods of drought (Drew and Schomer 1984).

Based on recent nonpoint source assessments, Rookery Bay fully meets its designated use as a Class II water body for support of shellfish harvesting (FDEP 1996a).

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). Although insufficient data precluded calculation of TSIs during the 1970s and 1980s, the TSI for this watershed during the 1990s is 52.2.

Marco Bay

Neither current nor historic water quality data was available through STORET. However, Drew and Schomer (1984) presented some general information on the freshwater and tidal exchange, nutrients, and habitats of the estuary.

Freshwater flow into Marco Bay is through coastal wetlands, and from groundwater between the freshwater aquifer and the saline coastal aquifer. Inputs from the wetlands are approximately 100 to 200 times that of the groundwater input, with some of this large surface volume attributed to man-made drainage operations (Drew and Schomer 1984).

DO levels were frequently found to be lower in natural areas than in disturbed areas (i.e., canals). Accumulations of mangrove detritus and restricted backwater circulation were cited as the cause for the low DOs (Drew and Schomer 1984).

Nutrients are low in natural and artificial waterways of the Marco Bay/Estuary system. Locally, high nutrient conditions are theorized to result from certain wind conditions mixing the water column and causing releases from sediments (Drew and Schomer 1984). Chlorophyll a was highest in the canals. No data accompanied the descriptions.

Fakahatchee Bay

Current water-quality information on Fakahatchee Bay was not available from the STORET database. Relative comparisons between Fakahatchee Bay and adjacent Faka Union Bay were given in Drew and Schomer (1984) for freshwater input, salinity regimes, and nutrient loading. Salinity ranges from 0 to 40 ppt throughout the wet and dry seasons. Specific data on other water quality parameters are lacking. Heavy metal analysis from data collected in the 1970s did not indicate contamination of the waters, but some sediments did contain detectable amounts of lead, particularly those near areas receiving roadway runoff (Drew and Schomer 1984). Pesticides were also detected in some of the sediment samples; waters were described as uncontaminated.

Abbott and Nath (1996) cited increased freshwater from Faka Canal and abnormal salinity levels to blame for disappearance of seagrass meadows, displaced benthic habitats and fish communities, and declines in shellfish harvests.

3.5.2.4 Southern Big Cypress Swamp

The Southern Big Cypress Swamp is located in the southern half of the Big Cypress National Preserve and is part of the Big Cypress Swamp Watershed, USGS unit 03090204. The study area is situated in the western part of the Southern Big Cypress Swamp. Interest will focus on the Fakahatchee Strand, Okaloacoochee Slough, and the Barron and Turner River canals, two canals which hydrologically affect the western portion of the preserve. The Turner and Barron River canals were not originally designed for the specific purpose of draining land, but as a supply source for road construction materials (Drew and Schomer 1984).

Physical Description

Perhaps the most important drainage feature of the Big Cypress Swamp is the Fakahatchee Strand. A strand is an elongate area of large trees growing within drainage depression with no well-defined channel. The Fakahatchee Strand is a natural community of mixed hardwood swamp about five miles wide and twenty miles long. Along with Okaloacoochee Slough, it is a principal drainage slough of the western Big Cypress Swamp (McElroy and Alvarez 1975).

Land use within the Southern Big Cypress Swamp is primarily wetlands, with an estimated less than 5% of land under agricultural use and less than 5% in small towns. Census data record that in 1990, Everglades City, at which the Barron River Canal discharges, had a population of 317, and Chokoloskee, a small fishing town at which Turner River Canal discharges, had a population of 240 (U.S. Department of Commerce 1992).

The Turner and Barron River canals drain freshwater from the strands and sloughs of the Big Cypress Swamp, and also receive additional freshwater input from the shallow water aquifer. Okaloacoochee Slough and Deep Lake Strand are two such features that contribute freshwater to the canals. The Barron River Canal flow rate varies from 0 to 8.27 m^3/s (0 to 292 cfs) over the course of a year. During dry season, flows are low, from 1.42 to 2.84 m^3/s (50 to 100 cfs), but increase during the wet season to between 2.84 and 4.96 m^3/s (100 to 175 cfs). Over the long term (decades), flows average 2.89 m^3/s (102 cfs). Given the age of the canals, constructed over 50 years ago, water levels in the Barron and Turner River Canal watersheds are assumed to have stabilized. A series of removable stop-log gates control flow along the Barron River Canal, inserted during the dry season to conserve the aquifer and removed during the wet season to accommodate increased drainage (Drew and Schomer 1984).

Historical Description

Historical data from STORET indicate that water quality within much of the Big Cypress has been "fair" to "good" with respect to physical and biological parameters, and nutrient condition. However, metals were detected in previous sample data from Chokoloskee Bay at levels higher than in other local estuaries. Monitoring data from 1980-89 indicate that Barron River Canal had good water conditions with a pH of 7.6, good water clarity as indicated by low turbidity (2.0 NTUs), low TSS (1 mg/L), and low color (55 PCUs). However, DO levels failed to meet State criteria with an average of 4.2 mg/L. Conductivity was normal at 536 micromhos. The Turner River Canal exhibits freshwater conditions inland and estuarine conditions nearer the coast. Samples of the Turner River Canal collected near the Tamiami indicate that physical water quality is good with an average DO of 7.3, low turbidity of 1.0 NTUs, and pH of 8.4. Conductivity had an average measurement of 1300 micromhos. Where the Turner River Canal flows into Oyster Bay, turbidity was higher at 4 NTUs, color was higher at 40, and conductivity was higher at 41250 micromhos due to higher salt content. DO was high at 8.5.

Biological parameters, BOD, chlorophyll a, and fecal coliform bacteria, were 1.3 mg/L, 7 µg/L, and 14 MPN/100 ml, respectively. None of these values exceeded (i.e., failed to meet) State standards or screening levels. Nitrogen and phosphorus levels of Barron River canal runoff into the Gulf have been historically low. The annual average for total nitrogen was 0.98 mg/L, and for total phosphorus, concentrations were low at 0.02 mg/L. The TSI for Barron River canal runoff into the Gulf was 46 and for Turner Canal, 47.

Freshwater Systems

The literature provided very little historical or current water quality data for the Fakahatchee Strand Basin. A recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). WQIs were calculated by decade (1970-1979, 1980-1989, 1990-1998) and are 60.7, 55.3 and 55.8 for the Fakahatchee Strand Basin respectively.

An analysis of water quality trends over time indicates an overall degradation of water quality in the 1990's. Water quality parameter most responsible for these degraded water quality conditions include dissolved oxygen (WQI=81). The level of confidence is much stronger with the 1990's data, particularly with the recent addition of more water quality data.

Estuarine Systems

Chokoloskee Bay

Recent water quality information was obtained from Gibson (1997) for 1990-1995. Historical data were obtained from the STORET database and from Drew and Schomer (1984).

The hydrology or rates of flushing and mixing of Chokoloskee Bay are not well known (Drew and Schomer 1984). Historically salinity has varied from 2.5 ppt to 20.2 ppt at the mouth of the bay. The water has been relatively clear as indicated by the average turbidity (3 NTUs), and color (30 PCUs). DO was high at 8.5 and the pH was normal for saline waters at 8.5. High conductivity (41,250 micromhos) is normal for waters with high salt content. No historical bacterial analyses or chlorophyll a measurements were available.

Historically nutrients increase with the rainy season from apparent increased flow from the Barron River Canal. Other sources of nutrients are possibly the oxidation of drained soils and runoff from agricultural and roadways (Drew and Schomer 1984). Total nitrogen has historically been lower than average at 0.64 mg/L compared to other Florida streams. Total phosphorus likewise has been lower than average at 0.03 mg/L. The TSI indicated that the overall nutrient status of Chokoloskee Bay was good, with a 46. Contaminants have been sampled in the Bay, but seasonal increases were theorized to result from “desorption by dissolved ions in seawater” as salinity varied (Drew and Schomer 1984). Manganese, copper, lead, and zinc were metals that increased with an increase in salinity. Concentrations of these metals were reported to be 1.5 to 3 times higher than metal concentrations from estuaries that received natural drainage (Drew and Schomer 1984).

The literature provided very little historical or current water quality data for many of the bays and estuaries of Southwest Florida. Limited data are available for the Ten Thousand Isles region, and the associated bays of Chokoloskee and Faka Union.

While the above descriptions summarize water quality from current literature, a recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). However, data were insufficient to calculate TSIs for Chokoloskee Bay, Faka Union Bay, and the Ten Thousand Isles region.

3.5.3 GROUNDWATER (AQUIFERS)

The Surficial, Intermediate, and Floridan Aquifer systems are the principal aquifers within the study area. The Floridan Aquifer system is widely used for ground water supply in other areas of the State but, within the study area, it is of naturally poor quality, having a high degree of mineralization. Thus, only the Surficial and Intermediate Aquifer Systems are used for groundwater supply (SFWMD 1995). The Floridan Aquifer is separated from the Surficial and Intermediate Aquifers by several layers of confining beds. Recharge areas for the Floridan Aquifer are outside the study area.

Within the study area, the Surficial Aquifer system contains the undifferentiated water table aquifer and the confined lower Tamiami Aquifer. The Biscayne Aquifer is another principal aquifer system within the Surficial Aquifer that occurs outside the study area (SFWMD 1995).

Florida Geological Survey: Water Quality

The primary data and discussion material for aquifer water quality was provided from Florida’s Ground Water Quality Monitoring Program. This program derives aquifer water quality data from three sources: Background Network wells, Very Intensive Study Area (VISA) Network wells, and Private Well Surveys. Only preliminary data from the Background Network were available from 1984 through 1988. A summary of these water quality data for the Surficial, Intermediate, and Floridan Aquifers is presented in Appendix E (**Table 27**). With the data available, it is not possible to determine the impact of septic tanks on groundwater quality.

Study Area: Water Quality

To evaluate more recent and geographically specific water quality data available within the study area, supplemental data (USGS) were gathered (including STORET) through June 1998 and water quality trends were revisited. To assess historical and current water quality trends for the study area aquifers, summary data statistics for various water quality parameters were recalculated for the following time periods: 1970-1980, 1980-1990, and 1990-1998.

3.5.3.1. Surficial Aquifer System

The Surficial Aquifer System is located beneath and adjacent to the land surface and is composed of Pliocene to Holocene quartz sands, shell beds, and carbonates. It consists of porous unconsolidated quartz sand deposits mixed with hardened carbonated rocks belonging to the Upper Miocene to Holocene Series (Florida Department of Natural Resources 1992). The carbonate rocks are the water-producing zones (SFWMD 1995).

Within the Surficial Aquifer system, the water table is mostly unconfined, but in deeper regions some partially confined or locally confined conditions may predominate from beds of low permeability. Underneath the Surficial Aquifer are broad thick beds that are more confining. In South Florida, sediment beds of the Surficial Aquifer are the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formation, the Key Largo, and Miami Limestones, and the undifferentiated sediments (Florida Department of Natural Resources 1992). In general, Surficial Aquifer water levels slope downwards in a southwesterly direction towards the coast. Little seasonal fluctuation of the Surficial Aquifer water levels occurs (Dames and Moore 1997).

Median values for water quality measurements for the Surficial Aquifer are within State drinking water standards, with the exception of iron and lead. The MCL secondary standard for iron is 0.3 mg/L and the average for the Surficial Aquifer within the SFWMD was 0.88 mg/L. The high maximum values (>5mg/L) are likely the result of using unfiltered samples during analysis (Florida Department of Natural Resources 1992). Iron is high in the Surficial Aquifer system due to its proximity to iron minerals, organic rich soil horizons, and dissolved humic substances (Florida Department of Natural Resources 1992). Lead occurs in the surficial at “high” levels (Florida Department of Natural Resources 1992). Given the lack of natural sources of lead in Florida, the presence of lead is attributed to human sources, most often lead weights used in water level recorders (Florida Department of Natural Resources 1992).

Saltwater intrusion, incomplete flushing of seawater from the Everglades, and leftover irrigation water from the Floridan Aquifer system have created areas of increasing mineralization and high dissolved solids along the coast (SFWMD 1995). The Surficial Aquifer System is susceptible to anthropogenic contamination due to its closeness to the land surface. Lack of confinement, high recharge, and relatively high permeability and high water table all increase contamination potential. The increasing demands heighten the constant threat of saltwater intrusion, often resulting in water usage restrictions to users of the Surficial Aquifer (SFWMD 1995).

Physical and Geological Description

Water quality data in this section is derived from the FY95/96 Trend Ground Water Quality Monitoring Program for Collier County (Gibson 1997). Ground water samples from sixteen monitoring wells sampled quarterly were analyzed for “specific chemical analytes that are indicative of natural ground water geochemistry and potability” and compared to public water supply standards. In 1995-96, total dissolved solids, iron, chloride, and sulfate levels in the monitoring wells exceeded MCL standards established in F.A.C. 17-550 for treated community water supplies, but still compared favorably with historical data. The report concluded that these conditions “appear to represent the norm” for Surficial Aquifer waters in Collier County (Gibson 1997). The lower Tamiami Aquifer supplies Collier County with most of its potable water supplies (Dames and Moore 1997).

Withdrawals/Public Use

The principal source of urban water in Lee County is the Shallow Water Table Aquifer. The Shallow Water Table Aquifer is also used for agricultural irrigation. Transmissivities for the water table within Lee County range from 10,000 to 1,000,000 gpd/ft. Typical yields from public water supply wells are around 300 gpm (SFWMD 1995).

The Tamiami is a major potable resource for Collier County serving as the primary source of municipal, industrial, and agricultural water supply (SFWMD 1995). The water quality is similar to that of the water table aquifer, but often with lower iron concentrations, making it more suitable for potable supplies. Chloride concentrations may still be high in some coastal areas, with levels up to 10,000 mg/L. Aquifer thickness ranges from 150 feet to over 250 feet. Transmissivities range from 100,000 to 500,000 gpd/ft (Dames and Moore 1997). Water use of the Surficial and Intermediate Aquifers by Collier and Lee Counties in 1995 is presented in **Table 6**. More water is used in agricultural irrigation than any other category for both counties. In Collier County, agricultural irrigation accounted for approximately 68% of all water use in 1995.

Table 6. 1995 Water Use For Collier And Lee County*

County	Public Supply	Domestic Self-Supply (private well)	Industry/ Commercial Self-Supply	Agricultural Irrigation Self-Supply	Recreation Self-Supply	TOTAL
Collier	14,250	1,785	2,181	51,985	16,641	**86,842**
Lee	14,673	2,081	1,974	22,063	12,011	**52,802**
TOTAL	**28,923**	**3,866**	**4,155**	**74,048**	**28,652**	**139,644**
Percentage of Total	***20.7%***	***2.8%***	***3.0%***	***53.0%***	***20.5%***	***100%***

Source: SFWMD, 1998b * Note: Millions of Gallons per Year

A recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). No data were available from 1970-1979 but slight increases in most minerals and an increase in pesticides was observed from the 1980s to the present decade.

3.5.3.2. Intermediate

The Intermediate Aquifer System is located in the Hawthorn group sediments and is comprised of two confined or in place semi-confined aquifers. The Sandstone Aquifer present in Lee County and Collier County north of Alligator Alley and the mid-Hawthorn aquifer underlie Collier County (Dames and Moore 1997).

Physical and Geological Description

The Sandstone Aquifer is composed of sandy limestone, dolomites, and sandstone up to 100 feet thick and is possibly part of the Peace River Formation. The aquifer slopes southeastward, gradually thinning out. The transmissivity is generally below 100,000 gpd/ft with hydraulic gradients ranging from 0.5 feet per mile to 5 feet per mile. A recharge zone exists northeast of Immokalee. The iron content is relatively low and the chloride concentrations are usually less than 600 mg/L. Increases in hardness and alkalinity occur as one moves toward the coast. Water quality is described overall as good. Within Collier County, the direction of water flow in most confined layers is southwestward (Dames and Moore 1997).

Limestone and dolomites from the Acadian Formation comprise the mid-Hawthorn Aquifer. Transmissivities are less than 50,000 gpd/ft. The mid-Hawthorn averages 100 feet in thickness with highly mineralized water. High levels of chlorides, calcium, magnesium, and sulfate are present within this aquifer. The mid-Hawthorn slopes toward the east-southeast and is under sufficient hydrostatic pressure to produce artesian conditions for wells drilling into this aquifer (Dames and Moore 1997).

Mean water quality parameters meet State drinking water standards with the exception of lead and total dissolved solids. Total dissolved solids in the Intermediate Aquifer range from 47 mg/L to 4188 mg/L within the SFWMD. Contact of water with carbonates and chemically unstable silicates (e.g. clays, opal), as well as saline intrusion are probable sources of high total dissolved solids (Florida Department of Natural Resources 1992).

A recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). No clear trends in water quality were evident for the Intermediate Aquifer. However, from 1980 to 1998, most mineral concentrations decreased, while iron and fluorides slightly increased. Pesticide concentrations increased notably.

3.5.3.3. Floridan Aquifer

The Floridan Aquifer within the study area is characterized by low hydraulic potential, low flushing, and saline intrusion from long contact/high dissolution of base strata of aquifer and coast (Florida Geological Survey 1992). It is composed of Tampa Formation sediments and is connected to the underlying Suwannee and Ocala Limestone, and Avon Park, Oldsmar, and Cedar Keys Formations. It is separated from the Intermediate Aquifer through confining sediments of the Hawthorn Group. The transmissivity ranges from 75,000 to 450,000 gpd/ft in the upper areas of the Floridan. Water quality has been described as brackish, degrading with depth and towards the coast (Dames and Moore 1997).

Mean chloride levels for Floridan Aquifer wells within the SFWMD exceed the States MCLs for drinking water. Median levels are 419.6 mg/L and the State standard is 250 mg/L. Median levels of total dissolved solids also exceed State standards (Florida Department of Natural Resources 1992).

A recent compilation of water quality data from all available organizations within the study area was conducted to support the impact analyses of this report (Appendix E). No distinct trends were observed, but slight increases in some minerals were noted along with a small decrease in chlorides.

3.6 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

The State of Florida contains some 20,000 waste generators and facilities, most associated with business and industry in populated areas. The exception to this is the use of pesticides and a variety of solvents associated with agri-business.

3.7 AIR QUALITY

Southwest Florida's air quality" is among the best in the State. Based on existing data, the EIS study area is an attainment area for ozone and carbon monoxide pollution; however, particulate pollution and ozone have shown upward trends in recent years (SWFRPC 1995). Portions of this upward trend, specifically particulate pollution, is attributable to land clearing and other development activities.

3.8 NOISE

Much of the eastern study area is currently undeveloped, and as such, exhibit relatively low ambient noise levels. Heavy traffic roadways in and around the urbanized area may have noise levels on the order of 65 to 70 decibels (dB), measured 30 meters (100 feet) from the traffic artery. Around construction areas, or near the airports in Ft. Myers, Lehigh Acres and Naples, noise levels may exceed the EPA recommended upper level of 70dB by 25 to 30 decibels.

3.9 AESTHETIC RESOURCES

Consideration of aesthetic resources within the project study area is required by the National Environmental Policy Act of 1969 (NEPA) PL 91-190, as amended. Aesthetic Resources are defined in ER 1105-2-50 as "those natural and cultural features of the environment which elicit . . . a pleasurable response" in the observer, most notably from the predominant visual sense. Consequently, aesthetic resources are (commonly referred to as) visual resources, . . . features which can potentially be seen.

The EIS study area has a variety of natural systems that contribute to the aesthetic resources of the region. These range from aquatic (marine and freshwater) systems to upland forest systems. These natural communities provide a solid base of aesthetic values and functions that serve the permanent and seasonal residents of the region. Natural systems within the EIS study area include hundreds of kilometers of coastal shoreline, as well as a number of bays, sounds, and other shoreline water body features. The Region's economy is highly dependent on these areas providing natural attributes that are important to residents and tourists and providing food resources. Due to the attractiveness of coastal areas, there is an intense demand for land in these areas.

The EIS study area also contains a number of municipal, County, State, and Federal parks and preserves, including Rookery Bay National Estuarine Research Reserve, Estero Bay Aquatic Preserve, Collier-Seminole State Park, Wiggins Pass State Preserve, Koreshan State Park, Lover's Key State Park, Florida Panther National Wildlife Refuge, Ten Thousand Islands National Wildlife Refuge, Corkscrew Regional Ecosystem Watershed, Big Cypress Preserve, Picayune State Forest, and Fakahatchee Strand State Preserve. The study area also contains private preserves such as the Audubon Society's Corkscrew Swamp Sanctuary.

3.10 RECREATION RESOURCES

In the Southwest Florida EIS study area, there are hundreds of public parks and recreation areas, excluding beaches and boat access sites. These areas are administered by the Federal government, State government, Lee and Collier County governments, and various municipal governments, as well as by private agencies and private commercial interests.

Types and sizes of parks vary widely in the Region. Parks and recreation areas have been classified into two categories: user-oriented and resource-based. User-oriented recreation areas are defined as those containing facilities which can be provided almost anywhere for the convenience of the user. Among such facilities are ballfields, golf courses, and playgrounds. Resource-based outdoor recreation areas are dependent upon some particular element or combination of elements in the natural environment. These areas include beaches or hunting areas. Sizes of parks in Southwest Florida range from less than one acre to several thousand acres.

Within the urban setting, most of the regionally-significant parks and recreation areas are owned by the State of Florida or a local government. Outside the urban setting, nationally and internationally recognized preserves are managed for various active and passive recreational uses by the USFWS, the National Park Service, the Florida Department of Environmental Protection, the Florida Division of Forestry, and the South Florida Water Management District.

3.11 HISTORIC AND ARCHEOLOGICAL RESOURCES

The Southwest Florida region has a large number of historic and archaeological" sites. According to the Division of Archives, Florida Department of State, there are over 2,600 known historic and archaeological sites within Lee and Collier Counties; 733 sites in Collier County and 1,914 sites in Lee County (McClarnon 2000). Only parts of the Region have been extensively surveyed; consequently, there may be considerably more sites to be discovered.

At present, few of Southwest Florida's historical or archaeological sites are listed on the National Register of Historic Places. Collier County has twelve sites listed, including the Seaboard Coast Line Railroad Depot, while Lee County has twelve sites, such as the Koreshan Unity Settlement Historic District.

The first residents of Florida, referred to as Paleoindians, mainly inhabited northern Florida, as water (then a scarce commodity in Florida) was more readily available from deep water springs and limestone-based catchment basins found most prevalently from the Hillsborough River north through the Florida panhandle (Milanich 1995). As the last Ice age ended (about 9000 B.C.), Florida became wetter, and the water sources around which the Paleoindians could camp more plentiful (Milanich 1995).

Early residents of the study area belonged to one of several cultures that arose during the Archaic period, from approximately 7500 B.C. through approximately 500 B.C. Later, regional cultures appeared throughout south Florida, including the Belle Glade, the Glades, and the Caloosahatchee cultures (Milanich 1995). The Glades culture would later give rise to the Tequesta Indians on the southeast coast, while the Caloosahatchee culture were the ancestors of the Calusa Indians.

Southwest Florida was later the home of the Calusa people, whose unbroken history has been traced back to 500 BC by archeologists (Milanich 1995). The Calusa were the most important aboriginal group in Southern Florida in terms of influence, population size and density, and military power (Milanich 1995). Calusa towns were spread throughout Southwest Florida from Lake Okeechobee to the coast around Port Charlotte, and southward along the coast to the Ten Thousand Islands area. Major Calusa towns are thought to have been located on Horr and Marco Islands, on Mound Key in Estero Bay, and along the shores of Charlotte Harbor.

3.12 SOCIOECONOMIC RESOURCES

In Southwest Florida, the major economic contributors are retirement, tourism, construction, and agriculture. Each has an important part in the economy of the Region (SWFRPC 1995).

Southwest Florida has been a destination for retirees for years, especially since World War II. The effects of this influx of retirees are seen in the age of the population of the Region. Older people make up a larger proportion of the population of Southwest Florida than they do in the State as a whole. Based upon 1993 estimates, twenty-five percent of the EIS study area population is age 65 or older (SWFRPC 1995).

It is expected that retirement will continue to be important economically, even as the population grows more diverse. Retirees have time and money to spend on recreation and entertainment. They also tend to require more health and medical services. Households comprised of elderly or disabled residents represent a significant concern in Southwest Florida.

Tourism is a second major factor in economic development. It is becoming a year-round activity, with increasing numbers of summer tourists to balance the "snowbirds" and winter residents. Tourism is also a factor in population growth. Persons who visit as tourists may decide to move here during their working years or later as retirees.

The growing population within the study area results in the construction of more housing. From 1980 to 1993, housing unit growth in the Region averaged 5.8% per year (SWFRPC 1995). Collier County has had the greatest overall percentage of growth since 1980 (110.2%), although Lee County has had the greatest increase in the number of dwelling units (67,576) (SWFRPC 1995).

In addition to new housing, both tourism and retirement lead to other development of all kinds, although residential building forms the majority of the total permit activity noted above. Movie theaters, restaurants, shopping centers, grocery stores, and service stations are all needed for tourists, and new permanent and seasonal residents.

The importance of agriculture in Southwest Florida has changed to reflect the pattern of development in the Region. Increased development pressures in the coastal counties have caused agriculture to be less important there compared with other economic sectors. Farm acreage in the Region decreased 8.9% from 1982 to 1992 (SWFRPC 1995).

Citrus, long important in the Region, is increasing as production has shifted over the last few years from other areas of the State to Southwest Florida and its milder weather.

4. ENVIRONMENTAL EFFECTS

A Corps permit decision authorizes a particular location and quantity of wetland fill and includes appropriate conditions. A decision is made upon application for an individual permit and is made after review of site-specific and project-specific information submitted by the landowner or provided by other sources. The information that is gathered is based on the understanding of what natural resource and other issues are applicable to the project.

The Corps presently makes its determinations of the benefit and detriments of proposed fills on a case-by-case basis. The factors to be considered, and the weight to be afforded each factor, are presently left to the professional judgment of the program manager with oversight from Regulatory Division management. The “no action” alternative would be to continue evaluating permit applications in the same manner as before the EIS.

The Corps proposes to use the information in this EIS in the review of future permits. The information will be used to identify the issues that may be relevant to the project site, provide a source of information on potential effects of the project on various issues, to provide a reference on the potential effects of the location and quantity of fill, and to describe potential effects of alternative permit conditions or constraints. The Corps is not proposing to decide, based on this EIS, to establish the location of fill, quantity of fill, or on any condition or constraint on any piece of property. That decision can only be made after review of an application.

The EIS provides a set of standardized natural resource criteria in reviewing permit applications in Southwest Florida. This set is called the Permit Review Criteria and is found at Appendix H. Important natural resource issues are shown by several maps, one for each resource, and by the Natural Resources Overlay Map in the Appendix. The Overlay Map is divided into anticipated future use areas where a project may have a high potential for adverse effect on the natural resource. The program manager (person reviewing the permit application) would evaluate each application using the criteria and evaluations suggested in the EIS applicable to the important resources found in that area. Just as some areas have greater or lesser degrees of environmental importance, so does the review of applications require greater or lesser degrees of rigor. As seen, some areas have no issues mapped. For these areas, the program manager would continue to use his/her discretion as to the appropriate reviews.

The Natural Resources Overlay Map will be used to determine the applicable permit review criteria. The map was created by the Corps based on evaluation of the effects of five future landscapes (Ensembles) that suggested different locations of development and different criteria for the permitting of those developments. The five future landscapes (Ensembles) were based on five combinations of criteria that specified by maps and legends the location of wetland fill or conversion of natural plant cover, the quantity of fill or conversion, and other conditions or constraints. The comparison of the Ensembles allowed for the identification of areas where projects may have the greater impacts to natural resources.

The use of the Permit Review Criteria and the Natural Resource Overlay Map will decrease the probability of potential effect being inadvertently overlooked on a project. The use of the assessments described in the permit review criteria will more quickly identify the degree of that effect and thereby the level of concern. The convenient reference to pertinent information compiled in this EIS will increase the knowledge and expertise of the project reviewer and applicant to address the adverse effect.

It is important to note that the Proposed Action does not significantly change the Corps' program. The Corps already analyzes its permitting decisions for effects on natural resources, including cumulative effects. The proposed action would standardize and simplify Corps' procedures for doing so. Notwithstanding the level of effort that went into preparing the Ensembles, the Ensembles are **not** the Proposed Action. The reader is cautioned that the Ensembles are simply predictions of the future, based on anticipated actions by city, county, State, and Federal governments, as well as private industry.

These predictions had, and have, no purpose other than to identify the most important resources that would be affected in the future. Accordingly, the Ensembles were used to develop the Natural Resources Overlay Map, which shows Corps reviewer where to apply the Permit Review Criteria. Because the Corps believes the Natural Resources Overlay Map clearly identifies resource impacts, the results of Corps' review using the Permit Review Criteria together with the Natural Resources Overlay Map are expected to be more protective of the natural resources than the no-action alternative of continued piecemeal reviews.

4.1 GENERAL ENVIRONMENTAL EFFECTS

General effects that may be expected include an increase in surface water flows, as most of the alternatives contain provisions that would seek to improve culvert connections and restore and/or improve flowways. Additional negative effects include loss of native vegetation, loss of hydrology and loss of fish and wildlife resources. Each of the Ensembles (and the Alternatives therein) contain design elements which would provide for environmental change. It should be noted, however, that a majority of these design elements are not wholly within the purview of the Corps to implement.

4.2 VEGETATION

Placement of fill in wetlands requires a Department of the Army Permit issued by the Corps in accordance with Section 404 of the Clean Water Act. Therefore, the number of acres of wetlands that could be impacted was estimated for each Ensemble. Interpretation of aerial photography indicates that approximately 45% of the study area is currently wetland. The actual extent of wetland can only be determined after a site visit and analysis of the vegetation, soil, and hydrology. For the Federal definition of wetlands, this analysis is based on the 1987 Corps of Engineers Wetlands Delineation Manual. For the State, this is based on Chapter 62-340, Florida Administrative Code, Delineation of the Landward Extent of Wetlands and Surface Waters. The aerial interpretation will probably be a conservative estimate, that is, will underestimate the quantity of wetlands, since only those with obvious hydrology would have probably been identified in the Geographic Information System as wetlands. Based on previous experience, the wetlands that are particularly difficult to identify in the study area are wet prairie and hydric pine flatwoods. Each of the Ensemble maps presents a prediction of the location and extent of urban development, agriculture, and other land cover types. For each land cover type, a subgroup of the ADG (1) looked at the configuration and type of existing wetlands that fell within the mapped area; (2) reviewed the criteria that went with that land cover; and (3) estimated the quantity of wetlands that could be filled. For example, for certain areas marked "Urban" in Ensemble R, the subgroup: (1) noted that many of the wetlands are generally impacted by nearby existing drainage canals; (2) reviewed existing criteria found in the Comprehensive Plan and Corps regulations; and then estimated the percentage of the wetlands that would be authorized for fill. The estimated percentage would be based on the ADG members' experiences that the typical configuration of urban projects and the nature of the wetlands has resulted in some level of unavoidable impacts to wetlands. This process was repeated for each of the alternatives and for each of the land cover types. For example, one of the criteria attached to one of the land cover types found in Ensemble U stated a prohibition of any fill in wetlands. Therefore, the evaluation is based on an estimate that zero percent of the wetlands would be filled. The total quantity of wetland that may be filled under Ensemble Q is 6.6% of the total area of wetland; for Ensemble R, 7.0%; for Ensemble S, 5.6%; for Ensemble T, 5.8%; and for Ensemble U, 5.5%. One percent(1.0%) represents approximately 1,821 ha (4,500 ac). This evaluation is important because the Federal regulations applicable to the Corps review of permits emphasize the need to avoid impacts to wetlands. An Ensemble that has less impact would better satisfy this requirement than one that had a higher percentage.

Uplands are an essential part of the natural system. They provide nesting, foraging and resting areas for species that live on uplands but forage on species that live in wetlands. Uplands support listed species, absorb rainfall, and provide clean runoff to wetlands and ultimately to groundwater or to the estuaries. The uplands also provide overflow areas for floods. Currently, wetland and upland vegetation, combined, occupy approximately 58% of the study area. Some of the wetlands and uplands also include exotic plants. Existing public preserves are estimated to encompass approximately 27% of the study area.

Therefore, about half of the natural vegetation is currently found in privately owned undeveloped areas or as inclusions within urban, rural, and agricultural areas. Each Ensemble maps locations of contiguous areas that are or are proposed to be publicly owned preserves or areas that are preserved by others (such as conservation organizations or mitigation banks) for natural resource benefits. The area so mapped totals, for Ensemble Q, 38% of the total study area; for Ensemble R, 38%; for Ensemble S, 42%; for Ensemble T, 42%; and for Ensemble U, 43%. A visual inspection of the Ensemble maps will show that the largest difference (in terms of acres) is in the periphery of the urban area. Therefore, all of the Ensembles predict an increase in contiguous preserves. Natural vegetation outside of preserves would have a higher probability of being filled and be subject to impact from surrounding land use.

In addition to the simple quantity of vegetation, the preservation of vegetation in certain landscape location is vital to maintaining fish and wildlife resources. Seasonal wetlands within the foraging range of rookeries, vegetation that connects major habitat areas, coastal habitat, and other regionally significant natural resources are discussed under Section 4.4.

The analysis so far simply reports losses of acres of vegetation. It is unrealistic to expect that there will be zero impact to wetlands. Therefore, another consideration is whether or not the Ensemble identifies adequate locations for the replacement of that vegetation. Identification of a large area of potential mitigation sites indicates that the applicants will have a wide selection of locations within which to provide that replacement. A narrow selection increases the chance that inadequate mitigation may occur because: (1) not all of the land identified in the Ensemble will be available (for example, no willing seller); and (2) some of the lands identified (for instance, rare upland habitats or uplands used by listed species) will not be suitable for the restoration or creation of wetlands. All of the Ensembles propose expansion of preserves greater than what would be expected to be provided by applicants as part of permits; that is, the acquisition and restoration of lands as conditions of permits supplement, but do not supplant, public land acquisition efforts such as the draft Strategic Land Conservation/Preservation Plan for Southwest Florida prepared by the Southwest Florida Regional Planning Council.

The Federal regulations provide that unavoidable impacts (after demonstrating that no alternative site is available and after minimization of impacts) be compensated. Therefore, the compensation made available by each Ensemble was estimated. Compensation can be provided by the restoration of the remaining wetlands within the footprint of the project ("on site mitigation"), acquisition and restoration of degraded wetlands elsewhere in the region ("off site mitigation"), or creation of new wetlands either on-site or off-site. The quantity of mitigation is based on an assessment of the quality of the restoration or creation and the quality of the wetland impacted. For example, removing ditches, implementing controlled burns, or other work on three acres of poor quality wetlands could restore them to pristine condition. This restoration work could compensate for the loss of one acre of wetland impacted by development. The ecosystem benefits received from the four acres of poor quality wetland are replaced by the benefits received from three acres of high quality wetland and one acre of development. The actual mitigation assessment will be done at the time of the individual permit review. Each of the Ensemble maps presents a prediction of the location of preserve areas that will retain their natural vegetation. All of the Ensembles predict that the acres of preserve in the future will be larger than the acres currently in public ownership. These new acres are locations of "new" preserves. The acres of wetlands within these "new" preserves represent, for Ensemble Q, 17.0% of the total wetlands in the study area; for Ensemble R, 19%; for Ensemble S, 22%; for Ensemble T, 23%; and Ensemble U, 24%.

The Ensembles can then be compared by their acreage ratio. The ratio is the number of acres of wetlands in new preserves divided by the number of acres of wetlands that may be filled. The ratio for Ensemble Q is 2.6:1; for Ensemble R, 2.7:1; for Ensemble S, 4.0:1; for Ensemble T, 3.9:1; and for Ensemble U, 4.4:1. An Ensemble with a higher ratio would indicate a greater availability of choice in lands that could be acquired and restored to compensate for each acre of predicted impact.

The ratios reported are probably optimistic since not all vegetation types for which mitigation may be required may be found within the new preserves. For example, coastal wetlands in the study area would not be appropriately replaced by wetlands in Corkscrew Marsh proper; certain isolated herbaceous wetlands could not be appropriately replace by creating marshes outside the foraging range of rookeries; and losses within flowways would not be replaced by wetlands outside of the flowway.

The availability of compensatory mitigation can also be expressed in terms of the wetland quality. For each of the wetlands that were expected to be filled under the scenario presented by the alternative, the ADG subgroup estimated the wetland's quality at either high, medium, or low. The acres of wetlands scored high were multiplied by 3, scored medium by 2, and scored low by 1. The results were summed for a total number of "units" of impact. Then, the acres of wetlands in the new preserves which scored high were multiplied by 1, scored medium by 2, and scored low by 3. These scores reflect that there is a greater environmental lift resulting from enhancing a low quality wetland compared to a high quality one. (There is also a difference in ecosystem benefit depending on the location of the acquisition, such as if the site is on a habitat corridor: this is evaluated separately.) The "units" of potential restoration divided by the "units" of potential impact results in a ratio. Note that the ADG group prepared this computation for each of the single alternatives created by the ADG but then the Corps extended the computation over the four alternatives that make up each Ensemble. The ratio for Ensemble Q is 1.8; for Ensemble R, 1.8; for Ensemble S, 2.8; for Ensemble T, 2.8; and for Ensemble U, 3.3. An Ensemble with a higher ratio would indicate greater assurance that ecosystem benefits would be replaced because: (1) any restoration activity involves some risk that a portion will fail; and (2) the restoration work is typically funded by the development activity and so is not completed until after the impact, resulting in a temporal loss of benefits. Both of these effects would argue that permits would require ratios higher than 1.0:1. Mitigation Banks reduce this risk.

Section 4.20.1 describes the analysis of acres of fill authorized by Corps permits from 1991 to 1999. As shown by Table 18, authorizations averaged 508 acres per year. The actual date the fill is placed can be later than the year of the authorization. Those permits required compensatory mitigation through the creation of new wetlands (45 acres per year) and through enhancement, preservation or restoration of existing wetlands (1,456 acres per year). One net result is an average reduction of 463 acres per year in the number of acres of natural vegetation (from 508 acres to 45 acres). However, the habitat and other wetland functions lost from the 508 acres are replaced in the 45 acres of new wetlands and by an increase in quality of the 1,456 acres of existing wetlands. This is commonly referred to as the "Mitigation Ratio" of the projects. The mitigation ratio is 2.95 to 1 (1,501 acres of creation and restoration divided by 508 acres of fill). The number of compensatory acres required by the permit is based on an evaluation performed for each permit decision to determine if there has been appropriate compensation of the unavoidable loss of wetlands. The evaluation identifies the functions and values of the wetlands lost and the gains from the mitigation plan. This evaluation is narrative using professional judgement of the Corps reviewer. For larger and more complex projects, reviewers incorporated various numeric assessment methodologies into the evaluation. In 1998, the Corps published the Joint State/Federal Mitigation Bank Review Team Process. This included a numeric assessment technique to calculate mitigation. This technique incorporated the South Florida Water Management District's Wetland Rapid Assessment Procedure (WRAP). By public notice, the Jacksonville District of the Corps stated, "Although an applicant is not required to perform WRAP, inclusion of WRAP or another functional assessment would expedite the District's evaluation of permit applications and proposed mitigation banks." However, even with what sounds like a high mitigation ratio, there is still a loss of spatial extent of natural vegetation cover. For wildlife, a small number of acres of high quality habitat may support the same population as a large number of acres of poor quality habitat. So a simple replacement of functional capacity by enhancing or restoring poor quality habitat (or removing human impacts through preservation). But some aspects of the species life history needs are directly related to spatial location or total acres available. Therefore, the remaining sections of this EIS will look at these other aspects for the Corps to consider in its permit reviews.

Section 4.20.1 also describes an analysis that was performed of historic change of natural plant cover to other uses. The early paragraphs above in Section 4.2 describe the analysis of projected change for each of the Ensembles. Section 4.6 at **Table 9a** relates the projected conversions into change in footprint of development. Certain numbers from these tables are extracted into the following **Table 7** to describe the relative change in natural plant cover as a percentage of a theoretical starting natural condition. One observation that can be made is the jump in percent change per year in the 1953-1973 period when the region began to develop, but as the region became one of the fastest growing areas in the State, the percentage rose slightly then dropped slightly. The Corps' authority, Section 404 of the Clean Water Act, started in 1972. Many State and local authorities related to natural resources also began in this era. The roughly equivalent rate of conversion despite the rapid growth could possibly be ascribed to the collective results of these programs. It can be ascribed to the greater awareness of the natural resource issues on the part of the landowners and to the site design techniques that have been instituted by the development industry.

Table 7. Conversion of Natural Plant Cover in Study Area

	"Start"	1900-1953	1953-1973	1973-1988	1988-1995	1900-1995	Q	R	S	T	U
Wetland	48.8%	0.3%	2.7%	6.6%	1.8%		2.1%	2.3%	1.8%	1.6%	1.7%
Upland	13.9%	0.4%	6.7%	4.3%	2.7%		9.5%	8.5%	8.4%	8.2%	7.9%
Wet/Up	37.3%	2.8%	4.2%	5.1%							
Total	100.0%	3.5%	13.6%	16.1%	4.5%	38.0%	11.6%	10.8%	10.2%	9.7%	9.6%
Per Year		0.1%	0.7%	1.1%	0.6%	0.4%	0.6%	0.5%	0.5%	0.5%	0.5%
Figures for Wet/Up shown before 1988 because some plant cover categories can include both upland and wetland areas.											
Note that Wetland and Upland numbers are based on interpretation of aerials and other non-site specific information.											
Numbers should be used only for comparisons to each other due to many potential interpretative inaccuracies.											

4.3 FEDERALLY THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (Act) imposes duties on all citizens related to species listed under the Act. The Corps consults with the U.S. Fish and Wildlife Service (USFWS), as provided by Section 7 of the Act, on the effect of a project so that effect can be considered as part of the decision whether to issue a Department of the Army Permit. The Corps is responsible, under the Act, to use its authority(s) to protect existing populations and habitat of listed species and also to further the recovery of those species.

Florida Panther

The USFWS developed species and habitat-level recommendations for the protection of the Florida panther in the Multi-Species Recovery Plan for the Threatened and Endangered Species of South Florida (MSRP) (USFWS 1998). Those recommendations that pertain to the study area include: (1) minimize injury and mortality from panther/vehicle collisions; (2) identify and prioritize underpass needs in South Florida; (3) enforce available protective measures; (4) initiate Section 7 consultation (ESA) when applicable; (5) implement on-site minimization, habitat compensation, and mitigation on private lands through Section 10 of the Endangered Species Act when needed; (6) monitor the South Florida panther population; (7) establish South Florida education and outreach programs for the Florida panther; (8) preserve and protect Florida panther habitat; (9) complete acquisition projects comprised of Priority 1 and Priority 2 panther habitat; (10) expedite State of Florida land acquisition projects; (11) initiate new acquisition projects comprised of Priority 1 and Priority 2 habitat; (12) complete public protection of Big Cypress Area of Critical State Concern; (13) establish, restore, and maintain important panther corridors; (14) use landowner incentive programs to conserve, restore, and manage panther habitat; (15) utilize the

Environmental Conservation Acreage Reserve, Wetlands Reserve, Conservation Reserve program, Environmental Quality Incentives Program, Wildlife Habitat Incentives Program, and the USFWS Partners for Fish and Wildlife Program to encourage private landowner protection of panther habitat; (16) determine properties best suited for habitat restoration using landowner incentive programs; and (17) develop and implement a habitat monitoring program/plan.

The Florida Game and Fresh Water Fish Commission (FGFWFC) developed habitat conservation strategies for the Florida panther in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS). Using a panther density of 1/110 km^2 (1/42mi^2) based on home range information, the FGFWFC indicated that a population of about 50-70 would probably persist for a least 200 years under favorable management conditions, utilizing as much as 8,100-16,200 km^2 (2-4 million acres) of habitat. Maehr (1990) estimates that current conservation lands in the region could support only 18-24 panthers. Conservation of additional habitat areas is needed to manage the population for long-term survival. By modeling "preferred" and "secondary" habitat types, panther avoidance of barren land cover, roadless patches, and composition of land-cover within roadless patches, the FGFWFC established a qualitative measure and score for panther habitat that ranged from 1 to 8. The largest blocks of high-scoring land cover included Collier and Lee Counties. Private lands immediately north and northwest of the Fakahatchee Strand State Preserve, Big Cypress National Preserve, and Florida Panther National Wildlife Refuge, together with lands within these preserves, formed the largest contiguous block of land cover with the high index values. These areas include a large portion of the southeast quarter of the study area (Belle Meade, Southern Golden Gate Estates, CREW and surrounding private agricultural lands). These areas form the basis of the Strategic Habitat Conservation Areas for the Florida panther within the study area.

The Florida Panther Habitat Preservation Plan (HPP) mapped lands "...considered essential to maintaining the Florida panther population south of the Caloosahatchee River at its present level." These included Priority 1 ("The lands most frequently used by the panther and/or lands of high quality native habitat that should be conserved first...") and Priority 2 lands. Total priority habitat identified by the HPP encompassed 468,600 acres south of the Caloosahatchee River and 457,700 acres north of the river. The study area includes 74% of the Priority 1 and 34% of the Priority 2 lands south of the river and 29% and 23%, respectively of the total Priority 1 and 2 habitat (north and south of the river). The changes in land cover within the study area have a large influence on the range of the species.

Table 8a. Priority Habitat for the Florida Panther in South Florida

Ensemble	Percentage of Priority Habitat south of river				Percentage of all Priority Habitat in the HPP			
	In Preserves		On Private lands		In Preserves		On Private lands	
	Pri I	Pri II	Pri I	Pri II	Pri I	Pri II	Pri 1	Pri II
Q	58%	7%	16%	27%	22%	5%	6%	18%
R	64%	7%	11%	26%	25%	5%	4%	18%
S	64%	14%	10%	19%	24%	10%	4%	14%
T	66%	12%	8%	20%	26%	8%	3%	13%
U	66%	14%	8%	20%	25%	10%	3%	13%

An Ensemble with a higher percentage of habitat on public lands would have greater assurance of preserving the existing population. All of the Ensembles predict additional lands to be placed into public or other preserve, as described by this table. These preserves also serve to preserve the mix of upland and wetland native vegetation as described earlier in Section 4.2.

Table 8b. Priority Habitat for the Florida Panther in the Study Area

Percentage of All "Priority" Habitat Within the Study Area									
Ensemble	In Preserves			In Agriculture			Other Private Land		
	Pri 1	Pri 2	1+2	Pri 1	Pri 2	1+2	Pri 1	Pri 2	1+2
Q	78%	20%	56%	11%	51%	26%	11%	29%	18%
R	86%	22%	62%	13%	69%	34%	2%	9%	4%
S	86%	43%	70%	12%	28%	18%	2%	30%	12%
T	90%	38%	71%	9%	53%	25%	1%	9%	4%
U	89%	42%	72%	9%	35%	19%	2%	23%	10%

Several of the Ensemble maps include criteria to restrict the intensification of agriculture or to preserve existing agricultural or rural land uses. Such criteria would preserve panther habitat on those agricultural lands not included in public preserves, increasing the assurance of preservation of the species since not all of the private land ownership will be of the nature that would preclude preservation of panther habitat. Therefore, the above percentages should be evaluated in terms of criteria which limit additional development; that is, although Ensembles R and S appear to protect 86% of Priority habitat, Agricultural land under R does not have the limitation on intensification found in Ensemble S.

Further examination of the table shows that even under Ensemble U, 28% of the Priority I and Priority 2 habitat, particularly Priority 2, is at risk of not being available for this species.

Occupied panther habitat is about evenly divided between public and private lands. If private land habitats are lost the existing public lands in South Florida are judged capable of supporting only 9 to 22 (Maehr 1990b) of the minimum 50 adult panthers needed to sustain a genetically viable population (MSRP 4-127). Breeding and dispersing panthers use the Corkscrew Swamp system connected to the core population center to the southeast through Camp Keais Strand. Unlike the core population center, there have been limited attempts to track and radio-collar panthers in the Greater Corkscrew Region. That the road mortalities in Rural Lee County are sub-adult males seems to support the premise that this area is primarily used by dispersing juveniles.

Early radiotelemetry investigations indicated that panther (n=6) use of mixed swamp forests and hammock forests was greater than expected in relation to the availability of these vegetative communities within the panthers home range area (Belden et al. 1988). As investigations expanded onto private lands between 1985 and 1990, it was determined that panthers (n=26) preferred native, upland forests, especially hardwood hammocks and pine flatwoods, over wetlands and disturbed habitats (Maehr et al. 1991a). For pine flatwoods, which comprised about 12 percent of the habitat available to male Florida panthers (n=5) and female Florida panthers (n=5), mean habitat use between 1986 and 1994 averaged 33 and 32 percent respectively. For hardwood hammocks, which comprised about 13 percent of the habitat available, mean habitat use averaged 38 and 31 percent respectively (Maehr 1996). Hardwood hammocks provide important habitat for white-tailed deer (Odocoileus virginianus), an important panther prey species (Harlow 1959, Belden et al. 1988, Maehr 1990a, 1992a, Maehr et al. 1991a). Understory thickets of tall, almost impenetrable, saw palmetto (Serenoa repens) have been identified as the most important resting and denning cover for panthers (Maehr 1990a). Agricultural and other disturbed habitats, freshwater marsh, thicket swamp, and mixed swamp are not preferred, and are either used in proportion to their availability or are avoided (Maehr 1990a). Panthers have not been found in pastures during daytime radiotelemetry flights but may travel through them at night (Maehr et al. 1991a, Maehr 1992a). Male and female panther home range size is inversely related to habitat quality; the greater the extent of agricultural land and wetland habitats the larger the home range, and the greater the extent of mixed hardwood forests and dry pine forests the smaller the home range. High-quality habitat produces abundant prey and influences female panther reproductive success (Maehr 1992b, Maehr et al. 1989b). The largest contiguous tract of panther habitat is in the Big Cypress Swamp/Everglades physiographic regions. Big Cypress National Preserve, Everglades NP, and Florida Panther NWR together comprise about 927,793 ha of native habitats--46 percent of which is forested. However upland forests, e.g. pine forests and hardwood hammocks, comprise only 8 percent of the total land area (Duever et al. 1986, USFWS 1996, NPS 1998). (Page 4-120)

Overall, management activities directly benefiting the panther and panther prey are limited to upland habitats which comprise only 8 percent of the total land area in Big Cypress National Preserve, Everglades NP, and Florida Panther NWR (Maehr 1996). The Immokalee Rise physiographic region includes all of Hendry County and parts of Collier, Glades, and Lee counties (i.e., the core of occupied panther habitat). Pine flatwoods in this area declined 88 percent from 153,928 ha in 1900 to 17,970 ha in 1989. Pine flatwoods have also been severely fragmented and today are comprised of thousands of patches less than 50 ha in size (Mazzotti et al. 1992). Pine flatwoods have been replaced by pasture, row crops, and citrus. Hardwood hammocks have increased (probably due to land drainage) from 6,703 ha in 1900 to 9,516 ha in 1989 but have never comprised more than 2 percent of the vegetative cover in the Immokalee Rise physiographic region (Mazzotti et al. 1992). Given the high level of panther use and scarcity as a cover type it is important that hardwood hammocks be maintained in conditions attractive to panthers and panther prey. (page 4-131). The effects of the invasion of melaleuca on the quality of habitat is unknown. Many of the FLUCCS series counted as habitat have young melaleuca, not enough yet to change the FLUCCS series, but the invasion is starting to choke out the understory and midlevel canopy layers. Most of the research on the panther has occurred in areas with little invasion and so there is little direct data.

This species range historically probably extended throughout the entire study area. **Table 7** of Section 4.2 suggests greater than a third of the natural cover has been lost. In addition, existing natural cover still present west of Interstate 75 is of less value. **Table 19** in Section 4.20.1 suggests that some of the plant cover particularly used by this species are also those with the greater historic losses. The Ensembles vary slightly in the total area of cover impacted but as seen from the figures for Priority Habitat above, the location of land uses and their relation to loss of land cover has a great influence on the habitat available to the species.

<u>Scrub-Jay</u>

The USFWS developed species and habitat-level recommendations for the protection of the Florida scrub-jay in the Multi-Species Recovery Plan. Those recommendations that pertain to the study area include: (1) determine the distribution of Florida scrub-jays and status of scrub habitat in South Florida; (2) maintain scrub-jay habitat and distribution data in a GIS database; (3) protect and enhance Florida scrub-jay populations; (4) develop a reserve design for Florida scrub-jays in South Florida using landscape maps, GIS and spatially-explicit population models; (5) protect, manage and enhance Florida scrub-jay populations on public lands; (6) protect, manage, and enhance Florida scrub-jay populations on privately-owned lands; (7) enforce available protective measures (initiate Section 7 of the Endangered Species Act consultation when applicable, implement on-site minimization, habitat compensation, and mitigation on private lands through Section 10 of the Endangered Species Act when needed); (8) conduct risk assessment analysis to determine the probability of persistence of the scrub-jay in south Florida, given the current amount of suitable scrub habitat as well as potentially restorable scrub habitat; (9) study the effects of habitat fragmentation due to urbanization; (10) monitor scrub-jay populations; (11) inform and involve the public (biological needs and species protection); (12) prevent degradation of existing scrub habitat; (13) prioritize areas identified in reserve design for acquisition and management; (14) protect scrub-jay habitat on private lands through easements, acquisitions, and donations; (15) continue State and Federal (land) acquisition efforts; (16) maintain suitable habitat for scrub-jays; (17) prevent loss or fragmentation of scrub habitat within scrub-jay reserves; and (18) monitor scrub habitat that is occupied by scrub-jays to insure public lands are managed to maintain scrub in suitable conditions for scrub-jays, and to assess when unmanaged areas become unsuitable for scrub-jays. Also monitor to ensure the site is not becoming a "sink" for the population.

The Florida Game and Fresh Water Fish Commission (FGFWFC) in their <u>Closing the Gaps in Florida's Wildlife Habitat Conservation System</u> (GAPS) modeled limited available data (survey information being compiled by Archbold Biological Station for the USFWS was not available). This analysis identified scrub-jay family locations; patches of oak scrub, sand pine scrub, and dry prairie within 160 m (525 feet) circles of the point data; and isolated patches of oak scrub, sand pine scrub, and dry prairie within 8.1 ha

(20 ac) defined by the circles (approximate size of a scrub-jay territory). The analysis also mapped concentrations of scrub-jay occurrences, and highlighted areas were habitat patch size was considered to be capable of supporting scrub-jay families. The analysis indicated a site of potential importance to scrub-jay conservation efforts in northeast Lee County both north and south (study area) of the Caloosahatchee River in the vicinity of the Caloosahatchee State Recreation Area; FFWCC's Hickey Creek Gopher Tortoise Mitigation Park; and Bedman Creek. Other locations include an isolated population in Immokalee and south of S.R. 82 in Collier County. Historically, scrub-jays inhabited scrub habitat in the vicinity of Estero in Lee County. Scrub-jays were also reintroduced to Rookery Bay National Estuarine Reserve in Collier County in the 1990's.

There are 26 known families of scrub-jays in the study area. Not all habitat has been surveyed, so others may exist, although there is only a limited amount of remaining scrub habitat. In a typical permit, the scrub-jay habitat associated with an existing family would be preserved, based on what is expected to be the breeding/foraging needs of that family. However, removal of the remaining scrub vegetation in the region may preclude any expansion or dispersal of scrub-jays from the site. Ensembles Q, R and U would surround 20 scrub-jay families with development or other non-preserve land cover, Ensemble T, 18, and Ensemble S, 15. Several of the Ensembles include criteria to restrict the intensification of agriculture or the preservation of agricultural or rural uses that protect listed species habitat. Such criteria would increase the assurance of preservation of the species. An Ensemble with a higher number of scrub jay families in contiguous preserves would provide more assurance of the preservation of the species. This would be one of the additional benefits of preserving native plant communities, discussed in Section 4.2. Out of the 26 known families, 6 would be located within preserve areas in Ensemble Q; 6 in Ensemble R; 11 in Ensemble S; 8 in Ensemble T; and 6 in Ensemble U. Examination of these numbers point out that from 15 to 20 scrub jay families (or 57% to 77%) may be at risk under any Ensemble.

This species probably was more common in the study area. **Table 19** in Section 4.20.1 suggests that some of the plant covers with a greater potential to find scrub habitat was not a large portion of the study area but has also declined.

Red-cockaded woodpeckers

The USFWS developed species and habitat-level recommendations for the protection of the red-cockaded woodpecker in the Draft MSRP (USFWS 1998). Those recommendations that pertain to the study area include: (1) determine distribution and status of red-cockaded woodpeckers; (2) develop a reserve design for red-cockaded woodpeckers; (3) protect, manage, and enhance red-cockaded woodpecker populations on public lands; (4) enforce available protective measures (Section 7 of the Endangered Species Act where applicable and Section 10 of the Endangered Species Act when needed); (5) conduct risk assessment analysis to determine the probability of persistence of red-cockaded woodpeckers in South Florida, given the current amount of available, suitable pineland habitat, and include pineland areas that could be restored or enhanced to become suitable habitat; (6) study the effects of habitat fragmentation due to urbanization; (7) monitor red-cockaded woodpecker sub-populations; (8) inform and involve the public; (9) prevent degradation of existing red-cockaded woodpecker habitat in South Florida; (10) prioritize areas identified in reserve design for management and acquisition; (11) protect red-cockaded woodpecker habitat on private lands through easements, acquisitions and donations; (12) support State (land) acquisition efforts; (13) maintain adequate nesting habitat in addition to currently active cluster, to replace clusters abandoned or lost through mortality, and to provide for population expansion; (14) maintain adequate foraging habitat to support existing groups and to facilitate establishment of new territories; (15) prevent loss or fragmentation of pine flatwoods within reserves; (16) restore and enhance red-cockaded woodpecker habitat; (17) determine the potential carrying capacity for clusters of red-cockaded woodpeckers on existing public and private lands where suitable or restorable habitat exists; (18) monitor pineland habitat that is occupied by red-cockaded woodpeckers to insure public lands are managed to maintain habitat in suitable condition for red-cockaded woodpeckers, and to assess when unmanaged areas become unsuitable; and (19) insure public awareness of the importance of pine flatwoods communities.

The Florida Game and Fresh Water Fish Commission (FGFWFC) in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled locations of active colonies in Southwest Florida and isolated pineland, sandhill, dry prairies, and mixed hardwood-pine landcover types within 500 m of active red-cockaded woodpecker clusters to identify core habitat areas for the red-cockaded woodpecker. The analysis relied heavily on known occurrence information, therefore it does not include all areas where red-cockaded woodpeckers might occur. The analysis indicated that few large patches of habitat are known outside of public lands and that the largest patches of potential habitat are found in Orange, Glades, Collier, and Hendry counties. For the study area, the analysis highlighted the 14 active clusters west of Big Cypress National Preserve in an area west of S.R. 951 and in the Belle Meade CARL project. The analysis indicated that, although isolated, the red-cockaded woodpecker population in this area was sufficiently large to sustain the population for many generations with occasional translocations from other populations to alleviate the long-term threats. The analysis also noted the presence of isolated red-cockaded woodpecker clusters in Lee County, north, south, and east of the Southwest Florida International Airport . Recently, red-cockaded woodpeckers have been documented in the CREW CARL project and historically, red-cockaded woodpeckers were documented at Audubon's Corkscrew Swamp Sanctuary.

There are 40 known groups of red-cockaded woodpeckers in the study area. Not all habitat has been surveyed so others may exist, although there is only a limited amount of mature pine forests in the region. In a typical permit, a large number of acres in association with existing cluster may be preserved, based on the foraging needs of that group. However, removal of the pine forests beyond that then precludes any expansion of or dispersal from that colony and the adjacent development creates disturbance that could result in the death of the individual birds or abandonment of the site. Ensemble R would surround 38 groups with development or other non-preserve land type, Ensemble Q, 30; Ensemble T, 28; Ensemble S, 27; and Ensemble U, 22. Several of the Ensembles include criteria to restrict the intensification of agriculture or the preservation of agricultural or rural uses that protect listed species. Such criteria would increase the assurance of preservation of the species. An Ensemble with a higher number of groups in contiguous preserves would provide more assurance of the preservation of the species. This would be one of the additional benefits to preserving native plant communities, discussed in Section 4.2. In addition, maintaining habitat connections, discussed in Section 4.4, provides greater opportunity for expansion of red-cockaded woodpecker groups. Preservation of existing sites is also very important since there is a paucity of old-growth pine forests in the study area. Out of the 40 known locations, 10 would be located within preserve areas in Ensemble Q; 2 in Ensemble R; 13 in Ensemble S; 12 in Ensemble T; and 18 in Ensemble U. An Ensemble with a higher number of colonies in contiguous preserves would provide more assurance of the preservation of the species. However, even under Ensemble U, 22 clusters (or 55%) of the red-cockaded woodpecker clusters are at risk.

This species range historically probably extended throughout the upland forested areas of the study area. **Table 19** in Section 4.20.1 suggests that the Pinelands community has been particularly heavily reduced.

Bald eagle

The USFWS developed recommendations for the protection of the bald eagle in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) determine the distribution of the bald eagle in South Florida; (2) protect and manage bald eagle populations in South Florida; (3) prevent or mitigate the effects of behavioral degradation; (4) identify and quantify effects of disturbance on nesting eagles and incorporate into management plans; (5) identify and quantify the effect of disturbance on bald eagle feeding sites and incorporate into management plans; (6) reduce bald eagle mortalities in South Florida; (7) enforce laws protecting bald eagles; (8) continue to monitor bald eagle nesting activities in South Florida; (9) develop public information and education materials to inform the public of the recovery needs of the bald eagle in South Florida; (10) prevent further loss and degradation of bald eagle habitat in South Florida; (11) continue to gather information on the effects of habitat loss and degradation of habitat on bald eagles in South Florida; (12) identify alterations to terrestrial and aquatic habitats that adversely affect bald eagles in South Florida; (13)

quantify essential characteristics of occupied bald eagle habitat; (14) quantify responses of bald eagles in South Florida to habitat alteration; (15) protect bald eagle habitats in South Florida through site management; (16) continue to implement and adhere to "Habitat Management Guidelines for the Bald Eagle in the Southeast Region"; (17) protect eagle habitat through cooperative agreements, easements, acquisition or other appropriate means; (18) identify and incorporate important bald eagle habitat in land use plans and planning, (19) use Section 7 of the ESA to protect bald eagles and their habitats; (20) develop methods to restore previously occupied habitat or to establish new territories; and (21) increase public awareness of habitat-related that affect the recovery of the bald eagle in South Florida.

The Florida Game and Fresh Water Fish Commission (FGFWFC) in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled important nest locations and a 3-km zone around nesting locations, including freshwater marsh and open water that constitute foraging habitat. The analysis also created a 1-km zone around nesting locations to isolate potential nesting habitat. The forested uplands and wetlands within this zone were highlighted as potential nesting areas. Areas within the study area identified as important to bald eagles included most of the coastal areas of Lee and Collier County. Nesting sites on private lands along the Gulf Coast were perhaps most threatened because many nests occur on development corporation properties (Wood et al. 1989).

There are 27 known bald eagle nests in the study area. Not all habitat has been surveyed. However, most nests are found in coastal areas. In a typical permit, the nest would be buffered consistent with the Habitat Management Guidelines for the Bald Eagle in the Southeast Region (USFWS 1987). Loss or disturbance around the nest may affect the pair by reducing or eliminating breeding success, precluding any expansion of the population. Adjacent development may create disturbance and loss of foraging habitat that could result in the abandonment of the site. Ensembles Q, R and U would surround 9 nests with development or other non-preserve land type, Ensemble T, 8; and Ensemble S, 7. Several of the Ensembles include criteria to restrict the intensification of agriculture or the preservation of agricultural or rural uses that protect listed species. Such criteria would increase the assurance of preservation of the species. Some alternatives also stress preservation of lands and flowways (also discussed in Section 4.4) near the coastal area, and preserving foraging habitat. The wetlands within the foraging range are considered, in Section 4.4, to be of high priority for wetland-dependent species. An Ensemble with a higher number of nests in contiguous preserves would provide more assurance of the preservation of the species. Out of the 27 known locations, 18 would be located within preserve areas in Ensemble Q; 18 in Ensemble R; 20 in Ensemble S; 19 in Ensemble T; and 18 in Ensemble U. Therefore, even under Ensemble S, 24% of the bald eagle nesting locations are at risk.

Wood Stork

The USFWS developed species and habitat-level recommendations for the protection of the wood stork in the Multi-Species Recovery Plan (USFWS 1998). These recommendations that pertain to the study area include: (1) preventing degradation of nesting, foraging, and roosting habitat; (2) protecting and enhancing wood stork protection through provisions of Section 7 of the Endangered Species Act; (3) determining the foraging ecology and behavior of wood storks (prey base, critical foraging areas and foraging requirements); (4) protecting wood storks from mercury and other contaminants; (5) systematic censusing of wood storks in the Big Cypress basin to determine the potential sources of habitat deterioration; (6) prioritizing habitat that needs protection; (7) assisting private landowners in managing for wood storks by providing Best Management Practices, incentives, or management plans; (8) developing consistent with the Habitat Management Guidelines for Wood Storks (Ogden 1990); (9) utilizing existing wetland regulatory mechanisms to protect foraging habitat in south Florida (Federal and State permitting actions); (10) developing Habitat Conservation Plans; (11) adaptive restoration and enhancement of suitable habitat, especially in the Big Cypress basin; (12) enhancing breeding and wintering activities of wood storks in south Florida, especially significant colonies like the Audubon's Corkscrew Swamp Sanctuary; (13) determining the effects of natural and human-caused hydrologic events on the ecology of the wood stork prey base; and (14) acquire land identified as important for wood storks.

The FGFWFC, in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled wetland systems of potential importance to wood stork nesting colonies based on approximate distances that individual species will travel to forage (30 km for wood storks). Although the importance of specific wetland areas surrounding individual colonies likely changes from year to year based on rainfall and specific hydrologic conditions, the study indicated the importance of several large wetland systems such as the Corkscrew Swamp and wetlands with the Big Cypress basin. Wetland areas near nesting colonies also play a critical role during the nesting season, soon after the young hatch (Browder 1984).

Since the 1960s, the wood stork population has shown a substantial decline in southern Florida and a substantial increase in northern Florida, Georgia, and South Carolina (Ogden et al. 1987). The deterioration of the Everglades and Big Cypress basins has resulted in decreased nesting by wood storks in south Florida and increased nesting in northern Florida, Georgia, and South Carolina. The number of pairs nesting in the traditional colony sites located in the Everglades and Big Cypress regions of southern Florida declined from 8,500 pairs in 1961 to fewer than 500 pairs from 1987 through 1995. During the same years, the number nesting in Georgia increased from 4 pairs in 1965 to 1,501 pairs in 1995, and the number nesting in South Carolina increased from 11 pairs in 1981 to 829 pairs in 1995.

From 1991 through 1995, the USFWS coordinated a systematic multi-state survey of wood stork nesting colonies. The results of these surveys suggest that, on average, from 1991 to 1995, approximately 35 percent of the total nesting effort in the southeast U.S. occurred in south Florida. Historically, south Florida supported greater than 70 percent of the total wood stork nesting effort in the southeast U.S.; if these data are indicative of the ability of degraded south Florida ecosystems to support wood stork nesting, then south Florida ecosystems are functioning at approximately 50 percent of their previous capabilities.

Since the 1970s, wood storks have also shifted their nest sites to areas that are artificial impoundments or where islands have been created by dredging activities (Ogden 1991). The percentage of wood storks that nested in either altered wetlands (former natural wetlands with impounded water levels) or artificial wetlands (former upland sites with impounded water) in central and north Florida colonies increased from about 10 percent in 1960 to between 60 and 82 percent between 1976 and 1986. Nests in these artificially impounded sites often support exotic species such as Brazilian pepper (Schinus terebinthifolius) or Australian pine (Casuarina equisetifolia). Ogden (1996a) has suggested that the use of these artificial wetlands indicates that wood storks are not finding suitable conditions within natural nesting habitat or that they are finding better conditions at the artificial wetlands.

The reproductive success of storks requires habitats that provide high concentrations of certain size classes of fish over a 125 to 150-day breeding cycle. Because seasonal and annual rainfall patterns are so variable in south Florida, the quantity of these foraging habitats also varies among years (J. Ogden, SFWMD, personal communication 1998). As a result, wood storks probably have always had highly variable reproductive success throughout their history, a phenomenon that is mitigated by the relatively long life spans of adult storks. Nevertheless, most experts agree that the decline of the U.S. wood stork population far exceeds the range of historic variability in total population size and is correlated with water management activities in south Florida (Palmer 1962, Frederick 1993, Ogden 1996). During wet years, current water management practices prevent the formation of shallow pools that concentrate the fish on which wood stork forage. During dry years, current water management practices over-drain the freshwater sloughs, reduce freshwater flows into the mainland estuaries, and reduce their ability to produce the fish on which wood storks forage. As a result of these water management practices, wood storks in south Florida have experienced increased frequencies of nest failure. For example, in 1962, 1978, and 1983, wood storks in Everglades National Park did not initiate nesting. In the 1998 nesting year, only 25 pairs of wood storks were recorded nesting in Everglades National Park.

Historical data on colony locations identify the Everglades basin colonies and the Corkscrew colonies as the primary nesting locations for wood storks in south Florida (Ogden and Nesbitt 1979). In the late 1950s and early 1960s, wood storks nesting in the Everglades basin accounted for 12 percent (1,000 out of 8,609 nests based on two-year average) of the Florida population. The 1991-95 survey data reveal that the Everglades basin colonies represents on the average, 3 percent (129 out of 4,065 nests based on a four-year average) of the Florida population. More recent data provided by Ogden (1998) on three-year averages on nesting pairs of wood storks in the Everglades Basin show 343 pairs for the 1994-96 average, 283 pairs for the 1995-97 average, and 228 pairs for the 1996-98 average. These averages are higher than the three-year average for the base years, 1986 to 1995. The base year averages were a low of 130 pairs and a high of 294 pairs. In the 1998 nesting year, only 25 pairs of wood storks were recorded nesting in Everglades National Park.

Data from the late 1950s and early 1960s indicate that the Corkscrew colonies accounted for 51 percent (4,350 out of 8,609 nests based on a two-year average). The survey data also show that the Corkscrew colonies represent on the average, 12 percent (510 out of 4,065 nests based on a four-year average) of the Florida population.

On the average, the south Florida sub-population represents 53 percent of the Florida population and 34 percent of the southeastern U.S. population. These data show a nesting population of 1,339 nests in 1991, 2,546 nests in 1993, 2,015 nests in 1994, and 2,639 nests in 1995. More recent data provided in the wood stork recovery plan (USFWS 1997) give a Florida breeding population of 2,327 pairs in 1991, 4,823 pairs in 1993, 3,588 pairs in 1994, and 5,523 breeding pairs in 1995. Twenty-one breeding colonies were present in 1991, 28 breeding colonies were present in 1993, 26 in 1994, and 30 in 1995.

The wood stork is a key indicator of the health of the wetlands in the south Florida ecosystem. The wood stork is a landscape option dependent species. There is already, in Southwest Florida, an extreme loss of early season forage habitat (short hydroperiod wetlands). Wetlands near existing rookeries can be considered more important to support nesting foraging needs. Some literature has suggested wetlands within 30km are particularly important for this period of their life history (nesting) but storks will routinely travel as far as 75km. Wood storks will travel even more extensively for their "maintenance" needs, so wetlands throughout the region are equally important as those in proximity to the existing rookeries. Woodstorks appear to be attracted to Southwest Florida but when there are no early season foraging available in November to January, they are moving to North Florida and other states to initiate nesting. Southwest Florida has apparently lost many of its wetlands that dry down or concentrate early after the summer wet season, and instead wood storks are waiting until the deeper wetlands are drying down later in the winter before initiating nesting. These sort of wetlands are both shallow (thus more attractive to being filled) and more easily affected by surface water drainage modifications compared to the deeper wetlands. However, both shallow and deep wetlands are needed, since they dry down at different months during the nesting season. Part of the character of the use of wetlands by wood storks is their dependence on prey concentration during drawdown and the size of the prey which is driven by ability of prey to move from deeper wetlands (where a portion of the population avoids foraging when young) to the deeper wetlands (so called "recharging") via connections between wetlands. Wood stork use of wetlands for forage habitat is also impacted by loss of function (hydroperiod, connectivity, recharge/restock). Furthermore, this ability of the species to search for new locations gives great hope for the recovery of the species but only if that species has "options" for establishing nesting locations. Therefore, none of the remaining wetlands are unimportant since the species decline and/or movement to other areas is indicative of a stressed population and that the wetlands are at full carrying capacity. Protection or restoration of existing wetlands will prevent or restore include the following characteristics: water source sheet flow (gradual hydration) or pulse (weir); water is runoff from native vegetation (marsh ready) or from development (metals, etc.); concentration pond present in winter or dries out in winter (no prey maintained) or is constant depth (no concentration); connected to other marshes (movement of fish); shallow littoral zone or a sharp edge only shallow part of year; and shrub/tree buffer for resting/perching/cover.

This species range still extends throughout the entire study area but natural foraging habitat (as compared to ditches and retention ponds) is more and more a smaller proportion of its total foraging needs. **Table 19** in Section 4.20.1 suggests that some of the Fresh Marsh, Wet Prairie and Pineland covers appear to have halved. Wood stork populations continue to decline as they appear to be moving to other areas of Central Florida and the Eastern Seaboard to nest, indicating the continued decline of natural foraging will impact the maintenance of this species in the region.

Audubon's Crested Caracara

The USFWS developed species and habitat level recommendations for the protection of the Audubon's crested caracara in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) determine the distribution and abundance of Audubon's crested caracara; (2) protect and enhance existing populations of Audubon's crested caracara; (3) locate and map potential habitat within the former range of the caracara that might be rehabilitated for reintroduction purposes; (4) encourage landowners to protect caracara nesting sites by providing incentives (awards, credits for mitigation, special recognition, etc.); (5) establish habitat management guidelines to protect the nests and nesting pairs of Audubon's crested caracara; (6) increase public awareness of the biology, ecology, status and trends of the Audubon's crested caracara; (7) protect and enhance currently occupied habitat; (8) protect privately-owned, occupied lands wherever possible; (9) conduct Section 7 (Endangered Species Act) consultations on all Federal activities that might affect caracaras and their habitat; (10) create, restore, or expand occupied habitat wherever possible; (11) use LANDSAT imagery and updated aerial photographs to monitor changes in land use in the core of the caracara population; and (12) educate the public on the value of prairie communities and prairie management needs.

The FGFWFC, in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled landcover and breeding bird atlas records (Kale et al. 1992), a survey by Millsap (1991), and FNAI data points, as well as a 1-km zone around territory centers to define central territory areas, not total territory size. Within these central areas, the FGFWFC isolated dry prairie, hardwood hammock, freshwater marsh, shrub and brush, and grass and agriculture landcover that might be used by caracaras (Layne 1978a). The analysis indicated limited, mostly historical information for the Audubon's caracara in the study area and did not model significant conservation areas for the caracara in the study area. However, the analysis did not include all documented caracara use, including data for agricultural lands in southeastern Lee County and north Collier County.

Caracara breeding pairs are found in prairie with areas of shrub and forest areas, though most of this plant community in south-central Florida is now improved or semi-improved pasture. Ensembles proposing the continuation of low intensity agriculture or the preservation of areas of native vegetation will provide opportunities for the population to continue or expand. In addition, the preservation of seasonal wetlands within a framework of contiguous preserves, as discussed in Section 4.4, may be important since the presence of seasonal wetlands may be an important habitat factor as caracaras frequently forage in wetlands or depend on wetlands for prey base.

This species range historically probably extended through a large portion of the study area. **Table 7** of Section 4.2 and **Table 19** Section 4.20.1 suggest losses of the natural plant covers but these tables recorded the conversion of natural cover to pasture and similar covers as a loss.

Piping Plover

The USFWS developed species and habitat-level recommendations for the protection of the piping plover in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) determine the distribution and abundance of wintering piping plovers in Florida by surveying beaches and other suitable habitat to determine additional wintering sites; (2) protect and enhance the wintering piping plover population in Florida by managing human use of beaches important to piping plovers; (3) investigate the effects of human disturbance on wintering plovers; (4) monitor known and potential wintering sites; (5) monitor human use of piping plover wintering sites; (6) protect essential wintering habitat by preventing habitat degradation and disturbance; (7) utilize the Section 7 (Endangered Species Act) consultation process to minimize the effects of Federal actions (beach renourishment, coastal armoring) on piping plover wintering habitat; (8) protect wintering habitat from disturbance by recreationists and their pets; (9) provide for long-term protection of wintering habitat, including agreements with landowners and habitat acquisition; and (10) monitor and manage wintering and migration areas to maximize survival and recruitment into the breeding population.

The FGFWFC, in their study Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled habitat distribution using survey and point data from the USFWS, FNAI, and FGFWFC wildlife observation data bases. The analysis included mapping of coastal salt marsh, coastal strand, and barren land cover (sandy beaches). For the study area, the analysis concluded that Estero Island (Estero Island Critical Wildlife Area - Ft. Myers Beach) and Tigertail Beach (Big Marco Critical Wildlife Area - Marco Island) were potentially important habitat.

Barrier island beaches within the study area are used by this small, migratory shorebird as wintering sites and summer habitat for some juvenile birds. These beaches include those on the Gulf of Mexico in the vicinity of Estero and Marco Islands. None of the Ensembles directly affect these sites although indirect effects may occur as a result of human disturbance (pets, noise, nuisance animals) and dredge and fill activities associated with increased coastal development. The piping plover habitat could also be affected by degradation in water quality resulting from changes in watersheds, as discussed briefly in Section 4.9. Changes in water quality are described in Section 4.10.

Snail Kite

The USFWS developed species and habitat-level recommendations for the protection of the snail kite in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) expand and refine existing information on movements and distribution of the snail kite, particularly changes attributable to drought; (2) protect and enhance existing population; (3) use provisions of Section 7 of the Endangered Species Act to protect the snail kite; (4) increase public awareness about snail kites; (5) prevent degradation of existing snail kite habitat; (6) control or remove exotic vegetation in wetlands; (7) ensure that information on wetlands of importance to snail kite nesting and feeding is considered in review of regulatory permits; (8) prevent cultural eutrophication of lakes and marshes; (9) restore areas to suitable habitat; (10) monitor habitat/ecological processes; and, (11) increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem.

The Florida Game and Fresh Water Fish Commission (FGFWFC), in their Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS), modeled habitat distribution for the snail kite using known nesting and foraging sites and mapping freshwater marsh, shrub swamp, and open water found in these areas. A 0.5-km zone was established around these habitat patches which included dry prairie and grassland that may constitute appropriate habitat areas in very wet years. For the study area, the analysis identified marshes, canals, and agricultural retention areas in southeastern Lee County (Lehigh Acres) and north Collier County as Strategic Habitat Conservation Areas for the snail kite. Snail kites have also been documented in association with borrow pits in the southern Lee County.

The snail kite has a highly specific diet composed almost entirely of apple snails, found in shallow freshwater marshes. These longer-hydroperiod marshes are found throughout the study area. This species is particularly sensitive to the degradation of water quality from runoff of surrounding urban development and agricultural activities. Ensembles that propose preservation of the seasonal wetlands within a framework of contiguous preserves will have a greater probability of maintaining this species in the study area. The discussion of seasonal wetlands is found in Section 4.4 below.

West Indian Manatee

The USFWS developed species and habitat-level recommendations for the protection of the West Indian manatee in the Multi-Species Recovery Plan (USFWS 1998). These recommendations that pertain to the study area include: (1) protect and enhance existing populations by identifying and minimizing causes of manatee injury, mortality, and disturbance; (2) minimize collisions between manatees and watercraft; (3) post and maintain regulatory signs; (4) enforce and encourage manatee protection regulations; (5) establish policies for authorizing boat races and other water sport events; (6) assess and reduce mortality caused by large vessels; (7) continue Section 7 (Endangered Species Act) and State reviews of boating facilities and watersport events; (8) minimize other human-related disturbances and harassment; (9) support the monitoring of manatee populations in South Florida; (10) maintain and improve the GIS for data on manatees and manatee habitat; (11) increase public awareness; (12) prevent degradation of existing manatee habitat in South Florida; (13) support the acquisition of manatee habitat in South Florida (additions to State Reserve, Preserve and Parks and Federal National Wildlife Refuges, Parks, and Preserves); (14) support the designation, management, and maintenance of Federal manatee sanctuaries and refuges in South Florida; (15) protect and promote regeneration of seagrass beds in South Florida; (16) include manatee protection and monitoring measures in management plans for Federal and State protected areas; (17) assist counties to develop manatee protection plans; (18) assist in implementing manatee protection plans; (19) restore and create manatee habitat in South Florida; (20) support the maintenance and restoration of water quality in fresh water sources; (21) enhance manatee habitat in South Florida; (22) determine an index of habitat fragmentation in South Florida; (23) develop and implement a manatee habitat monitoring program; and (24) establish effective manatee management programs at Federal and State protected areas.

Designated critical habitat for the manatee on the west coast includes the coastal waters and rivers from the Crystal River and its headwaters (King's Bay) in Citrus County south to Whitewater Bay in Monroe County (50 C.F.R. 17.95), including most coastal waters in the study area.

The second most significant threat to manatees is the loss and degradation of habitat, due primarily to direct damage by aquatic recreational and commercial boating activity, coastal construction, and pollution from sewage discharge and stormwater runoff (MMC 1992; Smith 1993). Coastal land conversion on the west coast, accompanying the growth of Florida's human population, has occurred largely along coastal waters and rivers used by manatees. Seagrass beds incur most of their direct damage from boat propellers (Zieman 1982). Boat-induced turbidity results from propeller dredging of bottom habitats and propeller wash and wave wake disturbance. Sediments around seagrasses become unconsolidated and suspended delaying recolonization for two to five years or longer, depending on the species.

Future coastal development will continue to degrade habitat that provides manatee food, therefore ecosystem effects of coastal development need to be evaluated (Marmontel *et al*. 1997). Seagrasses along the Florida coast have been in decline since the 1950's. In Tampa Bay, about 16,188 ha of seagrass flourished along the shallow shelf of the Bay. By 1982, only 8,741 ha remained baywide (TBNEP 1995). In Sarasota Bay, seagrasses have declined by 30 percent (SBNEP 1994). From 1945 to 1982, seagrass acreage declined by 29 percent in Charlotte Harbor; with an additional 809-3,238 ha of seagrasses destroyed or damage by boat propellers (Haddad and Sargent 1994).

The January 1999 synoptic survey documented 137 manatees in Collier County, compared to 218 manatees in 1998 and 417 in 1997. The Lee County survey documented 251 manatees as compared to 218 manatees in 1998 and 417 in 1997. The Caloosahatchee River in Lee County is the site of one of the largest wintering aggregations of manatees in Florida at the Fort Myers Power Plant in Lee County.

Manatee deaths resulting from several factors are well documented through a carcass recovery program initiated in 1974. Several factors have contributed to the current status of the manatee: collisions with watercraft; being crushed by flood gates or canal locks; other human causes (poaching, entanglement in fishing nets, ingestion of fishing gear, vandalism, etc.); perinatal deaths; disease, cold-related deaths; red tides; and hurricanes.

From 1974 through December 1998, 3,502 manatee carcasses were recovered in Florida, of which 1,065 (30 percent) were attributed to human-related causes. Of these, 828 were caused by collisions with watercraft, 145 were flood gate/canal lock-related, and another 92 were categorized as other human-related. Collisions with watercraft accounted for 78 percent of human-related causes of death during this period. The loss of 741 dependent calves occurred during this time period, cold stress was implicated in 124 deaths, and 458 died as a result of natural death. Ninety-nine manatee deaths that were verified were not recovered, 588 deaths remained undetermined due to decomposition, and 426 deaths had an undetermined cause.

The frequency of perinatal deaths (stillborn and newborn calves) has been consistently high over the past six years and represented 24 percent of all manatee deaths in 1994 (USFWS 1998). The cause of increasing perinatal deaths is uncertain, but may result from the increase in collisions between manatees and watercraft. Some newborn calves may die when their mothers are killed or seriously injured by boat collisions, when they become separated from their mothers while dodging boat traffic, or when stress from vessel noise or traffic induces premature births (MMC 1992).

In 1996, an epizootic of unprecedented proportions struck manatees in Southwest Florida. From March 5, 1996, to April 27, 1996, 158 manatee deaths were associated with the event (MTAC 1996). Most of the manatees were recovered from Lee County, followed by Collier, Charlotte, and Sarasota (FDEP 1996). A multi-agency research team determined the cause of the massive die-off was due to the ingestion of high levels of red tide toxin produce by the phytoplankton, *Gymnodinium breve* (FDEP 1996).

In 1998, 231 manatees died in Florida, the third highest mortality year on record, including 66 from watercraft-related mortality, the highest watercraft-related mortality ever recorded. As of December 1998, Lee (104) and Collier (85) counties were second and third, respectively, behind Brevard County (159) in the number of watercraft-related manatee deaths in the State of Florida. Watercraft-related mortalities are most significant in Southwest Florida, where deaths increased from 11 to 31 percent (Ackerman et al. 1995) from 1976 to 1994.

The annual number of manatees found dead in Florida has increased at a rate of 5.3% per year, averaging 89 per year during 1976-1981 and 153 per year from 1986-1992 (Ackerman et al. 1995). Collisions with boats were the most important identified cause of mortality; boat-related mortality has increased 10.3% yearly since 1976 (Ackerman et al. 1995).

Collisions with watercraft account for 25 percent of annual manatee mortalities, which is the largest, controllable cause of manatee mortalities. The risk to manatees is high where boat traffic occurs in waterways frequently used by manatees. These risks can be reduced by selecting suitable sites for the development and location of future navigation channels and docking facilities and by controlling the manner in which boats are operated. Therefore, increasing the number of watercraft may only increase the risk of manatee mortalities unless there are adequate Manatee Protection Plan (MPP) and/or established and enforceable speed zones.

On October 24, 1989, the Governor and Cabinet approved recommendations submitted by the Florida Department of Natural Resources (now FDEP) to protect the manatee and its habitat, and to increase boating safety in the State's waterways. In these recommendations, 13 key counties with high levels of manatee mortality and use, including Lee and Collier Counties, were identified and mandated to develop comprehensive protection plans to reduce manatee mortality including regulatory speed zones for boats and boat facility siting policies. Collier County adopted a Collier County Manatee Protection Plan in May 1995 and implemented enforcement by posting additional manatee speed zones in 1998. Despite proposals for a Lee County Manatee Protection Plan, no manatee protection plan has been adopted in Lee County. A proposal is currently under review by FDEP. The Collier County MPP established additional speed zones in 1995, which were posted in 1998.

In the development of the Collier County MPP (Collier County 1995), six areas were evaluated in Collier County for manatee distribution and abundance. The sites were chosen based on possible future conflict between the manatee and human activities. The sites included Port of the Islands, Naples Bay, Everglades City, Ochopee, the Collier/Lee County line (project area), and the Marco Island area. A total of 3,207 manatee sightings were recorded from 1986 to 1989. For any month in any study area, the highest mean number of manatees per survey was in the Marco Island area (36.4), followed by Port of the Islands (28.6); the Naples area (6.7); Everglades City (2.6); Ochopee (2.3); and the Lee/Collier County border (1.3).

The Ensembles do not directly address boating, but the changes in the land cover in the change the runoff characteristics and the water quality of nearshore waters as discussed in Section 9.10. Increases in population correlate with increases in boats utilizing manatee habitat.

American Crocodile

The USFWS developed species and habitat-level recommendations for the protection of the American crocodile in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) protecting and enhancing existing colonies of American crocodiles; (2) acquiring or otherwise protecting habitat for crocodiles; (3) reducing crocodile mortality (road and human-induced); (4) continuing assessment of pesticide and heavy metal contamination levels in crocodile eggs; (5) protecting nesting, basking, and nursery habitat; (6) restoring suitable habitat (removing exotic plants, restoring native vegetation, and restoring hydroperiods and hydropatterns in the Big Cypress, Rookery Bay, and Ten Thousand Islands drainage for deepwater adult refugia and suitable lower salinity nursery areas; and (7) managing crocodile habitat and restricting human use of important crocodile habitat.

The Florida Game and Fresh Water Fish Commission in its Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) modeled potential crocodile habitat by isolating mangrove, coastal salt marsh, and freshwater marsh cover types within the known breeding range of the species. This area did not include the southwest coast at the time because of the lack of information on successful breeding. Since 1994, at least three separate nesting locations have been documented on the southwest coast, although the eggs have been infertile. The GAPS study indicated that it was imperative that the current crocodile habitat quantity and quality not be reduced because of the small population size and limited geographic distribution. Extrapolations to similar habitat can be provided for the study area (at least as far north as Pine Island in Lee County) and include at least the waters and estuaries of Estero Bay, Estero River, Fishtrap Bay, Imperial River, Rookery Bay, McIlvane Bay, Collier Seminole State Park, Faka-Union Canal and Ten Thousand Islands Area.

Urbanization has substantially altered much of the occupied habitat. Human activities such as camping, fishing, and boating may increasingly disturb crocodiles. Several small groups and individuals are found in the mangrove swamps and along low energy mangrove-lined bays, creeks, and inland swamps from Sanibel Island at the north end of the study area south to Collier Seminole State Park. Some of the population decline on the east coast has been attributed to changes in the timing and quantity of freshwater flows. Although there is no direct causal relationship between freshwater flow alterations and American crocodile numbers, historic alterations to the natural flow have been known to directly affect plant and animal communities in the estuarine environment. Also, availability of fresh water from upstream areas is essential to hatchling crocodile survival. Therefore, Ensembles that propose maintenance of flowways, as discussed in Section 4.4, and those that would tend to reduce the potential for changes in hydropatterns, would increase the potential for preservation of this species. Those Ensembles that protect coastal habitat would also increase conservation of this species.

American Alligator

Although this species is found throughout the study area in marshes, swamps, ponds, streams, ditches, and borrow pits, it is Federally listed as threatened because it is similar in appearance to the endangered American crocodile. Ensembles that propose the preservation of seasonal wetlands within contiguous preserves, as discussed in Section 4.4, and those that propose wider flowways, as discussed in Section 4.4, should maintain the current population of this species.

Eastern Indigo Snake

The USFWS developed species and habitat-level recommendations for the protection of the eastern indigo snake in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) determine the distribution of the Eastern indigo snake in South Florida; (2) protect and enhance existing populations of indigo snakes in South Florida; (3) protect indigo snakes on public lands; protect indigo snakes on private lands; (4) enforce available protective measures; (5) conduct Section 7 consultations on Federal activities that may affect indigo snakes; (6) implement the USFWS South Florida Ecosystem Office's Indigo Snake Guidelines for Section 7 and 10 (Endangered Species Act) and incorporate the guidelines into permits where feasible; (7) monitor indigo snake populations; and (8) improve public attitude and behavior towards the indigo snake.

The FGFWFC in its Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) did not perform analysis on the Eastern indigo snake.

Loggerhead Sea Turtle, Green Sea Turtle, Hawksbill Sea Turtle, Kemp's Ridley Sea Turtle

The USFWS developed species and habitat-level recommendations for the protection of sea turtles in the Multi-Species Recovery Plan (USFWS 1998). Those recommendations that pertain to the study area include: (1) protect and manage populations on nesting beaches; (2) evaluate nest success and implement nest protection measures; (3) reduce effects of artificial lighting on hatchlings and nest females; (4) implement and enforce lighting ordinances and resolve lighting problems in areas where lighting ordinances have not been adopted; (5) ensure beach nourishment and coastal construction activities are planned to avoid disruption of nesting and hatching activities; (6) monitor trends in nesting activity; (7) continue information and education activities; (8) protect and manage nesting habitat; (9) ensure beach nourishment projects are compatible with maintaining good quality nesting habitat; (10) prevent degradation of nesting habitat from seawalls, revetments, sand bags, sand fences or other erosion control measures; (11) acquire or otherwise ensure the long-term protection of important nesting beaches; (12) restore areas to suitable habitat; (13) reestablish dunes and native vegetation; and (14) remove exotic vegetation and prevent spread to nesting beaches.

The USFWS also developed species level recommendations for the protection of the Kemp's ridley sea turtle in the Multi-Species Recovery Plan. The recommendation that pertains to the study area includes continuing standardized surveys of nesting beaches to determine if Kemp's ridley sea turtles nest in south Florida.

The Florida Game and Fresh Water Fish Commission in its Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) did not perform analysis on the four sea turtle species that occupy the coastal areas of the study area.

Loggerhead Sea Turtles nest on beaches in the study area. A few instances of nesting by Green and Kemp's Ridley Sea Turtles have been reported. The primary activities that affect nesting sea turtles include artificial lighting, beach nourishment, increased human presence, and exotic beach and dune vegetation. None of the Ensembles directly affect the beach environment; however, increases in human presence occur as a result of more development in the study area.

Right Whale, Sei Whale, Finback Whale, Humpback Whale

Analysis of these whale species was beyond the scope of the study area.

4.4 FISH AND WILDLIFE RESOURCES

4.4.1 MULTI-SPECIES RECOVERY PLAN

The U.S. Fish and Wildlife Service (USFWS) published a Multi-Species Recovery Plan for the Threatened and Endangered Species of South Florida in 1998. The USFWS representatives and certain others on the ADG used their knowledge of this plan and of recovery plans developed for specific species and compared these to the alternatives developed by the ADG. These members discussed how, in their judgement, the alternative by map or criteria enhanced the implementation of these Plans. The group recorder assigned a score from 1 to 6 to represent the groups comparison of the alternatives. The group presented the comparison graphically. Since an Ensemble is created by assembling four ADG alternatives, the Corps extended this evaluation by summing the four scores. The minimum possible score is 4 (best) and the maximum is 24. Ensemble Q totals 17, Ensemble R, 23, Ensemble S, 6, Ensemble T, 13, and Ensemble U, 9. The scale of 4 to 24 is not an absolute scale, but a comparison between alternatives: that is, alternatives could be developed that are "better" than Ensemble S and certainly if there was no Comprehensive Plan, an Ensemble could be developed that would score "worse" than Ensemble R. An Ensemble that scores lower indicates that it includes features that support these plans.

4.4.2 GAPS

The Florida Fish and Wildlife Conservation Commission in its Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) identified the Southwest Florida Region (6 counties including the study area) as probably the most important region in Florida in terms of maintaining several wide-ranging species that make up an important component of wildlife diversity in Florida. Those areas highlighted by the regional analysis include Catherine Island, Corkscrew Swamp Sanctuary and surrounding area, Bird Rookery Swamp, Flintpen Strand (CREW), South Golden Gate Estates (Picayune State Forest), Belle Meade (Picayune State Forest), Central Golden Gate Estates area, and an area near Lehigh Acres (Able marsh north to Hickey Creek). The Section on Coastal Barrier Resources highlights coastal areas.

The GAPS study modeled for Areas that Support Globally Rare Plant Species. These include taxa listed as “imperiled globally because of extreme rarity” or “imperiled globally because of rarity” by the Florida Natural Areas Inventory (FNAI). Within the study area, the Fakahatchee Strand (Save Our Everglades CARL project) was listed as a Strategic Habitat Conservation Area for plants.

The GAPS study also modeled 120 species of vertebrates for species-rich “hot spots” where many species might co-occur. The overlay of public land boundaries was then used to indicate areas that were not protected in the existing system of public lands. This analysis identified the areas immediately north of Fakahatchee Strand State Preserve north to Corkscrew Swamp Sanctuary as potentially important regions of rich diversity that are not protected under the public lands system.

The GAPS report maps approximately 4.74 million hectares (11.7 million acres), or approximately 33% of the total area of the State, that would provide "...some of the State's rarest animals, plants, and natural communities with the land base necessary to sustain populations into the future." Of this area, 1.95 million hectares (4.82 million acres), or 13% of the area of the State, is not currently publicly owned and is designated Strategic Habitat Conservation Areas (SHCAs). SHCAs depict lands needed to concurrently meet the minimum conservation goals of a particular list of focal species and plant communities. The study area represents approximately 2.5% of the area of the State, yet has approximately 8.2% of the total area of SHCAs in the State. The area of SHCAs that would be located within areas proposed for preserve under the Ensembles is, for Ensembles Q and R, 4.6% of the total area of SHCAs in the State; for Ensemble S, 5.4%; and for Ensembles T and U, 5.7%. The shortfall therefore ranges from 3.6% (71,133 ha(175,768 acres)) to 2.5% (49,237 ha (121,664 acres)). (Of the total area mapped as SHCA within the study area, Ensembles Q and R, 56% would be within areas mapped as preserve, Ensemble S, 65%, and for Ensembles T and U, 69%.) An Ensemble with a lower percentage indicates greater reliance on habitat found on private lands.

4.4.3 WADING BIRD ROOKERIES

There are 25 known wading bird rookeries in the study area. Additional wildlife surveys could document additional locations. In a typical permit, the actual rookery location would be preserved. Ensemble Q would surround 8 rookeries with development or other non-preserve land type; Ensemble R, 12; Ensemble S, 8; Ensemble T, 7; and Ensemble U, 8. Therefore, out of the 25 known locations, 17 would be located within preserve areas in Ensemble Q; 13 in Ensemble R; 17 in Ensemble S; 18 in Ensemble T; and 17 in Ensemble U. Wading birds utilize core foraging areas of seasonal wetlands extending 15 kilometers (30 kilometers for wood storks) from rookery centers. Even though high numbers of rookery locations are within preserves in all of the Ensembles, surrounding areas, within the foraging range, may be impacted and the hydropattern of the wetlands, even if they are preserved, affected. An Ensemble with a higher number of rookeries and their associated foraging range in preserves would provide more assurance of the preservation of the species.

4.4.4 SEASONAL WETLANDS

Seasonal wetlands are important foraging habitat for wading birds. During the dry season, the water level drops until the surface water is only found in small depressions, concentrating the fish and insects on which the birds forage. During the wet season, the water expands into the surrounding areas, providing for increases of the fish and other wetland species. Due to their seasonality, these wetlands are often the first to be considered for filling for development. If they are preserved within development areas, the seasonal hydrology and upland buffer are usually not present, decreasing the function of the wetland. In addition, preserved wetlands are often hydrated from the surface water management system, increasing the likelihood of unnatural hydropatterns and poor water quality. The quantity of freshwater marsh in the study area was estimated based on interpretation of aerial photography. The acreage figure can be misleading since many marshes are small. Thirty percent (30%) of the total acres of freshwater marsh would be surrounded by development or other non-preserve land type in Ensemble Q; 27% in Ensemble R; 24% in Ensemble S; 25% in Ensemble T; and 14% in Ensemble U. The following proportion of the area of marshes would fall within proposed preserves: for Ensemble Q, 70% of the total area of freshwater marshes in the study area; for Ensemble R, 73%; for Ensemble S, 76%; for Ensemble T, 75%; and for Ensemble U, 86%. However, slightly more than half of the existing marsh is found in the southeast quarter of the study area, an area with the least development pressure. Looking at the remaining three-quarters of the study area, the area of marshes that fall within preserves are: for Ensemble Q, 40%; for Ensemble R, 46%; for Ensemble S, 50%; for Ensemble T, 49%; and for Ensemble U, 72%. It is worthy of note that the relatively small change in the footprint of development between Ensembles R and Q (Q expands) and R and S (S contracts) results in a relatively large change in percent. This indicates that the location of the preserves is important and the quantity of preserve is only one factor in assessing ecosystem protection. However, natural foraging habitat (as compared to ditches and retention ponds) still extend throughout the entire study area but is more and more a smaller proportion of the total foraging needs for wading birds. **Table 19** in Section 4.20.1 suggests that some of the Fresh Marsh, Wet Prairie and Pineland covers appear to have halved. Wading bird populations continue to decline, indicating the continued decline of natural foraging will impact the maintenance of this species in the region.

4.4.5 HABITAT FRAGMENTATION AND CONNECTIVITY

The fragmentation and connectivity of preserved natural vegetation is very important to wildlife. Certain members of the ADG visually compared the Ensemble maps to determine if connections are explicitly provided between major habitat areas or if the Ensemble fragmented habitat. Considerations were given to the width, length, and number of connections. These members assigned a score from 1 to 6 depending on how, in their judgement, the alternative by map or criteria enhanced the implementation of these Plans. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The minimum possible score is 4 (best) and the maximum is 24. Ensemble Q totals 21; Ensemble R, 18; Ensemble S, 6; Ensemble T, 10; and Ensemble U, 8. The scale of 4 to 24 is not an absolute scale but a comparison between alternatives; that is, alternatives could be developed that are "better" than Ensemble S and certainly if there was no Comprehensive Plan, an Ensemble could be developed that would score "worse" than Ensemble Q. An Ensemble that scores lower generally were those with wider connections between major habitat areas. Wider connections are considered to be more immune to disturbance from adjoining land uses. Also, if they are wide enough, they may contain a mix of upland and wetland, a mix of habitats not found in a narrower connection.

4.4.6 FLOWWAYS

Integrity of flowways were also important but the resulting scores were similar to those previously reported for fragmentation and connectivity. This is not surprising since most of the habitat connections mapped followed natural flowways. Ensemble Q totals 18; Ensemble R, 23; Ensemble S, 5; Ensemble T, 6; and Ensemble U, 8. An Ensemble with a lower score generally emphasized routing of flows through contiguous natural areas. These rivers, sloughs, and strands are the major ecological features of the study area. Wide flowways consisting of natural vegetation preserved their ability to store floodwaters and to prevent pulse flows downstream.

4.4.7 REGIONALLY SIGNIFICANT NATURAL RESOURCES

Section 4.2 includes a discussion of the total acres of the native upland and wetland plant communities proposed for preservation. The Southwest Florida Regional Planning Council has prepared a map describing which of these natural resources are of regional significance and has developed goals related to maintenance of natural resources in the region. Certain members on the ADG used their knowledge of these goals and compared it to the alternatives. These members assigned a score from 1 to 6 depending on how, in their judgement, the alternative by map or criteria enhanced the implementation of these Plans. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The minimum possible score is 4 (best) and the maximum is 24. Ensemble Q totals 20; Ensemble R, 17; Ensemble S, 4; Ensemble T, 6; and Ensemble U, 7. The scale of 4 to 24 is not an absolute scale but a comparison between alternatives; that is, alternatives could be developed that are "better" than Ensemble S and certainly if there was no Comprehensive Plan, an Ensemble could be developed that would score "worse" than Ensemble R. An Ensemble that scores lower indicates that it includes features that are viewed as more explicit supporting these goals.

4.4.8 HIGH PRIORITY WETLANDS

Based on a project directed by the U.S. Environmental Protection Agency (EPA), the FFWCC identified important wetlands and uplands important to wetland-dependent species. The analysis was based on the maps of existing vegetation prepared for the GAPS report. Approximately 37% of the study area is mapped as important wetland and 19% is mapped as important upland, a total of 56%. When wetlands are preserved within another land use, often times only a small area of accompanying upland is preserved. This inventory indicates upland may be one third of the total area considered important to wetland dependent species. Ensemble Q would either directly fill or surround 21% of the total acres (of wetlands identified as important to wetland dependent species) with development or other non-preserve land type, Ensemble R, 21%; Ensemble S, 18%; Ensemble T, 14%; and Ensemble U, 13%. Therefore, of the total acres of wetlands identified as important to wetland dependent species, under Ensemble Q 79% would be found within areas of preserve; under Ensemble R, 79%; under Ensemble S, 82%; under Ensemble T, 86%; and under Ensemble U, 87%. Of uplands identified as important to wetland dependent species, 37% would be found under Ensemble Q within areas of preserve (and therefore 63% would either be cleared or surrounded by development); 38% under Ensemble R (62%); 46% under Ensemble S (54%); 77% under Ensemble T (23%); and 49% under Ensemble U (51%). The major difference is in the amount of upland placed in contiguous preserves. Under all Ensembles, the wetlands within the preserves will form a greater proportion than compared to proportion in the current study area.

4.4.9 MARINE AQUATIC RESOURCES

Marine aquatic resources can be impacted by activities along the shoreline. Certain members on the ADG used their knowledge of data such as those compiled by the Florida Marine Research Institute and local knowledge, and then compared it to the development in the coastal fringe proposed by the alternatives developed by the ADG. The group recorder expressed the assessments as a score from 1 to 6, the assessments based on how, in their judgement, the alternative by map or criteria enhanced or degraded estuarine aquatic resources. In particular, how impacts to the fringe affected its ability to provide aquatic nursery and foraging habitat. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The minimum possible score is 4 (best) and the maximum is 24. Ensemble Q totals 20; Ensemble R, 21; Ensemble S, 7; Ensemble T, 7;

and Ensemble U, 8. The scale of 4 to 24 is not an absolute scale but a comparison between alternatives; that is, alternatives could be developed that are "better" than Ensemble S and certainly if there was no Comprehensive Plan, an Ensemble could be developed that would score "worse" than Ensemble R. A separate evaluation of the native vegetation that was impacted found that the Ensembles generally did not impact the coastal salt marsh nor the mangrove communities. The difference is in how the pineland and hardwood hammocks behind the fringe are treated. Ensembles that proposed development in these communities, particularly around Estero Bay and Rookery Bay, were assigned higher scores (less protective of the aquatic fringe).

4.5 HISTORIC PROPERTIES

Historic Properties are site-specific. The landscape scope of the EIS prevented the collection of data concerning the effects on any individual sites. Impacts to Historic Properties under all Ensembles should be approximately the same at the scope of this EIS. This issue will be addressed in accordance with Federal and State regulations in the course of the permit application review on a case-by-case basis.

4.6 SOCIO-ECONOMIC

The primary purpose of this section is to compare the effects on the overall economy of the region with and without these suggested criteria, not to present an analysis of the entire local economy. At the scale of the regional economy, we foresee no significant change in economic output from current conditions that would result from either the Proposed Action or any of the alternatives.

The most important reason why no significant economic change is expected from the Proposed Action or any of the alternatives is the existence of the presence Corps permitting program. Limitations on wetlands fill are already in place. The proposed action and the alternatives do not change the law or regulations. They would serve merely to standardize permitting procedures that are already in place and therefore would not have any significant economic effect, at least on a region-wide basis. In fact, standardization of permit review would be expected to benefit the economy by promoting predictability.

Second, the Corps program has no impact whatsoever except to the extent it may be more restrictive than existing limitations on developments, such as the Comprehensive Plans. In many cases, the limitations are similar. Only to the extent that the Corps decision varied from the Comprehensive Plans would the Corps program have any effect at all. In many cases, the limitations are similar, and considering the Corps program is already in place, we anticipate no economic difference in moving to the Proposed Action or any alternative.

Last, even if there were a change resulting from either the Proposed Action or any other alternative, the effect of the change would necessarily be extremely limited. As will be seen in **Table 9a**, the footprint of development essentially doubles under any of the Ensembles and only from 3% to 5% of that footprint is located on future wetland fill. Therefore, the maximum range of potential effect is 2%. The effect of losing even 2% of developable area probably has no effect on the sustainability of the economy.

4.6.1 PROPERTY RIGHTS

The ADG report described property rights as "...the right to use your property as you choose without harming others, subject to applicable law and regulation (local government land plan and State and Federal permitting regulations), timely compensation for value lost due to regulatory change, and time compensation for taking." Descriptions of the Comprehensive Plan (represented by Ensemble R) included "realistic expectation of existing property uses and vested development rights" and recognizing the "expectations of landowners." The ADG minutes also report the statement "...that the Comprehensive Plan establishes maximums." There is acceptance that the Comprehensive Plan imposes certain restrictions on the use of property. Certain members on the ADG used their experience in this area to score each ADG alternative for three factors. The factors were whether the alternative affected (1) the fair market value of property; (2) the reasonable expectations for use of land and return on investment; and (3) vested rights. These members assigned a score from 1 to 4 depending on how the alternative restricted the use of property. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The maximum possible score is 48 (least effect) and the minimum is 0 (greatest reduction). Ensemble Q totals 45; Ensemble R, 47; Ensemble S, 18; Ensemble T, 21; and Ensemble U, 12. The scale of 0 to 48 is not an absolute scale but a comparison between alternatives; that is, for example, alternatives could be developed that are "better" than Ensemble R and an Ensemble could be developed that would score "worse" than Ensemble U. Ensembles S, T, and U because they impose additional restrictive criteria (particularly those that stated agriculture would not intensify beyond current use), reduce the area of agriculture, and provide less area of urban development compared to Ensemble R. Ensembles S and T were not scored as low as Ensemble U. Some of the remarks that explained this give insight to those scores: (1) explicitly mapping flowways as preserve areas has greater impact than a goal statement in the narrative criteria; (2) descriptions of restoration proposals that imply "more intense acquisition" has greater impact than those proposals that imply willing sellers; and (3) criteria written in terms of absolutes has greater impact. Generally, mapping lands as proposed preserve or imposition of criteria on their use will have an influence on the ability of the owner to realize his or her expectations for use of the property. On the other hand, the owner of a property adjacent to land that is acquired for preserve could see the market value increase.

4.6.2 COMPREHENSIVE PLANS

The Lee and Collier County Comprehensive Plans are the local elected officials' statement of local land use policy. The Lee County Comprehensive Plan (Ordinance 89-02 with amendments) at Chapter II (Future Land Use), states one goal is "To maintain and enforce a Future Land Use Map showing the proposed distribution, location, and extent of future land uses..." The County Future Land Use Element of the Growth Management Plan (Ordinance 97-67) states the goal is "To guide land use decision-making..." Certain members on the ADG used their experience in this area to score each ADG alternative for the significance of the difference between the alternative and the current local land use plans. These members assigned a score from 1 to 4, 4 indicating agreement with the local land use plan. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The maximum possible score is 16 (most agreement) and the minimum is 0 (greatest difference). Ensemble Q totals 14; Ensemble R, 16; Ensemble S, 7; Ensemble T, 7; and Ensemble U, 5. All of the Ensembles except for R differ from the local land use plans. The more additional criteria or restrictions imposed, the lower the score.

There was considerable discussion during the ADG meetings of the relationship between the County Comprehensive Plans and the Corps Regulatory Program. The Lee County Comprehensive Plan is described by Ordinance 89-02 with amendments. The Future Land Use Map designates certain areas as Wetlands. Policy 1.5.1 states "Permitted uses in Wetlands consist of very low density residential uses and recreational uses that will not adversely affect the ecological functions of wetlands. All development in Wetlands must be consistent with Goal 84 of this plan." Goal 84 lists several policies for review of projects affecting wetlands. Policy 84.1.2, states, "1. In accordance with F.S. 163.3184(6)(c), the county will not undertake an independent review of the impacts to wetlands resulting from development in wetlands that is specifically authorized by a FDEP or SFWMD dredge and fill permit or exemption." Also, "2. No development in wetlands regulated by the State of Florida will be permitted by Lee County without the appropriate State agency permit or authorization." The Collier County Future Land Use Map (Ordinance 97-67) includes a "Areas of Environmental Concern Overlay" and states "This overlay contains general representations for information purposes only; it does not constitute new development standards and has no regulatory effect." The Collier County Land Development Code (Ordinance 91-102 with amendments), Section 2.16.19, states "Where proposed use or development requires State or Federal development orders or permits prior to use or development, such development orders or permits must be secured from State or Federal agencies prior to commencement of any construction..." Both the Collier and Lee County Plans reference the additional restrictions imposed by State and Federal wetland permitting. Whatever the Plan may say, the landowner is further constrained by wetland permits. Both Counties do, as part of their Development Order and permitting procedures, consider the effects of proposed projects and project site plans on the wetlands and other natural resources. In practice, however, the result for the landowner is that he or she may be presented with conditions in the Federal wetland permit that are different or more restrictive than is explicitly described by County ordinances. Arguments are presented that the Federal permitting should be consistent with the Comprehensive Plans. A counter argument is that since the Comprehensive Plans defer to and incorporate the Federal permitting, the permitting is, by definition, consistent.

4.6.3 LEHIGH ACRES

Lehigh Acres is the primarily location in Lee County for affordable housing. Area platted and infrastructure placed many years ago and many have bought with intention and expectation of building homes. The value of the average house in Lehigh Acres was 65% that of Lee County and less than 42% that of Collier County (in 1990). In addition, recent infrastructure upgrades have been constructed with public funds to support the future homeowners. Difficulty in restoring this area described by study presented by ECWCD on the Greenway of Ensemble S. Of the 20,602 acre footprint, only 91.1 acres of wetlands remain. There are 11,065 different owners of parcels in the footprint and even within the wetland areas only, 204 owners. The administrative cost of acquisition would be high. Also, the reduction in availability of land will generally increase other land prices due to scarcity. And, since these lots already have infrastructure will further increase the cost of alternative housing. Other Ensembles suggest permit review criteria. These have the potential to cause the landowner an added expense to retain environmental and legal services to respond to these criteria when applying for a permit to fill his/her wetlands. Filling of wetlands for single family houses in Lehigh Acres have been typically authorized by the Corps through a Nationwide Permit, a relatively abbreviated administrative process.

4.6.4 ECONOMIC SUSTAINABILITY

Permit decisions are one of many influences on the economic sustainability of the region. This issue is very complex and the evaluation of the potential effects of any of the Ensembles would require a professional economic impact analysis and there is great uncertainty as to how the economy will respond to the implementation of a particular Ensemble. In place of such an analysis, the ADG identified seven factors. A change in one or more of the factors could be used to identify whether an Ensemble affects this issue. Economic sustainability was defined as the "protection, enhancement, and expansion of the long term economic viability of the region, including: agricultural, commercial, construction, environmental, fisheries, industrial, residential, recreational and tourism elements." The seven factors are job creation, home affordability, cost of living, property tax base, cost to implement, and increased taxes. Certain members on the ADG used their experience in this area to score each of these factors for each of the ADG alternatives. They reported that Lee and Collier County planners have spent many hours to develop the Future Land Use Maps of the Comprehensive Plans and that these probably are the most representative of an optimal economic alternative. These members assigned a score from 1 to 4, 4 indicating the better for economic sustainability. The alternatives representing the Comprehensive Plan did not receive a "4" for all factors. The minutes record the group stating their struggle with scoring of the factors because of the difficulty to anticipate what will occur in the future. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The maximum possible score is 16 (positive perceived economic influence) and the minimum is 0 (less protective of economic sustainability).

Table 9. ADG Ranking Scores of the Impact of Each Ensemble upon Socio-Economic Sustainability Factors
(Score of 16 being the maximum positive influence)

Ensemble	Job Creation	Home Affordability	Cost of Living	Property Tax Base	Cost to Implement	Increased Taxes
Q	13	11	10	13	12	12
R	13	11	10	14	13	13
S	6	6	7	7	5	6
T	5	6	7	6	6	6
U	4	4	7	5	3	4

For the job creation factor, one of the influences noted is that some Ensembles proposed restrictions on the intensification of agriculture. One illustration that was presented is that row crop farming generally requires labor for fall, winter, and spring, but not in summer, but that citrus, more intensive, would provide opportunity for year-round labor. For the home affordability factor, one of the influences noted was the restriction on density (number of homes per acres). If the cost of infrastructure (roads, utilities, etc.) for one acre of development could be spread across, say, 20 homes instead of 10 homes, then the cost of each of the 20 homes would be lower than the 10 homes. For the cost of living factor, the difference between the Ensembles is less dramatic, but the increase toward Ensembles S, T, and U can be ascribed to the additional costs to develop under the more restrictive criteria. For the property tax base factor, Ensembles S, T, and U have smaller areas of development than Ensembles Q and R and propose restrictions on the intensification of agriculture, reducing the total value of property on which to collect taxes to support local government functions. Ensemble Q slightly increases the area of development, therefore slightly increasing the property tax base. For the cost to implement this factor, the additional preserves and the restoration activities proposed by Ensembles S, T, and U are more expensive than those proposed in Ensembles Q and R. The increased taxes factor is directly related to the cost to implement this factor and the property tax base factor. The larger costs of Ensembles S, T, and U (relative to Ensembles Q and R) divided by the smaller tax base results in a higher tax per $1,000 of assessed value.

4.6.5 LOCAL ECONOMY

The various factors identified by the ADG are closely interrelated within the local economy. Figure 12 and the following narrative provides a simplistic description of these relationships by tracing how money flows through the local economy. This paragraph will introduce the subject of economic analysis since we feel it is important to explain terminology that will be used in the remainder of the Socio-Economic section of this Environmental Impact Statement. First, some activity on a parcel of land creates a product of value that is sold for money. For example, on some acres of land, a farmer produces a crop that is sold to consumers outside of the local area in exchange for money. The Farmer records the exchange as a sale. That money is then distributed to employees (as wages), to the owner of the farm, to taxes and fees, and is used to purchase from other local companies the various services that also contributed to production of the crop. For example, two of these companies are a Trucker and Company 1. Both the Trucker and Company 1 record the purchases as sales. The money these companies received are also distributed to wages, to the company owners, to taxes, and is also used to purchase services from other companies. For example, Company 1 purchases service from Company 2. Now, some of that money is paid to an employee of Company 2. That employee then purchases a home. The Homebuilder records the purchase as a sale and then uses some of that money to, for example, to pay the Trucker whose services contributed to construction of the house. Note that one of the dollars the sale of the crop has moved through the local economy and has been recorded several times as a sale (Farmer, Company 1, Company 2, Homebuilder, and Trucker). By definition, the "economic impact" of the sale of the crop is found by adding all the related individual sales of each of the companies as the money moves through the economy. When reporting the economic impact dollar figure, economists will typically also report the sum of the wages and the number of jobs related to the sale of the crop. The dollar amount of the wages are, of course, a subset of the dollar amount of economic impact, but by itself is a very important measurement of the local economy. For analytical convenience, the dollar amount of the economic impact is divided by the dollar amount of the sale of the crop to calculate what is called the "economic multiplier". Using the example above, for one dollar of sale of crop, perhaps thirty cents goes to Company 1 and 10 cents to the Trucker. Of that thirty cents, fifteen cents goes to Company 2, then ten cents goes to the employee of Company 2, who spends five cents with the homebuilder, where one cent goes to the Trucker. So, in this very simplistic example, the dollar of the crop sale has generated fifty-one cents of sales in the local economy, for an economic multiplier of 1.51 ($1.51 total sales divided by $1.00 crop sale). Another measurement of the local economy is the "gross economic output", simply the sum of the total sales of all the companies in the local area for all industry types (for some types of activities, measurements other than sales are used).

4.6.6 PUBLIC SERVICES AND PRESERVES

Superimposed on the economy are the local government fiscal actions. Local government revenues are based on property taxes, sales tax, and other taxes and fees. These taxes and fees are paid by businesses using the money received from sales or paid by the purchaser (such as in the case of sales taxes). The property tax is based on assessed value of the land which in turn reflects the economic activity (or potential activity) taking place on it. Local government expenditures include those for schools, roads, safety, and other services to the public and businesses, and for the management of public preserves. Public preserves do not generate property tax revenues nor do activities on those lands generate products that are sold. Most residents can directly appreciate the contribution of roads, schools, etc., to their day to day activities. However, the contribution provided by the preserves is not as direct or obvious. For example, the presence of preserves attracts visitors who stay at the hotels in the area to visit or view preserves areas and the purchases by the hotels result in jobs at local companies. Another example is that natural shoreline within public preserves maintain nursery habitat for fish later caught by recreational or commercial fishermen. Wetlands within the preserves further contribute to the local economy by: providing habitat that make possible wildlife viewing by tourists and residents; assimilating pollutants and trapping sediments that maintains clean water quality; storing stormwater runoff that reduces the risk of property damage; and recharging groundwater that supplies drinking water. In addition, the very presence of preserved areas in the community increases its attractiveness as a place to live and therefore the value of the commercial and residential property, which is purchased by persons with more wealth who pay higher real estate and other taxes. We also note that a parcel of land located on the edge of an urban area goes through an economic cycle: first, it is very sought after as residential and commercial partly due to its adjacency to the rural or natural areas and development creates the newest jobs and homes in the local community; but then, as it is itself surrounded by development, turns

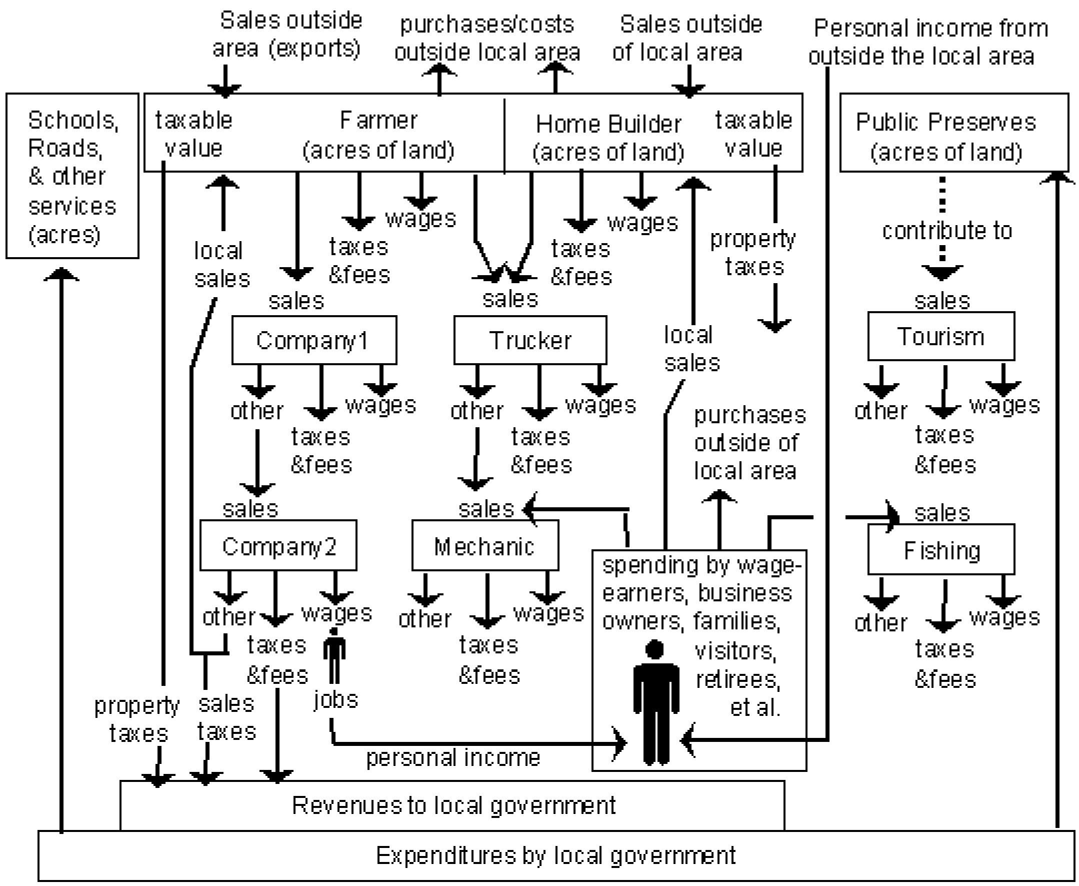


Figure 12 **Flow of Money in the Local Economy.**

into a less valued property and so has higher vacancy and can even slide to a blighted condition that eventually can result in a call for government investment to revitalize the area. Much has been written of examples and of techniques to describe or quantify the value of preserves to the local community. However, it is extremely difficult to identify all of the interrelationships in order to ascribe which economic benefit derived from which feature of a preserve, and some of the benefits are not measured directly in economic terms (for example, how much is clean water worth?). Based on the examples above, we can conclude that the presence of preserved natural plant communities makes possible certain businesses in the local economy (tourism, etc.), provides a natural resource infrastructure (habitat, flood attenuation, etc.), and increases the value of the remaining lands that are developed (and therefore the economic activity and government revenues that result). The values of these services are not expressed in dollars, even though they may in fact, and probably will, have effects on the economy. That same acre of natural plant community, if developed into agricultural, commercial, retail, or residential use, results in the production of services (produce, housing, etc.) whose value can be measured in dollars. The Corps Regulatory Program, when reviewing an application to fill wetlands, is, among other things, weighing the lost value of the services provided by the natural plant community against the increase in economic output from the farming, housing, etc. that will take place on the fill. The permit reviewer, however, is comparing apples to oranges. First, the wetland services are typically described using acres or as wetland functional capacity units, while the farming, housing, etc., can be described using dollars and employment. Second, the services affect different places in the local economy: the natural area benefits are more attenuated (for example, providing nursery habitat that provides fish that contributes to the fishing industry that then provides employment) than the direct economic output from the filled land (for example, homebuilding directly results in construction jobs and additional employment in the community providing construction related services). Third, the natural area benefits are diffused across the general public while the activity on the filled land directly satisfies the needs and expectations of the landowner and a segment (sometimes a large segment) of the community (homeowners, construction, retailers supporting the new residents, etc.) An economy has a mix of services and that mix is related to the mix of land uses, both natural and developed. As noted in an early paragraph in this section, some individuals on the ADG indicate that the Future Land Use Maps of the Comprehensive Plans are probably the most representative of what the community wants. There is no available economic analysis or characterization of the Comprehensive Plans nor is there an explicitly stated economic goal. Based on the effort spent in developing the plans and their adoption by the Boards of County Commissioners, these documents represent the best indication of the local community's desired mix of services. However, a landowner can apply for and the Corps may approve fill that is not consistent with these plans. In addition, neither plan is explicit as to the total acres of development envisioned since they describe an allowable density (number of residential units, number of square feet of commercial, etc.) for the entire parcel or geographic area but then essentially refer the landowners to the State and Federal permitting to determine whether or not any of the houses or commercial space can be built on wetlands. Therefore, it could be argued that the Corps could deny all future applications for wetland fill and would still be consistent with the County Comprehensive Plans. In practice, the Corps must weigh the impacts and benefits of each individual decision. The five Ensembles provide a range of acres filled and other criteria. While the other sections of Chapter 4 of the EIS generally compare between the Ensembles the value of the natural plant community, the rest of this section will describe what is known of the value of the economic activity that would take place on the fill and use that information to compare the Ensembles.

4.6.7 FOUR STUDIES

This section describes the results from four economic analysis studies relate to the study area of the EIS that look at one or more of the aspects of the local economy. All fundamentally include the same analysis tasks: determine the local sales and labor force for a particular local industry; determine the interrelationship of other local businesses to the local industry (for example, the repair of vehicles) using the U.S. Department of Commerce's Regional Input-Output Modeling System (RIMS II); determine the portion of those sales that are exported outside of the local economy (for example, what portion of produce is sold outside the local area); and, determine the additional effects on other businesses in the local economy by employee and business spending. The studies differ in: the geographic size of how they defined the local economy; the focus of the industry studied; and, the purpose of the study. All four report their findings in terms of dollars per acre (or dollars per house, which can be related to acres). None of these analyses valued benefits from preserved natural plant communities.

Florida Stewardship Foundation, Inc, in its The Contribution of Agriculture to Collier County, Florida, November, 1996, compared economic outputs of the various industries in Collier County, estimated the economic impact of agriculture, compared each industry's share of government revenues and expenses, and presented information on common perceptions and misperceptions regarding agriculture based on 1992 figures. The report indicates that as a result of 291,960 acres under agriculture, businesses involved in agricultural production had direct sales of $326 million with 9,670 jobs and a payroll of $83.3 million. After multiplying the effect on other businesses, the economic impact in a single year resulting from agricultural production totals $534 million of sales and 14,937 jobs with payroll of $132.7 million. The document divides this number ($534 million) by the acres of agriculture to arrive at a recurring (annual) "opportunity cost" of $1,796 per acre. The study also notes that businesses providing agricultural services are closely related to production and when their contribution to the local economy is added, the total economic impact of agriculture is $636.6 million sales and 18,157 jobs with a payroll of $165.9 million. The study also estimates the one-time (first year) economic impact of residential construction to be $638,957 per acre and the recurring (annual) economic impact from residential resales to be $1,288 per acre, based on, among other things, an estimated 4.3806 units per acre. The report also projects these numbers into the future with inflation and other factors.

The National Association of Home Builders, in The Local Impact of Home Building in Naples, Florida, October, 1997, estimated the economic impacts of the home building industry in the Naples Metropolitan Area. The study estimates the one-time (first year) economic impact for every 100 single-family homes (after multiplication of the effect into the local economy) to be $14.614 million and 297 jobs and for every 100 multifamily units to be $14.758 million and 299 jobs. NAHB then estimates the recurring (annual) economic impact resulting from the spending of the occupants of the 100 single family homes (new residents for the community) to be $2.767 million and 71 jobs and for the 100 multifamily units, $2.089 million and 52 jobs.

The Florida Stewardship Foundation, Inc., in The Florida Panther & Private Lands, An Economic Analysis, December 1997, compared the impact of three alternative methods for management of agricultural lands identified as either Priority 1 or Priority 2 by The Florida Panther Habitat Preservation Plan in Lee, Collier and Hendry counties. The alternatives are: (1) government purchase and management of lands; (2) conservation easements in return for government payment to the landowner for development rights; and (3) the "conceptual plan" of various tax credits and other payments in return for a 25 year renewable lease. The study looks at the many different costs and impacts directly related to the purpose of the study. However, one part of the study estimates the recurring (annual) impact of agriculture on the three county economy to be $1,074 per acre of agriculture (averaged over all the agricultural acreage in the region).

These three studies provide an indication of the economic cost per acre for agriculture and housing if a similar analysis was performed for the EIS study area. For agriculture, the first and third studies indicate a recurring (annual) economic impact of $1,796 per acre and $1,074 per acre respectively. The difference is discussed in detail in the second report but one factor for the second, lower, figure is the larger proportion of low intensity agriculture. For residential, the first report indicates a construction (one-time) economic impact of $638,957 per acre and a recurring (annual) impact of $1,288 per year, based on 4.3806 units per acre. The second report provides figures based on 100 houses, but if the second report numbers are converted based on 4.3806 single family houses per acre, the construction (one-time) economic impact would be $640,180 per acre and the recurring (annual) impact would be $121,360 per acre. For the recurring (annual) impact, the first report based the calculation on resales of the houses and the second report based the calculation on the added income to the community of the new household.

Fishkind and Associates, Inc., in Economic Analysis of the Draft Environmental Impact Statement on Improving the Regulatory Process in Southwest Florida, January 13, 2000, estimated the economic impacts on the total economy in Lee and Collier Counties based on the difference between the Draft Permit Review Criteria (Appendix H of the Draft Environmental Impact Statement (DEIS)) and the Comprehensive Plans. Due to the time constraints imposed by the public comment period, this analysis is not as detailed or elaborate as the others. The study reports that the Southwest Florida region (defined as Lee, Collier, Charlotte, Glades and Hendry Counties) had 252,310 payroll employees in 1998 and, based on the U.S. Department of Commerce's Regional Input-Output Modeling System (RIMS II) multiplier for the region, they generated a total economic output of $9,608,700,000, or $38,083 per employee. The study then reports that employment increased by an average of 5,991 jobs per year from 1990 to 1998 and that area of development (of all types, residential, commercial, agricultural and public uses) increased by an average of 20,853 acres per year, for an average of 3.48 new jobs per acre of new development. The resulting total output is then calculated at $12,229 per acre. The study states "...the relationship between employment growth and land use established in the 1990-1998 period is likely to hold in the future. The characteristics of future growth in SW Florida are expected to be similar to the 1990-98 period." Within the boundaries of Lee and Collier Counties, the study reports the area of existing development in 1998 is 992,294 acres and that the land mapped as development but currently vacant plus expected conversion of agricultural land (the acres "available" for development) total 546,265 acres. At 20,853 acres per year, these two Counties will reach build-out in 26.2 years and at $12,229 per acre result in a total increase in economic output of $5,977,000. The $12,229 per acre figure is different from the various figures reported in the first three studies because, among other things, the three studies looked a single industry while the $12,229 is based on all economic activity. The study then looked at the Permit Review Map and calculated the area that it shows to be mapped as development within the boundary of the EIS study area (which is a portion of Lee and Collier Counties). Then the study stated that, because of the additional new criteria described in the Appendix H of the DEIS, developers will likely reduce density or intensity of their projects to minimize their need for wetland fill. This will further reduce the land available for development. The study prepared estimates for a 10%, 25%, and 50% reduction and calculated the difference from the estimate of the land available within the EIS study area under the Comprehensive Plan. The difference was reported 136,165 acres at 10%, 191,045 acres at 25% and 282,513 acres at 50%. The study then multiplies the acre figures by $12,229 per acre to arrive at the reduction in the economic output. In addition, build-out will occur sooner than under the Comprehensive Plan, based on 20,853 acres per year. These differences in build-out were then incorporated in an analysis of future government revenues and costs. The report calculates that, from 1991 to 1997, revenues have been increasing at 2.03% a year while expenses have increased at 2.62% a year. The report notes that existing tax base can only increase by 2.5% a year or the rate of inflation, whichever is less, and that the new construction added $1,682,748 to the tax base in 1998, or $80,694 per acre based on 20,853 per acre. The report states that "...new construction adds significantly to the property tax base. Reducing the growth in the tax base ultimately requires ever-higher property taxes in the future to balance the County budgets." A fiscal analysis was then performed for the years 2000 to 2025 for the Comprehensive Plan and for the 10% and 50% plans, incorporating annual estimates of population growth, growth in property tax base, increase in value of existing tax base, and per-capita government costs and revenues. Under the Comprehensive Plan buildout, property tax rates are estimated to raise from 5.13 in the year 2000 to 8.62 in the year 2025 to achieve a balance of revenues and costs by approximately 2014 and maintain that balance while under the 10% plan, the rate raises to 9.86 and to 11.77 under the 50% plan (although Florida has a 10-mill cap). The study concludes that the tax rates will escalate under the Comprehensive Plan but that, if less land is available for growth in the tax base then the rates will escalate faster and higher.

Three additional papers also discuss government costs and revenues. The Council of Civic Associations, Inc., in From Ranches to Rooftops: Residential Development in Lee County, Florida and Its Impact on Taxpayers, discusses that, applying a calculation procedure used in a study in Oregon, that the current impact fees may not cover the cost of providing infrastructure for new homes. Over time, the paper argues, this may result in a future increase in taxes. Florida Stewardship Foundation, Inc, in The Contribution of Agriculture to Collier County, Florida, attributed the revenues collected by Collier County to each industry and then attributed the budgeted expenses to the industry to which the expense is related. Based on the way these revenues and expenses were apportioned, the report states that for every $1.00 of revenue generated by agricultural related services, $0.37 is spent by Collier County for direct services related to agriculture and for residential, for $1.00 generated, $1.20 is spent. These two papers suggest that converting land to residential use increases government costs relative to revenues (whereas the analysis in the previous paragraph simply notes there is an imbalance in total government budgets). An appropriate analysis of this concern will depend on the how government revenues and costs are estimated and allocated. A third study, the National Association of Home Builders, in The Local Impact of Home Building in Naples, Florida, notes that increases in local government revenue result both directly from the construction activity and from other businesses which benefit from the spending by the new resident to the community but did not estimate changes in local costs.

4.6.8 LAND CONVERSION

In order to quantify the changes in the economic activities, the Corps used the same map of existing land use as was used in the ADG. The existing land use mapping legends were lumped into Development, Agriculture, Upland, Wetland, and Water. The Corps then overlaid that map with the areas mapped by the five Ensembles. The Ensemble mapping legends were lumped into Development, Agriculture, or Public Preserves. Where an Ensemble map "Development" area overlaid an "Agriculture" area on the existing land use map, the acres are recorded in the following table as converted from agriculture to development. A more detailed analysis can be performed if there was less lumping, for example, within the Ensemble mapping legend for "Rural" there will be small nursery agricultural activity as well as residential activities. So the numbers tallied must be recognized as estimates but are considered sufficient to display the order of magnitude of the potential changes. The tally is found at **Table 9a**.

4.6.9 DEVELOPMENT PERMITTING

For development, the estimated future wetland fill (which will require a Corps permit) ranges from 3% to 5% of the total build-out footprint of development for a maximum difference of 2%. Considering that the area of development approximately doubles under all the Ensembles, development of this 2% of land area will only be a small contribution to the total economy. It is also probably within the potential error of the per acre estimates of economic output. However, this 2% difference results in much more dramatic change in some of the other evaluation factors in this EIS, for example, in the 16% difference of seasonal wetlands that are primary habitat for wading birds. However, while the economic effect on the total economy is small, the effect on an individual project may be large. For example, a project to develop an industrial facility has severe constraints on the shape of the buildings and roads where a small wetland on the site may, unless filled, prevent the development of the facility. A retail project has constraints on parking lot size and location. A low or moderate priced residential project must place housing units near each other and use straight roads to reduce the utility and other infrastructure costs and use a large percentage of the site to spread the land costs across as many housing units as possible: all these constrain the ability to avoid wetland fill. Some project sites are constrained where they can locate their entrance road due to concern by transportation departments to provide spacing between entrances and provide distance from intersections to maintain traffic speed and safety on public roads. Some sites are constrained by locations of right-of-ways such as for roads and powerlines that sometimes will not fall on the site boundary. There may be other parcels in the County that have less wetland or do not have an entrance road constraint, but then the County Comprehensive Plan may not allow the particular desired use on such parcels out of concern for traffic congestion, adjoining neighbors, or other factors. But then, when the landowner applies for a Corps permit for the wetland fill, the Corps review may extend into the other portions of the site. For example, if the wetland fill is for an entrance road, thereby making the upland development possible, the Corps will also ask the applicant to describe the practicability of alternate site plans to increase upland buffers to the other wetlands on the site to minimize the total impacts to wetlands from the permit decision. In this particular example, the Corps will also, as required by the Endangered Species Act, consult with the Fish and Wildlife Service regarding effects of the entire project on Federally listed species and ask the applicant to describe practicability of alternate site plans. Therefore, for some projects, the current Corps review process imposes analysis effort and constraints even on the upland areas of the project. (In the case of the Endangered Species Act, the landowner has certain responsibilities under that law even if there is no Corps permit involved). Note that the area of upland converted to development in Ensembles S, T, and U are less than Ensemble R since that resulted in benefits to other evaluation factors in the EIS, such as those for wildlife.Ensembles S, T, and U also include criteria or descriptive review language, some of which represents constraints on project development beyond current practice or regulation. As noted in the Fishkind and Associates, Inc., report, this could have the effect that the actual acres developed will be less than the acres theoretically available in the table. That report simply reduced the available acreage by 10%, 25%, and 50% to find a range of the resulting impact to the economy. We have no way of estimating the extent to which this would occur, but suspect some of that acres would be developed but at a higher cost to the project.

4.6.10 AGRICULTURE PERMITTING

For agriculture, additional wetland fill is expected to be requested for some of the expansion and conversion of existing lands. Most of the activities within existing agricultural lands are exempted from the Corps permitting program under Section 404(f) of the Clean Water Act. As in the example in the earlier paragraph for development, for some applications for wetland fill for agricultural projects the Corps may be reviewing alternative site plans on the upland areas to avoid or minimize impacts to other wetlands on the site and to Federally listed species. (In the case of the Endangered Species Act, the landowner has certain responsibilities under that law even if there is no Corps permit involved). Note that the total footprint of agriculture in Ensembles S, T, and U are less than Ensemble R (the land converted to public preserves) since the restoration of the uplands resulted in benefits to other evaluation factors in the EIS, such as those for wildlife. Ensembles S, T, and U also include criteria or descriptive review language, such as "limited intensity", some of which represents constraints on project development beyond current practice or regulation. Since more intensely managed crops or crops that fill a higher percentage of the parcel are considered to be less attractive to native wildlife, these Ensembles generally where scored as more beneficial for wildlife, for example, the Florida panther, than if they had (such as for Ensembles Q and R) the potential for converting to high intensity. However, while the acres are shown as available for agriculture, maintaining the wildlife habitat results in an economic impact on the landowner and the economy. The Florida Stewardship Foundation, Inc., paper The Contribution of Agriculture to Collier County, Florida (described in an earlier paragraph) reports the economic output per acre of land varies by crop type. This constraint would prevent the landowner from changing crops in reaction to market demand. The second paper, The Florida Panther & Private Lands, An Economic Analysis (described above) discusses the economic impact of this constraint has in the ability of the landowner to convert the land to development. This constraint may also reduce the ability of the landowner to secure loans to maintain agricultural production.

Table 9a. Distribution of Land Conversions within Ensembles

Distribution of land conversions within future development footprint										
	Q		R		S		T		U	
(1) Existing Development	163,998	39%	164,062	44%	163,971	42%	163,998	45%	163,997	46%
New from:										
vacant	22,655	6%	32,465	8%	32,465	8%	17,521	5%	32,465	8%
agriculture	70,778	17%	53,332	14%	66,001	17%	52,179	15%	50,306	14%
upland	76,516	19%	67,460	18%	66,685	17%	64,560	19%	61,719	17%
wetland	16,108	4%	17,177	5%	12,557	3%	10,504	3%	11,816	3%
(2) Total new	195,867	46%	170,434	45%	177,708	46%	159,708	42%	156,306	44%
(3) onsite preserve	55,427	14%	41,684	11%	48,489	12%	39,311	11%	35,308	10%
Future Developed Footprint										
(1)+(2)+(3)	405,482	100%	376,180	100%	390,168	100%	348,073	100%	355,611	100%
Distribution of land conversions within future agriculture footprint										
	Q		R		S		T		U	
(1) Existing Agriculture	166,617		166,390		166,617		166,617		166,798	
(2) Loss to other	80,937		68,870		100,192		84,240		85,201	
(3) Stays agric =(1)-(2)	85680	65%	97,520	59%	66,425	71%	82,377	68%	81,597	69%
New from:										
upland	12,000	9%	12,000	7%	12,000	13%	12,000	10%	12,000	10%
wetland	4,000	3%	4,000	2%	2,000	2%	5,330	4%	4,000	3%
(4) Total new	16,000	12%	16,000	10%	14,000	15%	17,330	14%	16,000	14%
(5) onsite preserve	30,831	23%	50,976	31%	13,312	14%	21,768	18%	19,809	17%
Future Agriculture Footprint										
(3)+(4)+(5)	132,511	100%	164,496	100%	93,737	100%	121,475	100%	117,406	100%

Notes.
1. "Existing" is actual developed/farmed acres and does not include existing on-site preserves. "Onsite preserve" is natural plant communities remaining within total footprint of existing and new development/agriculture.
2. Rural uses placed under Development although agricultural activity also takes place in those areas.
3. "Vacant" are lands such as those in Lehigh Acres that have roads but no homes yet built.

4.6.11 ECONOMIC OUTPUT CHANGE

The economic studies presented above, narrative and numeric, suggest an almost linear relationship between availability of land to develop and increase in economic output. While this may be true for some industries, there can be (and probably are) increases in economic activity on lands that have already been converted from natural plant cover. The Corps has not multiplied the acres of wetland and upland fill by any of the dollar per acre estimates to generate a predicted growth in economic output because the actual change is based on an evaluation of many other factors than land. The estimates are based on dividing current economic output by current acres of land. This approach is not invalid for summarizing the current economy but is questionable when used to imply "no land = no development". Land is only one contribution to economic activity although for some, such as agriculture, is more important than other activities. However, since the difference in the acres of wetland fill is a small portion of the total change in land cover, the economic impact of the permit decisions by the Corps, as a percentage of the total economy, will be small because only a small proportion of the change in land cover involves fill in wetlands. The economic impact to the individual landowner remains potentially high depending on the nature of the site and the project. However, the Corps review of natural resource effects provides a benefit to the local economy, though diffused and is not measured in dollars. Under all of the Ensembles, including the County Comprehensive Plan, the area eventually reaches build out and so other economic growth other than based on wetland fill will take place. The uncertainty as to how the economy may respond to the proposed criteria is great, just it is also great as to how it will respond to buildout.

4.7 AESTHETICS

Aesthetics proper was not directly evaluated. However, many people are attracted to this area for the presence of natural areas. Therefore, larger areas of preserved natural vegetation provide more opportunity to preserve the aesthetics of the landscape. The areas of preserve are described in Section 4.2.

4.8 RECREATION

Many of the population in the study area were attracted to the area for the recreational opportunities in the coastal waters and the inland forests and marshes. The coastal waters are affected by changes in water quality that may result from the upstream land uses presented by the Ensembles. These changes are presented in Section 4.10. The inland forests and marshes are largely accessible through publicly owned lands. The management of these public lands are affected by changes in the surrounding non-public lands. Certain members on the ADG used their knowledge of public land management and their general ecological principles to assess each ADG alternative. They considered (1) the compatibility of the surrounding land use with the land management plans of the public lands and (2) whether the alternative would be expected to degrade or improve the natural resources on the public land. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be a compilation of the four assessments. For Ensemble Q, connections were not marked between major public lands, particularly those between Estero Bay and Six Mile Cypress Slough and Estero Bay and the Corkscrew Marsh system. The width of Camp Keais Strand (connecting Corkscrew with the Florida Panther National Wildlife Refuge) was narrower in Ensemble Q then the other Ensembles. This Ensemble has the greatest area of urban development that "intrudes" eastward into the Corkscrew Marsh and Belle Meade systems. This intrusion increased the length of the boundary where public and urban lands are adjacent. Ensemble R has more preserve than Ensemble Q, thereby buffering the public lands more. This Ensemble has greater area of agriculture than the others which, while preferred to urban, if converted to intense agriculture would result in loss of habitat utilized by species that move between the public and private lands. The criteria associated with the Future Land designations of Wetlands (in Lee County) and Environmentally Sensitive Lands (in Collier County) were considered not as explicit in protecting natural resources on adjacent land uses as some of the other Ensembles. Ensemble S increases the area of contiguous preserve adjacent to public lands compared to Ensembles Q and R, and shows some of the connections to Estero Bay that were noted as missing in Ensemble Q. This Ensemble has more rural and intensive development adjacent to the Corkscrew Marsh than Ensembles T and U. Ensemble T particularly increases (compared to Ensembles Q and R) preserves around Hickey Creek and other areas along the shore of the Caloosahatchee River but not as much as Ensemble S. Ensemble T has less urban development in the vicinity of the Corkscrew Marsh and Belle Meade systems but more agriculture in the Immokalee area than Ensemble S. Ensemble U has more restrictive criteria and maps the existing strand in Golden Gate Estates as preserve. Ensembles that were considered to be supportive of public land management were those that surrounded the preserves with low-intensity activities to buffer urban development and also expanded the preserve area upstream and downstream along existing flowways to connect with other public lands.

4.9 COASTAL BARRIER RESOURCES

The activities in the watershed can affect the coastal barrier resources, particularly if they change the water quality of the runoff, as discussed in Section 4.10. Existing fish and other wildlife, as discussed in Section 4.4, are protected if existing natural resources are maintained, particularly those identified as regionally important and those along the shoreline.

The Florida Game and Fresh Water Fish Commission in its Closing the Gaps in Florida's Wildlife Habitat Conservation System (GAPS) highlighted some of the important habitats for shorebirds, migratory birds, nesting sea turtles and other components of biological diversity in coastal communities. Among the more important areas identified were the mangrove swamps of the Ten Thousand Islands (along the southern shore of the study area). In Lee County, Punta Rassa and islands to the west and Estero Bay are important to wading birds, shorebirds, and bald eagles. In Collier County, many of the beaches, bays, passes, and barrier islands (including Keewaydin, Kice, Cape Romano, Helen Key and Coon Key) between and including Barefoot Beach State Preserve south to the Ten Thousand Islands are important to wading birds, shorebirds, bald eagles, sea turtles, gopher tortoise, black bear , scrub lizard, peregrine falcon, and several State-listed plant species.

4.10 WATER QUALITY

4.10.1 EVALUATION

A change in the activity on a particular site, particularly if it removes the existing natural vegetation, is one of the many influences on water quality on the coastal waters. This issue is very complex and a thorough evaluation of the potential effects of any of the Ensembles would require a very elaborate water quality and quantity modeling. In place of such an model, the ADG performed a simple analysis and then the U. S. Environmental Protection Agency performed a more detailed analysis of the changes in land cover and reported resultant changes in quantities of water quality constituents in the runoff. The ADG identified five factors. A change in one or more of the factors could be used to identify whether an Ensemble affects this issue. The issue was defined as the maintenance of quality of the waters in the region. The first four factors are pollution loading, freshwater pulses, habitat loss, and groundwater impact. These were assessed during the ADG meetings. The fifth factor is a Water Quality Index, which measures the change in the concentration of pollutants in the receiving waterbodies. This index is calculated by the EPA analysis at the end of this section. Certain members on the ADG used their experience in this area to score each of these factors for each of the ADG alternatives. For two of the four component alternatives, these members assigned a score from 1 to 5, 1 indicating the less likely there will be a change in water quality. For the third component, they used a scale from 1 to 3. For the fourth component, the members assigned either a "+" or a "o" where "+" means the factor "was addressed". Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the three numeric scores (the 1,2,3 scale converted to 1, 3, 5) and displaying the fourth "+"/"-" score. The minimum score is 3/"+" (least likely to affect water quality) and the maximum is 15/"o" (more likely an adverse effect).

Table 10. ADG Ranking Scores of the Impact of Each Ensemble upon Water Quality Factors
(Score of 3/"+" is least likely to adversely affect water quality; the maximum score is 15/"o")

Ensemble	Pollution Loading	Freshwater Pulses	Habitat Loss	Groundwater Impact
Q	13/"o"	12/"o"	13/"o"	11/"+"
R	15/"o"	13/"o"	12/"o"	11/"+"
S	6/"o"	7/"o"	6/"+"	5/"o"
T	9/"+"	6/"+"	7/"+"	7/"o"
U	6/"+"	6/"+"	4/"+"	6/"o"

For the pollution loading factor, the major influences are the type of land use and the type of treatment. For example, urban areas have more polluted runoff but new urban development typically implements best management practices such as detention ponds to treat runoff prior to discharge into waterbodies and management actions such as street sweeping. Ensembles S, T, and U have smaller areas of urban then Ensembles Q and R and so would have lower pollution loading. In addition, Ensembles T and U propose smaller areas of development in Lehigh Acres and Golden Gate Estates, areas where implementation of BMPs on single family lots is sometimes impracticable. Ensemble S referenced an idea to implement regional stormwater management systems located on existing canals downstream of multiple urban activities. This was proposed as an idea for the developing area along the Caloosahatchee River where implementation or retrofitting of BMPs is impracticable. This contributed to the low score for Ensemble S. For the freshwater pulses factor, the major influences are the area of new impervious surface and the acres of wetland preservation. For example, urban areas have a greater percentage of paved and roofed surfaces and so the runoff is very rapid. However, an increase in urban is at the expense of wetland areas that would provide temporary storage of peak runoff flows. Ensembles Q and R have a higher amount of development and a lower amount of preserve than Ensembles S and T so they would tend to increase downstream pulses of water. The regional stormwater management proposal in Ensemble S also would reduce freshwater pulses. For the habitat loss factor, the major influence is the quantity of wetlands, particularly along shorelines. For example, a reduction in the area of these wetlands reduces the ability of waterbodies to assimilate pollutants. Ensembles S, T, and U have larger areas of preserves than Ensembles Q and R. For the groundwater impact factor, the major influence is area of natural vegetation preserved. The bulk of the urban water supply in Lee and Collier County is from the Surficial Aquifer System (some of wellfields draw from the lower Intermediate Aquifer System and below that the Floridian Aquifer System). The Surficial is recharged primarily from rain over the entire area. Ensembles Q and R scored relatively well as protective of groundwater with their specific criteria to protect the lands surrounding existing wellfields but Ensembles S, T, and U provided larger areas of preserve.

The following narrative describes the water quality index factor.

4.10.2 WATER QUALITY INDEX

4.10.2.1 Introduction

A review of the historical water quality within the study area was provided in the Affected Environment section. Although this historical review constitutes a comprehensive summary and indicates regionally deteriorating water quality through time, the data were inconclusive for many watersheds due to inadequate of monitoring data. Impacts to surface water quality associated with future land use alternatives are analyzed and discussed in this section.

The focus of this analysis was to provide a useful tool for planning purposes and for the comparative analysis of future land use alternatives. To estimate future water quality impacts to receiving water bodies which potentially result from different land use alternatives, a process for water quality analysis was developed. The methodology of this process included water quality modeling as one of several steps. After consideration of various water quality models, a model was selected which proved consistent with the resolution of the input data and which evaluates water quality impacts of large scale land use changes. Additionally, the chosen model provides a design which sufficiently and cost effectively guides planning decisions of a broader nature. Given the limited resolution of the Alternatives land use data and other sources of variability (see Section 4.10.2.6), it is also important for potential users to understand that the results of this assessment must be considered as tools for comparative Alternative analysis in the ADG and NEPA process. As such, the resulting data were used as a relative comparison of potential water quality impacts resulting from future Alternative land use scenarios.

In addition to the modeling effort completed for this report there are other efforts within the Study Area that are currently ongoing. One such effort is being pursued by the South Florida Water Management

District (SFWMD) that utilizes the MIKESHE/MIKE11 model codes. However, it does not appear that any of these efforts will cover the entire study area in the foreseeable future.

Analyses were conducted separately for each of the ten watersheds within the study area (**Figure 13**). Watersheds were selected as the hydrologic unit defining the storm water runoff to the receiving water bodies as defined by the SFWMD. Several input data are required for the water quality model, including but not limited to: the type and amount of each land use, the amount of annual rainfall, and the size of the receiving water body for each watershed. The water quality modeling provides estimates for several water quality parameters as output.

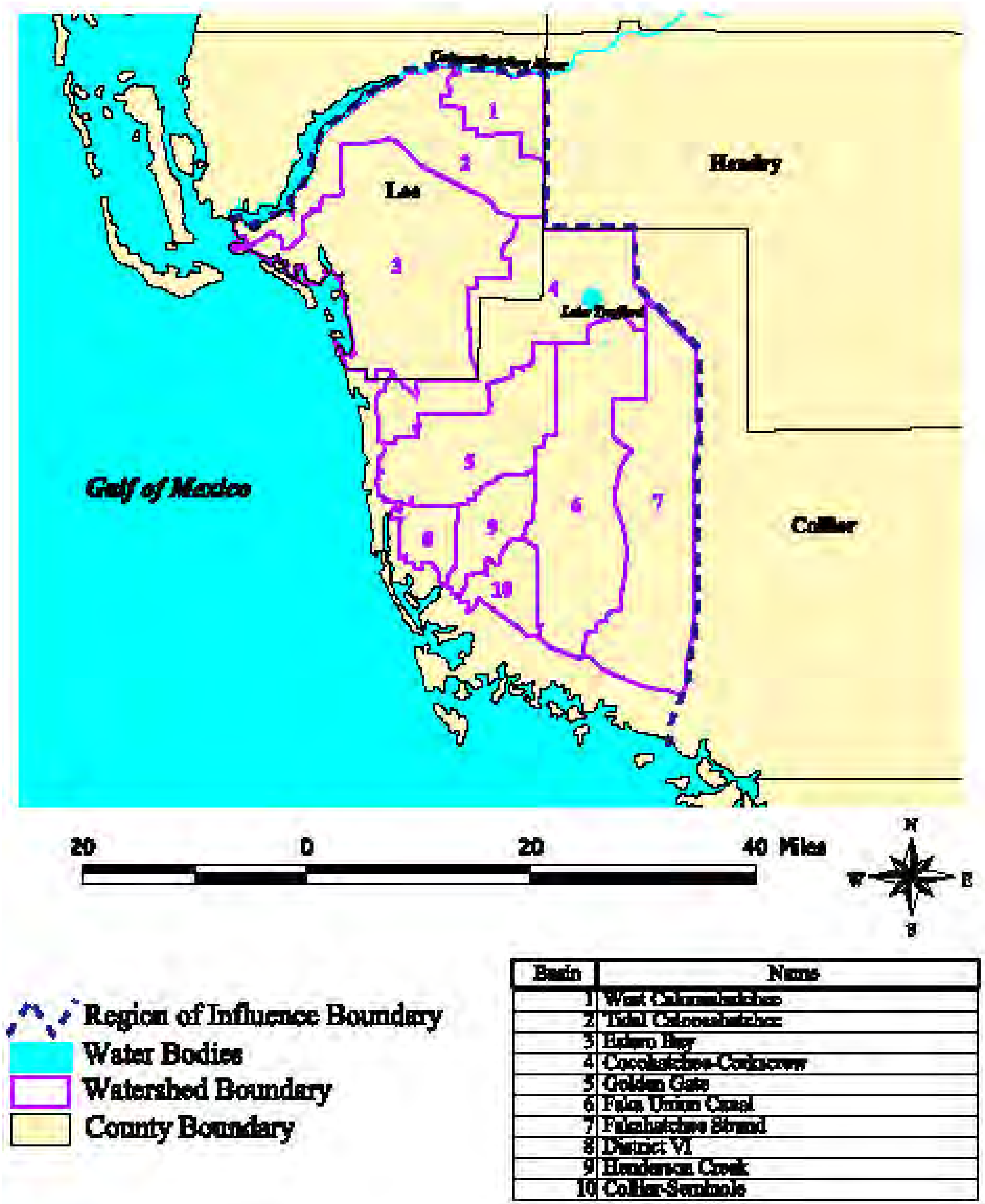


Figure 13. SFWMD Watersheds and Basins within the Study Area.

In non-industrial areas, stormwater runoff is typically the primary source of water quality degradation to the receiving water bodies, such as lakes, rivers, canals, and estuaries. Different types of land use affect the water quality of the stormwater runoff based on the amount of impervious surface and pollutant levels.
Generally, the greater the impervious surface area within a given land use, the greater the amount of runoff and the faster the discharge.

Best Management Practices (BMPs) are designed and constructed to reduce the potential pollutant loading of the stormwater runoff by trapping pollutants before entering the receiving water body (Rushton and Dye 1993). Additionally, BMPs are designed to reduce the increased flow rate and volume of stormwater runoff that potentially results from development (CH2M Hill 1991).

Estimates of future water quality within the receiving water bodies were summarized into an index of water quality (IWQ) for each watershed. An overall IWQ was then developed for the entire study area for the Current Day land use and each Alternative. The IWQ serves as a single unit of measure from which to compare water quality impacts among each of the Alternatives. The utility of using a water quality model and IWQ estimates within the EIS emphasizes the water quality process as a practical methodology for comparing land use Alternatives, and not a prediction of future water quality. The following sections describe the methodology used to evaluate potential environmental impacts to surface water quality from the EIS land use Ensembles.

4.10.2.2 Future Land Use

The future land use outlined in the Lee County Comprehensive Plan (Lee County 1997) and Collier County's Future Land Use Element of the Growth Management Plan (Comp Plan) (Collier County 1997) was selected as the first future land use Alternative for analysis. The Comp Plan is considered the baseline for interpretation of the future land use Alternatives, and therefore a similar methodology will be applied to the analyses of Ensemble U.

The specific land use/land cover data for each Alternative is the primary essential element in preparation of this water quality analysis process. The Current land use is based on 1995, whereas the Alternatives provide the future land use. The future land use of the Comp Plan Alternative and Ensemble U were provided as ARC View GIS maps. The Alternative land use data were based upon proposed permitting and mitigation guidelines, using very broad land use designations. Key to this methodology, is developing a consistent categorization of land use types for Current Day and each Alternative. Therefore, water quality modeling based on land use requires that the land use types conform to specific land use categories of the water quality model.

A Florida State system of land use designation and identification provides the level of detail necessary for converting land use data to the land use categories essential to the model. The Current Day land use types were easily summarized into the ten land use categories. These categories typically include, but are not limited to:

Low Density Residential	Single Family Residential
Multi-Family Residential	Commercial
Industrial	Agricultural
Open Land	Mining / Extraction
Wetland	Water

4.10.2.2.1 Comprehensive Plan Alternative

In order to make an accurate conversion to the land use types essential to the model, a GIS spatial analysis was performed. This process identified which Current Day land use types corresponded with future land use types in the Comp Plan. This is more easily understood by envisioning the future Comp Plan land use map laid upon the Current Day map and identifying and quantifying areas of intersection between the two land use systems for each watershed drainage basin. The result of the GIS spatial analysis process provided a matrix table for identifying the types and quantities of Current Day land use types which correspond to each of the Comp Plan land use designations.

The next step of the water quality analysis process required an interpretation of the Lee and Collier County Comprehensive Plans in order to determine the amount of growth permissible for the future build out within each county. This was performed by identifying those land use categories which would experience a growth, a loss, or remain constant. This determination was made based on the descriptions in the Future Land Use Designation Description Section of the Collier County Plan and the policies contained in section two of the Lee Plan. As there is a finite amount of land within each county, the number of acres of a given land use type experiencing growth will have to be offset by an equal number of acres of alternate land use types experiencing a loss.

The Comp Plan Alternative may also allow for a mixture of future land use types to experience growth within a given future land use designation. To provide a reasonable interpretation of future growth under these circumstances, each of these land use types encouraged by the future land use designation would experience a level of growth in the same proportion as they existed in the Current Day land use distribution. For example, if the Comp Plan Alternative allows growth within the industrial and commercial land use types, then the total acres of these two land use types will increase but maintain the same ratio that existed before build out.

4.10.2.2.2 Ensemble U

As with the Comp Plan Alternative, an understanding and interpretation of the Ensemble U land use categories, restrictions, and mitigation within each of the ten (10) watersheds were required. This conversion of Ensemble U from the ADG-produced (Alternatives Development Group) criteria to land use categories was completed in a similar manner to that used for the Comprehensive Plan Alternative.

GIS spatial analyses were conducted utilizing the Ensemble U land use coverage concurrently with those for the Comprehensive Plan and the Current Day (1995). This data provides the ability to "fill in the blanks" (missing land use information) left by the lower level of detail in Ensemble U and was especially evident in the urbanized areas. This process was accomplished by determining areas of agreement between the Comprehensive Plan and Ensemble U to provide the higher level of detail provided by Lee and Collier Counties.

The Ensemble U "Urban" land use category is an example of this expanded detail process of interpretation. The Urban land use was converted (expanded) to Comprehensive Plan land use categories of Central Urban, Urban Community, Intensive Development, Urban Residential, Urban Residential Fringe and many others. These expansions of land use detail were performed in order to provide the best interpretation of the future land use designated by the ADG-produced criteria. With this exception, the Ensemble U land use analysis was completed in the same manner as outlined for the Comprehensive Plan Alternative.

It was recognized that these interpretations of the Alternatives constitute one scenario when considering the proportion of growth among the various land use types. Other scenarios were also considered but provided no difference in the overall water quality analysis process. The interpretation of land use growth for the Alternatives was identified as a potential source of variability (Section 4.10.2.6) in the overall water quality analysis process.

4.10.2.3 Best Management Practices

Best Management Practices (BMPs) primarily refer to the types and uses of surface water pollution control methods which are utilized within the study area to improve the water quality of the stormwater runoff (i.e. wet-detention ponds) (Driver and Tasker 1990). The location and size of the study area BMPs (Storm Water Treatment Certifications) were available as an ARC View GIS map (South Florida Water Management District) and were summarized by land use type, location, and quantity of acres (SFWMD 1995). BMPs are recognized as having various Pollutant Removal Efficiencies, and therefore, function by potentially reducing the concentrations of the surface water runoff pollutants to a given receiving water body (Rushton and Dye 1993). The pollutant removal efficiencies used in this analysis were extracted from a study conducted in the nearest metropolitan area from which data were available (Tampa Bay Region) (Dames & Moore 1990). The use of data from outside of the study area was necessary due to the lack of monitoring data available for the study area. Within the study area, the total number of acres of each land use type were partitioned into two subsets, those utilizing BMPs and those without. This partitioning was conducted for the Current Day land use data as well as for the Comp Plan and Ensemble U.

Current land use data were partitioned based on the number, location, and quantity of BMPs actually permitted. In order to discern the same BMP partitioning information for each Alternative, an estimated projection of future BMP acres was required. The Alternative BMPs therefore included three components: a) acres of BMPs currently permitted, b) acres of BMPs currently under application, and c) acres of BMPs estimated to accommodate the future growth projections (Section 1.2). As a very conservative estimate, acres of BMPs necessary to accommodate the growth projections of the Alternatives were equated to the increase in acres of Urban land use with the exceptions listed below.

An estimated projection of future BMP acres within two historic development subdivisions was conducted separately. Currently, there are no requirements for BMPs associated with new construction within the Lehigh Acres and the Golden Gates subdivisions. In these areas, BMPs were not utilized. Additionally, smaller areas that do not require BMPs were identified and treated in a similar manner. Estimated projections of future BMP land use types for the Alternatives were identified as a potential source of variability (Section 1.6) in the overall water quality analysis process.

4.10.2.4 Water Quality Modeling

To accommodate the water quality analyses, the study area was partitioned into ten hydrologic units or watersheds. Watershed boundaries within the study area include portions of the larger national watershed system (Caloosahatchee and Big Cypress Basin) as defined by the USGS, as well as the smaller watersheds and basins defined by the South Florida Water Management District (**Figure 13**).

GIS spatial analyses performed to estimate changes in land use types associated with the Alternatives and were conducted individually for each of the ten study area watersheds. The resulting database consisted of land use types and quantities (acres) within the study area watersheds for the Comp Plan and Ensemble U.

Water quality modeling was performed for the receiving water bodies of each of the ten watersheds incorporating: 1) acres of each land use type; 2) associated surface water pollutant loading rates; 3) average annual rainfall; and 4) receiving water body data (Wanielista and Yousef 1993). The resulting water quality model output provided estimates of four key surface water pollutants for each watershed:

Biological Oxygen Demand (BOD)
Total Suspended Solids (TSS)
Total Nitrogen (TN)
Total Phosphorus (TP)

BMPs are designed and implemented to provide improved removal efficiencies for several water quality parameters (Kehoe 1992). Analyses were performed separately for those parcels of land which included BMPs and for those which did not. The model data estimates water quality for key surface water pollutants within each watershed for the Current Day and each Alternative land use. These data were then utilized for determining indices of water quality for each of the Alternatives. As a comparative analysis of relative change, the modeling output data are provided as a percent change from the Current Day land use to each of the Alternative land use scenarios.

4.10.2.5 Index of Water Quality

A methodology for calculating an index of water quality (IWQ) was developed and utilized for the study area. Use of a IWQ summarizes the modeling output of several water quality parameters into a single unit of measure and provides a means for Alternatives comparison.

Indices of water quality were based on the estimates of three water quality categories: clarity, oxygen-demanding substances, and nutrients (FDEP 1996). IWQs were calculated for each Alternative as well as the Current Day (1995) in order to assess water quality trends for the study area. Methodology for IWQ calculations are discussed in the Affected Environment and Appendix sections.

An overall IWQ was developed for the entire study area for the Current Day land use and each Alternative. In order to accommodate the varying runoff potential and size of each watershed, each of the overall IWQs were developed by normalizing the individual watershed IWQs. Normalizing was performed by multiplying each of the watershed IWQs by the corresponding watershed area (number of acres) and then dividing by the total study area. This procedure accounts for potential impacts of high IWQ values in a small watershed versus a large watershed.

4.10.2.6 Sources of Variability

The methodology developed for the water quality analysis process of the study area Alternatives on surface water quality has identified sources of variability inherent to various stages of the analytical process. **Table 11** identifies potential sources of variability and their relative contribution to the water quality analysis process. The inherent variability are considered relative to all Alternatives and as such, remain constant and therefore, do not impact the overall comparison of alternatives. Additionally, any new data that might be inserted into this process at a later date may create new sources of variability.

Table 11. Summary of Variability within the Water Quality Analysis Process.

SOURCE of VARIABILITY		**POTENTIAL for VARIABILITY**		
		Low	**Medium**	**High**
Current Day				
	Land Use Data	✓		
	Interpretation	✓		
Alternatives				
	Land Use Data		✓	
	Description Interpretations		✓	
	Discerning Land Use from Mixed Land Use Growth/Loss Projections		✓	
WQ Model				
	Rain Fall Data			✓
	Runoff Coefficients	✓		
	Pollutant Loading Rates			✓
	Receiving Water Body Data		✓	
BMPs				
	Percent Removal Efficiencies			✓
	Interpretation of Current Day BMPs	✓		
	Interpretation of Alternative BMPs		✓	
IWQ				
	Representation of Trends		✓	

	WQ Parameters		✓	
	Derivation of IWQ			✓

4.10.2.7 Water Quality Impact Analysis Results

The following section discusses the results from the water quality analysis and the IWQs for the Current Day and each Alternative land use. This methodology provides an effective assessment for relative comparisons of land use Alternatives with respect to water quality. While this analysis provides a relative comparison of water quality among Alternatives, it does not address potential secondary impacts that may occur with diminishing water quality. Secondary impacts were not assessed due to limitations in the data available for the study area; these include:

Ecosystem Impacts
Habitat destruction (i.e., mangroves, seagrasses, hard bottom, and other systems that include sessile organisms)
Change in trophic structure
Proliferation of exotic/invasive/undesirable aquatic plant and fish species
Degradation of Aquatic Resources
Fish Kills
Fish Consumption Advisories
Shellfish Harvesting Restrictions
Reduced fishery yield (species and/or abundance)
Aesthetics
Algal Blooms
Water Clarity
Odor

4.10.2.7.1 Current Day

Several water quality parameters were modeled for the Current Day land use (1995) in order to provide a baseline from which to compare future trends and changes with each Alternative land use. The water quality model results are summarized as a percent change from Current Day land use and will be provided in later sections.

Water quality parameters that would contribute most to degraded water quality within the Current Day (1995) land use study area include BOD and TSS. Those watersheds that contribute most to degraded water quality include District VI, Golden Gate Canal, Estero-Imperial Integrated, and Cocohatchee/Corkscrew Basins.

4.10.2.7.2 Comprehensive Plan Alternative

Table 12 provides a summary of the water quality model results for the Comp Plan Alternative land use as a percent change from Current Day.

Table 12. Estimated Percentage Change of Modeled WQ for the Comp Plan Alternative.

Comprehensive Plan Alternative	Water Quality Parameters			
	BOD	TSS	Total N	Total P
WATERSHEDS	(% Change)	(% Change)	(% Change)	(% Change)
Tidal Caloosahatchee Basin	49.3	82.4	-2.7	22.6
West Caloosahatchee Basin	105.5	159.0	5.1	60.1
Estero-Imperial Integrated Basin	28.5	14.1	-3.8	15.8
Cocohatchee/Corkscrew Basin	50.7	33.9	2.1	35.0
Golden Gate Canal Basin	38.6	37.4	7.9	42.3
District VI Basin	7.7	-4.0	-13.7	2.5
Henderson Creek Basin	20.2	12.8	11.3	56.9
Collier/Seminole Basin	25.4	4.5	0.6	13.3

Faka-Union Basin	32.5	0.8	9.2	26.5
Fakahatchee-Strand Basin	8.2	12.6	1.1	5.6

Notes: Percentage Change from Current Day Land Use

Water quality parameters that would contribute most to degraded water quality within the Comp Plan Alternative include BOD and TSS. Several watersheds within the Comp Plan Alternative have potential to contribute to degraded water quality in the study area and include: Golden Gate Canal, District VI, West Caloosahatchee, Tidal Caloosahatchee, Henderson Creek, and Cocohatchee/Corkscrew Basins.

4.10.2.7.3 Ensemble U

Table 13 provides a summary of the water quality model results for Ensemble U land use as a percent change from Current Day.

Table 13 Estimated Percentage Change of Modeled WQ for Ensemble U.

Ensemble U	Water Quality Parameters			
	BOD	**TSS**	**Total N**	**Total P**
WATERSHEDS	**(% Change)**	**(% Change)**	**(% Change)**	**(% Change)**
Tidal Caloosahatchee Basin	39.6	62.4	-7.7	11.1
West Caloosahatchee Basin	35.9	7.2	-28.8	-17.2
Estero-Imperial Integrated Basin	27.9	6.0	-8.6	5.7
Cocohatchee/Corkscrew Basin	44.4	30.4	1.3	27.9
Golden Gate Canal Basin	35.0	33.4	4.0	32.7
District VI Basin	26.8	20.7	2.4	24.9
Henderson Creek Basin	6.2	1.9	-2.4	15.2
Collier/Seminole Basin	16.5	-4.3	-1.0	5.6
Faka-Union Basin	12.0	-15.2	-1.2	4.3
Fakahatchee-Strand Basin	0.5	-2.8	0.0	0.2

Notes: Percentage Change from Current Day Land Use

Water quality parameters that would contribute most to degraded water quality within Ensemble U include BOD and TSS. Several watersheds within Ensemble U that have potential for degraded water quality in the study area and include: District VI; Golden Gate Canal; Tidal Caloosahatchee; and Cocohatchee/Corkscrew Basins.

4.10.2.7.4 Comparison of Alternatives with the Current Day Land Use

Table 14 provides a summary of the IWQs based on model results for the Current Day, the Comp Plan Alternative, and the Ensemble U land use.

Based on the results of the modeling process, Ensemble U shows less potential for water quality degradation than the Comprehensive Plan Alternative. The potential water quality impacts are shown for the individual watersheds and for the entire study area in **Figure 14**. The difference in potential water quality impacts is due to the more permissive land use criteria within the Comprehensive Plan Alternative and the requirements for restoration and preservation within Ensemble U. Ensemble U also has an additional criterion that requires retrofitting of certain areas that are not required by regulation to have stormwater management systems.

The Fahkahatchee-Strand Basin was identified as the watershed having the best potential water quality and contributing the lowest IWQ (48.5) to Current Day land use, whereas the District VI Basin had the worst potential water quality and contributed the highest IWQ (73.2) value. The overall study area IWQ for the Current Day land use was 56.9.

Table 14 Comparison of IWQs for each Watershed.

WATERSHEDS	Land Use IWQs w/BMPs		
	Current Day	**Comprehensive Plan Alternative**	**Ensemble U**
Tidal Caloosahatchee Basin	58.0	69.2	66.5
West Caloosahatchee Basin	48.0	71.2	53.0
Estero-Imperial Integrated Basin	59.5	64.8	63.5
Cocohatchee/Corkscrew Basin	56.0	67.6	66.5
Golden Gate Canal Basin	66.7	74.0	72.8
District VI Basin	73.2	73.1	77.0
Henderson Creek Basin	58.3	64.3	59.2
Collier/Seminole Basin	54.8	60.8	59.3
Faka-Union Basin	56.1	63.7	57.5
Fakahatchee-Strand Basin	48.5	50.7	47.1
Total Study Area:	**56.9**	**64.3**	**61.1**

The Fahkahatchee-Strand Basin was also identified as having the best potential water quality and contributing the lowest IWQ (50.7) to the Comp Plan Alternative, whereas the Golden Gate Canal Basin had the worst potential water quality and contributed the highest IWQ (74.0) value. The overall study area IWQ for the Comp Plan Alternative was 64.3. The Fahkahatchee-Strand Basin was again identified as having the best potential water quality and contributing the lowest IWQ (47.1) to Ensemble U, whereas the District VI Basin had the worst potential water quality and contributed the highest IWQ (77.0) value. The study area IWQ for Ensemble U was 61.1.

Comparative changes in water quality between the Current Day land use and each Alternative are represented in **Table 15**. Water quality drivers refer to those water quality parameters with a percent change from Current Day greater than 25 percent. Watershed drivers refer to those watersheds with the highest IWQ values and which contribute the most to increasing the overall study area IWQ.

Table 15. Summary of Water Quality Impact Analyses for Current Day and each Alternative.

	Watersheds w/ WQ Drivers		**Watershed Drivers**		
WQ Parameters	**Comprehensive Plan**	**Ensemble U**	**1995**	**Comp Plan**	**Ensemble U**
BOD	**7**	**6**	**District VI**	**District VI**	**District VI**
TSS	**4**	**3**	**District VI**	**Golden Gate**	**District VI**
TN	**0**	**0**	**District VI**	**Golden Gate**	**District VI**
TP	**5**	**2**	**District VI**	**Golden Gate**	**Golden Gate**

Notes: WQ Drivers: Indicate Watersheds with Percentage Changes in Water Quality Greater than 25%

Projected changes in water quality between the Current Day and the Comp Plan Alternative land use are best summarized by an increase in the study area IWQ from 56.9 to 64.3, indicating a potential decline in water quality. This decline was primarily driven by urban land use and the BOD and TSS water quality parameters. The West Caloosahatchee Basin has been identified as the watershed projected to experience the greatest change in water quality during build out of the Comp Plan Alternative. From the Current Day land use to the Comp Plan Alternative, water quality is estimated to potentially further degrade in all watersheds except for District VI, which indicates little to no change. Changes in the IWQ values among watersheds are represented in **Figure 15**. The shaded scale represents incremental changes (5%) in the IWQ values from the Current Day to the Comp Plan Alternative land use. The IWQ comparisons for each of the watersheds between Current Day and the Comp Plan Alternative are represented in **Figure 14**.

Estimated changes in water quality between the Current Day and Ensemble U land use are best summarized by an increase in the study area IWQ from 56.9 to 61.1, indicating a potential decline in water quality. This potential decline was again driven by urban land use and the BOD and TSS water quality parameters. The Cocohatchee/Corkscrew Basin has been identified as the watershed projected to experience the greatest change in water quality during build out of Ensemble U. From the Current Day land use to Ensemble U, water quality is estimated to further degrade in all watersheds except for Fahkahatchee-Strand, which actually indicates a slight improvement. Changes in IWQ values among watersheds are represented in **Figure 16**. The shaded scale represents incremental changes (5%) in the IWQ value from the Current Day to the Ensemble U land use. IWQ comparisons for each of the watersheds between the Current Day and Ensemble U are represented in **Figure 14**.

Comparisons of the Comp Plan Alternative and Ensemble U water quality are best summarized by a decrease in the study area IWQ from 64.3 to 61.1, indicating potentially better overall water quality with Ensemble U. All of the Ensemble U watersheds would indicate improved water quality over the Comp Plan Alternative, except for District VI Basin. Although District VI Basin land use types do not significantly change between the Comp Plan Alternative and Ensemble U, the potential degraded water quality of this basin with Ensemble U is partly a result of nearly 2,000 fewer acres with incorporated BMPs. This difference is a result of different land use types, not differences in criteria regarding BMPs. IWQ comparisons for each of the watersheds between the Comp Plan Alternative and Ensemble U are represented in **Figure 14**.

4.10.2.8 Mitigation of Water Quality Impacts

The analysis of water quality impacts associated with the EIS Ensembles have revealed some actions to potentially mitigate the impacts of future development activities and improve the knowledge of water quality related BMP effectiveness within the study area. An examination of the ratio of acres of developed land served by BMPs to total acres impacted by various forms of development indicates great disparities among the watersheds. The differential in this ratio among watersheds exceeds 100%.

In addition to the above concerns, approximately 14 water bodies within or likely impacted by the study area have been placed on the EPA's 1998 303(d) list by FDEP. These water bodies include: Tamiami Canal; Naples Bay; Gordon River; Lake Trafford; Cocohatchee River; Imperial River; Estero Bay; Hendry Creek; Estero Bay Drainage; Spring Creek; Billy Creek; Daughtrey Creek; Manuel River; and Matlacha Pass. Section 303(d) of the Clean Water Act (CWA) requires each state to develop a list of waters not meeting water quality standards or not supporting their designated uses. In time, Total Maximum Daily Loads (TMDLs) are required for these waters because technology-based effluent limitations, current effluent limitations required by State or local authority, and or other pollution control requirements are not stringent enough to meet current water quality standards (FDEP 1998).

The following are concepts identified in preliminary discussions between EPA and the Corps concerning potential actions to increase the assurance of maintaining and improving water quality in the study area. These water quality protection concepts are included in this document to disclose that these ideas have been presented.

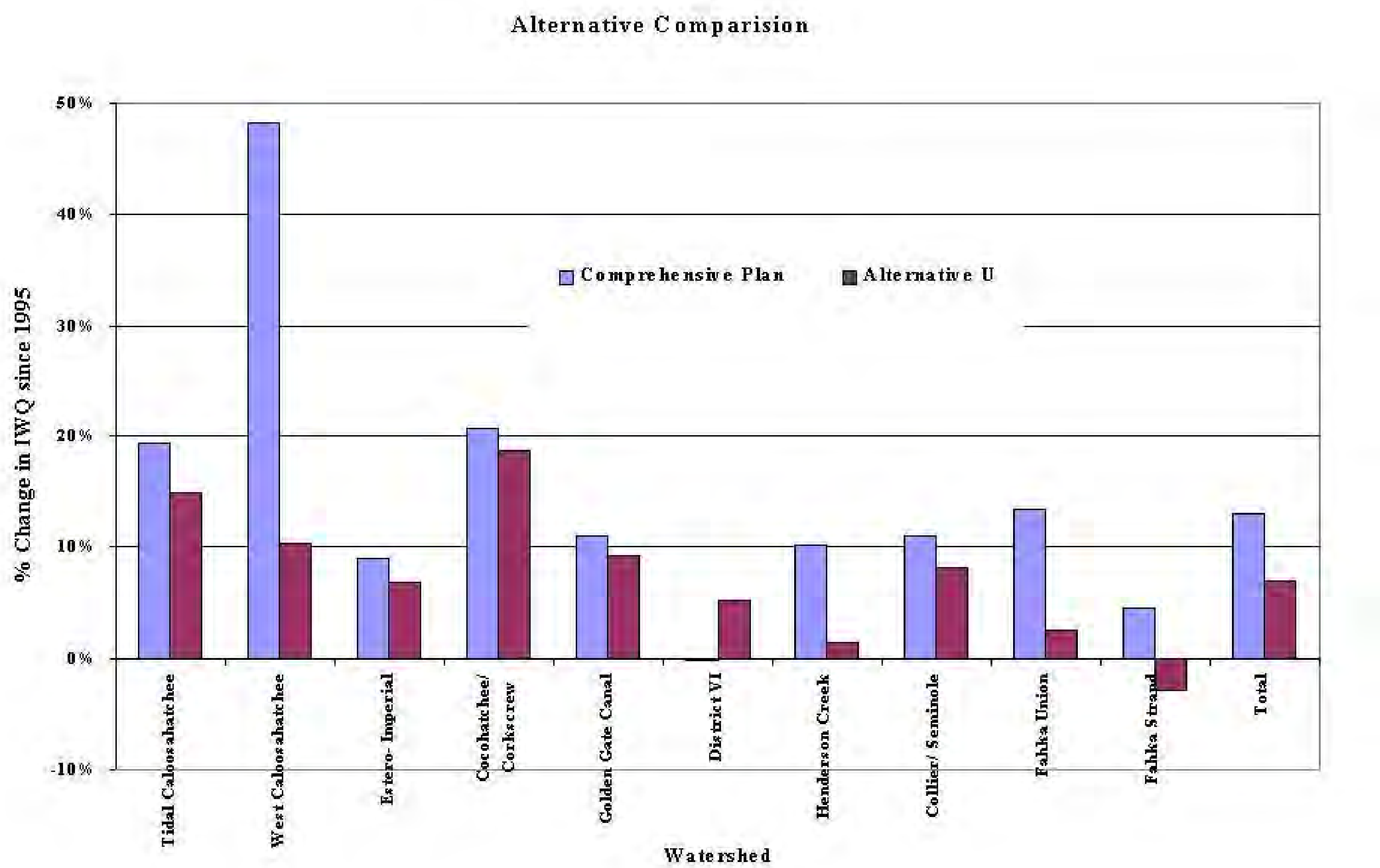


Figure 14. Comparison of Change in IWQs for Each Alternative Land Use from the Current Day (1995).

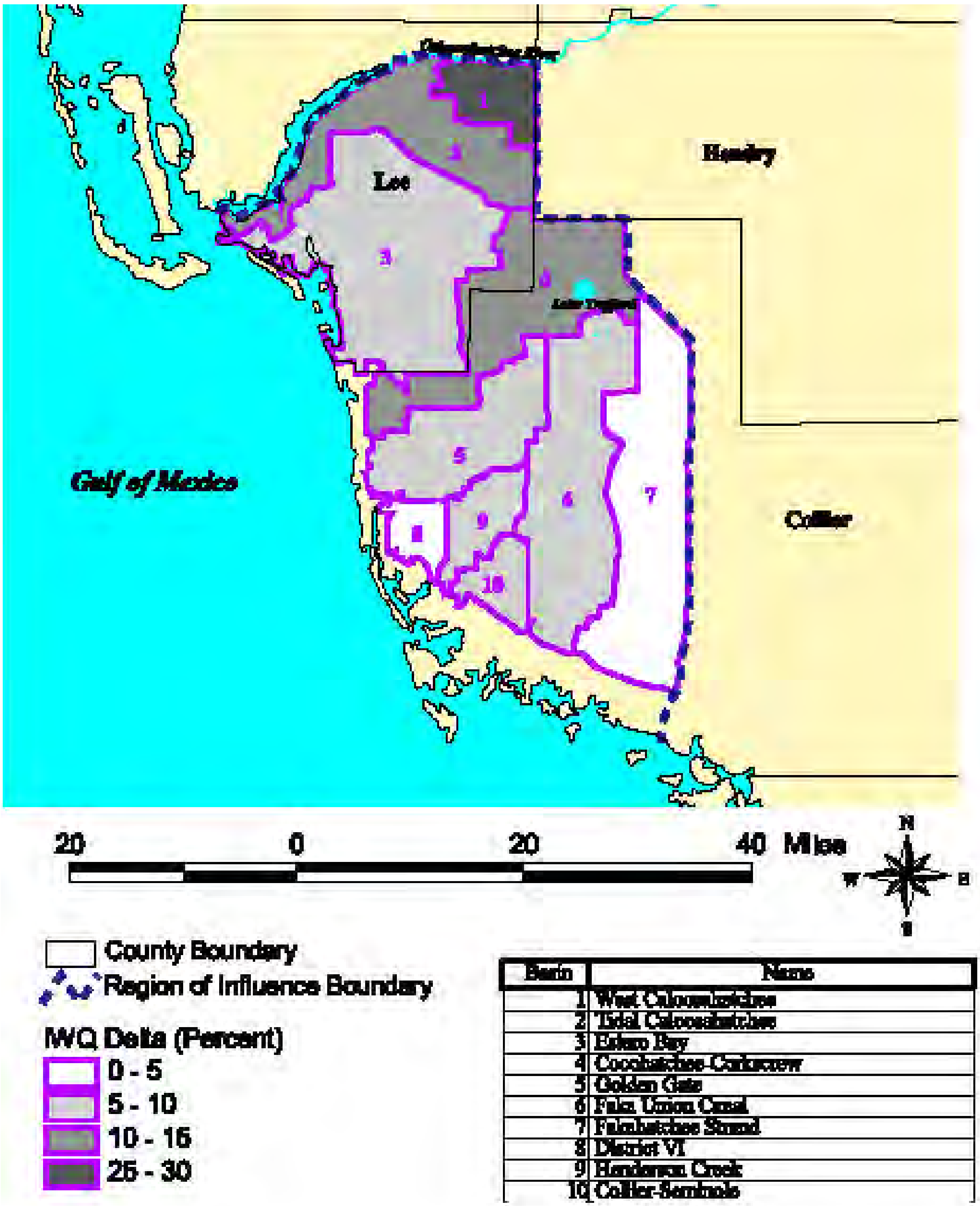


Figure 15. Changes in IWQ Values from Current Day to the Comp Plan Alternative Land Use.

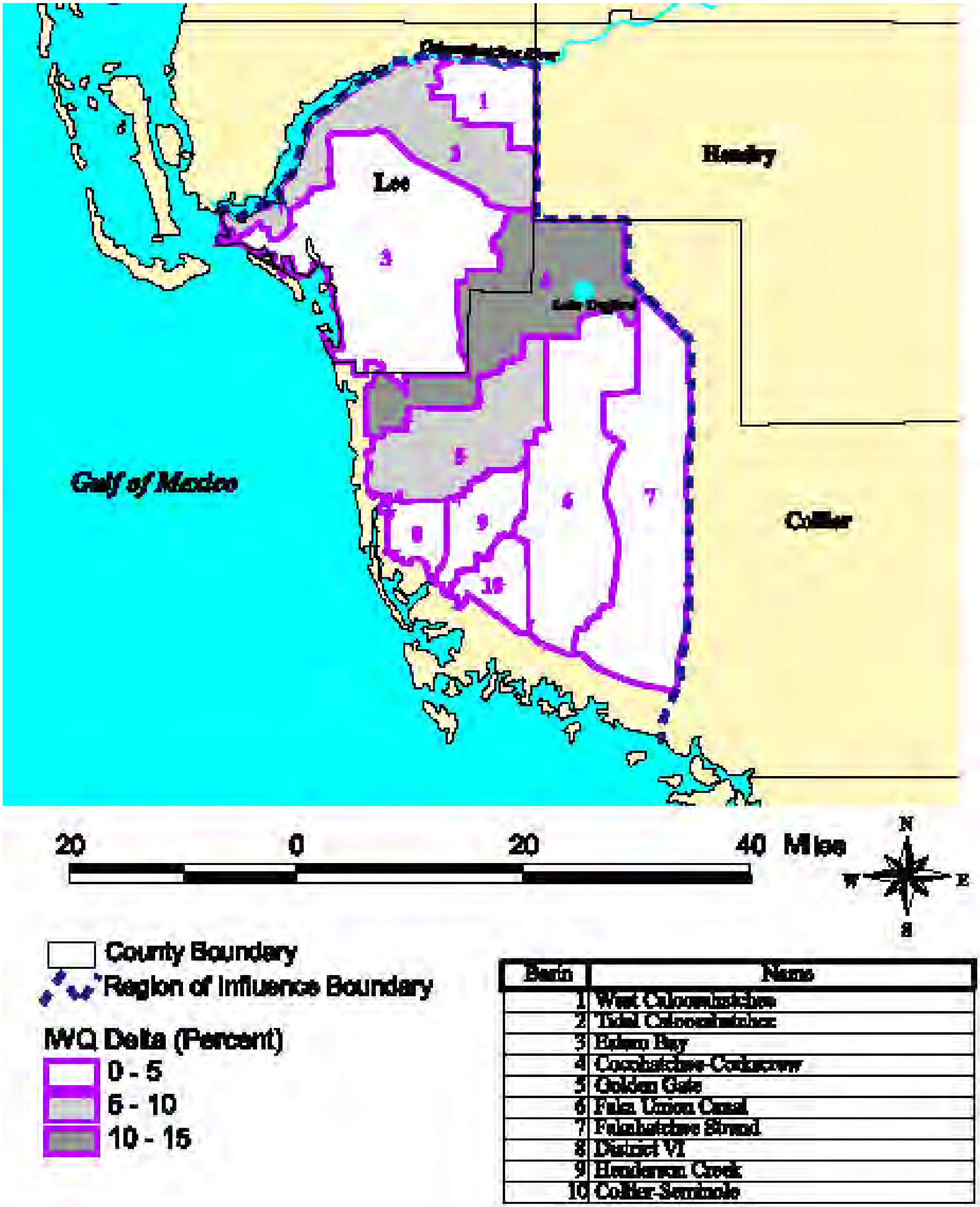


Figure 16. Changes in IWQ Values from Current Day to the Ensemble U Land Use.

4.10.2.8.1 Southwest Florida Feasibility Study (USACE/SFWMD) - Potential for Retro-fitting

Through the Corps' Central and Southern Florida Restudy Comprehensive Plan, a Southwest Florida Feasibility Study (the Study) will be initiated in 2000 for the geographic area of Collier and, Lee Counties and portions of, Charlotte, Glades, and Hendry Counties. The Study will provide a framework to address the health of aquatic ecosystems, including; water flows, water quality (including appropriate pollution reduction targets), water supply, flood protection, wildlife, and biological diversity and natural habitats. The Study also will address water resources problems and opportunities in southwest Florida. The Study may additionally provide opportunities to address solutions for reducing pollutant loading to area waterbodies from existing developments that pre-date existing State and Federal stormwater programs.

4.10.2.8.2 Water Quality Best Management Practices (BMPs)

The following ideas are based on the potential lack of sufficient BMPs and their clustered distribution within developed land uses in the study area:

4.10.2.8.2.1 Develop Local Stormwater Retention/Treatment Ordinances by Lee/Collier Counties

The EPA and other cooperating agencies could work with both local county and municipal governments within the EIS study area to develop stormwater retention and treatment ordinances that will afford greater water quality protection to local water bodies. This cooperative measure would include an evaluation of regional stormwater solutions, retrofitting of specific WQ pollutant load problem areas to determine activities that provide the greatest benefit to cost ratio. One scenario to be evaluated is the use of part of the canal system within Lehigh Acres and an appropriate amount of surrounding land to create a regional stormwater management system.

4.10.2.8.2.2 Enhanced Stormwater BMP Development for Priority Sub-Basins

The EPA and other cooperating agencies have assessed whether the development and implementation of enhanced stormwater management systems in identified sub-basins within the EIS study area is appropriate. The goal of this analysis is to adequately protect WQ conditions in the area while allowing for continuing economic development in those sub-basins that currently exhibit the highest levels of WQ degradation associated with non-point source (NPS) pollutant loading. The FDEP's current 303(d) list for impaired waterbodies in the EIS study area and the EPA's evaluation for this EIS of additional 1990's water quality data for the ten EIS sub-basins describe the basins exhibiting degraded water quality. One concept identified that could reduce the potential for further water quality decline is for future projects proposing wetland fill in degraded basins to treat of 95% of the pollutant load in their surface water runoff. This concept includes the following ideas that might be considered in implementing this concept:

1) Projects involving wetland fill within 303(d) listed watersheds would include treatment designed to the goals of the State of Florida ERP Minimum Stormwater Treatment Performance Standards, provided at Florida Administrative Code (FAC) Code Rule 62-40.432(5) currently required for Stormwater Management Systems (SMS) discharging to FDEP Outstanding Florida Waters (OFWs). This State of Florida OFW stormwater requirement requires a SMS designed to "achieve at least 95% reduction of the average annual load of pollutants" (typically measured as 95% reduction of Total Suspended Solids (TSS)) from waters discharged from SMSs approved by the ERP program.

2) Projects involving wetland fill within EIS sub-basins having EPA 1990's Water Quality Indices (WQI) of 52.0 or greater would include treatment designed to the goals of Florida ERP Stormwater Rules (FAC Code 62-40.432(5) currently required SMS for discharges to FDEP OFWs. This State of Florida OFW stormwater requirement requires the design and construction of a stormwater management system to remove 95% of average annual pollutant loads (typically measured as 95% TSS reduction from waters

discharged from Stormwater Management Systems approved by the ERP program. The following EIS sub-basins have EPA 1990's WQIs greater than 52.0: Tidal Caloosahatchee Basin, Estero Bay Basin, Cocohatchee – Corkscrew Basin, Golden Gate Canal Basin, Henderson Creek Basin, Collier – Seminole Basin and Fakahatchee Strand Basin.

3) Assurance that design efficiency of the constructed Stormwater Management System (SMS) would be provided by stormwater quality monitoring (the plan and reporting details would be negotiated between the applicant and the Corps/EPA on a case by case basis) and if appropriate by provisions for constructing an expanded SMS (such as by reserving non-mitigation lands for expansion of the SMS or establishing a mechanism to provide sufficient funds to construct an expansion)

4) Certain Stormwater Management System (SMS) designs may be encouraged; for example, those that incorporate and maximize the acreage of vegetated wetlands and grassed swales. Long-term maintenance of biological treatment systems associated with SMS is important. Other concepts for incorporating vegetated wetlands into SMS design include the use of native wetlands as buffers to SMSs, incorporation of littoral zone wetlands within SMSs, and utilization of constructed wetlands downstream of stormwater retention ponds to act a pollutant scrubbers, prior to discharge of runoff water offsite.

4.10.2.8.2.3 BMP Improvement Incentives

The EPA and other cooperating agencies will work with the private sector, municipalities, the Florida Department of Agriculture and Consumer Services, and other appropriate interest groups to evaluate what new non-point source pollutant reduction BMP incentive programs could be implemented in the EIS study area. The goal of this cooperation would be to reduce non-point source pollutant loading of area streams, canals, estuaries, wetlands and other water bodies. This evaluation would focus on suburban, rural, and agricultural areas that are currently exempt from the Environmental Resource Permit (ERP) program, Section 404, NPDES, NPS, and other regulatory programs.

4.10.2.8.3 Monitoring

The types of data necessary to make informed decisions within the study area regarding the actions listed above which do not currently exist include: 1) effectiveness of stormwater management systems as currently regulated; 2) pollutant concentrations of stormwater management system effluent; and 3) WQ impacts of different land use types within Southwest Florida. The primary benefit received from a comprehensive water quality monitoring program is the identification of water quality problems outside of the ERP program.

Listed below are ideas to provide the necessary information to make informed decisions on changes in regulatory criteria in order to provide improved protection to the water bodies within the study area.

4.10.2.8.3.1 Storm-Event WQ Monitoring in Future 404 / Environmental Resource Protection Permits

The State of Florida ERP program permits have a technology-based WQ assumption which presumes that if the required stormwater management is implemented by permitted developments, then the State WQ standards in the receiving water bodies will be protected (see Chapter 62-25, Florida Administrative Code in Appendix). Storm-event WQ monitoring in the EIS study area is not currently available to confirm the performance of the permitted stormwater management systems.

Land development projects permitted in the EIS study area by the Corps' Section 404 program and other cooperating regulatory programs could be required to implement programs to determine the effectiveness of their systems. Criteria would be established to determine which of the above mentioned projects would be required to participate in this stormwater monitoring program. These criteria could be tailored to include projects that are perceived to have a larger impact on the surrounding environment due to size, proximity to receiving water bodies, and land use impacted.

The stormwater monitoring program will require WQ monitoring during storm-events at the stormwater management system outlet structures to confirm the technology based WQ presumption for the following WQ constituents: DO, TSS, TP, TN, BOD, zinc, lead, and pesticides. This constituent list is preliminary. Regular reporting back to the EPA, the Corps, and other cooperating agencies would also be required as part of the WQ monitoring permit conditions of the 404 permits and other cooperating regulatory programs.

4.10.2.8.3.2 Create a Comprehensive Storm-Event WQ Monitoring Program (EPA/FDEP/SFWMD)

A cooperative effort could be made to develop an accurate analysis of ongoing WQ conditions and issues in the EIS study area. The goals of this comprehensive program would be to determine the relative contribution of the following land use areas on the decline of water quality within the region: large land development projects which predate regulatory standards requiring the management of stormwater for WQ concerns (i.e., Lehigh Acres, Golden Gate Estates, District VI, and others); land development projects and agricultural activities that comply with current regulatory standards; and, other land uses or activities within the study area that will provide the information necessary to make the proper regulatory or legislative decisions.

4.10.2.8.3.3 Review of the NPDES Non-Point Source Permit Programs

Under provisions of Section 402 of the Clean Water Act (CWA), the EPA is authorized to issue permits requiring BMP programs to treat non-point source (NPS) stormwater runoff to Waters of U.S., in municipal areas with populations greater then 100,000 (MS-4 Program) as well as for construction sites greater then 5 acres. The NPDES stormwater program will be delegated from the EPA to FDEP in May, 2000. Phase 2 of the NPDES stormwater permit program will extend the MS-4 permit requirement to municipalities between 50,000-100,000 in population in October, 1999. Lee County is currently permitted under the MS-4 Phase 1 program and Collier County will be permitted under Phase 2 of the NPDES MS-4 program. As a result of concerns with the detention and treatment of stormwater runoff in the EIS study area, the EPA and other cooperating agencies could conduct a review of the existing NPDES Stormwater program and make appropriate recommendations on how to revise this CWA program in such a manner that would reduce pollutant loading to water bodies in the EIS study area.

4.10.3 MANAGEMENT

Section 4.10.1 reports that, among other things, that the evaluation considered whether the alternative increased the area of development, thereby increasing pollutant loading, and noted that many but not all new development implement Best Management Practices (BMPs), which would reduce the load in the runoff. Section 4.10.2 uses a numeric model to compare change in water quality from today (1995) and two alternative futures (Ensembles R and U), expressed as a composite "Index of Water Quality" (IWQ). The variables used in the model are interdependent and changing the value of one variable will require the calculation of the entire model to determine the resulting effect on the IWQ. Most of the variables are assigned the same values in modeling the existing condition (1995), Ensemble R and Ensemble U. The primary differences between Ensembles R and U are: (1) the number of acres of land converted from one use to another; and (2) the number of acres whose runoff is treated by BMPs. In general terms, Ensemble U, compared to Ensemble R, suggests fewer acres of land converted to development (residential, commercial, etc.) and, of the acres that are developed, a larger proportion of those acres be provided with BMPs. The Corps prepared **Table 16** to compare the two Ensembles for each basin.

For example, for the Tidal Caloosahatchee basin, 44% of the total area of the basin will be converted from agriculture, open land, and wetland to some form of development under Ensemble R (columns E, F, G, and H). Under Ensemble U, 42%. Therefore, the quantity of conversion under Ensemble U is approximately "similar" to Ensembles R (column A). However, 42% of the total area of the basin will be served by BMPs under Ensemble R compared to 49% under Ensemble U (Column J). Therefore, there is "slightly more" treatment of BMPs by Ensemble U (column B). The resulting IWQ is slightly lower for Ensemble U than for Ensemble R (column M).

The table indicates varying influence on the IWQ by the change in acres of land converted and acres of BMP. The variation reflects the unique characteristics of each of the basins and the way the Ensembles were drawn. The influence described by the model, though, is consistent with the best professional assessment in Section 4.10.1. Management decisions to fill wetlands (which contributes to the quantity of land converted to development) and decisions on whether BMP treatment will be implemented can, cumulatively, affect water quality. The model provides a mechanism to explore these potential decisions for particular watersheds.

Table 16. Influence of Increased Development Area Resulting from Ensemble R and Ensemble U upon Water Quality Model.

Ensemble "U" Compared to "R"		Basin	Period of Change - Ensemble	Percentage of Total Area of Individual Basin							Index of Water Quality (IWQ)		
				Land Cover Gained / Lost				Area Served w/BMPs					
Portion of Basin Changed to Dev	Proportion of new BMPs to new Dev			Dev (E)	Agr	Open	Wet	1995	R or U	Delta (K)	1995	R or U	Delta
Similar	Slightly More	Tidal Caloosahatchee	1995 to R	44%	-6%	-36%	-3%	12%	42%	30%	58.0	69 2	11 2
			1995 to U	42%	-4%	-35%	-3%	12%	49%	37%	58.0	66 5	8 5
		Golden Gate	1995 to R	39%	-10%	-24%	-5%	8%	22%	14%	66.7	74 0	7 3
			1995 to U	34%	-10%	-22%	-1%	8%	27%	18%	66.7	72 8	6.1
Slightly Less	Much More	West Caloosahatchee	1995 to R	64%	-3%	-58%	-3%	2%	56%	54%	48.0	71 2	23 2
			1995 to U	58%	-2%	-54%	-2%	2%	93%	90%	48.0	53 0	5 0
Somewhat Less	Similar	Fakahatchee Strand	1995 to R	7%	-1%	-3%	-3%	17%	18%	1%	48.5	50.7	2 2
			1995 to U	0%	-1%	0%	1%	17%	17%	0%	48.5	47.1	-1.4
		Collier Seminole	1995 to R	19%	-15%	-8%	4%	37%	44%	7%	54.8	60 8	6 0
			1995 to U	10%	-7%	-6%	3%	37%	42%	5%	54.8	59 3	4 5
		District VI	1995 to R	49%	-12%	-31%	-5%	6%	55%	50%	73.2	73.1	-0.1
			1995 to U	39%	-12%	-26%	-1%	6%	45%	39%	73.2	77 0	3 8
Less	Somewhat More	Estero Imperial	1995 to R	42%	-9%	-29%	-4%	45%	69%	24%	59.5	64 8	5 3
			1995 to U	29%	-11%	-19%	1%	45%	74%	29%	59.5	63 5	4 0
		Cocohatchee	1995 to R	25%	-10%	-16%	0%	41%	54%	13%	56.0	67 6	11 6
			1995 to U	12%	-11%	-9%	8%	41%	50%	9%	56.0	66 5	10 5
Much Less	More	Fahka Union	1995 to R	26%	-3%	-8%	-14%	21%	22%	0%	56.1	63.7	7 6
			1995 to U	7%	-6%	-3%	2%	21%	24%	3%	56.1	57 5	1.4
		Henderson Creek	1995 to R	42%	-1%	-30%	-10%	11%	24%	14%	58.3	64 3	6 0
			1995 to U	6%	-3%	-4%	1%	11%	17%	6%	58.3	59 2	0 9

Note#1: Excerpts from model made by U.S. Army Corps of Engineers for purpose of comparing to ADG generalized assessment.
Note#2: "Dev" = Sum of five development categories used in model. "Agr" = Sum of agriculture and mining categories used in the model.
Note#3: "Open" = Open Lands with natural vegetation. Includes "vacant" lands adjacent to roads. "Wet" = Wetlands.
Note#4: "Land Cover Gained / Lost". 26% = 26% of total area of basin will be converted from Agriculture, Open, and Wetland to Development.
Note#5: "Proportion of New BMPs to New Development"= Change in column (K) divided by Change in column (E).

4.11 SOLID WASTE

There are landfills within the study area. None of the Ensembles make changes related to these.

4.12 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The scope of this Environmental Impact Statement limited the amount of data collected. As such, detailed information concerning hazardous, toxic, and radioactive waste generation or accumulation sites was not sought or considered. This issue will be addressed in accordance with Federal and State regulations in the course of the permit application review.

4.13 AIR QUALITY

Due to the programmatic nature of this project and the limiting scope of this Environmental Impact Statement , no specific air quality" data were collected. The short-term impacts from the changes in the permit review process associated with this project are not expected to significantly impact air quality. No air quality permits would be required for this action. Effects upon air quality" will be reviewed on a case-by-case basis, as necessary.

4.14 NOISE

The scope of this Environmental Impact Statement limited the amount of data collected. As such, detailed information concerning noise generation or noise-sensitive sites was not sought or considered. This issue will be addressed in accordance with Federal and State regulations in the course of the permit application review.

4.15 PUBLIC SAFETY

Hurricane preparedness is a particularly important issue for this study area. The study area is generally near sea level in elevation, therefore particularly vulnerable to flooding during storms. The study area is located near the end of the Florida peninsula, therefore limiting the evacuation options. The Southwest Florida Regional Planning Council presented in its <u>Hurricane Storm Tide Atlas</u> the expected extent of inundation from a hurricane for each county. Their <u>Hurricane Evacuation Study</u> provides the estimates of the population that would thereby need to be evacuated and the number of shelters, hotels, and private homes available outside of the area of flooding. The study then estimates the number of hours to evacuate to shelters and to evacuate the remainder of the population out of the region. For certain assumptions (type of storm and time of year), the evacuation time is predicted to be greater than the goal set by the RPC. The solution is to construct new roads or to provide more shelter space. The RPC has conducted a study to identify additional shelters. None of the Ensembles were considered to have changed hurricane preparedness except for the southwest portion of study area for Ensemble Q, where the increased urban area could possibly result in an increase in population.

Changes in the management of water flows can affect flooding of homes and other developed areas during less than hurricane storms. A variety of actions can affect or constrain effective water management. This issue is very complex and a thorough evaluation of the potential effects of any of the Ensembles would require a very elaborate water quantity modeling. A hydrologic study and model was recently completed for a portion of the study area by the South Florida Water Management District. Many of the recommendations of that study were incorporated by the ADG into their alternatives". The ADG performed a simple analysis in lieu of an elaborate model. The ADG identified seven factors. A change in one or more of the factors could be used to identify whether an Ensemble affects this issue. The factors are: infrastructure existence, home damage, home construction, flood depth/duration, historic flow patterns, water storage, aquifer zoning. Certain members on the ADG used their experience in this area to score each of these factors for each of the ADG alternatives". These members assigned "+" if the factor was addressed, "o" if it was not, and a "-" if a degradation. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by counting the number of "+" assigned. The minimum score is 0, indicating factor not addressed or negatively addressed.

Table 17. ADG Ranking Scores of the Impact of Each Ensemble upon Public Safety Factors
(Score of 0 indicates factors not or negatively addressed)

	Infrastructure Existence	Home Damage	Home Construction	Flood Depth	Historic Flow Patterns	Water Storage	Aquifer Zoning	Number of "+"
Q	1	0	0	0	3	2	0	6
R	3	2	3	2	1	2	1	14
S	1	0	0	4	5	4	3	17
T	0	0	0	4	5	2	2	13
U	0	0	0	5½	4½	2	2½	14½

For the infrastructure existence factor, Ensemble R was considered to have addressed this since it was considered to have provided for the funding of the maintenance and improvement of stormwater infrastructure. For the home damage factor and the home construction factor, Ensemble R was considered to have addressed this since it provides criteria that homes would either not be built within the 100 year floodplain or elevated to prevent damage. For the flood depth factor and historic flow factor, Ensembles S, T, and U provided wide flowways which are considered to have great influence on restoring the depth and duration of flooding and the maintenance of historic timing and quantity of flows. For the water storage factor, all of the Ensembles providing for preservation wetlands that can provide for storage of surface water. Ensembles S, T, and U propose larger area of preserve. For the groundwater factor, the concern was for establishing groundwater table levels such to protect natural resources. The additional area of preserves in Ensembles S, T, and U were considered to influence the preservation of adequate groundwater levels.

4.16 ENERGY REQUIREMENTS AND CONSERVATION

There is not expected to be any change in energy requirements resulting from any change in the permit review process. However, additional area of development does increase energy demands of the region.

4.17 NATURAL OR DEPLETABLE RESOURCES

A significant resource in the area is limerock quarried from open pits. Approximately 10,700 acres within the study area are currently used for quarrying limerock from open pits. Harper Brothers, Inc., provided an estimate that the cost of aggregate and baserock for a recent road project would have increased by 57% if the material had to be instead hauled from Dade County.

4.18 SCIENTIFIC RESOURCES

The Rookery Bay National Estuary Research Reserve (RBNERR) was established in 1978 in accordance with Section 315 of the Coastal Zone Management Act. The initial Reserve covered an area of approximately 1620 ha (4000 ac). Currently, some 3850 ha (9510 ac) of coastal and submerged lands surrounding Rookery Bay are include in the Reserve. The Reserve represents one of the few remaining, relatively pristine, mangrove estuaries in North America, and serves as a natural field laboratory for research and educational purposes (RBNERR 1996). The Proposed Action is not expected to directly impact nor indirectly affect the use of the Reserve for educational or scientific purposes.

The Florida Panther and Ten Thousand Islands National Wildlife Refuges (USFWS) and the Big Cypress National Preserve (NPS) also serve as viable locations for private and public research efforts. While these areas are not proposed to be directly affected by any of the Ensembles, some do propose development adjacent to these sites. This adjacent development could affect research efforts.

4.19 NATIVE AMERICANS

The Immokalee Reservation of the Seminole Tribe of Florida is located within the study area. The reservation is approximately 640 acres. The existing land use map describes small areas of development (including a residential area and the Seminole Gaming Palace) and agriculture. The majority of the site is native wetland and upland. The five Ensembles varied in their mapping: one mapped as "development", two "agriculture", and two as "preservation". This variety is due to the small size of Immokalee Reservation compared to the size of the mapping. The purpose of the maps, that encompass approximately 1,500 square miles, are to present general concepts (for example, wildlife habitat corridors) and the lines were not drawn to exactly match property lines or to avoid small areas of development. The proposed Permit Review Criteria, described in Section 2.2, does not designate a set of criteria for applications within the Immokalee Reservation. The Corps will continue to recognize the status, governmental authority, and powers of the Seminole Tribe of Florida and the rights under any tribal agreement with any agency of the U.S. Government.

4.20 CUMULATIVE IMPACTS

Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). The ADG studied the cumulative and secondary impacts of each alternative, looking at the effects upon both environmental resources (factors such as water pollution, wetlands, hydrology) and human systems (factors such as infant mortality, road needs, crime rates, and lands remaining in protected status).

4.20.1 PAST ACTIONS

The Corps Regulatory database (RAMS) was used to identify permits authorizing fill in the EIS study area. Extracted permits that were located within the study area and whose approved work types were "Fill-All Roadways", "Fill-Dev(Res/Ind/Comm)", "Fill-Golf Course", and "Fill-Other Misc.". This list includes nationwide and individual permits. When each permit is issued, the Corps Project Manager will type into the database the acres of fill broken into six plant types and the acres of compensatory mitigation broken into four categories. The list extracted from the database was reviewed to remove duplicate entries for those permits that have been modified or renewed as well as to correct obvious data-entry errors (such as square feet of fill entered instead of acres). Only permits from 1991 were used since these acreage categories were not entered earlier. The results are shown in the table. These reflect authorized fill. Some projects are not built or are built years after the permit is issued.

Table 18. Corps Permits Authorizing Fill from 1991 to 1998 inclusive in the Study Area

Acres of Fill	Forested	Herbaceous	Unvegetated	Subtotal	Tota
Coastal	215	229	53	497	
Freshwater	1,597	1,894	79	3,570	4,067
Compensate	Create	Enhance	Preserve	Restore	Tota
Wetland	357	9,706	1,913	27	12,004
Average 508 acres fill permitted per year. Average 63 permits per year.					
Ratio 2.95 acres compensatory mitigation per 1 acre of fill.					

Five maps of the study area were used to estimate the historic change in plant cover. The first three are for the years 1900, 1953, and 1973 found in the Department of Interior report Carrying Capacity for Man and Nature in South Florida (Costanza 1975). The second two are for the years 1988 and 1995 prepared by the South Florida Water Management District. The level of detail and complexity of the landscape of each map after 1900 increases compared to its predecessor. For example, the natural vegetation in 1995 is drawn using 10,485 polygons categorized into 50 plant types while the 1990 maps uses 469 polygons and 11 plant types. Therefore, small patches of a plant type within a larger plant cover that are seen in the 1995 map will not show up in the 1990 map. The mapping accuracy (both delineation of the boundary of a plant type and also the identification of the plant type) will of course be less accurate. Then, over this period of time the plant cover in some areas will change from natural causes as well as from drainage works or other activities. However, since so many commenters on the Draft EIS asked for this, the following analysis was performed. It cannot be stressed too much that the numbers reported are imprecise due to the constraints listed above. The analysis was performed by comparing in turn maps from adjacent years. The 1995 map was compared to the 1988 map. Areas of natural vegetation on the 1900 map that were mapped as development on the 1953 map were sub-mapped. This resulted in square polygons the smallest of which would be around 125 acres. Then, the sub-map was compared to the 1995 map with its smaller polygons. Any areas of natural vegetation that were shown on the 1995 map were subtracted from the sub-map polygons. In addition, some of the polygons extended into natural waterbodies and so the areas of water were also subtracted. The resulting tally is recorded in the 1990-1953 column of the following table. This is the estimated acres of natural plant cover converted to development. This analysis was then repeated for the 1953-1973 map pair, the 1973 and 1988 map pair, and the 1988 and 1995 pair. The 1988 and 1995 maps used different categories of plant types from the earlier three. Acreage from the 1988 and 1995 maps were assigned to the closest comparable category of the earlier maps, thereby introducing another source of inaccuracy to the analysis results. The table also shows the distribution of natural vegetation on the 1995 map. Then the acres from each of the map pairs were added to the 1995 acres and the results shown in the "Start" column. This would represent the theoretical distribution of natural plant acres in the study area before any conversion to other uses. However, as noted above, changes of natural plant types to other plant types occur before converted. Also, the distribution is influenced by how the 1995 and 1998 plant type acres are assigned to the older categories. For comparison, the distribution in the 1990 map is presented by the table. As expected, the major difference is in the Scrub/Shrub and Pinelands types, the more difficult to interpret with aerial photographs and the ones also likely to change from other causes. Smaller differences are seen in the Wet Prairie and Fresh Marsh types.

Table 19. Distribution and Change of Natural Areas to Development

1900 Map	Plant Cover	Start	1900-1953	1953-1973	1973-1988	1988-1995	1900-1995	As of 1995
7.7%	Scrub/Shrub	12.5%	0.4%	6.1%	3.9%	0.2%	10.7 %	1.9%
35.9%	Pinelands	30.3%	2.7%	4.2%	4.9%	2.6%	14.4 %	15.9%
1.2%	Hardwoods	7.0%	0.1%	0.0%	0.1%	0.1%	0.4%	6.6%
27.7%	Cypress	27.9%	0.0%	1.1%	4.7%	0.6%	6.4%	21.5%
8.8%	Wet Prairie	5.8%	0.0%	1.2%	0.5%	0.6%	2.3%	3.5%
4.2%	Fresh Marsh	3.6%	0.2%	0.3%	1.0%	0.2%	1.7%	1.8%
1.3%	Salt Marsh	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%
11.1%	Mangroves	9.8%	0.1%	0.2%	0.4%	0.2%	0.8%	9.0%
97.9%	Subtotal	98.6%	3.5%	13.1 %	15.6 %	4.5%	36.7 %	61.9%
2.1%	Others	1.4%	0.0%	0.6%	0.4%	0.2%	1.2%	0.1%
100.0%	Total	100.0%	3.5%	13.6 %	16.1 %	4.7%	38.0 %	62.0%

4.20.2 PRESENT AND FUTURE ACTIONS

The ADG identified ten issues that generally are not measurably affected by the changes made by a single project. Effects accumulate from multiple projects eventually to the point where they are measurable. The measurement of the effects is complex and the effects have multiple causes.

Prediction of the changes can be attempted using appropriate logistics models. In place of such a model, the ADG performed a simpler analysis. The ADG identified ten factors and also subdivided them into social factors and environmental factors. A change in one or more of the factors could be used to identify whether an Ensemble affects this issue. The social factors are infant mortality, road needs, crime rates, and hurricane vulnerability. The environmental factors are air pollution, water pollution, watershed indicators, wetlands, hydrology, and quantity of preserves. Certain members on the ADG used their experience in this area to score each of these factors for each of the ADG alternatives". The relative comparisons made by the members in their discussions were converted by the group recorder a score from 1 to 7, 1 indicating the less likely there will be a cumulative degradation of the factor. Since an Ensemble is created by assembling four ADG alternatives, the evaluation here will be reported by summing the scores. The minimum score is 4 (least likely degradation) and the maximum is 28 (greater potential for degradation).

The infant mortality factor is influenced by the relative change in urban and agriculture. An Ensemble that increases (relative to another Ensemble) the area of urban and concomitant urban effects and also decreases the area in agriculture could be expected to see increased infant mortality. The road needs factor is influenced by area of urban development. An Ensemble with greater urban area will have a greater need for roads. The crime rate factor is influenced by increasing urbanization. The hurricane vulnerability factor is influenced by provisions for flowways to protect from flooding, infrastructure, and shelter availability. Ensembles S, T, and U provided flowways. The air pollution factor and the water pollution factors are both influenced by the change in the area of urban development. Ensembles with greater urban area are expected to contribute higher loads of pollutants to the region's air and waters.

Table 20. ADG Ranking Scores of the Impact of Each Ensemble upon Cumulative Social Factors
(Score of 4 is least likely degradation)

	Infant Mortality	Road Needs	Crime Rates	Hurricane Vulnerability	Subtotal of Social Factor
Q	17	15	3	11	46
R	20	24	8	13	65
S	11	11	5	9	36
T	16	14	7	3	40
U	13	15	10	4	42

Table 21. ADG Ranking Scores of the Impact of Each Ensemble Upon Cumulative Environmental Effects
(Score of 4 is least likely degradation)

	Air Pollution	Water Pollution	Watershed Indicators	Wetlands	Hydrology	Quantity of Preserve	Subtotal of Environmental
Q	16	15	20	20	14	19	104
R	20	18	18	19	18	20	113
S	15	13	10	13	10	11	72
T	11	9	11	13	13	12	69
U	14	12	12	12	11	10	71

The watershed indicator factor is based on the EPA Index of Watershed Indicators. The EPA in 1997 used available data to assign, for every watershed in the United States, scores to 14 indicators of watershed condition and vulnerability. The ADG did not repeat that exercise but did consider this index to be influenced by the portion of the landscape occupied by urban and agricultural uses. Ensembles with greater proportion were considered to have watersheds with greater vulnerability to degradation. The wetlands factor is directly influenced by the number of wetlands that may be impacted by the Ensemble. The hydrology factor is influenced by the presence of flowways and maintenance of contiguous wetland systems. The quantity of preserve factor is directly influenced by the acres of natural vegetation proposed for preserve and the influence of surrounding lands on the management of those preserves. In general, the four social factors tend to degrade with increasing percentage of urbanization, with Ensembles S, T, and U expected to have somewhat less degradation than Ensembles Q and R. The environmental factors tend to degrade with decreases in the percentage of the landscape preserved for its natural resource. Ensembles S, T, and U are expected to have much less degradation than Ensembles Q and R.

4.21 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.21.1 IRREVERSIBLE

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. One example of an irreversible commitment might be the mining of a mineral resource. A regulatory review process already exists to address the permit applications for impacts to Waters of the United States. The time, consumable resources, and human energy necessary to develop and promulgate new regulatory guidance associated with the implementation of the Proposed Action would be an irreversible commitment of resources.

4.21.2 IRRETRIEVABLE

An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resource as they presently exist are lost for a period of time. An example of an irretrievable loss might be where a type of vegetation is lost due to road construction. Natural communities (upland and wetland) impacted or altered as a result of changes in land use classification and development criteria would be irretrievably lost for a period of time. However, these communities could repopulate in time given the removal of influences maintaining the altered condition (in the case of agriculture), or removal of limiting factors (e.g., impervious surfaces associated with urban land uses).

4.22 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The proposed action (standardized identification of issues in review) and the alternative of continuing unchanged (no action) does not predetermine the issuance of a permit for a given development project. Therefore, there will be no unavoidable adverse environmental effects as a result of the implementation of the proposed action.

4.23 LOCAL SHORT-TERM USES AND MAINTENANCE/ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Protection of the human environment is a continual effort. Acceptable modifications to the existing regulatory review process have been identified and refined. The utilization of the data collected and analyzed by the ADG and the treatment provided in this Environmental Impact Statement, in concert with changes implemented by local and State regulatory agencies, have the potential to balance the needs of the citizens of Southwest Florida with the maintenance and enhancement of the long-term productivity of the study area.

4.24 INDIRECT EFFECTS

The purpose of the proposed action is to better address environmental concerns while providing the regulated community with a timely and relatively predictable permit review process. Protection of threatened resources and redirect of development focus could provide benefits through a greater awareness of the resource availability.

4.25 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

The project is consistent, at this programmatic level, with the State’s Coastal Zone Management Plan (see Appendix B and Section 4.30.7 on consistency determination). Further, the project was found to be consistent with the State's Coastal Zone Management Plan in the Florida Department of Community Affairs’ comments on the Draft EIS. A consistency determination would be made for subsequent individual permit actions and the State’s concurrence with the consistency determination would be sought. It is expected that the proposed action will be consistent with Federal, State and local plans and objectives.

4.26 CONTROVERSY

The diverse make up of the ADG was instituted in part to minimize the amount of controversy by inviting all aspects of the regulated community to join the regulatory agencies in the development of the new process. However, the proposed action and the action Ensembles of alternatives" represent a potentially marked departure from the regulatory process currently in place in the study area. It is anticipated that there will be concerns on the part of the regulated community as to the effects of the review process. It is also anticipated that analysis of resource impacts and impacts to quality of life issues will be concerns of the resource protection agencies and the community.

4.27 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

As stated above, the proposed action involves the modification of the existing regulatory review process, and may involve some factors not previously encountered. These may include, for example, the development of an abbreviated review process for impact categories occurring in selected areas and the increased scrutiny of cumulative effects on resources resulting from permit decisions. Undesirable effects resulting from the modification of the regulatory review process are not anticipated. However, in the unlikely event of unacceptable impacts, the Corps would take corrective measures as required by permit, law, or otherwise determined appropriate.

4.28 PRECEDENT AND PRINCIPLE FOR FUTURE ACTIONS

The modification of the permitting review process in Southwest Florida is a new approach to addressing permitting concerns. If the proposed action performs as expected, further use of this process to provide planning assistance to the remaining counties of Florida (and beyond) could be indicated.

4.29 ENVIRONMENTAL COMMITMENTS

The proposed action involves the modification of the regulatory review process utilized by the Corps in Southwest Florida. The Corps is committing to improve the effectiveness of its reviews of the environmental impacts of future decisions on permit applications. This document includes draft permit review criteria that, if adopted, provide more detail in the questions that will be asked of all permits. The Corps is committed to working with the U.S. Fish and Wildlife Service to develop more detailed analysis tools to be ultimately incorporated into the Corps' decision processes. For example, there are fairly specific guidelines for protection of bald eagle nests from construction and other activities in the vicinity of the nest. There is no similar document (with such specificity) for many of the other evaluation factors. Once the detailed analysis tools are available to be used in project development and design, then these can be applied not only to review of applications but also to a re-evaluation of the predicted total change in the landscape to determine whether, and to what extent, there are adverse effects as defined by the Endangered Species Act. The development of tracking of key habitat and other indices linked to Permit Review Criteria is anticipated. Key habitat tracking data and other indices would be reviewed annually. These will also allow for the assessment and revision of maps of potential habitat and refinement of assessment criteria. Revisions will occur on individual maps and criteria as new information is developed.

4.30 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

4.30.1 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The purpose of this EIS is to improve the Corps’ review of permit applications for cumulative impacts. In a study area where the area of urban and suburban development is expected to roughly double, the Corps must take an extraordinary interest in the cumulative impacts. The EIS is <u>not</u> to determine what the permit decisions will be. The EIS <u>is</u> to present to the decision-maker and to the public a list of issues and concerns that could be included in the application reviews. Since the Corps' permit decisions authorize conversion of wetlands to residential, commercial, or other use, the cumulative impacts will flow from the Corps decisions on the applications submitted by landowners to change land cover. The Ensembles present five predictions of the future (twenty+ years) landscape after individual decisions accumulate. (Individual decisions include not only the Corps' decisions regarding wetlands, but also the landowner's decisions to submit the application, landowners' decisions to convert uplands, local government decisions on zoning, and many others.) The Ensembles predict different proportions of land cover types. The EIS presents the impacts at that point of time in the future for 61 evaluation factors.

The Corps decision-maker will choose which of the 61 review factors to incorporate into future application reviews based on the size or critical nature of those impacts, among other considerations. This choice does not expand the Corps existing jurisdiction. Many of the 61 factors are already found among the Corps public interest factors. The goal of this effort is to move from generalities to specifics in how the application will be reviewed. This will improve the effectiveness, efficiency, and predictability of the permit decisions. The EIS relies on best professional judgement to synthesize existing information to report orders of magnitude changes in the evaluation factors and to understand what influences those changes. Elaborate and detailed new studies are not needed to determine whether or not an issue should be included explicitly in an application review. The library of studies and geographic information system (GIS) mapping of resources were gathered. Most importantly, the intense efforts by a group of senior representatives from the community and government agencies developed a broad range of predictions, agreed to the list of cumulative effects, and offered their insights on the differences between the Ensembles. The EIS presents a range of alternatives", considers cumulative effects, and considers the best available information. The effort is in compliance with the National Environmental Policy Act of 1969, as amended.

4.30.2 ENDANGERED SPECIES ACT OF 1973

All of the Ensembles predict effects on listed species through loss of habitat. Many of the species have their own evaluation factor. The analysis of each Ensemble by the individual evaluation factor provides a simple view of the predicted cumulative loss of habitat for each species. For individual species, the magnitude of the loss for each species is extremely worrisome. Collectively, however, the solutions are similar for all, for example, maintenance of large contiguous preserves, maintenance of habitat connections, and preservation of seasonal wetlands. This EIS, through the presentation of the information on the affected environment (Section 3 above), the Ensembles, and their evaluations, provide a method to link the landscape patterns with the needs of multiple species. The map accompanying the draft permit review criteria is one potential landscape out of the five presented by the Ensembles. One goal of the proposed permit review criteria is to provide better consultations under Section 7 of the Endangered Species Act by explicitly asking questions related to the multiple species and interrelationships between them and the landscape. Consultation with the NMFS and the USFWS will be undertaken for each individual future permit action. The evaluation factors used to analyze the effects presented in this EIS are not at a sufficient level of detail to enable determination of the extent of change in the landscape or adverse affects to species as this is defined by the Endangered Species Act. The Corps is committed to working with the U.S. Fish and Wildlife Service to develop more detailed analysis tools to be ultimately incorporated into the Corps' decision processes. For example, there are fairly specific guidelines for protection of bald eagle nests from construction and other activities in the vicinity of the nest. Once the detailed analysis tools are available to be used in project development and design, then these can be applied not only to review of applications but also to a re-evaluation of the predictions in this EIS.

4.30.3 FISH AND WILDLIFE COORDINATION ACT OF 1958

Under this act, any Federal agency that proposes to modify any body of water must first consult with the U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission (FFWCC) (formerly the Florida Game and Fresh Water Fish Commission). This EIS presents predictions of what might occur but the actual proposals will be made by landowners submitting applications to the Corps. Coordinations will be conducted on individual permit applications.

4.30.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (INTER ALIA)

(PL 89-665, the Archeology and Historic Preservation Act (PL 93-291), and Executive Order 11593). No archival research or consultation with the Florida State Historic Preservation Officer (SHPO) have been conducted as part of the preparation of this Environmental Impact Statement. Applications for Federal dredge and fill permit authorization will be reviewed on a case-by-case basis in accordance with the

National Historic Preservation Act, as amended; the Archeological and Historic Preservation Act, as amended, and Executive Order 11593. SHPO consultation will be initiated on an “as-needed” basis.

4.30.5 CLEAN WATER ACT OF 1972

As discussed in Section 4.10, there is a concern that the increase in development may degrade water quality. The Corps will require Section 401 water quality certification or waiver prior to issuance of any permit. The certification, issued by the Florida Department of Environmental Protection (FDEP) or the South Florida Water Management District (SFWMD) , states that State water quality standards would be met. Discussion concerning the Section 404(b) evaluation is included in this report as Appendix A.

4.30.6 CLEAN AIR ACT OF 1972

There is a general concern that additional development cumulatively will increase air pollutant load. The concern is not to the level where additional permit review criteria were identified. Projects will be coordinated with the U.S. Environmental Protection Agency (EPA) on a case-by-case basis to ensure compliance with Section 309 of the Act.

4.30.7 COASTAL ZONE MANAGEMENT ACT OF 1972

A Federal consistency determination in accordance with 15 CFR 930 Subpart C is not included in this report. The statutes that are used to evaluate consistency are included as Appendix B. The project was found to be consistent with the State's Coastal Zone Management plan in the Department of Community Affairs’ comments on the Draft EIS. State consistency determinations for subsequent permit actions will be performed on a case-by case basis.

4.30.8 FARMLAND PROTECTION POLICY ACT OF 1981

All the Ensembles predict a reduction in acreage of agriculture. Implementation of the draft permit review criteria and accompanying map will, for individual permits, question (albeit on the basis of habitat) proposed conversions of agricultural land to another use. Impacts to designated prime or unique farmland involving a Federal action or Federal funding will be addressed on a case-by-case basis.

4.30.9 WILD AND SCENIC RIVER ACT OF 1968

No designated Wild and Scenic river reaches would be affected by project-related activities. This act is not applicable.

4.30.10 MARINE MAMMAL PROTECTION ACT OF 1972

The Ensembles predicted direct conversions of natural vegetation to development. The evaluations described the resulting direct and indirect loss of habitat. None of the Ensembles predict direct effect on open water from dredging or filling and none mentioned adding or restricting marinas or boat docks. However, indirect effects identified included impacts from: greater presence of development on the coast (including additional boating); loss of vegetation along the shoreline; and, increased load of pollutants in water flowing from the watershed. The EIS analysis for marine mammals provides simple views of the predicted cumulative loss of habitat for each species, but do note the link between these species and landscape patterns in the watershed. Implementation of the draft permit review criteria will provide better consultations under Section 7 of the Endangered Species Act by explicitly asking questions related to the multiple species and interrelationships between them and the landscape. Consultation with the NMFS and the USFWS will be undertaken for each individual future permit action.

4.30.11 ESTUARY PROTECTION ACT OF 1968

Concerns are raised for potential impacts to Estero Bay Aquatic Preserve and the Rookery Bay National Estuary Research Reserve from, but not limited to, loss of adjacent habitat, freshwater pulses, and change in water quality. Implementation of the permit review criteria will improve the assurance that future permit decisions would preserve these resources.

4.30.12 FEDERAL WATER PROJECT RECREATION ACT

The principles of the Federal Water Project RecreationAct, (Public Law 89-72) as amended, are not applicable to the proposed action.

4.30.13 FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976 AND THE MAGNUSON-STEVENS FISHERIES CONSERVATION AND MANAGEMENT ACT

Based upon the programmatic nature of this action, no fisheries would be directly impacted, nor would the management of local fisheries. Actions requiring Federal permits or Federal funding will be reviewed for compliance with these Acts on a case-by-case basis.

4.30.14 SUBMERGED LANDS ACT OF 1953

The project would occur on submerged lands of the State of Florida. Projects will be coordinated with the State of Florida, Division of Submerged Lands on a case-by-case basis to ensure compliance with this act.

4.30.15 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

There are no designated coastal barrier resources in the project area that would be affected by this project. These acts are not applicable.

4.30.16 RIVERS AND HARBORS ACT OF 1899

The Corps' authority to issues permits is based on Section 404 of the Clean Water Act of 1972 and Section 10 of the Rivers and Harbors Act of 1899. The Ensembles predict varying extents of conversion of wetlands, applications for which are submitted under Section 404. None of the Ensembles made predictions nor proposed criteria related to dredging, filling, or structures in open water, applications for which are submitted under Section 10.

4.30.17 ANADROMOUS FISH CONSERVATION ACT

Anadromous fish species would not be directly affected by the proposed action. Possible impacts to anadromous fish species would be evaluated on a case-by-case basis in order to ensure compliance with the act.

4.30.18 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

All the Ensembles predict a large loss of native plant cover with the greater proportion of the loss predicted to be in upland. The EIS discusses one species, the piping plover, that winters on beaches in the study area but notes that none of the Ensembles directly affect the beaches (although there may be indirect effects resulting from change in water quality resulting from changes in the watershed). Implementation of the permit review criteria, which questions the loss of native plant communities, will increase the assurance that impacts upon migratory birds, flyways, or stopover areas would be minimized.

4.30.19 MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT

The Marine Protection, Research and Sanctuaries Act does not apply to this project.

4.30.20 E.O. 11990, PROTECTION OF WETLANDS

All the Ensembles predict the Corps will authorize the filling of wetlands, each Ensemble has a different quantity predicted. The implementation of the permit review criteria will strengthen the questioning of the need for the wetland fill. In particular, it adds a landscape perspective to valuing wetlands: projects proposing filling wetlands within the areas mapped preservation will be particularly questioned. Applications for impacts to wetlands will still be evaluated individually.

4.30.21 E.O. 11988, FLOOD PLAIN MANAGEMENT

Some of the Ensembles suggest improvement of water management and preservation (rather than development) around flowways to reduce flood hazards. Implementation of the permit review criteria specifically includes questions, for each application, whether these suggestions could be implemented. None of the Ensembles proposed relaxation of the current local rules regarding construction within the base flood plain (100-year flood).

4.30.22 E.O. 12898, ENVIRONMENTAL JUSTICE

The study area contains minority communities and low-income communities, the primary foci of this Executive Order. The ADG specifically evaluated Environmental Justice for each of the alternatives" they created, but generally found the alternatives to be equal. All of the alternatives (and the resulting Ensembles in this EIS) mapped existing areas of development as development or rural, and all the Ensembles propose expansion of that development. The expansion is found in many places in the study area and is adjacent to and provides job and housing opportunities for all economic and social categorizations.

4.30.23 E.O. 13089, CORAL REEFS

The proposed action is not expected to directly effect nor indirectly degrade the conditions of any coral reef ecosystems located within or adjacent to the boundaries of the study area. The proposed action is in compliance.

5. LIST OF PREPARERS

5.1 PREPARERS

Name (affiliation)/alphabetical	Discipline	Years	Role
Bob Barron (Corps)	Civil Engineer	15	Author
Kim Dryden (U.S. Fish & Wildlife Serv.)	Biologist	19	Fish and Wildlife
Jeff Rhodes (SAIC)	Biologist	5	Water Quality Model
Don J. Silverberg (Lotspeich & Assoc.)	Biologist/NEPA	12	Author

5.2 REVIEWERS

Name (affiliation)	Discipline	Years	Role
Kenneth R. Dugger (Corps)	Biologist	28	EIS contract oversight & general review
Al Lucas (EPA)	Ecologist	20	Water Quality & General Review
Jay Slack (U.S. Fish and Wildlife Service)	Biologist, Field Supervisor South Florida		Fish & Wildlife and General Review
Marilyn Stoll (U.S. Fish and Wildlife Service)	Biologist		Fish & Wildlife and General Review
Paul Szerszen (SAIC)	Engineer	15	Water Quality Model
Renee L Thomas (Lotspeich & Assoc.)	Biologist	12	General Review

6. PUBLIC INVOLVEMENT

6.1 SCOPING AND DRAFT EIS

A Notice of Intent (NOI) to prepare a draft of this EIS appeared in the Federal Register on 12 January 1998. In addition, the NOI was mailed to interested and affected parties by letter dated 12January 1998. A copy of the letter and NOI are in Appendix C. Two public meetings were held to receive comments. At public meetings held on 9 February 1998, more than 200 people (of whom 60 spoke) attended and provided comments regarding geographic area, specific issues, and the manner of the EIS process. The Corps also addressed a joint session of the Boards of County Commissioners of Lee and Collier Counties on 11 February 1998.

6.2 AGENCY COORDINATION

Representatives of the EPA, USFWS, FFWCC, SFWMD, FDEP, and the Florida Department of Community Affairs (DCA) were participants in the Alternatives Development Group" process, and played significant roles in the development, refinement and review of the alternatives" and the metrics associated with their evaluation.

6.3 LIST OF STATEMENT RECIPIENTS (DRAFT EIS)

Copies of the draft EIS were mailed to the following parties: local, state, and Federal agencies having jurisdiction or expertise; conservation groups; and other parties expressing a desire for a copy. In addition, the availability of the Draft EIS is published in the Federal Register. A complete mailing list for the NOI and NOA is in Appendix C.

6.4 COMMENTS RECEIVED

Comments received during the scoping process were considered in preparing the Draft EIS. A copy of these comments are in Appendix C. Comments on the Draft EIS will be considered in producing the Final EIS.

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APPENDIX A - SECTION 404(B) EVALUATION

Because this EIS is programmatic in nature, a final determination of compliance with the guidelines pursuant to Section 404(b)(1) of the Clean Water Act would be made for subsequent permit actions on a case-by-case basis. Compliance with these guidelines is required before a Department of the Army permit can be issued. These guidelines prohibit the issuance of a permit if there is a less environmentally-damaging practicable alternative, if water quality standards would be violated, if it violates the Ocean Dumping Act, if it jeopardizes the continued existence of a Federally threatened or endangered species, if it would adversely modify a designated critical habitat for such species, or if the activity would cause or contribute to significant degradation of Waters of the United States. See part 230.11 of Title 40 of the Code of Federal Regulations (CFR) for additional detail.

APPENDIX B - COASTAL ZONE MANAGEMENT CONSISTENCY

FLORIDA COASTAL ZONE MANAGEMENT PROGRAM
FEDERAL CONSISTENCY EVALUATION PROCEDURES

PRELIMINARY DRAFT
ENVIRONMENTAL IMPACT STATEMENT
ON
IMPROVING THE REGULATORY PROCESS IN SOUTHWEST FLORIDA
LEE and COLLIER COUNTIES, FLORIDA
DECEMBER 1998

Since this EIS is programmatic in nature, a final determination of consistency with the Florida Coastal Zone Management Program would be made for subsequent permit actions on a case-by-case basis. The following statutes would be applied:

1. Chapter 161, Beach and Shore Preservation. The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

2. Chapters 186 and 187, State and Regional Planning. These chapters establish the State Comprehensive Plan which sets goals that articulate a strategic vision of the State's future. It's purpose is to define in a broad sense, goals, and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

3. Chapter 252, Disaster Preparation, Response and Mitigation. This chapter creates a State emergency management agency, with the authority to provide for the common defense; to protect the public peace, health and safety; and to preserve the lives and property of the people of Florida.

4. Chapter 253, State Lands. This chapter governs the management of submerged State lands and resources within State lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; spoil islands; and artificial reefs.

5. Chapters 253, 259, 260, and 375, Land Acquisition. These chapters authorize the State to acquire land to protect environmentally sensitive areas.

6. Chapter 258, State Parks and Aquatic Preserves. This chapter authorizes the State to manage State parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park properties, natural resources, park programs, management or operations.

7. Chapter 267, Historic Preservation. This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

8. Chapter 288, Economic Development and Tourism. This chapter directs the State to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

9. Chapters 334 and 339, Public Transportation. These chapters authorize the planning and development of a safe balanced and efficient transportation system.

10. Chapter 370, Saltwater Living Resources. This chapter directs the State to preserve, manage and protect the marine, crustacean, shell and anadromous fishery resources in State waters; to protect and enhance the marine and estuarine environment; to regulate fishermen and vessels of the State engaged in the taking of such resources within or without State waters; to issue licenses for the taking and processing products of fisheries; to secure and maintain statistical records of the catch of each such species; and to conduct scientific, economic, and other studies and research.

11. Chapter 372, Living Land and Freshwater Resources. This chapter establishes the Game and Fresh Water Fish Commission and directs it to manage freshwater aquatic life and wild animal life and their habitat to perpetuate a diversity of species with densities and distributions which provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

12. Chapter 373, Water Resources. This chapter provides the authority to regulate the withdrawal, diversion, storage, and consumption of water.

13. Chapter 376, Pollutant Spill Prevention and Control. This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

14. Chapter 377, Oil and Gas Exploration and Production. This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

15. Chapter 380, Environmental Land and Water Management. This chapter establishes criteria and procedures to assure that local land development decisions consider the regional impact nature of proposed large-scale development.

16. Chapter 388, Arthropod Control. This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the State.

17. Chapter 403, Environmental Control. This chapter authorizes the regulation of pollution of the air and waters of the State by the Florida Department of Environmental Regulation (now a part of the Florida Department of Environmental Protection).

18. Chapter 582, Soil and Water Conservation. This chapter establishes policy for the conservation of the State soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both onsite or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

APPENDIX C - PERTINENT CORRESPONDENCE

An estimated 700 pages of comments were received during the scoping process. These comments have been made part of the record and were considered in preparing the EIS. A copy of these comments are available for inspection. Copies can be made upon request for a reasonable fee for reproduction. An additional 1098 pages (without enclosures) of comments input (plus 1,400+ letters from landowners in Lehigh Acres)were received in response to the Draft EIS. A summary of the comments and our response to them follows.

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
100	**Corps Authority & DEIS Process**			
110	**Land Use**			
111	**Engaging in Land Use Planning**			
	91	37	Document looks like a land use plan in many ways than it does an EIS	The Corps has never intended the EIS to dictate local land use planning. The Corps acknowledges that land use planning is a local responsibility. The maps in the EIS are intended only to assist the Corps in determining the cumulative impact of its individual permitting decisions based on the "big picture" of what the region is likely to look like in the long term. The maps are various predictions of the long-term conditions of the region, not "goals" of the Corps. The five maps in the alternatives do delineate areas of "development", "agriculture", and "preserves" based on various ideas how the land in the study area may be or should be distributed in 20+ years. These maps are used to prepare five estimates of acres of wetland fill, area of habitat lost, change in water quality, etc. The EIS recognizes that these maps represent the potential result of many individual decisions by the Corps, landowners, Counties, and others.
	213	72	Looks like a land use document. Either we have a concern on State's rights or a misunderstanding on what it is.	
	235	78	Acknowledge Corps policy is that primary responsibility for zoning is with state and local governments.	
	408	122	Corps state EIS is not land use document yet makes references to land uses that are or are not permitted.	
	410	122	Acknowledge Corps policy is that primary responsibility for zoning is with state and local governments.	
	454	144	Creating additional set of land use regula ions…Eis clearly indicate an intent to regulate land uses.	
	455	145	Corps jurisdiction is limited to those development which will impact waters of the United States.	
	519	173	Object to explicit implication of project review map as a future land use map that completely ignores exist zoning.	
	582	222	Corps state EIS is not land use document yet makes references to land uses that are or are not permitted.	
	584	223	Acknowledge Corps policy is that primary responsibility for zoning is with state and local governments.	
	847	426	Project Review Criteria appear to be essentially federal land use planning.	
	957	481	Concerned such a map borders on Federal involvement in local land use decisions.	
	1033	519	The EIS clearly indicates an intent to regulate land uses within the study area.	
	1038	519	Because Corps is limited to projects where activities trigger CWA..is not equipped to provide land use plans…	
	1156	739	Proposed action exceeds the Corps Authority by engaging in land use planning	
	1191	944	EIS functionally creates additional land use regulations which conflict with existing comprehensive land use plans	
	1209	948	(neither) CWA or ESA... provide the Corps with authority to usurp land use planning by local governments	
	1240	965	There is no general permit proposed and EIS includes a map that clearly designates land use.	
	1260	973	Inappropriate to have maps wi h land use designations…Corps reg do not authorized planning func ion..	
				The writer (comment 455) is correct that the Corps' jurisdiction is limited to waters of the United States. However, in making wetlands permitting decisions the Corps must consider all the effects of the permit ing decision, including the effects on uplands. One map represents the current County Comprehensive Plans (that is, if all decisions exactly matched these plans and these plans were not amended in the next twenty years). The estimates of wetland fill, area of habitat loss, etc., disclose the cumulative effect of potential Corps decisions. For some of the issues, the size of the potential impact is such that the Corps desires to ensure relevant information in the EIS is used in future permit reviews.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
				Bo h the Draft and Final EISs include (as an appendix) Draft Permit Review Criteria to describe how the information in the EIS may be used in permit reviews. In the Draft EIS, this consisted of several lists of questions correlated to areas delineated as "development", "agriculture", and preserves. The Corps intended to identify different levels of permit review rigor but many of the public interpreted these to be designating land use. The Corps has revised the Permit Review Criteria to remove the "development', "agriculture", etc. delineations. Instead, the revised Draft Permit Review Criteria presents questions and each question will have its own map. For example, a question related to a particular wildlife species has a map showing the potential locations where the species may be found. The rigor of the review for a particular project will depend on how many of the individual maps intersect the project location.
112	**Inconsistent with CZM**			
	734	304	EIS is consistent with Florida CZM	
	776	323	Consistent with historic preservation laws, conditioned upon early and sufficient consultation.	
	1157	743	Proposed action is inconsistent with Florida's Coastal Zone Management Plan	The Coastal Zone Management Act requires a determination of consistency of Federal activities with approved State coastal management programs. However, the term "Federal activity" does not include the issuance of a federal license or permit to an applicant or person. See 15 CFR 930.31(c). The proposed action is a modification of existing Corps procedures for issuance of 404 wetlands permits and therefore is excluded from the definition of "Federal activity." Moreover, the proposed action in and of itself cannot affect the coastal zone unless and until a permit application is received. Nothing happens unless and until a permit application is received. Once a permit application is received, the Corps cannot process the application unless the application includes the consistency certification required by 15 CFR 930.57. Thus, no action occurs without a consistency determination.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
				If the State objects to an applicant's consistency determination, the Corps cannot issue a permit, as stated in 15 CFR 930.65. Last but not least, the Florida Department of Community Affairs, Florida Coastal Management Program, has determined on February 23, 2000, that the DEIS is consistent with the Florida Coastal Management Program (see Comments, Page 304).
113	**Identify conflicts between proposed plan and Comp Plan [also 116]**			
	79	35	If there are problems with the Comprehensive Plan, we need to know about it	The Corps does not play a role in zoning or land use matters. The revised Permit Review Criteria describes and locates those natural resource issues that have the greater potential for degradation or improvement resulting from Corps permit decisions.
	199	63	I would appreciate specificity (in complaints on comprehensive plan).	
	216	72	Make sure greater understanding and that we know that our comprehensive plan will not be in conflict.	
	1162	783	Does not accurately or fully identify the possible conflicts between proposed action and state&local land use plans	
	1194	944	Identify the significant national issues and explain why they are overriding importance (to not accept local decisions)	
				An overlay map is included that shows where these issues overlap areas identified for development by the Comprehensive Plans. A potential conflict may occur if a project proposed in an area deemed appropriate by the Comprehensive Plan is determined by the Corps, after its review of the the application, to have not addressed the natural resource degradation.
114	**Gives undue weight to Comp Plans**			
	484	153	Too much emphasis is placed on consistency with local comprehensive plans.	
	1123	668	Gives undue weight to county comprehensive plans in assessing cumulative adverse impacts of the 404 program	The proposed action is the adoption of standardized review criteria that are keyed to a Natural Resources Map. The proposed action is unrelated to the Counties' Comprehensive Plans, except to the extent that the Natural Resources Map was derived from a predicted future based, in part, upon those Plans.
				However, since even these plans can be amended and landowners are free to submit applications to the Corps that are not in compliance with the local plans, the EIS does include four other potential futures
115	**Rewrite Comp Plans. Need more community involvement.**			
	31	13	The community should be the ones driving these decisions. The comprehensive plans must be rewritten.	We expect the information in this EIS will be useful to persons submitting comments to the Corps on future applications. Perhaps this information will be useful to some in other forums.
	52	17	Responsible growth is the answer.	
	61	21	Quality of life and economic well-being are threatened by unlimited and unmanaged growth.	
	65	23	Citizens of this whole area have to take a much greater interest in what is happening.	
	522	180	Depending on Corps not to yield to pressure from shortsighted, development-oriented politicians.	
116	**Comp Plans are only basis of regulations / represent community [also 610, 888, 627]**			
	87	37	Local government better able to balance diverse needs of community. Local comp plan only basis for regulations.	
	92	37	Comprehensive Plan has got to have full integrity through this process.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	232	77	EIS is inconsistent with the goals, objectives and polices of the Lee and Collier County Comprehensive Plans.	The Corps may not have adequately explained the proposed action in the Draft EIS. The proposed action is not a substitute for the Counties' Comprehensive Plans, but simply a standardized set of criteria for reviewing permit applications for wetlands fills within the region. The criteria are to be determined based on the presence or absence of natural resources shown on the Natural Resources Map. The Natural Resources Map is not at odds with local planning because it simply determines what criteria will be used in evaluating applications. Neither the criteria nor the map in any way pre-determine whether or what type of we land fills will be permitted. One of the goals of this EIS is to better coordinate wi h local and State processes.
	385	115	City prefer using local comprehensive plan to identify future land use.	
	398	120	Conflicts with local comprehensive plans	
	406	122	EIS is inconsistent with the goals, objectives and policies of the Lee and Collier County Comprehensive Plans.	
	436	127	EIS maps are inconsistent with the comprehensive plans.	
	440	133	EIS maps are inconsistent with the comprehensive plans.	
	456	145	Confused regulatory issues by creating conflicts with existing comprehensive plans and federal regulations.	
	533	183	Regardless of zoning and land use decision of local government, Corps has independent duty under CWA.	
	559	195	Eliminate Project Review Map and defer to Lee Plan Future Land Use Map for designation of land uses.	
	565	197	Rely on Lee County expertise to evaluate future land use and water quality trends.	
	580	222	EIS is inconsistent with the goals, objectives and polices of the Lee and Collier County Comprehensive Plans.	
	619	233	Adoption of the project review map will circumvent future land use map of the comprehensive plan.	
	630	241	Preferred alternative should be the existing comprehensive plans. Final document should have no conflicts with.	
	725	292	EIS assumes County comprehensive plans are unchanging documents. Should recognize they are quite fluid.	
	879	448	(list of actions)…speaks to their (Collier County) lack of sincerity in claiming willing to work with the Corps…	
	908	464	Local government much better to balance the diverse needs..comprehensive plan..only legitimate planning basis..	
	955	481	Comprehensive Plan are our preferred alterna ive and one upon which the public bases significant reliance..	
	1035a	519	Lee Plan based on best available data..hours of public hearings..	
	1241	965	Each community should have the right to decide what it wants to look like and not have its image mandated by feds	
	1393	1100	Unconstitutional usurpa ion of local land use perogatives…work collaboratively with local…	
	1398	1101	Corps..either..justify its actions or abandon..in favor of initiating collaborative approach with…counties.	
	1401	1103	Landowners developing in accordance with Comp Plans face an added obstacle…	
				For example, the Lee County Comprehensive Plan states "Permitted uses in Wetlands consist of very low density residential and recreational uses that will not adversely affect the ecological functions of wetlands" and, later, "...the county will not undertake an independent review of the impacts to wetlands..." Collier County's Area of Environmental Concern Overlay "...has no regulatory effect." Both Coun ies refer the landowner to state and federal permitting programs. Therefore, landowner will look to other parts of the County Plans for criteria on density, type of activity, etc., and, we hope, will be able to look at the EIS for criteria on wetlands and wetland related issues.
117	**Corps and County does not take into consideration the public.**			
	152	52	Three regulatory commissions have not taken in consideration the public (Corps, Lee County, Lee County Health).	Corps solicited public comments on the Draft EIS for 189 days and three public hearings in addition to meeting with local civic groups.
118	**Intrudes Federal into local**			
	188	61	The Draft EIS threatens comprehensive growth plans by adding unprecedented federal level of intrusion.	The proposed action does not add any further intrusion. The

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	225	76	Things should be under state and county control.	Corps' 404 wetland permitting program has been in place for many years. The proposed action would simply standardize the review procedure and add predictability. No new requirements have been added. If a landowner desires to fill a wetland to change the land use from vacant/natural to some other use, he/she must obtain not only local building permits but also a separate permit from the Corps under Section 404 of the Clean Water Act. Corps authority based on Federal laws and is independent of local authorities
	268	82	Federal government getting involved and is not as responsive to the local needs and local concerns.	
	283	85	Complicates permitting process by adding a layer of outside control at odds with comprehensive plans.	
	294	86	Call on Corps to cooperate with local government but not allow them to drive the process.	
	323	90	Most people are scared of the federal government for good reason.	
	328	91	If local government was doing a good job managing growth, need for a federal EIS would not be so great.	
	380	115	Add federal level of intrusion on local government. Maps do not coincide with those of local government.	
	971	483	Local land used decisions should remain at the local level.	
	1250	966	Corps more restrictive..other agencies more expansive..threaten ability of local govt to make land use decisions	
120	**Did not analyze existing program (no action)**			
	141	48	Let us look at the current permitting system.	Added an analysis of the recent number of permits, acres of authorized fill, and compensatory mitigation required.
	153	52	EIS mentions a retaining pond for water flowing to River yet Corps issues permit to build ou let to River.	Permit decisions are based on the individual circumstances of the proposed project so may not always follow suggestions in a generalized document such as this EIS.
	198	63	A lot of recent development has actually improved the environmental quality.	Noted in EIS.
	286	85	EIS not take into account that development now planned in a much more sophisticated fashion than past.	Noted in EIS.
	397	120	Corps should quantify cumulative impacts of the current 404 process using existing data. Make data available.	Analysis added.
	539	184	Should examine the effectiveness of permit conditions…include whether current process ensures no net loss.	Note that with the current state of knowledge there is no existing assessment technique that provides absolute assurance of no net loss in biological systems. Added description of review process to evaluate impacts.
	545	186	Our experience is the practicable alternatives requirement has been ignored by the Corps.	Difficult to analyze since degree of "practicable" is different for each project depending on its purpose and circumstances.
	848	427	Has not evaluated the current performance of the regulatory program (no-action).	The current performance of the Corps' regulatory program is not an issue. The proposed action is to implement standardized permit review criteria and a Natural Resources map that informs program managers where and how to apply the criteria. The "no-action" alternative is to continue current case-by-case analysis, in which program managers individually determine what criteria are important and what weight to afford them.
	1096	591	My belief that many of he permits issued by the Corps are causing violations of the CWA and ESA	Noted.
	1158	746	Did not analyze the beneficial&adverse impacts of the Corps current regulatory program & state & local programs	EIS focuses on Corps program. Looks at prospective impacts of program for next 20 years.
	1370	1081	Sect 2: Current permitting process should be described in detail..how applications reviewed for impacts..	Section rewritten.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1371	1081	Sec 2: Describe how alternative futures are currently determined in contrast to method proposed by this document.	Section rewritten. The other four Ensembles present various criteria for permit reviews. The evaluations suggest some of these may reduce the risk that degradation may occur.
	1394	1101	Should include detailed assessments of…the no action alternative, defined as..maintaining the existing…	Sections rewrittent to clarify and expand assessments of proposed and no action.
	1395	1101	Complete accurate inventroy..of wetland types, their functions and values, and cumulative gains or losses..	Expanded analysis of historic & current acreages by plant type. Wetlands have many functions and are valued for many things, these are found under the various subheadings.
	1396	1101	(gains/losses study) useful to local..officials..to revise..Comp Plans..to protect important resources.	Information learned from EIS allow preparation of Permit Review Criteria which provides natural resource maps.
121	**Benefits from existing permit program (or lack of)**			
	211	71	More recent developments, with better technology, better than 70s, make sure changes based on new, not old.	Added an analysis of historic (pre-Corps-permitting), recent, and the five projected changes in natural plant cover (the five Ensembles), the aspect most directly related to the Corps permits. Evaluation of Ensembles describe range of potential effects environmentally.
	264	81	I happen to agree with the Corps hat they can do a better job.	
	329	91	Some who say he local government is doing a good job protection the environment. It's just not true.	
	470	148	Believe that Florida is at the breaking point environmentally…no way can withstand further assault on ecosystem.	
	1064	537	Corps is effectively protecting (natural) resources through current permitting process..	
	1396	1101	Compensatory mitigation for authorized wetland impacts…support and exceed…no net loss…	
122	**Existing mitigation and regional restoration efforts**			
	51	17	Please introduce into the EIS the mitigation banking concept.	Added.
	192	62	Business community is very concerned and has a vested interest in maintaining the quality of life.	Noted.
	276	84	Naples and Ft Myers are envy of world..because of the commitment to quality in the developers who are here.	Noted.
	393	116	Please see our letter commenting on the C&SF Comprehensive Review Study.	Comments on issues not related to permitting.
	401	120	Not address opportunities for both environmental and economic sustainability	Describes tradeoffs. Expanded economic.
	851	432	Failed to consider mitigation and non-regulatory conservation efforts in Lee and Collier Counties.	Added reference. Comprehensive Plans also incorporate and these incorporated as Ensemble.
	1174	801	Failed to take account of mitigation and regional restoration efforts in its evaluation of alternatives	Added reference.
	1402	1103	Failed to recognize existing programs that increase wetland acreages	Added reference.
123	**Fails to assess past and on-going impacts [also 240 for wetland]**			
	18	10	To know effects, must know what was once present and has been destroyed, what is going to be in future.	Added an analysis of past and recent changes from natural plant cover. This was based on comparing five existing maps characterizing land cover at five different years. The Corps based this EIS on reporting existing information and so did not pursue preparation of new studies. Permit informa ion was reviewed and no trend was found. A high number of applications are received one year, a low number the next, then high again he following year.
	60	21	I would hope you do trend analysis of permit applications.	
	308	88	No past cumulative environmental effect analysis.	
	487	163	Historic data on wetlands coverage and water quality needs to be incorporated into the analysis.	
	648	249	Does not provide a detailed assessment of cumulative impacts of past permitted actions.	
	860	440	Dr. Larry Harris at UF might be a useful contribution to development of model (of past/ongoing/future impacts)	
	861	440	How many permit applications are submitted? How many are granted? How successful are mitigation projects?	
	862	440	Recommend Corps utilize the Airborne Laser Terrain Mapper to assess changes in land use.	
	1118	645	Fails to adequately asses past and on-going wetland impacts	
	1352	1078	Based on number&types of applications from 13May98, applications have increased…DEIS underestimates impacts	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
				The Corps tracks number of applications received and approved/denied in a year but an application received one year may be approved the next year so the statistics are useful for workload but not to compare fate of applications. Anedotal information suggests many of the larger projects the permitted quantity of fill, site design, and other aspects are diffferent from the application so other changes are occurring as a result of permit review that are not recorded in a database. Therefore, a projection based on past permit data would be unreliable. The EIS instead uses projected changes in land cover and uses those to estimate acres of fill although this also introduces potential for error. The permit decision includes an evaluation of the risk compensatory mitigation will fail and suitable monitoring conditions are provided to address this. Some forms of compensatory mitigation no longer are used due to past failures, one of the reasons one sees, as shown in the EIS, the large proportion of restoration type of mitigation compared to the historically less-successful creation.
124	**Highlight existing conditions (drainage, roads) not a pristine system**			
	339	93	Highlight some of the existing conditions and constraints…roads, drainage…we are not a pristine system.	Described in existing conditions of the watersheds.
130	**EIS Internally inconsistent whether is preferred alternative [also 820]**			
	732	303	In essence there will not be a "preferred alternative" until review sec&cum impacts of each application completed?	The proposed action is the Corps' preferred alternative.
	827	421	Difficult to reconcile Project Review Map with Corps statements that EIS would not include preferred alterna ive.	
	1159	756	Is internally inconsistent about the existence of a preferred alternative.	
140	**Other alternatives not analyzed**			
	850	431	There are alternatives to a mapping exercise and development of criteria based on maps (listed)	The EIS section has been rewritten to clarify. The EIS essentially compares alternatives for criteria.
	1160	757	Failed to consider a range of reasonable alternatives to meet the purposes of the EIS (8 ideas listed) (17pp)	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
			(The ideas are: information repository for use by reviewers; improved interagency/intergovernmental coordination; mapping resources of federal interest under inordinant stress; improved coordination with non-regulatory programs for wetlands; use of ADG Overlay of Alternatives Map; coordinate resource planning and acquistion programs; develop general permits; develop mitigation siting criteria; improve coordinationw tihe non-regulatory programs at Federal, State and Local levels.)	These criteria are found in the legends of the Ensembles. There are 38 of these based on the numeric coding system applied to he legends. Based on comparison of the Ensembles reported by the EIS, the various criteria have varied influence on the degree or risk of degrada ion to natural resources resulting from the Corps permit decisions. The commentors' ideas are essen ially different ways of implementing the information in the EIS. The Revised Draft Permit Review Criteria describes one implementation using a subset of criteria selected from those in the EIS. The rewritten section on implementation describes other uses of the EIS evaluations of the Ensembles. These drew on ideas presented in the comments.
141	**Incentive based solutions that benefit the environment**			
	191	61	We support incen ive-based solutions that benefit the environment.	We will be willing to participate or otherwise assist in such efforts.
	405	120	Chamber of SW FL will assist interests to identify system of economic incentives	
142	**No range of alternatives. Ensembles are variations of a theme.**			
	307	88	No reasonable range of alternatives. All the ensembles are basically variations of a theme.	The Corps feels there are really only two alternatives for conducting permit reviews: The present method (no action alternative) in which the program manager determines the criteria to be applied and the weight to afford each alternative, or a set of standardized review criteria together with a map that all program managers would apply in determining what factors to apply, and when, where, and how to apply them. Although it would be possible to develop an infinite array of standardized criteria, the Corps feels that creating alternatives that are simply variations on a same theme would be counterproductive. If adopted, the proposed alternative would result in criteria that could then be adjusted (using appropriate NEPA analysis, if required) based on new information received as well as experience in the field.
150	**Law violated.**			
151	**FACA**			
	806	359	Corps did not comply with Federal Advisory Committee Act.	The Alternatives Development Group (ADG) was not an advisory committee and therefore not bound by the requirements of FACA.
	1035b	519	EIS [based on] group not represent diversity of viewpoints	
	1163	784	ADG violates the Federal Advisory Committee Act	
	1206	946	Corps failed to comply with requirements of the Federal Advisory Committees Act	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
				The ADG acted essentially as a focus group to help the Corps define important issues, gather information to measure those issues, and to develop and compare alternatives for the DEIS. Al hough members of the ADG certainly offered their individual opinions, the Corps did not solicit, and the ADG did not provide, any group advice or recommendations. The Corps alone is responsible for the content of the DEIS, including the determination of what alternatives were included in the DEIS the presentation and interpretation of the evaluation of those alternatives. Moreover, even though the ADG was not subject to FACA, the ADG substantially complied with FACA. Members were selected to represent a broad range of interests within the community to ensure functional balance. Meetings were publicized and open to the public, and minutes are available from an independent reporter. Most importantly, the Corps has taken, and will take, no action unless and until that action has been subject to full and fair consideration of public comments through the NEPA process.
152	**CEQ: not an EIS. Not state action, but predicts action in future.**			
	729	301	EIS does not address proposed fed'l action, but attempts to predict action on predicted future. Not an EIS per CEQ.	The EIS discloses cumulative adverse and beneficial effects from a range of potential individual decisions.
	1327	1039	As a result of our review of the PEIS..a rating of EC-2 has been assigned.	
153	**What is the agency action?**			
	918	470	What is the agency action that is under evaluation?	The proposed action is adoption of a set of standardized permit review criteria together with a Natural Resources map that all program managers would apply in determining what factors to apply, and when, where, and how to apply them when evaluating applications for permits to fill wetlands within the region.
160	**Analysis not based on avail data but ADG subjective**			
	129	47	Not a lot of data in the document.	The ADG members use this data in their area of expertise. One of the benefits of the ADG was that each member presented and interpreted that data to others of the group. This mimics actual regulatory processes. For example, the Corps does not require peer-reviewed submittals of information related to an application but rather expects
	241	78	Question whether regulatory policy implemented prior to collection, analysis, peer review of scientific data.	
	272	83	It is troubling to rely on a nameless individual's best professional judgement if data may be available.	
	335	92	Apparently these members [of the ADG, building industry, etc.] are not knowledgeable in economic sustainability.	
	383	115	Lack scientifically based data and analysis.	
	402	120	Based on best professional judgement instead of peer reviewed scientific fact.	
	423	123	Question whether regulatory policy implemented prior to collection, analysis, peer review of scientific data.	
	596	224	Question whether regulatory policy implemented prior to collection, analysis, peer review of scientific data.	
	639	242	Process of delineating flowways…by group consensus is subjective and lacks scientific objectivity.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	905	464	Delineation flowways, etc. by ADG is subjective..request decisions be made based on sound scientific information.	submittal describing effects based on professional judgment of the applicability of available scientific and other knowledge. This has allowed the Corps to present the information and issues in the DEIS in terms and using terminology understandable by the general public. The maps and different legends do represent the opinions and experiences of the individuals participating but the Corps took care to have broad representation in the preparation of the Draft EIS and then broad distribution to the public for comment.
	1043	520	Result (replumbing, etc) not based on science, but on supposition & conjecture, rising to arbitrary & capricious	
	1070	539	Use current, accurate, peer reviewed data evaluated by individuals with appropriate technical expertise…	
	1164	786	Evaluation of alternatives is often not based on available data & relies instead on the ADGs subjective grading.	
	1216	949	Generation of land use maps was unfair and allowed viewpoints of some members to dictate the use for a parcel..	
	1242	965	Corps attempting to designate land uses without the best data and analysis	
				The use of judgment and subjective analysis was the chosen level of effort to develop maps and present broad geographic concepts and evaluations to discover orders of magnitude differences. More refined maps and evaluations could certainly be obtained with more elaborate analysis but the tradeoff would be time and expense.
	1365	1080	Pg ii: include more emphasis on data and methodology used by the ADG	Details are found in body of EIS.
161	**Use more science / add more later with supplemental EIS**			
	33	13	We want to see some science and for you to say you are going to use ongoing scientific information.	The EIS sought to identify conditions where the Corps permit decisions could have orders of magnitude effect on natural resource and other issues. For those issues of concern, the Corps intends to pursue, cooperate with or remain actively cognizant of additional development of scientific knowledge. For example, the implementation of monitoring on water quality treatment of developed areas with EPA. Also, further work with the FWS on evaluation of effects on Endangered and Threatened Species. Development of rigorous scientific conclusions related to any of these issues for a regional basis is very expensive and time-consuming. In the meantime, regulatory decisions must be made based on available informa ion.
	38	14	Like to be assured Corps will based its decisions on verifiable scientific evidence.	
	48	17	Include report "Regional Effects of New Citrus Development on the Ecological Integrity of Wildlife Resources"	
	59	21	There is more science that needs to go into this.	
	84	36	ADG delineation of flowways, etc., subjective. We ask decisions be made based on sound scientific information.	
	107	43	Flaws in the EIS in science.	
	132	47	Should be more science to back up the boundaries that are drawn.	
	203	68	EIS done with the mos accurate and scientifically based information possible.	
	253	79	Corps has sufficient data. If new data surfaces, should be ongoing process, publish a supplemental EIS.	
	266	81	Include all the data that should be.	
	295	86	I ask the Corps to cooperate more with the USFWS because they have the scientific expertise the Corps has not.	
	303	88	Need to move forward now, then take these other concerns and do a supplemental EIS.	
	325	91	To incorporate missing data, I would suggest you consider other means, perhaps a supplemental EIS	
	331	91	This science thing is a smoke screen to slow this whole process down.	
	337	92	To say there was no scientific involvement in this EIS is a misstatement.	
	563	197	Eliminate Project Review Map because data and analysis is not detailed scientific..	
	655	250	Data needed to support conclusions on economic sustainability, and others..	
	677	263	Obtain the latest scientific data and utilize expert opinions of cooperating agencies.	
	855	435	Make sure any conclusions are based on sound scientific facts and not on any groups "best judgement"	
	889	461	Give full attention to the science necessary for formulating the basis for your decisions.	
	1108	597	expeditiously issue a final EIS and ROD based on best available scientific information.	
	1109	597	supplement the final EIS and ROD to incorporate the best available information and to effectively limit future impacts	
162	**No consensus**			
	70	28	No consensus in ADG so concern about process and ability to address the key issues in a balanced way.	Lack of consensus not a concern since the EIS presents he divergent views.
	227	76	Widely divergent conclusions depending on what Ensemble was considered.	
163	**Old data**			
	112	44	EIS Appendix, using 1974 maps. A lot of changes in 25 years.	Used most current data that was available for the entire study

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1068	537	Significant problems with the underlying data used..	area.
	1319	1035	With all the erroneous material you have used, I would think you should go back to the drawing board..	
164	**Can't be good study at 50 cents per acre**			
	113	44	EIS study is about 50 cents per acre. I don't think you get a very good quality study at 50 cents per acre.	The EIS seeks to describe broad geographic concepts and issues. Additonal funds and time would refine the actual evaluations but probably not change the order of magnitude differences reported.
165	**Review science used / peer review**			
	119	45	Don't believe some new science brought into the EIS would withstand light of day or rigorous review.	The EIS references the conclusions or observations of a large number of research reports and does not create new research that would require peer review. Care has been given to present multiple and conflicting reports where available. Many of these documents are used in permit reviews or other decision areas. EIS seeks to put in understandable terms and apply the scientific and non-scientific information that relate to issues valued by the community. This mimics the permit review process where the decision is made considering both the economic or personal desires of the landowner and the values placed by the general public on environmental issues. The appropriate peer review for the EIS discussions is the public who would be affected by future permit decisions.
	125	46	Make sure whatever decisions are made in this document are based on the most valid science.	
	314	89	This whole process has to be peer reviewed, just like the restudy.	
	553	187	Include scientific peer review.	
	821	414	EIS relies on unadopted and unauthorized policy documents (Gaps and Mitigation Bank Review Team)	
	966	482	Make sure..any scientific data upon which the EIS is based has withstood impartial peer challenge and review.	
	821	414	EIS relies on unadopted and unauthorized policy documents (Gaps and Mitigation Bank Review Team)	GAPS presents the minimum number of acres of preserved lands would be needed to maintain species valued by the public. The Corps has heard comments "Is there not already enough land in preserve?" or "Do not issue more permits because will lose wildlife." GAPS is simply one document that presents a completed analysis that could be used to answer these questions and so is presented in the EIS. There is in the scientific arena many other techniques that could be used but none have been actually performed for the study area. The Corps has not adopted this as policy. The Mitigation Bank Review Team document describes how bank permits will be jointly reviewed with other agencies and provides an optional technique to calculate mitigation. The optional technique is referenced by the EIS but the technique itself is not used in the EIS analysis.

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	966	482	Make sure..any scientific data upon which the EIS is based has withstood impartial peer challenge and review.	Would be impossible to confirm status of every document referenced in report. Instead, EIS relies on presentation of documents that present contrary views.
166	**Presented as science but is questionable and imprecise**			
	189	61	Some questionable and imprecise methods are being presented as scientific conclusions.	The methods used are similar or even exceed the level of detail found in current permit reviews.
	434	126	Informed are questionable and imprecise methods presented as to scientific conclusions when not scientific.	
	438	132	Informed are questionable and imprecise methods presented as to scientific conclusions when not scientific.	
167	**ADG analysis of socioeconomic & property rights is biased**			
	362	101	For socioeconomic and property rights, DEIS relies too heavily on the ADG and the bias of the members	The EIS narrative has been expanded beyond ADG comments and includes other studies.
170	**Cumulative Impact analysis/approach flawed**			
	190	61	Corps realizes that this flawed process and this unworkable approach . . . The document needs serious redrafting.	The EIS presents a range of potential quantity and location of fill the cumulative total of many individual permit decisions, though it is recognized that changes in result in something not exac ly like any of the maps. For each quantity, the EIS reports the potential effect on a large number of issues, thereby capturing the total cost of the permit decisions.
	343	95	EIS is flawed. What you are doing is splitting our community.	
	361	101	Corps has failed to capture the real costs of all aspects of its permit decisions in terms of pollution, flooding, …	
	403	120	EIS must be deferred from implementation until (listed) goals achieved.	The EIS presents state of knowledge on which implementation can be considered. Portions of EIS and Permit Review Criteria rewritten with he goals in mind.
	730	301	Does not address energy rqmts, natural resource rqmts, mitigation, conflicts wi h local land use, and no "no action".	Are found in various sections of EIS.
	859	439	DEIS fails to include the review and analysis required to protect hydrological and biological resources.	EIS presents analysis of how the degree of impacts to hydrologic and biologic vary depending on the where and how wetlands are filled but purpose of EIS is not to establish threshold of "protection".
	949	477	Do the maps accurately describe actions that are "reasonably foreseeable"? Future Land Use Maps do not depict…	The EIS presents a range of potential quantity and location of fill the cumulative total of many individual permit decisions, though it is recognized that changes in result in something not exac ly like any of the maps.
	950	477	What are effect of project when one includes past, present and future ac ions that would have similar effect?	EIS presents five maps hat represent the range of reasonably forseeable actions so the word "predicted effect" in the DEIS essentially meant this. EIS section rewritten to clarify.
	1293	1012	DEIS ignores EPA recommended "watershed" approach to review, assessment and making final permit decisions.	The "Hub" or center of the study area is one watershed. When establishing the scope, the study area was expanded since some issues are not bound by a single watershed.
	1360	1080	Nationwide permit program undergoing consultation…therefore assumptions used to forecast futures will change.	EIS presents range of impacts so changes in program may fall within.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1366	1081	Pg iv and 1-4: emphasis be placed on discussion of identification of direct and indirect effects	Focus of EIS was on cumulative total of direct and indirect effects.
	1372	1081	Section 2.1&2: term "contiguous preserve" should be defined and the analysis should be revised, if necessary.	Section rewritten. Contiguous preserve described areas mapped as preserve on the maps but term chosen to differentiate from on-site preserves within development fabric. Term dropped.
	1373	1081	Section 2.1.5: Concept of Ensembles is not clear.	Section rewritten.
	1384	1084	Table 3: Does not include indirect effects. Edit SHCA description. ADG did not assess upland. Redo seasonal %'s	EIS describes direct effect of wetland fill but indirect effects of total footprint of all projects, including those with no wetland fill. SHCA statement reflects the source document wording. Contiguous preserve described areas a preserve as opposed to seasonal marshes preserved within a development and analysis reflects higher risk of impact to the latter. Table 3 is intended as a brief synopsis of the detailed analysis in Section 4.
171	**Analysis incomplete / no uplands [also 713]**			
	486	163	Deficient in defining the boundaries of the cumulative effects.	Boundary of effects is boundary of study area.
	488	164	Should assign an acreage figure with its baseline assumptions for cumulative effects on pages 126-127 of DEIS.	Comparison to historic figures added.
	489	164	Some cumulative effects factors used by ADG not appropriate for analysis related to environmental permitting.	Some issues were included in EIS because they were ones valued by the community.
	490	164	No comprehensive list of environmental cumulative effects or time frame assigned for analysis.	The entire EIS is essentially a cumulative impact analysis with the best estimates of growth over a 20 year imeframe.
	504	169	Address cumulative impacts in a more comprehensive way…more detailed analysis (lists).	Have added analysis of historic trends of plant cover losses and related that to various wildlife issues in particular. Water quality analysis already shows past and future trends. Suggestion for establishment of benchmarks noted: agree would be useful but are none currently and is not the role of Corps Regulatory program to establish. EIS will help Corps understand tradeoffs between one impact and other when issuing a decision for a permit.
	663	251	Corps implicite position that it need not consider cumulative impacts (on uplands) is not supported by caselaw.	Corps authority limited to authorizing fill in wetlands (among others not applicable to the EIS) but, in some circumstances, the Corps has a duty to consider related upland impacts in deciding to authorize wetland fill. Therefore was included in EIS but will not be applicable in many permit reviews.
	676	262	Utilize the best available information on growth projections in the assessment of cumulative impacts.	Started with County Comprehensive Plans then developed alternatives where local knowledge indicated may be or should be different.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	863	441	Should give greater consideration to the loss of uplands associated with wetland filling.	The EIS maps did not confine themselves to just wetland areas of the landscape. Included upland issues.
	1175	806	Evaluation of cumulative effects is flawed.	Approach is different from typical review of a single project since here are looking at collective impacts of all projects.
	1294	1012	Any proposed project, be there wetland losses or not, which affects surface waters must be reviewed by Corps	Corps only reviews applications for permits. Permits only required for fill in wetlands or any physical work in navigable waters.
172	**Must assess and limit**			
	255	79	Corps must properly and fully address cumulative impacts.	Agree, within limits of authority.
	291	86	I do not understand why the EIS has no limit on he cumulative effects.	Purpose of EIS is to disclose effects, not to develop thresholds.
	1101	596	Provide more complete assessment of past, on-going, and future cumulative adverse environmental impacts	Assessment for wildlife, vegetation, and water quality impacts cover from historic to 20 years in future. More "complete" assessment would require new studies, expense, and funds. Goal was to look quickly at broad range of issues.
	1110	632	Corps must both assess and limit the cumulative adverse environmental effects of its 404 permit program	This EIS not reporting on the 404 program, but on potential decisions in a geographic area so can be better prepared to address adverse effects.
	1111	632	NEPA requires a "hard look" at the cumulative impacts..	This EIS focuses on effects of wetland fill but has included effects of other non-wetland ac ivities.
	1112	633	NEPA requires identification of an environmentally preferred alternative for limiting cumulative impacts..	The EIS presents many alternative criteria some of which may reduce impacts if incorporated into reviews. The difficulty is the Corps does not propose or implement the projects and in its permit decisions, if issued, find the alternative to be the least damaging practicable alternative. The Permit Review Criteria describes Corps concerns but the applicant will propose the alternative based on project specific needs.
	1113	635	NEPA requires a ROD and Corps action to limit the cumulative impacts..	The EIS is not evaluating the regulatory program, but is looking at what can be incorporated into future reviews. Cumulative impacts continued to be considered in ongoing reviews.
	1114	635	404, 404(b)(1) guidelines, and Corps regulation require Corps both assess and limit cumulative impacts..	The regulations quoted describe the Corps du ies at the time of each individual permit decision.
	1115	637	Fish and Wildlife Coordination Act requires Corps to consult with resource agencies…including cumulative impacts	Noted.
	1116	638	ESA also requires the Corps to assess and limit cumulative impacts…	Noted.
	1368	1081	Sect 1.3: should put more emphasis on requirement to protect natural resources..	The paragraph is correct in stating the goal of the EIS initiative itself. The paragraph already states requirement related to natural resources.
	1369	1081	Sect 1.4.5: Determinations in tiered documents should reference federally listed species and critical habitats..	Added.

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173	**Does not or incompletely assess**			
	299	87	Does not describe the full extent of wetland loss, etc., that are the cumulative impacts of the past, present, future.	Added analysis of recent Corps permitting with acres, etc., and also historic plant cover changes. The entire EIS is assessing the potential future effect of twenty years of permit decisions so impacts reported are the various cumulative impacts of many potential individual decisions. Where available the EIS also includes information on thresholds (for example, water quality) but for most issues there are no existing accepted thresholds (e.g., for wildlife habitat). Neither this EIS nor Regulatory program purpose is to establish of thresholds or limits.
	483	153	Cumulative impacts of past permitting are not adequately assessed.	
	524	181	Does not review direct/indirect/cumulative impacts of 404 program. Add number of permits, acres, ..(list).	
	683	265	EIS needs specific criteria for assessing secondary&cumulative impacts and plan to monitor impacts of decisions.	
	1102	596	adopt permitting reforms that will significantly limit future cumulative impacts of the 404 program	
	1117	640	DEIS does not adequately assess the past, present, future cumulative adverse impacts of Corps permits (6pp)	
174	**EIS does not limit cumulative adverse effects**			
	300	87	Does not commit to limit cumulative adverse impacts.	The EIS presents a range of potential adverse effects. The goal of the EIS is not to limit any particular effect but to ensure he decision-maker understands the effect that could result from many individual decisions.
	477	152	Reduced cumulative impacts is not accomplished adequately by the DEIS.	
	485	163	Corps must limit cumulative and indirect impacts.	
	852	434	Why did EIS have no limit on cumulative impacts?	
	1132	677	DEIS does not limit the cumulative adverse environmental effects of 404 permit program	
	1358	1079	Document is being produced to legitimize changes to the process which will have negative impacts to resources..	
175	**EIS must limit cumulative adverse effects**			
	646	247	Conclude cumulative&secondary impacts are negative and must make substantial changes to permitting program.	Noted. Will consider in preparation of ROD.
	1133	678	EIS and ROD must commit to a clear course of action to limit cumulative adverse impacts.	
176	**Not consistent with guidelines proposed at start.**			
	319	90	The EIS study is not consistent with the guidelines proposed when ini iated.	Remained consistent to principles of the unsigned MOA although were administrative differences
177	**Corps, not ADG, independently review information and reach own conclusions**			
	530	182	Ceded excessive authority to the ADG. Corps must independently review information & come to own conclusions.	No authority was given to ADG. The ADG's role was to predict future conditions based on several sets of condi ions. Corps wanted views of those most affected by permit decisions. ADG process provided stakeholder dialog and clarification that allowed the Corps to better present a cross-section of the ideas heard and evaluate potential impacts. The Corps developed its own Natural Resources Map based, in part, upon similarities between various predictions by the ADG.
	959	481	Recommend close review of the five Ensembles to make sure they are an adequate cross section of the ADG work.	
	1356	1079	EIS is an administrative attempt to shift responsibility for changes in permit review from Corps to ADG	
	1357	1079	Law squarely places he responsibility and burden of determination of proposed impacts on the Corps.	
178	**More detailed analysis**			
	505	169	Present solutions to all fish and wildlife resource issues identified in EIS.	Applicants are responsible to identify solutions.
179	**Did not address our scoping comments**			
179	**523**	181	Raised many issues in our scoping comments but not addressed in the DEIS.	Not all issues suggested in scoping could be covered within time and primary goals of EIS.

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180	**Support (or none) for EIS**			
	2	6	The EIS is a good work and it's a work in progress.	Noted.
	4	6	Support for Corps efforts	
	23	11	This EIS is a starting point.	
	265	81	Comment your effort to streamline the process.	
	544	185	Lack of comment in his letter should not be interpreted to mean that we support the data, analysis, or conclusions	
	731	302	Support use of five ensembles to determine impacts of permit decisions. Critical are factored into decisions.	
	877	447	I support your draft EIS and would like to see it strengthened.	
	1097	591	I hope you do not interpret the lobbying efforts by developers..as reflecting the desires of the people…	
	1234	963	Strongly support the EIS	
	1267	991	City of Sanibel supports the DEIS as the first step in attempting to reduce the damaging cumulative impacts..	
	1285	1007	Support the current efforts to improve..permitting..but have reservations regarding degree of commitment	
	1320	1035	Hendry County is less inhabited…to impact an area with higher people density…seems a waste of taxpayer $$	
	1322	1037	The EIS achieves this objective by evaluating..permits in a landscape context..especially the cumulative impacts..	
181	**What issue generated need for EIS?**			
	609	227	What issue generated the need for an EIS?	No single issue. Simply a concern whether permit by permit review could be improved in a region with a large number of permits in proximity to each other in an area wi h many natural resource issues.
182	**Support for Ron Inge's comments**			
	783	331	Support Mr. Ron Inge and his comments (see page 480)	Noted. We share your high regard for Mr. Inge.
	801	353	Concur with Mr. Inge's sentiments (see letter page 480)	
	1254	968	I agree wi h the contents of the letter you received from Ronald E. Inge..	
	1300	1017	I am in full support of the Horizon Council's position as stated in Ron Inge's letter..	
183	**Corps is driven by no-growth elements**			
	856	436	Corps has become lackey of the no-growth element of our society.	EIS presents all viewpoints.
	1235	964	Fairness: EIS based on activity of ADG.."no-growth" segment took prominent role and balance shifted..	
	1269	991	As a member of the ADG, I can say categorically that this (weighted with "no-growth" proponents) is not true.	
190	**Environmental Justice**			
	19	10	Corps, not ADG, must create and evaluate alternatives.	The EIS evaluates the proposed action (implement standardized review criteria and Natural Resources Map) vs. "no action" alternative (continue review procedure in which program manager determines scope of review and weight to be afforded to each factor). ADG dynamics provided rich source of ideas that were used in preparation of the alternate futures that in turn were used to create the Natural Resources Map.
191	**Poor not bear burden [also affordability 612]**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	450	142	Administration said poor should not bear undeserved environmental cost & burden. GGE owners forced out.	Corps has always recognized that single family landowners circumstances limit practicability of alternative site designs or other alternatives to limit impacts. In any case, the original Permit Review Criteria removes language interpreted as absolute limit to site design. Suggestions for site design criteria still in the Ensembles for purposes of evaluating potential impacts and benefits.
192	**Defacto racism in selection of ADG**			
	451	142	Defacto Racism: I tried to gain a seat but perhaps Hungarians are not welcome either.	Approximately 130 names were nominated for membership of ADG. Members selected to present broad range of expertise. National origin was not a factor.
	452	142	Defacto Racism: Environmental community trying to price minority citizens out of an existing housing market.	Noted.
193	**Defacto racism in pricing minorities out of market**			
200	**Wetland Analysis**			
210	**Misconstrues existing regulations**			
	1165	789	Analysis of environmental effects on vegetation misconstrues the regulations and is flawed (described)	"Avoidance" as a stand-alone criteria has been removed from the Permit Review Criteria. In the evaluation, avoidance is highlighted but is not the only factor evaluated in the EIS: but additional information on the other factors has been added. The subgroup that estimated the wetland impacts included a Corps representative and permitting consultant so the Corps has no reason to derive a separate estimate. The Corps sometimes is concerned with upland impacts where those are related to wildlife impacts resulting from the wetland fill or where the unique nature of the upland site would present potentially greater environmental impact than a loss of wetland.
220	**Not include smaller projects.**			
	58	21	You are not looking at the smaller projects in your analysis.	All areas of potential development are included.
230	**Mapping of wetlands imprecise. [also 447]**			
	104	42	Corps criteria for wetlands use soils maps, that are very imprecise.	Did not use soils map because not always show effect of drainage.
	351	99	Am interested in your definition of wetlands.	In the EIS, used plant communities that are typically wetland since the GIS maps based on interpretation of aerial photographs. For a permit, the wetlands are delineated based on a site inspection of plant, soil and hydrology indicators.
	353	99	Are you calling as wetlands what the Big Cypress Basin Board flooded?	Areas flooded by temporarily blocked weirs are not wetlands.

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	538	184	Actual percentage of jurisdictional wetlands is far higher than listed by the DEIS.	Depending on the plant cover type and the expertise of the interpreter the actual acreage may be either higher or lower than mapped at any one location.
	568	198	Aerial interpretation of wetland can vary widely..so eliminate percentage thresholds for wetland acreage in DEIS	Wetland percentages removed from Permit Review Criteria.
	837	422	Wetland maps used to determine thresholds may be highly inaccurate. Corps should eliminate %.	Percentage retained in Ensembles to compare.
	933	473	Is information used (to estimate wetland acres) current and correct? Data should be readily available.	Information based on interpretation of aerial photos. Corps performed comparison of hree separate such maps for some of the plant cover types and found that while the actual number of acres would be different, he % distribution would be very similar. So the comparison based on % used.
	1292	1012	Believe the es imate (37% of study area is wetland) is low and actual acreage is nearer 61%	Perhaps soil scientist referenced was reporting hydric mapping units? Some of the plant covers are very difficult to identify as wetland or upland so % could be higher than reported. Discussed briefly in new presentation of historic plant cover estimates.
231	**How many acres of agriculture mapped as wetland?**			
	261	80	Have you studied how many acres that are under cultivation that are classified as wetland.	No. EIS figures based on plant cover and agriculture not interpreted as wetland. Actual study would require site visits.
232	**5.6% too small?**			
	313	89	5.6% loss of wetlands I think is too small because of the individual loss of little parcels.	Included all areas of development. Areas with smaller parcels generally estimated to have higher % impact due to constraints on site layout.
	839	423	Did 5.6% include pending applications?	Included projects not yet built.
233	**What are assumptions in % estimate?**			
	816	414	Unclear what assumptions were made regarding wetland conversions in 5.5 - 7.7% cumulative total.	Assumptions included: industrial and small parcels higher % impact due to site design constraints; areas with higher percentage of wetland have higher % impact.
	818	414	Are wetland loss predictions federal or state?	Predictions based on aerial photo interpreted plant cover. Not based on site visit based wetland delineations.
	840	423	Does 5.6% include wetlands created/enhanced through mitigation? …there is no net loss in functional acreage.	No. Added narrative on functional replacement.
	841	423	How was the seasonal wetland percentage computed?	Summed areas of plant cover associated with seasonal wetland that are located within areas mapped as preserved.
240	**Provide table of past and future impacts [also 123]**			
	290	86	Present a table of number of wetland acres destroyed and is going to be destroyed in future.	Added tables based on groups of years since aerial mapping only performed periodically.
	853	434	Publish total acres of wetland destroyed since 1982 and total # of dredge and fill permits granted.	
	1291	1011	Request losses of wetland acres within EIS study area be presented by year, etc.	
241	**Map change in upland and wetland from permitted and unpermitted**			
	525	181	Corps should map change in upland and wetland areas from permits and illegal fill.	Tables added include upland and wetland. Upland not need

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	551	187	Corps must fully analyze the cumulative wetland and upland losses.	Corps permit. Tables include losses prior to permitting. Difficult to compare permit statistics directly to land cover losses due to difference between interpretation of aerial photo and actual wetland delineation based on site visit.
	1386	1084	Section 4.2: Needs additions, including historical and trend analysis of upland and wetland vegetation…	
242	**Strengthen analysis of upland habitat impact associated with wetland impacts**			
	526	182	Strengthen analysis of indirect impacts…upland habitat destruction associated with wetland fill activities.	Included figures on upland habitat but not possible to relate which upland associated with wetland. Due to nature of landscape in region, most projects have a mixture of both.
243	**Address effects of agriculture on wetlands**			
	535	183	Should address the effects of agricultural activities on wetland loss.	Added table showing projected losses due to agriculture.
	872	442	Address the extent of agricultural activities and the adverse ecological impacts.	
244	**Effects of mining on wetlands?**			
	501	168	Thoroughly review mining and not considered open space preservation.	Mining not a major percentage of land cover change so included in development category. Each mining site has unique circumstances that would make any generalizations difficult.
	536	184	Should examine the loss of wetlands from mining.	
245	**Table 3 data should show more seasonal wetlands in preserve.**			
245	**654**	250	Table 3, Seasonal wetlands: data must support conclusion that more wetlands will be in preserves then out.	% figures based on GIS analysis. For wading birds there are arguments to preserve these across entire landscape, so no preference stated.
250	**Evaluation**			
251	**Mitigation and assessment techniques inadequate underreporting losses.**			
	476	152	Mitigation & assessment techniques are inadequate which compounds the impacts of the losses here.	Narrative added describing mitigation assessments.
	478	152	Mitigation procedures need reform, including assigning more value to exotics-infested wetlands & raise ratios.	
	797	349	Like to see a unified wetland ranking system and set of mitigation op ions to compensate for the loss.	
	866	441	Should assess the mitigation process and ensure full functional replacement.	
	1383	1084	Section 2.6: Provide additional review of wetland mitigation policy..functional assessment, off-site, banking..	
252	**[spare]**			
253	**Oppose use of preserved wetlands for mitigation.**			
	506	169	Oppose use of preserved wetlands to mitigate loss of more wetlands, particularly in-lieu fee.	Noted.
254	**Mitigation credits for exotic vegetation?**			
254	**682**	264	Fails to address mitigation policies and credits for exo ic vegetation removal..these wetlands still provide habitat…	Presence of exotics are considered in either the narrative or numeric assessment of the presence of functions in a wetland. Wildlife and other studies performed for another EIS in Miami-Dade County and other information has over time resulted in a recognition that some func ions are still present in exotic-invade areas. This has increased value assigned these areas when proposed to be fill and, conversely, reduced the "credit" given for removing exotics as mitigation.
254	**820**	414	Why not agree areas with 75% melaleuca are automatically suitable for development?	
254	**1205**	946	Better explanation needed why mitigation ratios are so high when no credit given (for) control of invasive plants…	
254	**1251**	966	Under EIS, more incentive to cut isolated we land properties out of development request, eliminating exotic removal..	
254	**1270**	991	We hope you see the fallacy in this argument (development of exotic-invaded wetlands helps environment)	
254	**1276**	999	When wetlands filled..no similar wetlands created, instead cutting down so-called exotics..100% loss of wetlands	

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255	**Where is basis/data for ratios?**			
	937	473	Where is information to support the wetland ratios?	Calculations available upon request. Ratios calculated based on a very rough calculation of functional units.
	1258	973	No explanation or supporting documentation for your various ratios used for the functional value of wetlands…	
	1387	1085	Section 4.2: utility of potential mitigation analysis since neither effects of wetland impact & mit banks not analyzed.	The analysis is based on simple functional replacement but as noted in the expanded narrative other factors such as spatial loss of habitat not captured by such an evaluation. Mitigation banks located outside of the study area are a very small percentage of areas available for mitigation, well within the error range of the analysis.
300	**Wildlife Analysis**			
310	**Evaluation of cumulative wading bird impacts inadequate**			
	493	164	No discussion on mitigation of wading bird rookery effects or how alternatives could be changed to improve.	Described cumulative impacts to wetland forage habitat of wading birds by providing an analysis of the past, present, and potential future impacts to wetlands in the Study Area. This analysis, and further analysis of the cumulative effects of current wetland mitigation ratios, mitigation banks, and the location/mitigation of wetlands and proposed wetland impacts within the ecoscape, will be incorporated into the information which the Corps uses to assess proposed wetland impacts. This information, along with documented declines in wading bird rookeries, will be utilized to ensure that any future impacts to wetlands, without strict adherence to the avoidance and minimization criteria under the 404 Guidelines of the Clean Water Act.
	1120	649	Evaluation of cumulative wading bird impacts is inadequate.	Analysis of potential impacts to wading birds expanded to include potential impacts to forage habitat in proximity to rookery sites and to elevate seasonal wetland loss as a regional issue. The Draft EIS did not intend to allow additional loss of seasonal wetlands under Ensembles which include more development, but did intend to elevate this wetland type specifically for the purpose of protecting amphibian, reptile, and fish populations, thereby protecting wading bird forage habitat
311	**Wading bird population down 90%**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	330	91	Wading bird population down 90% because of loss of habitat…and are indicators of health of environment.	Corkscrew Swamp Sanctuary is the location of the largest wood stork rookery in the United States. It has been a stated goal of the Corps and the Service during the development of the Draft EIS to curb continued losses of wading birds in southwest Florida, including the wood stork. The Corps and the Service met with Mr. Carlson, manager at Corkscrew Swamp Sanctuary, and Dr. John Ogden, to solicit recommendations for landscape-level solutions to loss of wetlands in the Study Area. The Service will support the Corp impact based on distance from wood stork and wading bird rookeries; cumulative loss of wetlands, particularly short-hydroperiod wetlands, including hydric pine flatwoods, wet prairies, and freshwater marshes; and landscape location.
320	**Evaluation of cumulative T&E impacts inadequate (or specific comments)**			
	21	10	Evaluation of listed species inadequate. Does not protect listed species habitat.	Added more analysis of impacts to listed species and establish guidelines for Corps project managers to avoid impacts to listed species in order for projects to be considered in the federal interest. Where listed species impacts are not avoided and conflict between a project proposal and the federal interest occur, the Corps and Service will formally consult on an individual project basis to determine if incidental take of a listed species is anticipated or if he project will result in jeopardy, and will incorporate mandatory measures to reduce incidental take or alternatives that will not result in jeopardy. In assessing potential effects to listed species, the Corps and the Service will consider direct, indirect, and cumulative effects and include landscape analysis of wide-ranging species.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	527	182	Should map the historical and current habitat of listed and sensitive species.	Added analysis of the historical extent of wetlands and other habitats and more analysis of impacts to sensitive and listed species and establish guidelines for Corps project managers to determine if impacts to listed species will be avoided so that the project will be considered to be in the federal interest. Where listed species impacts are not avoided and conflict between a project proposal and the federal interest occur, the Corps and Service will formally consult on an individual project basis to determine if incidental take of a listed species is anticipated or if the project will result in jeopardy, and will incorporate mandatory measures to reduce incidental take or mandatory alternatives to avoid jeopardy. In assessing potential effects to listed species, the Corps and the Service will consider direct, indirect, and cumulative effects and include landscape analysis of wide-ranging species. The EIS is intended to identify sensitive species and resources, especially those species that utilize rare habitats such as xeric oak scrub, high marsh, tropical hammock, or coastal wet
	752	315	10 specific comments on the wildlife analysis…see pages 315 to 316	A. Table 3 is a summary of potential effect. Body of EIS presents protection status. B. Florida panther narrative revised to reflect the location of the breeding panther population. C. Clarification of panther habitat % made D. Clarification of Red cockaded woodpecker occurrences made E. Pine community already men ioned, historic loss emphasized in revised narrative. F. Woodstork rookery reference deleted and more emphasis placed on habitat needs. G. Narrative already states species uses coastal areas. H. Changed occurence references for crocodile. I. Added text on Indigo snake diet. J. Occurence information of Everglades mink and Florida Black Bear.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1121	650	Evaluation of cumulative impacts to threatened and endangered species impacts is inadequate (spp listed)(9pp)	Florida Panther. Assessment of the Florida panther expanded in the Final EIS to assist the Corps in avoiding jeopardy, limiting cumulative effects, and affirmatively conserving this species. Loss of available or occupied panther habitat assessed on a historical basis where the analysis is available. Although the Florida Panther HPP designates lands considered essential to maintaining the panther population south of the Caloosahatchee River at its present level, the plan was primarily intended to identify specific lands for purchase and conservation, and therefore could be used by the Corps in affirmatively conserving this species. The HPP was not intended to delineate lands for purposes of determining incidental take or jeopardy under the Endangered Species Act.
				Lands not identified as Priority 1 or 2 under the HPP can be assessed for impacts to panthers. However, the analysis of potential effects to Priority 1 and 2 habitat from various ensembles does indicate the severity of effects that could result from continuing land use intensification in southwest Florida. This information will be utilized in determining indirect and cumulative effects of projects which result in a change to the environmental baseline for this species.
				Scrub Jay. Known scrub jay habitat should not be at risk under any of the Ensembles as development of scrub jay habitat would be considered to be contrary to the requirements to protect the species under the Endangered Species Act. Protection of xeric oak scrub and other rare habitats expanded to the entire study area and a map of potential scrub habitat within the Study Area added.
				Red-Cockaded Woodpecker. Landscape-level protection strategy added. Known red-cockaded woodpecker habitat should not be at risk as development of red-cockaded woodpecker habitat would be considered to be contrary to the federal interest under any Ensemble. A map of potential red-cockaded woodpecker habitat added.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
				Wood Stork. Additional landscape level protection strategy added, including more detailed avoidance and minimization criteria for wood stork forage areas and specific identification of the elements of forage habitat that will be mitigated if avoidance and minimization have occurred, but impacts to wetlands used as forage habitat by the wood stork remain. See response to 311 330 91 above. At present there are not 14 wood stork rookeries, but only one in the project area, but reference to rookeries dropped in favor of emphasis on habitat needs.
				Everglades Snail Kite. Added discussion of the importance of maintenance of the spatial heterogeneity and spatial extent of wetlands habitat within the Study Area. See response to 310 1120 649 above for comments on short-hydroperiod wetlands. The Draft EIS does not indicate that only 50% of the remaining seasonal wetlands will be protected under the 404 permitting program. Page 99 of the Draft EIS states that 70-86% of seasonal wetlands under Ensembles Q-U would be protected if wetlands within he Preserve category are protected, 14-30% are at risk in Ensembles Q-U if they are surrounded by Development or other non-Preserve category
				West Indian Manatee. Significant discussions concerning the conservation of the manatee are occurring between the Corps, Service, and plaintiffs in the manatee lawsuit, which may address manatee concerns and the Record of Decision wll be coordinated with the results of those discussions.
321	Panther			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	529	182	Fails to recognize that to recover Florida panther and black bear, habitat restoration will be necessary.	Habitat restoration options for the Florida panther, including habitat management, exotic plant removal, additional land purchase and/or conservation easements, and wildlife crossings/fencing at roadways; as well as landscape-level restoration options such as the establishment of corridors betv development options within "lower quality" or "impacted" habit effects cannot be minimized by other actions or conservation strategies within the range of the panther.
	920	471	Re: "using available information" (BPJ)..neither explicitly lists nor explain how this judgement was best.	Documents reflected as "best professional judgement" such as
	921	471	Re: panthers, enough has been learned since PHPP developed..Corps should not rely on gray, non-peer-reviewed..	On April 24, 2000, the Service has provided a response to the pan her habitat evaluation model (PHEM.) submitted to the Corps by the Lee County Department of Transportation. The Florida panther is one of the most intensively researched animals in the world; additional research will not resolve those conflicts that exist between habitat conservation/panther habitat recovery efforts in southwest Florida due to urban and agricultural development. The focus of current proposals to develop remaining habitat in urbanizing areas appears to be shifting (and intensifying) the responsibility for panther habitat conservation from one group of private landowners (urban interests) to another (agricultural interests). The Corps and Service have a regulatory and affirmative conservation responsibility to conserve the panther within occupied range and seek landscape-scale solutions to panther recovery.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	925	472	Remove "higher % public lands greater assurance preserving pop".. private lands support high productive panther	Comments on the percentage of public lands in public ownership and their importance to the panther speak to importance of ecosystem protection which includes the public lands complex and do not devalue private lands as important to the panther. Percentages of the landscape in public ownership as depicted in the Draft EIS assist in the portrayal of landscape-level risk to the panther from encroaching urban and agricultural development on private lands.
	926	472	Pg 39, GAPS document has information gaps for many species.	The Corps and Service recognize the limitations of data presented by the Gaps report: all data has limitations. The data represents landscape-scale modeling critical to predicting cumulative effects of habitat loss on fish and wildlife populations.
	927	472	Pg 11, Panther population does not need preservation, but management that allows it to increase in number.	The Panther HPP was not the only document used to determine the location of panther habitat, other documents included the Florida Panther Recovery Plan and the South Florida Multi-Species Recovery Plan. Impacts to Priority 1 and 2 panther habitat as defined under the HPP were used in GIS analysis by the Alternatives Development Group. "Preser participated in the ADG and Draft EIS, includes habitat conservation, management, and restoration.
	928	472	Pg 26, we agree with sentence "the area needs a mapping effort that identifies existing flowways,…" (rural legend)	Significant mapping of flowways has already occurred as a result of the Big Cypress Basin Water Management Plan, Lee County Watershed Study, and Lower West Coast Water Supply Plan, as well as efforts by other state and federal resource agencies and local governments.
	929	473	Pg27, restoration of Picayune Strand will be detrimental to recovery of the Florida panther	Restoration of wetlands in Picayune Strand will benefit the recovery of the Florida panther: restoration and preservation of uplands, as well as management of existing panther habitat, are goals of the Picayune Strand restoration (South Golden Gate Estates). This effort has been the subject of 3 years of interagency planning (South Golden Gate Estates Watershed Planning Study) that includes digitized vegetation mapping based on historical 1940's aerial photographs.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	930	473	Assumption that all lands mapped at Pri I and II are used by panthers is not supported by current data.	The importance or potential importance of Priority 1 and 2 panther habitat as defined by the HPP for panther recovery is supported by a state and federal interagency group that includes the Service, Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, and the National Park Service. Priority 1 and 2 habitat as defined by he HPP does not include all habitat utilized by the panther. A detailed determination of the quality of panther habitat was not an objective of his Draft EIS. Other factors, including habitat fragmentation, human disturbance, and future land use, were considered. For purposes of estimating potential impacts of development wi hin the Study Area boundaries on the panther population, especially with regard to cumulative effects on a landscape scale, the use of the HPP and other available information is appropriate.
	1403	1105	Enclosed is latest annual Florida panther status report from FFWCC.	The previous annual report already included. The narrative discusses the genetic program. This latest information will also be available for future work.
322	**[spare]**			
323	**[spare]**			
324	**Wood stork**			
	1385	1084	Pg 40, 50, 91: Map indicating 14 woodstork rookeries does not appear to be correct.	Deleted references to rookeries and emphasized habitat needs.
325	**[spare]**			
326	**[spare]**			
327	**Eagle**			
	931	473	Where is data to support the assumption (implied) that FWS Bald eagle buffer zones are absolute or need larger?	Bald eagle protection requires more than temporary nest protection as defined by bald eagle nest buffers. Foraging, roosting, perching, and future nest habitat, especially in coastal and riparian areas, must be protected. The Corps is required under Section 7.(a) 1 of ESA to take affirmative conservation measures to protect this species. Other federal laws, including the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act, protect this species.
330	**Study Area too small**			
	17	10	Study Area too small for wildlife	The purpose of the Draft EIS was to assess the impacts of the Corps regulatory process on fish and wildlife resources within rapidly developing areas of southwest Florida, not
	315	89	Geographic scope too narrow. There is a lot of wildlife habitat that is east of 29..	
	542	185	Add areas from the east to the study area.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	868	441	Corps should expand extent of the study area (to east and 15 square miles within Estero Bay Watershed)	assess resources outside this area. The South Florida Multi-Species Recovery Plan and other resource planning documents more appropriately define wildlife habitat values for a larger ecosystem. The Corps does not have regulatory authority over all of agricultural clearing that has occurred east of S.R. 29. The Draft EIS recognizes that the Study Area only includes a small portion of the extensive range of the Florida panther. Information used in determining potential panther habitat impacts included specific consideration of east to west movements from core habitat east of the Study Area and north to south movements across the Caloosahatchee River and through rural areas in the eastern portion of the county.
	924	472	County boundaries to define study area is very artificial boundary for panther dispersal..	
340	**Endangered Species Act questions**			
	41	15	Endangered Species Act ran out at sunset.	The ESA is in effect. Within the Study Area, the peregrine falcon has been delisted, and the bald eagle is proposed for delisting.
	42	15	Anyone's land that has been seized for the Bald Eagle have been ever mitigated?	The law of regulatory "takings" under the 5th Amendment is beyond the scope of this EIS.
	745	308	Recommend consulting with USFWS and NMFS on effects of alternatives on listed species.	The Corps did not request consultation with the Service under the ESA for the alterna ives presented in the Draft EIS. The Service will continue to assess each individual Corps permit for impacts to federally listed species under ESA.
	846	424	EIS says applicants will need to address all listed and proposed species. What is a proposed species?	Proposed species are hose which have been proposed in the Federal Register to be added to the list of threatened or endangered under Section 4 of the Endangered Species Act.
350	**Florida Games Closing Gaps data is old**			
	243	78	Closing he Gaps report states the data on which the maps are based are already outdated.	The Draft EIS used existing available information, including the GAPS report. The use of existing information, and not generation of new studies, was agreed upon by
	425	124	Closing he Gaps report states the data on which the maps are based are already outdated.	
	467	146	"Closing the Gaps" map is out of date, inaccurate and inadequate.	
	567	198	Gaps analysis is outdated so eliminate percentage thresholds based on it.	
	598	224	Closing he Gaps report states the data on which the maps are based are already outdated.	
	842	423	Should eliminate % thresholds using Closing the Gaps since do not accurately reflect current conditions.	
	1202	946	"Gaps" map is out of date	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1247	966	"Closing the Gaps" mapping is old data.	representatives of local government, environmental groups, government agencies, and development interests during the scoping portion of the EIS. The Corps recognizes that the GAPS report is based on 1985-1989 data. The document was peer-reviewed. The GAPS report also only represents only minimal needs for focal species defined by the document. Available GIS data indicates that significantly more habitat loss and fragmentation has occurred since 1989; the Corps and the Service conclude hat the habitat impact and listed species analysis performed in the Draft EIS is extremely conservative. "Current conditions" if modeled, would be "more accurate" and reflect more habitat loss.
				It is he Corp's responsibility to address cumulative effects of be considered, as will trends in habitat loss. Percentages of allowable habitat loss under the Permit Review Criteria eliminated.
360	**Provide map of habitat loss for different species.**			
	309	88	Should have map that would look at habitat loss for different species.	The Draft EIS utilized available data on habitat loss for the Study Area, which included listed species habitat mapped in the GAPS Study. Since the exact location of some listed species and historical range of some listed species is unknown, estimates of impacts based on habitat loss within the Study Area represent the best available informa ion. The South Florida Multi-Species Recovery Plan also estimates historical habitat loss for some species.
	369	107	Corps needs to break down types of wetlands, important because of wildlife dependency on types.	Wetland types were considered during the evaluation process, and other publications (GAPS and Citrus Study) estimate losses of wetlands by type.
	865	441	Need to develop several digital maps to address impacts on listed species.	An estimate of historical habitat loss added.
370	**Not consistent with MSRP and GAPS**			
	310	88	Not consistent with Multi-Species Recovery Plan or Florida Game and Fish Commissions gap study.	The Corps has and will use, when appropriate, he GAPS and the South Florida Multi-Species Recovery Plan (excerpts included as Appendix G) as information to be considered when assessing the effects of the Corps regulatory process
371	**MSRP & GAPS not undergone peer review or rulemaking**			
	466	146	Neither MSRP or "Closing the Gaps" has undergone rulemaking nor peer review.	The South Florida Multi-Species Recovery Plan was derived from experts in the field and has been endorsed by the Service and thus represents agency action. The Corps
	967	482	USFWS Multi-Species Recovery Plan has not received adequate review or analysis.	
	1058	521	FWS & FL Game plans used but have not been subjected to public or scientific peer review	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1201	945	MSRP and "Gaps" studies have not been submitted to rulemaking or independent peer review and are controversial	invited the U.S. Fish and Wildlife Service to be a federal cooperator as part of its responsibility to affirmatively protect listed species under section 7. (a)1 of the ESA, and its responsibilities under the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, the National Environmental Policy Act, and the Coastal Zone Management Act.
380	**Include alternative that maximizes preservation areas and wildlife corridors**			
	549	187	Include a preservation alternative that maximizes preservation areas and wildlife corridors.	The request goes beyond the scope of he EIS. Also, the Corps of Engineers lacks authority to order anyone to remove roads or canals, or to designate preservation areas and wildlife corridors. The various Ensembles represented predictions of the future based on anticipated future actions by governments at all levels as well as private industry. From these Ensembles, the Corps prepared its Natural Resources Map which is to be used to determine the cumulative effects of wetlands permitting, in conjunction with the standardized permit review criteria.
	550	187	Roads and canals in preservation areas should be designated for removal.	
390	**Other**			
	843	423	Revise EIS to eliminate references to non-listed species.	The Big Cypress fox squirrel is a state-threatened species. Under the Fish and Wildlife Coordination Act, impacts to state-listed species, as well as general fish and wildlife concerns, must be given equal weight. De-listed federal species will not be considered for review under ESA except for monitoring purposes as established under the criteria for de-listing, however they will be considered under the Fish and Wildlife Coordination Act. The bald eagle will continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.
	844	423	Include language that there will be no review for species that have been delisted.	
	922	472	EIS suggests "wildlife habitat corridors" is a "broad concept". But can be defined narrow (see reference).	Wildlife corridors can be narrowly defined based on objective research, individual site characterization, and specific wildlife species needs. The reference to the term as a “broad concept scope of potential options, opinions, and opportunities for wildlife corridor planning that exist in the literature
400	**Economic Analysis**			
410	**Failed to perform an analysis**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	271	83	Lack of economic element…to measure economic impact, property values and future ad valorem tax base.	See revised Socio-Economic Impact analysis. The socio-economic impact of the proposed action (use of standardized permit criteria and the Natural Resources Map, in lieu of case-by-cases analysis for each individual permit application) is not expected to be significant. The Ensembles are predictions of future conditions based on he actions of governments at all levels as well as the private sector. They are not an "action" that has an impact.
	381	115	Lack an economic impact analysis.	
	400	120	No economic impact analysis and no funding mechanism for recommendations	
	437	127	No economic analysis of the impact of the draft EIS.	
	441	133	No economic analysis of the impact of the draft EIS.	
	570	199	Conduct economic impact evaluation of impacts on property owners, businesses and taxpayers.	
	618	233	Secure an independent analysis of the economic impact that the project review map and five maps represent.	
	637	242	Request complete economic impact analysis be completed.	
	1027	518	Corps performed no substantive economic analysis as part of he EIS	
	1173	800	Failed to perform any economic analysis of the alternatives.	
	1208	947	Corps cannot weigh impacts of EIS…without substantive economic analysis by trained professionals..	
	1310	1026	Do not see any information that analyzes the economic impact…	
411	**Relied on suppositions of ADG members**			
	464	146	Economic analysis on the impacts of the EIS on the economy not performed. Corps relied on suppositions of ADG.	The ADG identified the economic factors that could be affected by a change in quantity of wetland fill. The socio-economic section narra ive discusses these relationships and the narrative has been expanded to increase the understanding of this issue by the permit reviewer and public. The proposed implementation of the permit review criteria does not directly authorize or prohibit any we land fill but only suggests some standardization of procedures implementing existing restrictions on wetland fill. The economic analysis of that proposal was performed by the Corps.
	1028	518	Corps relied on suppositions of ADG members..none were trained economists…	
	1029	518	ADG members concerned about suppositions...stated economic impacts only be adequately determined with study.	
	1207	947	Corps stated performed no economic analysis..relied on expert judgement of ADG..but members not experts..	
420	**Economic Sustainability analysis is flawed**			
	67	23	Southwest Florida is not sustainable.	The issues raised by these comments are beyond the scope of the EIS. Since the Corps already does cumulative impact analysis, the economic impact of HOW it does that analysis (standardized criteria vs. discretion of program manager) is not expected to be significant, since neither method pre-ordains any particular action.
	120	45	Economic analysis is woefully lacking.	
	226	76	Don't think ADG did a sufficient job on analyzing the economic implications of our discussions.	
	236	78	Cost and effects on the economic sustainability must be determined considering (list of factors).	
	371	108	Analysis of property rights and economic sustainability appalling…took one special interest view of the issue.	
	399	120	Inadequately addressing economic sustainability and private property rights	
	411	123	Cost and effects on the economic sustainability must be determined.	
	540	184	Economic analysis provided by development interests will downplay value of certain ecological functions (listed).	
	585	223	Cost and effects on the economic sustainability must be determined.	
	726	292	Economic factor is inadequate…should be re-evaluated by committee of experts.	
	1124	669	Assessment of economic sustainability is deeply flawed (5pp)	
421	**Growth exceeds capacity of natural systems to sustain**			
	15	9	Growth does not pay for growth.	Noted.
	20	10	Urbanization already beyond capacity of natural systems to sustain clean water, etc.	Noted.
422	**Growth does not pay for growth**			
	365	106	Impact fees do not cover costs resulting from the need for increased public services.	Noted.
423	**Preservation less costly then restoration [also 926 costs to buy preservation]**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	68	23	Preservation is less costly then restoration.	Noted.
	750	308	See Dr. DeFreese work contradicts implication increasing preservation areas increases local government costs.	See Topic 420, comment 67
424	**Include benefits of preservation, less sprawl, tourism/fishery jobs**			
	195	62	Evaluation should include economic benefits of less urban sprawl, land preservation, tourism and fishery jobs.	See Topic 420, comment 67
	363	103	Economic analysis not include benefits of natural resource protection & how relates to property values. (10pages)	See Topic 420, comment 67
	555	191	Speaking as a tourist, I would not go to Florida to see urbanization.	Noted.
	665	254	Include negative economic impacts to private property rights of population grow h.	See Topic 420, comment 67
	679	263	Economic analysis is flawed due to the fact the economic value of preserves was not considered.	See Topic 420, comment 67
	712	288	It seems to us that our tourism is a far more dependable resource (economic) than construction.	Noted.
	727	292	Economic factor: evaluation should be broadened to recognize tourism, cost of large reservoirs, etc. (list)	See Topic 420, comment 67
	779	325	Re section 4.16 (energy rqmts): also, more compact development equates less energy and less fuel taxes.	Noted.
425	**Agriculture sustains urban infrastructure costs**			
	364	104	Comp Plan will eliminate agriculture as land use. Agriculture actually subsidizes urban infrastructure costs.	Only portion of agriculture converted to other use. Figures added to narrative.
426	**Failed to evaluate future water costs.**			
	366	106	Failed to evaluate future water costs of he alternatives in regard to economic sustainability.	Beyond the scope of EIS.
430	**Benefits of urban growth are myths.**			
	342	94	There is plenty of evidence which disproves these pro growth beliefs…urban myths. (lists these in comment).	Many of the points made directly or indirectly in the expanded narrative. Some relate to questions of whether future economy is sustainable and Corps not studying that (see comment for topic 472).
	710	288	We feel good of many (clean waterways,…) ha been trashed for the enrichment of the few.	Noted.
440	**Economic impact of regulations not analyzed adequately**			
	24	12	Economic impact of these regulations on private sector were just taken with a brush stroke.	Discussed in an expanded narrative.
	206	69	Need a very clear picture of what any economic impact of new restrictions or new processes are going to have.	
	246	78	Economic analysis must determine the effects on local business development, (list)	
	282	85	Need for economic analysis to determine effects of EIS on local business, development, taxes, property rights.	
	968	482	Recommend economic analysis be performed by impartial group to fully ascertain the implications of the DEIS on…	
	1189	883	(Report) Economic analysis of the DEIS	
	1246	965	Economic impacts of EIS were not properly addressed.	
	1341	1074	Address the cost and affects on the economic sustainability..associated with changing the regulatory process.	
	1342	1074	Address concerns in Bonita Springs Chamber of Commerce position paper, in particular economic impact	
441	**Ask input of Agricultural economists**			
	49	17	Suggest Corps work with group of agricultural economists.	Have used reports prepared by Farmland Trust.
442	**Restrictions cloud options for agriculture to be flexible.**			
	69	28	To keep agriculture profitable is to keep its options flexible. To cloud options reduces ability to sustain operation.	Added point to narrative.
443	**Cost to individual property rights [also 620,Lehigh][also 764 and 922]**			
	108	43	Lack of economic analysis on what Eis may cost in terms of individual property rights.	Added point that could have high impact to individual landowners. Corps has always recognized in permit reviews that circumstances of single family lot owners are such that options such as purchasing other sites or changing site design are often not practicable alternatives.
	164	55	Require a detailed environmental impact evaluation to determine effects on private property owners.	
	193	62	Concerned wi h any action that would add costs to affordable housing.	
	224	76	What guarantee that Golden Gate property values aren't going to plummet under your control?	
	357	100	Taking of quality of life is..government to classify your property in a way to depreciate assets worked hard for.	
444	**Existing roads overbuilt if development not occur**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	148	51	Another economic impact is road will not be used to full potential if development not occur as planned.	Permit Review Criteria revised to clarify that Corps not designating preserve. However, risk is present that landowners may not be able to address natural resource issues in project design. Corps hopes that information in this document and Permit Review Criteria may be usable to hose deciding to construct the infrastructure in the future.
	234	77	Areas designated preserve have access to public infrastructure, result in underutilization and cost to taxpayer.	
	409	122	Areas designated preserve have access to public infrastructure, result in underutilization and cost to taxpayer.	
	413	123	Cost of providing municipal infrastructure must be addressed.	
	583	223	Areas designated preserve have access to public infrastructure, result in underutilization and cost to taxpayer.	
	586	223	Cost of providing municipal infrastructure must be addressed.	
	1312	1026	Increased costs to homeowners for utilities from reduction (by designation preservation) of users on utilities..	
445	**Landowners expect growth**			
	149	51	Landowners are anticipating the growth will occur.	Noted.
446	**Loss of tax revenue/tax base. Increase costs to government.**			
	147	51	You are taking a significant amount of dollars away from the fire districts.	Permit Review Criteria revised to clarify that Corps not designating preserve. Tax base issue discussed in expanded narrative.
	277	84	Tax base increase also brings increased individual taxes. Increasing tax base just to increase population not good.	
	412	123	Government owned land depletes tax base.	
	414	123	Erosion of tax base must be addressed.	
	587	223	Erosion of tax base must be addressed.	
	1311	1026	Classification as "reserve" or "rural" reduces value of land for purposes al valorem taxation	
447	**Corps cannot determine % of total economy influenced if wetland map is poor [also 230]**			
	367	106	Corps cannot determine % of total economy its decisions affect since wetland mapping is imprecise.	Percentage estimates included in narrative and range from 3 to 5%. Maps may be imprecise but not to the extent that the characterization of "small" would change.
448	**Not include costs of past dredge and fill mistakes.**			
	368	106	Corps has not incorporated cost factors of past mistakes involving massive fill or dredging.	EIS is looking at future permit decisions.
450	**Historic/cultural**			
451	**Calusa not only historic culture**			
	774	323	Only mentions Calusa culture, which is only one of many culture periods in history of SW Florida.	Expanded narrative.
452	**Data used for historic/cultural review five years old**			
	773	323	Data used for cultural resources is five years old.	Obtained update.
460	**Need method to apply cost benefit or methodology for "practicable" in guidelines**			
	777	324	EIS needs to define/quantify "practicableness"…imply need for a methodology/tradeoff of cost-benefit of criteria.	The applicant must demonstrate hat there is no practicable alternative to the proposed project that .would have less adverse impact on the aquatic ecosystem. As described by 40CFR230.10(a)(2), an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.
	370	107	Review calculations of economic impacts to wetlands in terms of past, present, and future.	A detailed evaluation of the economic contribution of the wetlands filled in the past and preparation of estimates of what the economy would have looked like if there was less wetland loss would be difficult and speculative.
500	**Water Quality Analysis**			
510	**Evaluation of cumulative groundwater impacts inadequate**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	53	18	The wetlands are vital to groundwater recharge. Who is looking at that?	Groundwater recharge was reviewed in the "Affected Environment" section of he EIS
	685	272	Prepare detailed hydrologic data analysis including hydrogeologic column, cones of depression, etc.	This depth of hydrologic analysis was not necessary for ADG Alternatives evaluation
	687	272	Address mitigation due to overdevelopment of fragile and relatively thin low Tamiami acquifer.	Development and implementation of mitigations are addressed in the permit discussions
	688	272	Address location of septic tank located in recharge area of lower Tamiami acquifer.	Potential impacts of septic tanks within the recharge areas of aquifers will be added to Affected Environment section
	1119	648	Evaluation of cumulative groundwater impacts is inadequate.	Due to the importance of surface water evaluations, the study did not focus on ground water impacts
	1166	794	Failed to consider water quality data from the Counties	All available supplemental water quality data from Lee & Collier counties have been acquired, analyzed, and incorporated into the EIS
511	**DEIS says Biscayne Acquifer is a source**			
	372	113	Page 78 of EIS mentions Biscayne aquifer and its water supply. No potential to supply water to SW FL.	Agreed. Descriptions of the Biscayne Aquifer were only provided for general ground water discussions.
512	**Limit analysis only to certain acquifers**			
	373	113	EIS should be limited to surficial, intermediate, and the Floridian aquifer systems.	Agreed. EPA believes that the descriptions were limited to these three primary aquaifers
513	**EIS shows development on recharge areas**			
	374	113	EIS allows buildout of Lehigh Acres. Where will (list of wellfields) get water? Not Immokalee ridge stated in EIS.	EIS did not spend much time on future water supply since that topic more comprehensively described in the Lower West Coast Water Supply Plan process.
514	**City of Ft Myers is changing water supply source (change EIS)**			
	375	113	Lower Tamiami experiencing growth on its recharge area.	Noted.
	376	113	Corps let southwest Florida rely on Floridan Aquifer?	EIS did not spend much time on future water supply since that topic more comprehensively described in the Lower West Coast Water Supply Plan process.
	392	116	For your information, City is changing source of water supply.	Noted.
520	**Data**			
	196	62	ADG did not have enough water quality data.	Subsequently, additional water quality data from 1980 to present have been acquired from all available sources, analyzed, and incorporated into the EIS.
	722	291	Deficient in analyses of wq..evident insufficient data..however model employed is the best available.	
	1167	795	Water Quality analysis reflects significant data gaps and outdated data	
521	**Failed use data from Counties**			
	81	36	Lee County water quality data not used	All available supplemental water quality data from Lee & Collier counties have been acquired, analyzed, and incorporated into the EIS
	200	63	Lee County given 100 percent commitment as well as open books and so on…	
	204	68	Collier County has an existing data base for surface water quality. Not sure that has been plugged in completely.	
	210	71	There is more information on water quality.	
	212	71	WQ tables that reference observations in the order of 20 to 25 can be supplemented with hundreds of data points.	
	228	76	Need to get the water quality data into the study.	
	242	78	EIS not fully utilize County or SFWMD water quality data sources.	
	326	91	Both Lee and Collier Counties participated on ADG, I find it hard to understand how data were missing.	
	336	92	Where is the cooperation of our county government?	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	424	124	EIS not fully utilize County or SFWMD water quality data sources.	
	597	224	EIS not fully utilize County or SFWMD water quality data sources.	
	895	463	Water quality data from Lee County Environmental Lab was not used.	
	953	478	Inputting data into Storet..then will be incorporated into reevaluation of listing of impaired waters…should use this.	
	964	482	Extensive amount of water quality data that Lee and Collier County…have available..should be incorporated..	
	1053	521	EPA rejected data collected by Lee County…but was not in a database the EPA liked to use.	EPA did not reject any water quality data and exhausted all
	1196	945	Lee County's water quality data…was refused because it was not available in a particular…database	efforts to obtain any and all available water quality data from
	1307	1025	Understand considerable amount of scientific data…by Lee County concerning water quality and endangered spp..	All available supplemental water quality data from Lee & Collier counties have been acquired, analyzed, and incorporated into the EIS
	1323	1038	Since release of the DEIS, EPA worked with Lee & Collier County personnel…bo h counties provided additional data	Noted.
522	**Outdated / gaps [also 898 recommends 5yr moratorium to fix]**			
	461	146	Much of water quality data is both dated and generated too randomly.	Subsequently, additional water quality data from 1980 to present have been acquired from all available sources, analyzed, and incorporated into the EIS.
	647	248	EIS should address why water quality data were unavailable.	
	684	272	Prepare GIS base map showing major arteries, streams, drainage basins, acquifer, monitoring stations, etc.	Much of data is available but would need several maps to show this information clearly. EIS simplifies results to ten basins.
	739	308	Water Quality section needs updating with current data and rewrite to reflect SW FL systems (list)	All available supplemental water quality data from Lee & Collier counties have been acquired, analyzed, and incorporated into the EIS
	1052	521	Data (supporting representation of waterbodies not conforming) is limited, dated and insufficient	Subsequently, additional water quality data from 1980 to present have been acquired from all available sources, analyzed, and incorporated into the EIS.
	1054	521	Data EPA used was, in some instances, more than a decade old and collected too inconsistently..	
	1195	945	Much of data used in water quality model..is too old and to randomly generated..	
	1236	965	Water quality monitoring and data is flawed	
523	**Compare to other studies**			
	83	36	How does water quality results compare to PBS&J model of Estero Bay?	Not able to investigate at this time
530	**Model inappropriate**			
	82	36	What water quality model was used? How applicable is Tampa Bay efficiencies? Model Calibrated?	RETEN: Tampa Bay Efficiecies are applicable based on near geographic proximity and probable similarities in the BMP engineering utilized. Model was not calibrated.
	197	63	FDEP does not have a model that looks at pollution loading, so at the moment is by guess and by golly.	Noted.
	382	115	Lack an unflawed water quality model.	RETEN is a suitable water quality model when used to evaluate changes in large area land use for the purpose of relative alternatives comparison.
	638	242	Serious concerns regarding current water quality conditions in the EIS. Request model be available for review.	Water Quality Model was made available as requested
	640	243	Evaluate water quality locally using standardized methodology and considering all local information available.	All available supplemental water quality data from Lee & Collier counties have been acquired, analyzed, and incorporated into the EIS
	689	273	Address list of pollutants used by agriculture, industry, golf courses and others grouped by geographic area.	The alternative analysis addressed a large geographc area for which this is not appropriate

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	690	273	Address the diversion of surface water flows the cause higher unit runoff.	Historic alterations of surface water flow was reviewed in the "Affected Environment" section of the EIS
	735	306	WQ model should be calibrated, documented, and used only for relative comparisons of the alternatives.	RETEN is a suitable water quality model when used to evaluate changes in large area land use for the purpose of relative alternatives comparison.
	897	464	Which wq model was used?	RETEN
	901	464	Were point source discharges considered?	Point discharges were not considered due to the lack of criteria within the alternatives regarding point sources. The analysis was to compare the alterna ives relative to each other.
	902	464	Were impacts from Lake Okechobee considered?	No; Impacts from Lake Okeechobee were not considerd due to it lying outside of the study area and that none of the alterna ives addressed it.
	952	478	EIS modeling effort is not sufficent..combine with Corps feasibility modeling, so do not use as basis to choose altern	Noted.
	962	481	There is an acknowledged flaw within the water quality model…	Noted.
	963	481	Impartial peer review needs to be undertaken on this model.	The Water Quality Model was made available to the SWFWMD, Lee County, Collier County, and FDEP for review and evaluation
	1051	521	EPA based its model on position that a number of waterbodies in this area do not conform to CWA levels	Disagree; EPA did not base its model selection (or generate a model) on a position that a number of the study area water bodies are 303d listed.
	1168	796	Water Quality model employed is inappropriate for evaluating the principal effects on the aquatic ecosystem	RETEN is a suitable water quality model when used to evaluate changes in large area land use for the purpose of relative alternatives comparison.
	1237	965	Comments by technical experts on ADG on model were ignored	All ADG member comments were taken into consideration
531	**How applicable is assuming Tampa Bay treatment efficiencies**			
	898	464	How applicable is use of Tampa Bay BMP pollutant removal efficiencies?	Tampa Bay Efficiencies are applicable based on near geographic proximity and probable similarities in the BMP engineering utilized. Model was not calibrated.
532	**Calibration of model**			
	900	464	How was model calibrated with actual data?	The model was not calibrated, however a suitability analysis was performed to evaluate the model's relative capability for predicting accurate trends in WQ based on land use.
533	**SFWMD has better model**			
	462	146	EPA generated new water quality model even though the SFWMD was much further along in developing models.	Disagree; EPA employed RETEN, a suitable water quality model used to evaluate changes in large area land use for the purpose of relative alternatives comparison
	507	169	Perform a "very elaborate water quality and quantity modeling analysis" in conjunction with SFWMD.	The WQ modeling completed to address alternative analysis.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	903	464	Were results compared to model developed for Lee County Surface Management Plan?	No; As the Format of the two studies did not allow for a direct comparison
	904	464	How do results compare to SFWMD model for Estero Bay?	Study addressed inland waterways. Analysis of the water of Estero Bay not included.
	1050	521	EPA created own water quality model rather than building on existing models available from the SFWMD.	Disagree; EPA employed RETEN, a suitable water quality model used to evaluate changes in large area land use for the purpose of relative alternatives comparison
	1197	945	EPA generated a new water quality model even though the SFWMD was farther along in developing similar models	
534	**Peer review**			
	463	146	Since ADG meeting, only government agencies have seen model. Regulation must be subjected to peer review.	The Water Quality Model was made available to the SWFWMD, Lee County, Collier County, and FDEP for review and evaluation
	1238	965	Model not a scientifically peer-reviewed properly calibrated model	
535	**15 sq mi of watershed not in the study area**			
	541	185	Reexamine boundary of study area: SFWMD Phase I study of Estero Bay includes approximately 15 sq miles	Analysis was confined to ACOE SWF EIS Study Area. The area mentioned is at the very top of one of the wet year watersheds whose land use was not expected to change.
	1296	1012	Reexamine boundary of study area…15 sq mi of Estero Bay watershed not in study area	
536	**How do older systems compare to new?**			
	899	464	How are older systems compared to newer?	If the reviewer is referring to developments that do not have post-Stormwater Rule vs those that do. These development were held as having different impacts.
537	**Provide public review of model**			
	1055	521	No further public review (after ADG) and comment on this model has occurred..	The Water Quality Model was made available to the SWFWMD, Lee County, Collier County, and FDEP for review and evalua ion. Available to others upon request.
	1198	945	(the water quality model) has not been made available to local landowners or their consultants.	
540	**Alternatives**			
	1169	796	Did not consider he positive impacts of mitigation required by the Corps, Coun ies, SFWMD, and other programs	The interpretation of land use types for each alternative did consider and evaluate we land mitigation
	1172	800	There is no.. basis for concluding that the PR Map is preferable to comprehensive plans from water qual standpoint	Noted. Revised Draft Permit Review Criteria deleted map commented on.
541	**[spare]**			
542	**Failed to consider existing permit requirements**			
	1239	965	Several model runs indicated development was not have an adverse impact and these runs were ignored	Reviewer has confused the ADG Meeting WQ preliminary inhouse analysis with the more rigorous analyses performed by EPA for alternatives evaluation in the EIS
543	**Wrong alternatives analyzed**			
	494	165	EPA WQ analysis should be run for all alternatives.	WQ analysis were limited to the two extreme alternatives due to fiscal limitations.
544	**Not all water quality factors were addressed in every alternative**			
	508	169	Not all Water Quality factors were addressed for each Ensemble, so cannot analyze Ensembles from same base.	All analysis factors (Land Use, BMPs, Removal Efficiencies, etc.) were equally considered during analyses of each alternative
550	**Analysis needs to be improved**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	6	7	WQ analysis needs to be improved.	Water Quality analyses were substantially improved with the acqusition, analysis, and incorporation of new water quality data from Lee and Collier Counties
	118	45	Water Quality model and data is inaccurate.	Dissagree; RETEN is a suitable water quality model when used to evaluate changes in large area land use for the purpose of relative alternatives comparison.
	219	73	We are interested in improving the water quality analysis.	Noted.
	495	165	Water quality analysis is deficient and no discussion how to correct.	Water Quality analyses were substantially improved with the acqusition, analysis, and incorporation of new water quality data from Lee and Collier Counties
	751	309	37 specific comments on the water quality analysis in the order found in the comment letter.	
			751-A	Inaccurate; Water Quality stations, data, and subsequent analyses were specifically identified for each of the EIS basin boundaries
			751-B	Agreed; Supplemental references and documentation will be added to the Affected Environment sections to improve reader's understanding
			751-C	WQI and TSI Indices
			751-D	Agreed; Text will be corrected to reflect proper "avaerages" used.
			751-E	Agreed; The difference between "criteria standards" and "screening levels" is understood, text will be modified to clarify.
			751-F	Agreed; Mercury will be corrected to a metal, and not a conventional pollutant
			751-G	Agreed; Text will be modified as: "agricultural runoff s a contributing source of nutrients to this area"
			751-H	The timing and availability of the "recent compilation" of water quality data, as well as subsequent analyses did not permit inclusion into the summary and history.
			751-I	Agreed; Although the proper numeric criteria for coliform was used, it was incorrectly stated as a "screening level". This text change will be made.
			751-J	Agreed; The definition of surface water classifications will be corrected.
			751-K	Agreed; The use of "Impaired" will be scutinized to imply "water quality standards are not being met".
			751-L	Certain water bodies, such as ponds and canals typically support "naturally low water quality" characteristics as compared to Lakes and streams.
			751-M	References to documents will be made.
			751-N	Agreed; Vocabulary will be changed from "attributed" to "characterized".
			751-O	Agreed; Text will be modiffied to clarify that TSI or Trophic State Index is implied.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
			751-P	Agreed; Text will be modiffied to clarify
			751-Q	These numeric values have been provided within the tables of he report.
			751-R	Agreed; Text will be modified to clarify between "average" and "annual medians"
			751-S	Primarilly STORET data; Eceedence criteria were 0 85 ug/l and 0.86 ug/l for zinc and copper, respectively.
			751-T	Values are located within the 305(b) Report, check WBID 3259B.
			751-U	Values are located within the 305(b) Report, check WBID 3259L.
			751-V	Citation will be referenced for this data source.
			751-W	Information identifying the percent change by land use type will be provided.
			751-X	The Water Quality model RETEN does not provide estimates of hese parameters.
			751-Y	Agree; Table 1.1 will be updated as recommended by the Department
			751-Z	Agreed; However, RETEN is a suitable water quality model when used to evaluate changes in large area land use for the purpose of relative alternatives comparison.
			751-AA	The model was not calibrated, however a suitability analysis was performed to evaluate the model's relative capability for predicting accurate trends in WQ based on land use.
			751-AB	Agreed; A sensitivity analysis was performed.
			751-AC	Agreed; the model input data sets will be provided in the appendices.
			751-AD1	Partially Agree; Percent differences as a relative change in water quality parameters is a good method for displaying WQ results, however, IWQ allows for comparison of alternative s.
			751-AD2	Partially Agree; There are only slight differences in the modeling results of the alternatives based on the "avaeraging" methodology utilized here and by the Department.
			751-AE	Agree; Appendices will be modified to reflect the same text changes as agreed to in the main text portion of the Impacts analysis
			751-AF	Definition of South Florida study area boundaries will be defined and added to text.
			751-AG	Agreed; Text will be modified to clarify and / or correct.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
			751-AH	Agreed; Text will be modified to clarify and / or correct.
			751-AI	Agree; A source citation will be added for each table.
			751-AJ	Water quality data sources can be found within the STORET Database
	896	463	Considering the very limited data used, trends in water quality can not be made.	Water Quality analyses were substantially improved with the acqusition, analysis, and incorporation of new water quality data from Lee and Collier Counties
	965	482	The (water quality) study needs adequate peer review.	Water Quality were reviewed by EPA, FDEP, SFWMD, and Lee and Collier Counties.
	1139	675	West Caloosahatchee IWQ 48.0 in error? (EIS says Fahkahatchee Basin had lowest IWQ at 48.5)	Comment is correct and document will be modified.
	1188	856	(Report) Review of the water quality analysis for South Florida Land Use Alternatives for the ACOE EIS	Noted.
	1199	945	Statement (errors in wq model were irrelevant) is unacceptable since regulation must be based on..science…	Point was that model can be used to compare two alterna ives even if there are comments questioning errors in selection of some of the fixed assumptions.
	1170	798	Index of Water Quality does not provide strong support for any alternative	Agreed; IWQ is only one criteria utilized in the EIS and ADG process for evaluating Alternatives
	1171	799	DEIS compared the wrong alternatives	Alternatives selected were intended to be the bookends of range of possibilities.
560	**Mitigation of impacts.**			
561	**What is cost.**			
	85	36	What is cost of implementing proposed mitigation strategies. Prudent to monitor results of current NPDES initiatives.	Undetermined. Strategies listed to allow discussion of which may have potential for assuring maintenance of water quality.
	906	464	What are costs associated with adopting the proposed mitigaton strategies.	
562	**Wetlands are important**			
	723	291	Wetlands important to wq even in development category along eastern shore of Estero Bay	Noted.
570	**Fund Lee County to complete analysis and implement mitigation**			
	88	37	Rather than EPA continue WQ analysis, give funds to Lee County to complete its analysis and implement mitigation	Noted.
	909	465	Request funds be appropriated to Lee County to complete its analysis and to implement mitigation strategies.	
	954	478	County will take lead technical role in developing necessary science to use as basis for decisions.	
580	**[spare]**			
590	**Other**			
591	**Add the SFWMD Estero Bay report to the bibliography**			
	520	174	Add SFWMD Estero Bay and Watershed Assessment to the bibliography.	Agreed; References will be added to the bibliography
	521	176	Add DCA report "Water Quality Circulation…of the Estero Bay Estuarine System" report.	This SFWMD study had not been released when the report was released.
600	**Lehigh Acres (also applicable rest of study area)**			
	974	493	(Lehigh Landowners, Inc. Newsletter, Spring 1999) describing report of Alternatives Development Group & EIS	basis for some of the comment letters below
	982	499	(Lehigh Acres Lot Owners Association, Inc., Urgent Notice, Fall, 1999) regarding EIS.	basis for some of the comment letters beow
610	**Conflict with comprehensive plan / defer to.. [also 116, 627, and 888]**			
	106	43	Individuals who have no interest or knowledge of Lehigh were allowed to impose land use constraints.	See also comment 116. EIS presents Comprehensive Plan and four alternative maps (5 Ensembles) that incorporate ideas for changes in landscape and permit review criteria that
	826	421	Inconsistent with Lee Future Land Use Map. Burden of proof on Corps to justify any deviations from it.	
	956	481	Project Review Map places EIS & its goals as an alternative to Comp Plan, adding confusion of local..community.	

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1022	517	Lehigh slated for development for three decades and recognized as an area for development in earliest comp plans	may happen or were expressed as ideas to address a concern such as wildlife habitat loss. These ideas were addressing issues that affect the en ire study area and the effort was not aimed at Lehigh or any other particular area. Although the Corps recognizes the Comprehensive Plan as the State and County preferred plan, the Plan does state "...the county will not undertake an independent review of the impacts to wetlands..." and refers the landowner to State and Federal permitting. The Corps, therefore, cannot simply defer to the Comprehensive Plan has essentially stated "you can build if you get a permit". Under the Clean Water Act, the Corps must make its independent decision whether to authorize those lot owners who have wetlands on heir land to fill their wetlands. The 5 Ensembles present five different quantities of fill and present five different "futures" of expected environmental and other conditions.
	1034	519	The EIS creates an additional set of regulations that contradict the land uses in he Lee Comprehensive Plan.	
	1040	520	Permit criteria and project review map conflict with existing comprehensive land use plans.	
				Lot owners also have responsibilities under the Endangered Species Act if their property has natural plant cover used by listed species. Therefore, the 5 Ensembles present different quantities of habitat preservation and restoration. The EIS is not adding regulations. They already exist.
611	**Alternatives conflict with on-going tax-funded projects**			
	73	35	Greenway creates some degree of conflict with tax-funded projects in Lehigh Acres.	Agree.
612	**Is key affordable area for future homes in County [and not just Lehigh]**			
	77	35	Lehigh Acres is a key affordable area for the legitimate growth management potential of the County.	Corps has always recognized in permit reviews that circumstances of single family lot owners are such that options such as purchasing other sites or changing site design are often not practicable alternatives to filling the wetlands on their lots. Based on the report and other comments submitted, Lehigh Acres serves those that do not have alternative locations for homesites in the region. However, the continued recognition of this constraint will result in wetland and habitat impacts. Historically, the Nationwide Permit program provided an abbreviated administrative process for lot owners but has grown in complexity. So Corps added language to EIS proposing to implement development of a local General Permit that hopefully will provide abbreviated process but also include a mechanism for addressing impacts of lost wetlands.
	109	43	Lehigh Acres is an affordable housing community.	
	171	57	Lehigh is the last affordable house in Southwest Florida	
	221	75	We need to consider affordable housing when we start looking at the land and any restrictions imposed.	
	449	141	GGE is a lower-cost site than comparable urban areas. It gives the less affluent population an affordable avenue.	
	1030	518	Study (attached) concludes EIS will impact the availability of affordable housing…such a result is unacceptable	
	1044	520	Result (replumbing, etc) is particularly onerous when impacts persons whose means to address are limited…	
	1061	523	(report titled Regional Housing Affordability and Lehigh Acres referenced by comment#1030)	

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613	**Availability of Lehigh removes pressure from other areas.**			
	78	35	Regarding permits to south, let us help provide ability for people to move to Cape Coral and Lehigh Acres.	Noted.
620	**Property value [also 920 and 443]**			
	173	58	Two types: homeowners and speculators. Speculators gamble. If cannot build on lots, homes more valuable.	There is no guarantee under the law that a lot owner will be authorized to fill we lands, if wetlands are on their property. None of the alternatives state that the Corps will or will not issue a permit but only provide a disclosure of the potential impacts if it does.
	711	288	Corps use of EIS to uphold CWA and ESA must not be secondary to Florida's takings law.	
	975	498	We own property in Lehigh Acres which may be substantially affected by the..alternatives in the…EIS.	
	1224	959	We own property in Lehigh Acres which may be substantially affected by the..alternatives in the…EIS.	
621	**Taking land without compensation**			
	998	504	We object to any plan to take over our land..without compensation or consideration.	The EIS has not proposed to deny permits. That decision can only be made after a review of the individual circumstances of a lot owner based on information in his/her application. As stated above in comment 612, the Corps weighs the impacts on the environment and the individual landowner. However, the EIS is disclosing what is the total environmental impact of prospective decisions to better understand the ecological context of the loss of the wetland on the single lot. No compensation plan is needed since the Corps is not deniying permits with this EIS.
	1000	506	We have no objections to your plan provided we are compensated ... at least equal to current market value	
	1004	509	There is no plan to compensate property owners.	
	1008	510	Corps is going to take my property with no .. Compensation. Do not let this agency..take my property away.	
	1014	513	The proposed plan does not provide for the purchase of our lots…	
	1018	514	Land transfer, buyout or current status quo should be considered.	
	1019	516	In one fell swoop you can take it away?	
	1046	520	Neither EIS nor ADG provide discussion of compensation for landowners so affected.	
	1318	1034	If our land confiscated, will we receive compensation? What will be the basis for such compensation?	
622	**Uncertainty to get permits**			
	74	35	EIS creates tremendous uncertainty whether lot owners have the ability to get the necessary Corps permits.	For lots with wetllands hat uncertainty already exists in that there is no guarantee a permit will be issued. As the number of acres of wetlands in the region continue to be reduced, the general public's concern over the fate of the remaining ones has historically increased. By preparing a 20 year estimate, the Corps is trying to identify problems and solutions particularly for those owners who will not be building until later.
	103	42	Way to destroy the value of land is to have it get around the Corps is investigating it. Be done soon as possible.	
	512	171	How will the EIS affect our ability to use this property in the future?	
623	**Added expense to get permits [also 443 and 747]**			
	105	43	Spending $10,000 for a permit for a lot valued from $2,500 to $10,000 is an unaffordable burden.	As public's concern for fate of remaining wetlands increases, additional administrative requirements have been added to the Nationwide Permits that is the current Corps method to keep permitting costs down. The Corps hopes to develop a General Permit written just for Lehigh Acres to prevent permit cost burden.
	111	43	They can afford to clear pristine mangroves in Collier and get $2-$4,000 for a lot which you cannot do in Lehigh.	
	175	58	For a wetland lot, client spent $2,500 on permit and builder took six more months to build home.	
	789	343	Added layer of permitting increase cost of land development, pushing moderate income further from urban corridor.	
	1020	517	Impacts owners of single family lots who cannot afford to retain environ&legal services to obtain permits..	
	1243	965	EIS suggests no nationwide permits will be issued in EIS area..adverse impact on affordable housing	
	1308	1025	Permitting process will become much more expensive and involved as a result of additional review requirements..	
624	**Realtors not sure what to disclose**			
	75	35	Permit uncertainty causes a disclosure problem.	EIS narratives in the body of the document and the summary have been rewritten. The Permit Review Criteria have been revised to help landowner identify whether a natural resource issue may be present on the property.
	215	72	Criteria needs to be enough definitive so realtors know what to disclose. Uncertainty affects value of property.	
	359	100	Define the plan in better ways so that property owners know what we have and what the buyer's rights are.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
625	**Further deteriorates situation with many not paying taxes on lots**			
	76	35	Uncertainty adds difficulties where are people who do not pay taxes because is not worthwhile to move forward	Noted.
	97	40	The difficulty of obtaining permits, leads to uncollected tax funds, which is primary support of fire district.	
626	**Creates uncertainty for planning (fire stations)**			
	98	40	The uncertainty affects our decisions on fire stations, equipment, etc.	Only a small percentage of lots have wetlands Even if Corps denied those permits there will be a small impact.
	1047	520	Discussion of mechanism for generating funds to compensate affected landowners is necessary.	
627	**Vested rights. Also, Corps invalidating existing permits from State.**			
	100	41	What about the vested rights that we have in Lehigh?	The Corps is an agency of the Federal Government. The landowner, if wishes to fill wetlands, must obtain a Corps permit in accordance with the Clean Water Act. A State or local permit or other development authorization does not override a federal law.
	515	173	Lands identified preserve have valid permits for current&future use. Corps intends to invalidate permitted uses?	
	977	498	All legal battles..over years have resulted in vested, immutable development rights…that may not be altered.	
	1023	517	Vested development rights associated with residential lots and rights recognized by state and local governments.	
	1037	519	Persons affected..are of modest economic means who purchased property relying on vested rights	
	1226	959	Our rights are vested, immutable development rights…that may not be altered.	
	1345	1076	Since regulations hat existed at time of purchase permitted building home, these lot owners insist rights are vested	
628	**Thought had all state, federal, etc. requirements.**			
	101	42	People bought this land with knowledge and feeling that .. All requirements have been met. How compensated?	The requirement for a Corps permit to place fill in wetlands was ini iated by passage of Section 404 of the Clean Water Act of 1972. There are those who purchased lots before then that have been affected by this new law. Those who purchased after 1972 may unfortunately may not have been aware of this. The law applies to all wetlands no matter when purchased.
	709	288	We must be mindful that changing permitted use does not constitute a taking.	
	976	498	We..invested..with..understanding our property met all..regulations and was…completely buildable and salable.	
	1009	510	Do not let this agency require me to get a permit to build a home on property that was bought for that purpose only.	
	1011	512	Are you taking into consideration the landowners' rights to compensation for the properties that will be seized?	
	1012	512	When we purchased the lots, no mention was ever made they might not be buildable or nor saleable.	
	1036	519	People invested based on..existing plats and zoning…these not considered by Corps or ADG in generating EIS.	
	1225	959	We..invested..with..understanding our property met all..regulations and was…completely buildable and salable.	
629	**Property worthless / financial loss / uncertainty causing landowners to cancel plans**			
	154	53	A commercial identity canceled its plans for relocation. Many future landowners canceled any plans. Due to EIS.	The EIS does not predetermine what the Corps' permit decision will be. The Corps is concerned with the apparent continued decline of wildlife populations, water quality, and other issues. If the Corps waits until the decline becomes critical, some landowners may be surprised by a permit denial ("the straw hat breaks the camels back"). Through this EIS, the Corps is disclosing how much impact its program may have and has presented ideas for alternatives. The Corps hopes this results in public discussion of solutions.
	979	498	Hundreds of millions of dollars invested…if rules..changed..result will be the total economic devastation…	
	992	503	Retired couple..will not be permitted to build..since lot falls within wrong color on map..suffer adverse financial..	
	994	503	Very obvious..result of the proposed alternatives..is..thousands of individuals will not be permitted to build homes..	
	996	503	If this proposal is pursued, thousands of lot owners…will be left with worthless property.	
	1003	509	Proposal (water retention areas) will render most of our property worthless.	
	1006	509	Stop his proposal because could wipe our corporation.	
	1010	511	I need to know if my investment is threatened.	
	1045	520	Owners of lands designated for preservation will be denied any economically feasible use w/ reasonable return	
	1228	959	Hundreds of millions of dollars invested…if rules..changed..you will destroy the value of our land and lives of people	
	1245	965	More stringent criteria will make it difficult to develop certain areas. Not addressed regulatory takings or who pays.	
	1346	1076	Alternatives in the EIS cast an enormous shadow over the future use of thousands of lots in Lehigh Acres	
630	**Ecological value**			
631	**High and Dry / Lehigh safer from storm surge**			
	1002	508	Plan will force relocation of households from high/safest place from hurricanes to more vulnerable to destruction.	The Corps' 404 program does not force, encourage, prohibit, or discourage development or relocation in any loca ion under any circumstances.
	1032	519	Denying additional development in Lehigh Acres will force development in less hurricane safe areas.	
	1085	571	Corps proposed (Lehigh Greenway) force humans to concentrate in areas most vulnerable to (storm surge).	
632	**Delete Greenway**			
	71	35	When look at in detail, Greenway is not a good idea and recommend be eliminated from preferred alternative.	The additional site specific information, particularly that provided by East County Water Control District, has certainly
	72	35	Many of us believe the green belt situation in your ensembles should be eliminated.	

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	96	39	We request the Greenway be removed from the preferred alternative and shown as an urban area.	demonstrated the extreme difficulty to restore this area to what it once was. It still remains in the EIS in one of he Ensembles as an idea that was suggested and the EIS presents the assessment of effects. For example, in the vegetation section, of the total quantity of wetlands, only a very small quantity comes from the area of the Greenway. The socio-economic section now has a discussion of the difficulties of implementing the Greenway suggestion. Also, the Corps permitting jurisdiction is limited to just those few wetlands therefore the suggestion of the Greenway could not be pursued by the Corps regulatory program. The Greenway has been deleted from the Permit Review Criteria.
	102	42	Two mile strip is the highest part of Lehigh. Already 2,000 homes there.	
	123	46	Don't think adequate thought was place on greenway idea.	
	805	358	Greenway should be removed and shown as urban (due to impact to wetlands and large number of owners..study)	
	1084	570	Corps proposed plans (Lehigh Greenway) are doomed to fail in returning area to original state (lists reasons)	
633	**Other places with more wetlands than Lehigh to preserve**			
	174	58	The last place a logical person would go to preserve wetlands is Lehigh. Look elsewhere.	Noted.
	1330	1042	Move Lehigh Greenway into groves to east.	
634	**Impacts to wetlands decades ago. Development normally not require add'l wetland.**			
	1024	517	Many impacts to wetlands occurred decades ago and development does not normally require additional impacts.	Noted. Drainage canals in Lehigh Acres have removed most wetlands.
640	**No involvement by Lehigh community**			
	90	37	Ask that Mr. Clayton Miller or Jimmy Hull participate in ADG.	Mr. Clayton Miller participated at recent ADG meeting (only one since request made). Corps asked a small group of persons with general knowledge of area to help develop ideas and evaluations so that Draft EIS is as complete as possible. Corps still asked for public comment and extended the comment period when requested until 189 days. Purpose of Draft is to obtain such comments to revise document. Alternatives presented where broad concepts and size of study area precluded visiting every party affected. Number of landowners in 1,500 square mile area renders mailing very difficult. Prior to release newspaper and civic group interest had resulted in a large mailing list of interested persons and organizations.
	94	38	Everyone must be included in the process.	
	110	43	We need a democratic process here, and let us have something to say in he situation.	
	143	49	The Corps did not solicit comments from local government or representatives of Lehigh Acres.	
	144	50	Urge Corps to allow citizens of Lehigh to all get together and identify water management solutions.	
	157	53	Suggest a committee be formed of local businessmen and citizens to devise a plan for Lehigh Acres.	
	169	57	No one from Lehigh was ever consulted in this.	
	396	120	Significant group of affected public…excluded from development of DEIS.	
	993	503	Obvious Corps not concerned with plight of citizens…why didn't Corps send notices to all property owners?	
	1013	513	There was virtually no input of lot owners or local officials.	
	1026	518	Component (replumbing) developed without sufficient information by people with limited knowledge of Lehigh Acres.	
	1031	518	Residents and representatives of Lehigh Acres were not included in the ADG as members or as spectators.	
	1351	1077	Time to approach obvious partners to participate in a well designed plan that will manage grow h and protect environ	
641	**Not sure how much impact public will have on process**			
	267	82	I don't know how much impact the public will have on the overall process.	The Corps mission is to serve the public. Comments and concerns have resulted in substantial revisions of the Draft.
642	**Fed'l agency not bound to disclose documents presented**			
	269	82	Federal government not bound by the need to have a disclosure of all the documentation that might be presented.	Copies of all documents related to this project available upon request in accordance with the Freedom of Information Act. Contact the Corps Project Manager.
643	**We plan to submit information to incorporate into DEIS**			

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	275	84	We as landowners jointly develop some scenarios or some criteria for which you can employ in your final EIS.	Noted.
644	**Lack of involvement by public (not just Lehigh)**			
	181	59	Wide range of things (that have been expressed by speakers at hearing) need to be considered.	Before initation of EIS process, Corps visited civic groups, agencies, and elected officials with concerns and plans for approximately a year.
	332	92	Neglected and abused as a taxpaying landowner that was not notified of this study and brought into the process	
	334	92	I was quite acutely aware of the lack of citizens on the ADG.	
	360	101	EIS fails to acknowledge the grass roots efforts of so many people to initiate and petition for the EIS.	
645	**Involve business leaders.**			
	792	346	Enlisting business leaders to help in effort help allay fears of government desire for additional regulatory effort.	
646	**Fed'l government had full knowledge of Lehigh Acres (Interstate Land Sales Act)**			
	978	498	Federal government has had full and complete knowledge of Lehigh…registered through Interstate Land Sales Act..	Corps aware of Lehigh specifically through past permits.
	1227	959	Federal government has had full and complete knowledge of Lehigh…registered through Interstate Land Sales Act..	
650	**Remove Lehigh Acres from EIS**			
	1	5	East County Water Control District odes not believe that is should be included in the EIS.	Lehigh Acres included in EIS study area because of its landscape importance for some natural resources. For example, Wood storks from Corkscrew Marsh forage in Lehigh Acres as well as other areas. If a lot owner fills a herbaceous marsh on his/her wetland, he population of this endangered species would decline. By including Lehigh Acres, the EIS can describe the past loss of marsh and present the potential future loss of such marsh for the entire area.
	89	37	Don't understand, with so many platted lots, why Lehigh Acres is somehow so needed in this study.	
	95	39	East County Water Control District does not believe that is should be included in the EIS.	
	142	49	Object to study since original purpose was focused on Imperial River basin and Lehigh does not drain there.	
	150	52	Exclude Lehigh from EIS	
	176	59	I would like to see you white out Lehigh	
	807	359	Eliminate East County Water Control District from EIS or, at minimum, remove greenway.	
	1303	1023	There is not any legitimate reason for the Corps to expand the boundaries of the study area north of SR 82	
	1336	1066	I am firmly against any action the USACE may take regarding your environmental studies of the area (Lehigh Acres)	
651	**EIS originally concerned with growth south of Lehigh Acres**			
	1021	517	Genesis of EIS was concern about pace of growth in south Lee County, not Lehigh Acres.	Agree, but need to understand landscape context of some issues. Using the Wood stork example of the previous topic, a poten ial loss of marsh south of Lehigh Acres should be presented in context of the total potential loss of marsh used by the same rookery.
652	**Original focus of EIS changed to re-engineering Lehigh Acres**			
	1025	517	Original focus of EIS has shifted and now includes component focused on re-engineering/re-plumbing Lehigh Acres	Focus did not change. Continuing the Wood stork example, since historic loss of marsh has contributed to decline of the population and there is a projected continued loss of marsh, ideas were presented in the other Ensembles to restore some of the marsh that once existed in Lehigh Acres. The ideas are presented to disclose alterna ives to stop the decline of the population of this species.
660	**Alternatives**			
	981	498	Colonel Miller, Lehigh Acres ain't broke. Stop trying to fix it.	Filling wetlands in Lehigh Acres will result in some environmental loss. The EIS is disclosing that and the Corps hopes this will create public dialog leading to solutions.
	1041	520	Primary intent of EIS was to provide a streamlined permit process..	
	1042	520	ADG failed to recognize Lehigh Acres, with vested development rights, are appropriate for development.	
	1230	959	Request Corps abandon this illegal, illogical and ill-fitted proposal	
	1348	1076	Are other options.. that preserve the lot owner's investment..require coordination of state & local govt agencies	
	1349	1077	Association wrote letter in 1998 to Lee County stating that no long range plan for stormwater management existed	
661	**Other potential locations for retention.**			

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	156	53	Other locations that might be good for retention (listed in comment).	Noted. We are not going to prepare detailed analysis for all of these since the alternatives already prepared have resulted in an understanding of the natural resource issues that would be applied to such a review.
662	**Use delinquent tax lots for preservation**			
	167	56	Use lots with delinquent taxes for preservation.	Noted. But also note that will be difficult to implement. Lots are widely scattered so would have to do a buy/sell program to assemble contiguous areas. Also still must obtain title.
	1350	1077	Over 17,000 tax-delinquent lots…unique opportunity..delinquent lots in targeted areas (preserve) be acquired…	
663	**Use Ensemble R since conforms to Comp Plan**			
	170	57	Consider Ensemble R since it has the least impact and most conforms to the comprehensive plan.	Noted.
	958	481	Recommend Project Review Map be deleted from the study.	Replaced with Natural Resources Map.
664	**Opposed if diminishes property rights**			
	177	59	Oppose any ensemble that diminishes property rights of Lehigh Acres property owners	This EIS will not dimish whatever right exists to construct home. Recognize that if wetlands on lot, hat right already constrained by requirement to obtain 404 permit.
	1015	513	I strongly object to any plan that takes away my right to build a home on my lot…	
	1017	514	We strongly oppose any decisions that renders these properties useless.	
665	**Opposed if increases taxes**			
	178	59	Oppose any action that would create a tax burden on the taxpayers of Lehigh Acres.	Noted.
666	**I protest proposal to turn sites into wetlands/retention ponds.**			
	997	503	I strongly protest this proposal…	Noted.
	999	504	Lehigh deserves life instead of drowning in a swamp..a result of a behind a desk decision.	
	1001	507	We object to any plan that prevents us from building on our lot.	
667	**If purpose is to fix water quality, why have we been paying taxes to East County WCD?**			
	1005	509	If purpose is to improve the water, why have we peen paying high taxes to East County Water Control District?	ECWCD responsible to maintain infrastructure that drained the wetlands originally present.
668	**Proposal will cost lots of Federal $$**			
	1007	509	Stop this proposal because will cost millions in federal funding.	The proposal to adopt standardized Permit Review Criteria and the Natural Resources Overlay Map will cost little, if any, more than the the current costs of case-by-case permit review. The reader may believe the Corps is involved in regulating land use, or in building the various projects anticipated by the futures anticipated by the Ensembles, but neither is true. The EIS concerns only the proposed revision of permit review procedures.
	1016	513	In addition, this will require millions of dollars of Federal funding…	
669	**Will litigate (to protect property rights)**			
	980	498	If necessary, we will band together…and protect our vested interests through litigation.	Noted.
	1229	959	If necessary, we will band together…and protect our vested interests through litigation.	
670	**Permitting**			
671	**Remove roads, how access property?**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	984	501	If roads are removed, how will the owners of those lots fronting the removed roads access their property?	Removal of roads is beyond the scope of this EIS. We believe the commenter may have confused the predicted future from the Ensembles with the proposed action in the EIS, which is concerned with the adoption of standardized permit review criteria to be used with the Natural Resources Map.
672	**Canals removed, will flood lots?**			
	985	501	If canals are removed, would some lots that are now high and dry, become flooded?	See response to Comment 985 above.
673	**Will Corps require permits on lots for which permits not now required? [also 718]**			
	986	501	Will lot owners be required to obtain a permit from the Corps…on a…lot that is currently not subject to permitting?	No.
674	**Not room for modifying site design per criteria on 1/4 acre lot [also 748]**			
	988	502	(For) a one-quarter acre lot, there is not room for design modification (to meet the Permit Review Criteria)	Corps has always recognized in permit reviews that site size for single family lots constrains options for site designs to avoid wetland impacts.
	989	502	The result (of not able to modify to meet Review Criteria) is to either permit or deny the construction of a home.	
675	**If not meet criteria, forces denial? [also 725]**			
	990	502	EIS..clearly states large areas of Lehigh Acres is proposed to become preservation and water storage areas.	The Corps is not endorsing or proposing to implement the preservation and water storage areas. Implementation of preservation areas is not within the authority of the Corps of Engineers. Permit Review Criteria revised to remove preservation and other such designations.
	991	502	Since permit applications are reviewed case by case basis…lot in a 100 acre reservoir might be issued a permit..	
	1347	1076	Designation of preservation…means that the Corps expects to deny many permits to clear and fill lots..	
700	**Permit Review Criteria**			
710	**Derivation**			
	737	307	Clarify whether the permit reviewer would use criteria for both direct and indirect or only for indirect.	Both.
	1378	1083	Section 2.2.2: References to he PR Criteria always include reference to the PR Map.	Rewritten to clarify importance of map.
711	**Explain derivation of PR Map**			
	130	47	We are not quite sure how you got from the five to the one.	The Permit Review Map has been deleted and replaced with the Natural Resources Map, which is based on the Corps' analysis of the various futures predicted in the Ensembles. The Natural Resources Map identifies the expected natural resources expected to be present in any given area, based on prediction of the results of present and anticipated future actions by all levels of government and by the private sector. The Natural Resources Map will then be used to iden ify appropriate subjects for review using the Permit Review Criteria.
	133	48	Unclear how the leap was taken from the different ensembles to the final map.	
	160	54	How you made that leap from an area wi h no consensus to being designated primarily preservation.	
	237	78	Selection of lands labeled preserve appear to be arbitrary and erroneous.	
	340	94	Then there is no justification and we get to the project review map.	
	387	115	Reference map for review criteria should be explicitly stated.	
	416	123	Selection of lands labeled preserve appear to be arbitrary and erroneous.	
	589	223	Selection of lands labeled preserve appear to be arbitrary and erroneous.	
	849	429	Failed to explain the deriva ion of the Project Review Map.	
	1161	774	Failure to explain the derivation of the Project Review Map violates due process and is arbitrary and capricious	
	1377	1083	Section 2.2.1.1: Include the criteria by which choices of land uses from ensembles will be made.	
712	**Benchmarks not explained or justified (also, 80% county is preserve, how much more?)**			
	321	90	Over 70% of Collier is in public ownership. What is the limit?	Benchmarks have been removed from revision of Permit Review Criteria. Revision identifies the natural resource issue and how to assess impact but leaves solution to landowner to propose. Additional science and public dialog
	355	99	Government owns 85% of Collier County. How much more land are going to take?	
	636	242	DEIS provides maximum quantities. Once reached, will no further permits be issued? Is it first come first served?	
	656	250	No analysis on impacts of permitting filling of wetlands on protected birds.	

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	657	250	Is 5.4% of SHCA loss the mean or was data available that suggested 5.4% was adequate?	needed to develop thresholds.
	658	250	Are the 53% figure and other % figures sufficient to accomplish the objective of the SHCA and MSRP?	
	741	308	Spell out difference between current process and proposed review process with numeric values.	
	913	467	EIS utilizes system of % of impacts, yet not sufficient data and analysis to establish controls..(example provided).	
	1184	830	Benchmarks established have not been explained, not justified, and do not relate to..impairment of the resource…	
	1367	1081	Pg iv: language might mislead reader into assuming that some level of effects are acceptable until reach threshold..	
	1380	1083	Percentages are not supported by the current analysis in the DEIS..do not address impacts to listed species, etc...	
713	**Give weight unrelated to proposed discharge / wildlife more weight [also 111and 171]**			
	257	79	A project trigger, in order to trigger a Corps permit review, should not necessarily require wetland fill.	Corps authority limited to permits for wetland fill. Can only review impacts related to fill.
	270	82	Regarding comment #257, similar out-of-box thinking as Tulloch rule and courts very recently have said no.	
	932	473	Wildlife is being given greater weight in the overall review of project impacts.	One of the functions of wetland areas that are most highly valued by the public is that they provide foraging, nesting, and resting habitat for wildlife.
	946	475	Seems to place a greater emphasis on wildlife issues than all other issues.	
	1180	820	Permit review criteria give weight to factors that are unrelated to the proposed discharge	
714	**Do not Expedite permitting in areas labeled "development"**			
	30	12	Why significant burden on projects in "development" area?	Revised Permit Review Criteria eliminates development, preserva ion, etc. categories and substitutes maps showing areas where location of project has potential for adversely affecting natural resource. The rigor of review will increase as number of resource issues increase (and rigor or burden of review less in others). A portion of the area identified for development by the Comprehensive Plan do not have any resource issues mapped.
	126	46	There is no streamlining for permit applicants.	
	138	48	Why not streamline the process within those development areas?	
	222	75	Streamline development permitting in the areas where we welcome growth and make more demanding elsewhere.	
	305	88	Concerned that this EIS is a vehicle more to expedite the permit ing process than trying to improve the process.	
	418	123	Draft EIS does not streamline permitting.	
	591	223	Draft EIS does not streamline permitting.	
	615	230	Why is there a significant burden placed on projects within the development areas by this EIS?	
	706	286	EIS does not deliver on the promise of streamlining the process in areas designated for urban development.	
	1182	826	Permit review criteria do not expedite permitting process in areas designated as "development"	
	1210	948	EIS confuses, not streamlines, regulatory issues by creating conflicts with comprehensive plans and Corps regs	
715	**Questions overinclusive**			
	1183	828	List of questions and factors under each designation is overinclusive	Revised document now has a map for each question to correct his problem.
716	**Limited intensification agric ignore Corps JD limits / justify / bias / invalidate state permit.**			
	273	83	Intensification criteria would subject farms to permitting scrutiny where they may not currently be subject.	Criteria does not expand Corps permitting. However, if change in agricultural activity does not require wetland permit but adversely affects an endangered or threatened species, the landowner may have to satisfy the existing requirement to obtain a permit under the Endangered Species Act.
	516	173	EIS has neither the criteria for ranking from least to most intensive agriculture nor the justification for the ranking.	Agree is described only ingeneral terms. Is based on various different studies that observed there are less presence of many species in some crop types then in others.
	517	173	Corps intends to invalidate State permits to change land use from pastures or vegetable to citrus, forest to veget?	The Corps is an agency of the Federal Government. The landowner, if wishes to fill wetlands, must obtain a Corps permit in accordance with the Clean Water Act. A State or local permit or other development authorization does not override a federal law.

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	518	173	We would like full explanation of negative bias in the criteria against changing agricultural crops on agricul land.	There is no "bias" against any particular crop; however, wildlife use must be considered when assessing environmental impacts for wetlands permits.
	1185	832	Designation of limited intensification of agriculture…ignore governing legal requirements limiting Corps jurisdiction	Corps recognizes limit of authority. However, other federal laws may also apply to landowner so included.
	1211	948	Explain in EIS limitations on Corps authority (drained wetlands, agriculture…)	Expanded narrative.
717	**WQ criteria conflict with authority of State**			
	1186	836	Permit review criteria on water quality conflict wi h the structure of the CWA and the authority of the State.	Revised.
718	**Way to get to issues Corps cannot directly address / uplands [also 111, 171, 673, 712]**			
	127	46	This is a backhanded way to get at some issues that he Corps may not be able to directly address.	EIS presents total projected impact, both resulting from Corps decisions and decisions of others, to provided context and/or contribution of Corps decisions.
	934	473	Upland buffer: can Corps regulate activities in uplands?	Although the Corps has no authority to regulate upland activities, in some circumstances, the Corps will review the effects on upland if they are an indirect effect resulting from the wetland fill. Classic example is where wetland fill is required and provides access to an upland island, the Corps will typically must include in its evaluation of effects the resulting impact on uplands.
	940	474	Vulnerability of coastal forests: Adjacent uplands now regulated?	See previous response.
	947	475	Reference buffers, scrub jay habitat, etc.. Can Corps regulate activities in uplands that do not have listed species?	Yes. See previous response.
	1249	966	What is legal basis for instituting permitting criteria more restrictive than what is set forth in the adopted regulations?	Criteria revised to remove thresholds and describe how to assess impact.
719	**Illegal Corps grant permit review authority to other agencies/their plans (MSRP&GAPS)**			
	240	78	Corps in violation of CWA if through the EIS they grant permit review authority to agencies not intended by the Act.	Permit review authority has not been granted to any other agency. The Corps retains sole responsibility for its permit reviews. However, the Corps has legal requirement to consult with the USFWS, EPA, and FFWCC in permit reviews and gives great deference to their views within their areas of expertise. The original and revised permit review criteria maps incorporate their input on locations where development has higher poten ial to adversely affect wildlife and other natural resources. Sometimes their input will utilize information in the MSRP and other documents they have published.
	422	123	Corps in violation of CWA if through the EIS they grant permit review authority to agencies not intended by the Act.	
	465	146	EIS invests MSRP and SHCA with regulatory authority by asking whether applicant has complied with heir rqmts.	
	595	223	Corps in violation of CWA if through the EIS they grant permit review authority to agencies not intended by the Act.	
	970	483	USFWS & EPA now appear to have say in local land use…by basing questions & decisions on "their" preferred map.	
	1057	521	Such de facto regulation is inappropriate and skirts the protections set forth in federal and state rulemaking.	
	1200	945	USFWS and FGFFC have used the EIS process to invest (their) desired wildlife plans with regulatory authority..	
720	**The Presumption (certain activities are contrary to Fedl Interest)**			
	1072	540	DEIS may only recommend that a presumption be created and adopted through formal rulemaking	Noted.
721	**Unlawful to create the new permitting standard "federal interest"**			
	1177	812	Corps proposes unlawfully to create a new permitting standard "the federal interest"	Clearly the Clean Water Act, Endangered Species Act, and

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1193	944	Corps regs speak to "public interest"..EIS, "federal interest"…be consistent with regs or revise regs…	other laws express areas that are of particular interest to the U.S. and the phrase was used as a shorthand expression of this thought. Since the phrase is causing unneeded confusion, it has been dropped in the revision.
722	**Unlawful to create the presumption**			
	1178	813	Unlawfully creates a presumption that certain activities are contrary to the "federal interest"	Statement of presumption was expression of emphasis on no net adverse impact on natural resources as a result of a project. Due to the confusion raised, has been dropped.
723	**Public Interest Review & 404b(1) preclude use of the presumption**			
	943	474	Map, Criteria etc not consistent with 404(b)(1), etc. No opportunity for applicant to demonstrate alt is practicable.	Never was intent to remove or supersede these requirements.
	1179	817	Public Interest Review and 404(b)(1) guidelines preclude the use of the proposed presumptions	
724	**The Permit Review Map will be used as a land use map [also 111]**			
	114	44	Concerned the PRC Map will become a land use map.	The Permit Review Map has been deleted and replaced with the Natural Resources Map, which is based on the Corps' analysis of the various futures predicted in the Ensembles. The Natural Resources Map identifies the expected natural resources expected to be present in any given area, based on prediction of the results of present and anticipated future actions by all levels of government and by the private sector. The Natural Resources Map will then be used to iden ify appropriate subjects for review using the Permit Review Criteria.
	823	420	We assume Project Review Map implemented similar to comprehensive plan. If not, revise text significantly.	
	916	469	PR Map, for all intent and purpose, is a future land use map that undermines County Future Land Use Map	
	1066	537	Creation of land use categories..confilicts with he Corps current permitting policies..	
725	**What does "address criteria" mean?**			
	948	476	What does "if application doe not address the criteria?" mean. All answers may not be affirmative for environment.	Revised to more clearly identify how to assess impact.
726	**Eliminate PR Map and incorporate Lee&Collier Future Land Use Maps**			
	1080	554	Eliminate the Project Review Map and incorporate Lee&Collier FLUMs for designation of land uses…	Both Counties refer the landowner to state and federal permitting programs. Therefore, landowner will look to other parts of the County Plans for criteria on density, type of activity, etc., and will be able to look at the natural resource maps found in the Permit Review Criteris for criteria on wetlands and wetland related issues for purposes of the 404 permit.
	1315	1029	Corps should evaluate applications based on land uses designated within local comprehensive plan..	
730	**PRC amends permit regulations**			
	738	307	Review process described does not sound significantly different than the existing permitting process.	The proposed action is the standardization of permit review criteria and adoption of the natural resources map. The more
	919	471	PR map appears to set a policy or changes procedures yet states "does not change any law, regulation or policy.."	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1176	810	PRC: Effectively amend the permit regulations and constitute a rule requiring notice and comment	natural resources that are located in the project area, he more review criteria will be applied. The Corps can and does ask these questions and analysis using the current procedures, but now the landowner has better understanding of these in advance of application.
731	**Requires rulemaking**			
	564	197	Any reference to new review criteria, standards, questions, eliminated since must be promulgated by rule making.	The Corps is required to consider the impact of its permit decisions on natural resources, such as water and wildlife. The proposed action does not change what the Corps reviews, it only changes the methodology by standardizing the review criteria and identifying when and where those criteria should apply. The questions to be asked should not change significantly from current procedures on any given permit, but predictability and thoroughness will be enhanced. The proposed action is akin to a Standard Operating Procedure (SOP). Rule-making would be inappropriate since the procedure is only applicable to the special conditions of Southwest Florida.
	1071	540	DEIS should set forth suggested review criteria and recommend they be adopted through formal rulemaking.	
	1181	822	Permit review criteria violate Corps regulations and the Paperwork Reduction Act	
	1259	973	Appendix H appears to promulgate additional regulations…appears will trigger rulemaking process.	
	1305	1024	Corps has not satisfied the legal requirement to institute rule making or regulations applicable to…property..	
	1359	1080	Not clear what rules allow or promote for additional permit review criteria.	
	1374	1082	Section 2.2: Provide a reference to enabling legisla ion through which Corps has authority to enforce proposed…	
732	**Violates paperwork reduction act**			
	942	474	Promulgating additional regulatory requirement may be contrary to the Administrative Procedures Act.	There is no additional regulatory requirement.
733	**Do not implement until promulgated by Administrative Procedure Act**			
	245	78	Proposed standards not be applied until EIS process completed and promulgated through APA requirements.	The Permit Review Criteria are not standards but Corps statement of best available information on location and assessment of concern prior to receipt of site-specific informa ion.
	427	124	Proposed standards not be applied until EIS process completed and promulgated through APA requirements.	
	600	224	Proposed standards not be applied until EIS process completed and promulgated through APA requirements.	
740	**Revise Criteria**			
	46	16	PRC is too restrictive and inflexible to sustain economically viable agriculture in our region.	Permit review criteria are not restrictive in that they merely identify issues, and do not predetermine the result.
	117	45	Stretching the Big Cypress Basin criteria (in one Ensemble) beyond the geographic area might be stretching things.	Is an idea presented in one of alternatives but not extended to revised draft Permit Review Criteria.
	404	120	Criteria not accomplish more efficient, timely, appropriate permitting or balance demands development/environment	Revised criteria to increase specificity of how applied.
	532	183	DEIS fails to include adequate development land use standards.	Do not intend to issue standards.
	699	279	Individual applicants cannot answer some of the questions..can only be answered regionally.	Rewritten to focus on site-scale assessment.
	1145	686	Permit review criteria must be applied in manner that will actually restrict individual and cumulative impacts..	Noted. The Corps will not presume any result in advance of any permit application.
	1146	687	96 specific rewordings and additions to permit review criteria to limit cumulative impacts (pgs 687-708)	Reviewed and considered in rewrite of document.
	1187	839	10 other issues with the permit review criteria (concerns, suggested revisions, etc. listed)	Reviewed and considered in rewrite of document.
	1324	1038	Recommend the PR Criteria be more directly integrated into the main body of the final EIS.	Designed to be "ripped off the back" and issued to Corps permit reviewers for day to day use.

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1326	1039	The criteria will need to be substantially strengthened to reflect water quality and habitat considerations..	Expanded description of assessment.
	1382	1083	Relocate Permit Review Criteria into body of text.	See response to comment 1324 previous.
741	**Not specific or too specific/restrictive.**			
	9	8	PRC criteria not clear other han it is the amalgamation of some predictions and some projections.	Rewritten to focus on site-scale assessment.
	39	14	Could the EIS be more specific in listing these guidelines?	Clarified in document.
	137	48	Regarding preservation, the severe restrictions could really be used to deny just about any permit.	Removed preservation designation and description.
	311	89	Criteria needs to be much more specific, perhaps have numerical values attached.	Made assessment more specific.
	572	199	Eliminate or specifically define terms as "wide buffer", "major habitat area", and "contiguous preserve"	Done.
	845	424	Include definitions for "wide buffer", "major habitat area" and "contiguous preserve"	Dropped terms.
	944	474	Definition of Landscape and Landscape Scale (listed).	Dropped terms.
	945	475	Pg 6: definition of Buffer	Improved definition.
	1248	966	Ambiguity: wie buffer, major habitat area, and contiguous preserves are not defined	Dropped terms.
	1316	1029	Commit to formation of special working group to evaluate proposed criteria (current ones are broad…)	Noted. The Corps will consider appropriate methods of evaluating the criteria.
742	**Wetlands**			
	57	21	If you allow 5.6% we land loss, there are going to be people that have problems with that	Dropped % due to many concerns.
	659	250	No reference to the preferred size of a buffer with respect to isolated wetlands.	Expanded description.
	754	317	Threshold % for review in preservation category should be any impact.	Dropped % due to many concerns.
	755	317	Define "appropriate" mitigation in criteria. Minimum of 2:1 in preservation.	Revised criteria describes assessment. Can be also used to assess compensatory mitigation.
	767	320	50% fill in GGE is too high	Dropped % and specific reference to GGE.
	768	320	Reword Lehigh Greenway criteria to ask if project restores wetlands.	Dropped Greenway due to questions of feasibility.
	935	473	Upland buffer: include some criteria to determine the extent of buffering to wetlands.	Added.
	938	474	Maintain connectivity: What is minimum buffer width to maintain connectivity?	Added a figure.
	939	474	Maintain connectivity: Conflict with SFWMD criteria to berm project perimeter to contain storm events.	Noted.
	941	474	Vulnerability of coastal forests: No discussion how determine vulnerability.	Rewritten.
743	**Water Quality**			
	32	13	Require all new home retain the first one inch of rainwater on their property.	Rewritten completely.
	673	262	WQ Criteria: replace question A with "Are there pollutants and what are they?	
	674	262	WQ Criteria: insert adequate in question B, "Have adequate wetlands.."	
	697	278	If there is no commonly endorsed wq tool for watershed assessment, then no way applicant can answer questions.	
744	**Habitat & Listed Species**			
	698	279	SCHA is linked to % of state but if PDQ, Inc. elsewhere wipes out some SHCA, can we reduce ours to original %?	No. SHCA used to prioritize mitigation/land acquistion locations.
	753	316	Criteria for manatee&seaturtle are only direct impacts…stating habitat should be preserved does not help reviewer.	Dropped manatee due to ongoing development of assessment tools. Specific criteria for the manatee may be an appropriate subject for consideration if and when the assessment tools are developed. In the meantime, he program manager will use his/her best judgment to assess impacts to manatees. Dropped sea turtle since most impact (human disturbance, lights) outside of Corps control.
	756	317	Don't tie evalua ion of SHCA to a %	Agree. Dropped.
	759	318	Criteria should also evaluate impact to buffer of eagle nests.	Done.

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Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	760	318	Alligator should have separate criteria.	Alligator shares habitat so no need list twice.
	761	318	Shorebirds also impacted by direct disturbance of nest areas.	Emphasized.
	762	319	Criteria should also evaluate impact to buffer to rookeries.	Noted.
	763	319	Add criteria to protect sea turtle nesting.	Most impact outside of Corps control.
	764	319	Criteria should also evaluate impact to RCWoodpecker nesting and foraging areas.	Added.
	765	319	Criteria should also evaluate impact to Scrub jay nesting and foraging areas.	Added.
	766	320	Add criteria asking if manatee protected form increased vessel use.	Not added since development of assessment is ongoing.
	1056	521	FWS & FL Game planning documents are now being used as de facto regulations because of inclusion in EIS	Always were used in applicable permit reviews.
745	**Other public interest factors**			
	675	262	Criteria: add "State if the project avoids infringement on individual rights and community goals."	Added Comprehensive Plan.
	747	308	Page 10 of 28 of PRC, reference not found in section 4.4 of "regionally significant resources"	Fixed.
	748	308	Page 10 of 28 of PRC, why is "state whether buffer width affects estuarine fringe" is to be used.	Clarified.
	749	308	Page 13 of 28 of PRC, states no direct impact on beach, but renourishmeent, etc., occur outside nesting season.	Dropped.
	757	318	Change wording of criteria regarded to Xeric habitats.	Fixed.
	758	318	Suggest add criteria for seagrass (is preserved?)	Scope of EIS was looking at permitting in the watershed, not on permits in the waterbody itself. The Corps is very aware of the importance of seagrass and applications suggesting impacts to these already receive very high scrutiny
746	**No difference between legends**			
	11	9	No tremendous difference between the legends in the PRC.	Legends eliminated in revision of Draft Permit Review Criteria partly in response to these concerns.
	238	78	No advantage as to which designation the property lies within.	
	419	123	No advantage as to which designation the property lies within.	
	457	145	Criteria do not distinguish substantively between lands designated Development or Preservation.	
	592	223	No advantage as to which designation the property lies within.	
	1212	948	EIS sets forth complex cumbersome set of inquiries…lack of distinction in rqmts for Development & Preservation	
	1399	1102	Rewrite PRC..so it both facilitates w/in development areas and recognizes development interests in others	
747	**Adds cost, time, difficult bureaurcratic process. [also 443 and 623]**			
	47	16	Proposed concept (non-intensification of agriculture) will add tedious, difficult, and costly bureaucratic process	Noted.
	131	47	Not sure the Corps fully considered the workload issues associated with these additional permit considerations.	Rewritten to reduce number of questions.
	139	48	Some of the information required to answer the questions would require potentially a lot of money to answer.	Refined criteria to site-scale application.
	146	51	Landowners are going to have to pay a significantly higher dollar to their experts to answer the questions.	Clarified to increase specificity of questions.
	201	68	Concerned whether will be more government and bureaucracy and expense with building a home	Noted.
	214	72	Smaller property owners having to come up with the moneywise to be able to use their property.	Intend to propose General Permits for portions of areas where typical project addresses the criteria so homeowner does not have to reanswer.
	239	78	Based on the number of ques ions, he processing and implementation will be cumbersome, costly, time consuming	Rewritten to reduce number of questions.
	320	90	Current county permitting process already creates burdens and proposed EIS will make process even worse.	Corps already can and has asked these questions.
	333	92	How is this going to affect us economically and how much time and red tape eventually to get through process?	By identifying questions up front, hope reduce cost.

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	379	115	Complicates permitting process.	The permitting process is the same. The difference is that the proposed action would standardize review procedures. This is expected to enhance protection of natural resources and simultaneously enhance predictability for landowners by ensuring that all applications in any given location receive a similar and appropriate level of review.
	394	119	DEIS appears to add considerable new requirements and restrictions on the established program.	Rewritten to clarify that are not new requirements.
	420	123	Based on the number of ques ions, he processing and implementation will be cumbersome, costly, time consuming	Rewritten to reduce number of questions.
	458	145	Questions are unnecessarily complicated and difficult, resulting in increased costs for permitting.	Clarified ot increase specificity of questions.
	593	223	Based on the number of ques ions, he processing and implementation will be cumbersome, costly, time consuming	Rewritten to reduce number of questions.
	1213	948	Needs to be flexibility in intensity of the regulatory review…commensurate with the scope of the proposed activity.	Intensity based on number of natural resource issues.
	1218	949	Questions are unnecessarily complicated..resulting in increased costs of permitting and decreased certainty..	Rewritten to increase specificity.
748	**Clarify role of mitigation will play in counting impacts. Applicability of offsite.. [also 674]**			
	140	48	Clarify the role mitigation would play when counting impacts.	Draft criteria provides suggestions for assessment of impact. Can also be used to assess compensatory mitigation.
	633	242	Appropriateness and availability of off-site mitigation is not clear.	Appropriate if compensates for impact.
	695	278	Needs to be consideration of "off-site" applicability…also provides strong local planning link.	Added.
	707	287	Lacking is mitigation framework spelling out exactly how calibrated to suitability of different areas for development.	Removed designtion of development.
	743	308	Do not agree "mitigation only lands not in public ownership". TIIF has provided mechanism project-by-project basis.	Noted.
	744	308	Mitigation should occur within same watershed and subbasin.	Appropriate if compensates for impact.
	936	473	Upland buffer: will mitigation credit be awarded for preservation of upland buffers?	Yes, if relates to function of adjacent wetland.
749	**Are %'s for all permits or for certain areas?**			
	284	85	Are percentages in he definitions now the norm for all permits or just for certain areas?	For area. % dropped.
	614	230	Will the criteria and this EIS result in strict numerical limits on wetland impacts for specific projects?	No.
750	**Map not accurate**			
	115	44	PRC Map is not accurate.	Previous map removed removed and replaced with Natural Resources Map, which identifies resources that would be impacted by a project in any given area within the region. Maps based on most recent region-wide mapping and other information available. Corps will use site-specific information to confirm/rebut map.
	249	78	Revise EIS based on existing signs and existing condi ions.	
	285	85	Maps are imprecise maps.	
	431	124	Revise EIS based on existing science and existing conditions.	
	459	145	Map does not accurately reflect existing actual land uses.	
	474	151	Object to preservation designation on this active rock quarry site and rest of site classified industrial.	
	604	225	Revise EIS based on existing science and existing conditions.	
	811	383	Suggest additional ground-truthing.	
	824	421	Map not drawn to any recognizable scale.	
	1391	1096	Suggest additional ground-truthing.	
751	**Project mislabeled Preservation**			
	7	8	Specific project mislabeled Preservation.	Original Permit Review Criteria Map delineated areas using "Preserve", "Development", etc. that implied the Corps had designated a particular land use activity. Have replaced this map with an Overlay of Natural Resource Map hat identifies areas where projects have potential for adverse effect to clear
	183	60	Four of your maps show my property as preserve yet are not wetlands on it.	
	233	77	Project Review Map shows areas to be preserved that are already developed or are permitted.	
	260	80	There a lot of people that have small farms and under your maps, its preserve.	
	338	92	Eliminate designation of preservation from two parcels because the EIS is wrong (more info at 433 &).	

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	356	100	Request my property be reclassified. Improperly zoned.	this confusion. In addition, have added to the Criteria a definition of how to identify the presence of the resource on the site. In this way, the landowner can simply, at ime of application, submit site-specific information which will overrride the map.
	407	122	Project Review Map shows areas to be preserved that are already developed or are permitted.	
	433	126	Eliminate designation of preservation for Paul H. William's property (letter referenced by 338).	
	442	133	Designation of preservation on the subject property is incorrect (letter referenced by 338)	
	510	171	Our property has been improperly zoned Preservation and request that it be reclassified.	
	573	199	Majority of Boon&Freeman property is inaccurately location in "preserve"	
	574	200	Baucom property inaccurately designated preservation.	
	575	202	Areas in PAT 98-08 (Recreational Facilities in DRGR) would be precluded by preservation designation.	
	577	216	Both parcels designated preserve, however designated as Suburban and western parcel is developed.	
	578	216	Eastern quadrant shown as preserve despite its classification as Suburban in Lee County Future Land Use Map.	
	579	218	Designation of preserve not supported by competent data and analysis.	
	581	222	Project Review Map shows areas to be preserved that are already developed or are permitted.	
	623	235	I do not want my land preserved due to the fact my dreams are to slowly turn those 20 acres into a (home).	
	668	258	Comp Plan shows Corkscrew Road Improvement Unit as suburban but parts are shown as preservation.	
	728	294	Reconsider the proposal to rezone our parcels as preserve which greatly limits our building, raising crops, etc.	
	787	340	Request revise DEIS to reflect land be designated development consistent with previous government approvals.	
	803	355	I do not want my land preserved. Instead, get rid of the smell and close the landfill.	
	808	381	The site specific information indicates property more suitable for "development" area then "preservation"	
	812	390	The site specific information indicates property more suitable for "development" area then "preservation"	
	813	402	The subject property better meets the intent of the Rural category.	
	814	406	We suggest the property be placed in the "development" area.	
	815	414	The property has no significant resource value and does not fit the criteria for preservation.	
	858	436	Do not further restrict use of our land, allow the rules at date of purchase prevail (1980).	
	873	443	We intend to build a vacation home…going to write Gov Bush because..stopped acquiring land by the Corps.	
	1076	542	(Portions) of the property designated preservation should be redesignated to development classification	
	1077	549	Property should be re-designated to the "Development" classification.	
	1081	555	The Property should be re-designated to allow development consistent with the current regulations in place.	
	1082	567	The Property should be re-designated to allow development consistent with the current regulations in place.	
	1086	578	The Property should be re-designated to allow development consistent with the current regulations in place.	
	1153	716	…has placed (my 250 acres) in "preservation" category and wish to…vehemently object (lists reasons)	
	1190	941	Revise the project review map (from "preservation" to "development")	
	1221	951	Proposed designation of "preservation" should be eliminated and replaced with "rural"	
	1255	969	Historical aerials..reflect significant disturbance due to prior construction..for which Corps was…responsible	
	1256	971	Delete the designation of "preservation" from maps (for Mamiye property..)	
	1261	973	Delete the designation of "preservation" from maps (for Mollach property..)	
	1262	981	Delete the designation of "preservation" from maps (for Williams property..)	
	1299	1016	I urge you to remove this area from the "preservation" designation.	
	1301	1018	Object to the rural designation and he preservation designation on the Project Review Map..	
	1302	1022	I am filing my response during the extension period you granted me…	
	1304	1024	Reclassify the Baucom property from the "preserve" and "rural" designations to "development"	
	1334	1046	Request subject property be removed from the preservation designation and placed in the development designation.	
	1335	1060	Request Corps modify Permit Review Map as it relates to the Sabal Bay property…	
	1339	1069	(information on site to change designation of property from preserve to development)	
	1392	1096	Existing site conditions…clearly merits treatment as a development area instead of a a preservation…	
	1404	1118	Existing site conditions..clearly mertits treatment as a development area instead of a preservation…	

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752	**Add Section Township Range references, scale, other**			
	10	9	Add STR to PRC map.	When finalized, will prepare maps with such references as well as distribute electronic ones capable of zooming.
	917	469	PR Map is difficult to read, scale is non-existent, determining exact location of boundary involves guesswork.	
753	**Exempt existing land uses and pending applications.**			
	162	55	Exempt existing land uses from designations on the map.	Removed designations of land use. Revised maps use SFWMD mapping. Still will be inaccuracies but fewer.
	562	196	If Project Review Map retained, specifically exempt existing land uses.	
	635	242	Project Review Map does not recognize some existing vested development.	
	828	421	Pending applications should be exempt from review against the map and the corresponding questions.	
	960	481	Maps do not clearly reflect some existing land uses…how will Corps view…requests for future expansion, …	
	1048	520	ADG members relied on own memories, planning maps, or outdated aerials that did not reflect existing land uses.	
	1049	521	ADG members were encouraged to ignore the realities of existing land uses and development rights.	
	1074	541	State that projects under review before final adoption of the DEIS are not subject to the recommendations in he EIS.	
	1217	949	Land use maps did not incorporate accurate portrayals of existing land uses..	
	1244	965	Ignores existing land uses.	
	1306	1025	Corps should consider the actual current condition and use of..property..	
754	**[spare]**			
755	**ADG maps drawn to discuss concepts but used in EIS for regulatory purposes.**			
	435	127	Maps drawn by ADG meant to be used for discussion of concepts but are included in EIS for regulatory purposes.	Maps not being used for regulatory purposes. EIS document revised to clarify.
	439	133	Maps drawn by ADG meant to be used for discussion of concepts but are included in EIS for regulatory purposes.	
756	**(at a location), change designation from preserve to development but annotate flowway.**			
	443	137	Change designation from Preserva ion to Development/Compensate for Species & annotate flowway exists (letter)	Deleted designation and added flowway map.
757	**State that more detailed submittals should supersede data in EIS in permit reviews**			
	566	198	Allow flexibility in review process. More detailed and current submittal supercede data used by Corps in DEIS.	Each map has a description of how map drawn. In addition, a description is included of how to identify if issue is present based on site-specific information so landowner can readily demonstrate in application applicability of question. Maps are now essentially self-correcting.
	809	381	Consider a procedural mechanism, in conjunction with clearer criteria, to change classification based on added data.	
	825	421	ADG drew map at very large scale with little time or data. At least allow property owners to rebut boundaries.	
	1073	540	DEIS needs to recommend a formal process for challenging the classification of property through rulemaking.	
	1389	1096	Consider a procedural mechanism, in conjunction with clearer criteria, to change classification based on added data.	
758	**Reference Collier NRPAs**			
	649	249	Project review map should be based in part on the interim Natural Resource Protection Area in Collier County.	Did not include since is interim. Also focused on actual natural resource locatons so not to confuse with of double-counting.
759	**Reference Areas of Critical State Concern**			
	650	249	Project review map should also reference Areas of Critical State Concern.	Is based on natural resource issues so area mapped on that basis.
	667	257	Believe your review of DCAs study of Big Cypress Area of Critical State Concern would be helpful.	Noted.
760	**Legends**			
	634	242	Project Review Maps are confusing. Overlay of Alternatives map easier to understand.	Removed designations of land use.
	1067	537	Creation of land use categories..does not achieve the goal of balancing demands of growth and conservation.	
761	**Change terminology from Preserve/Development to Tier1/Tier2**			
	8	8	Change PRC Terminology from "Preservation/Development" to "Tier1/Tier2"	Changed to level of review. Level based on potential for adverse effect on natural resorces.
	161	55	Drop references to land use in non-consensus areas and instead designate different review levels.	
	560	196	If Project Review Map retained, opt instead for designations as Review Level 1, etc.	

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	1069	538	Eliminate references to land use categories and reclassify as standard and heightened review.	
762	**descriptions not complete / not descriptive**			
	116	44	The land use categories are not sufficiently scripted.	Dropped all descriptions of land use categories. Corps has no particular preference on type of land use type but does have an interest in natural resource issues. Criteria written around latter.
	287	85	Land use categories not defined.	
	810	383	Suggest more definitive criteria for mapping of areas.	
	829	421	Where is mining permitted on the map?	
	830	421	Where are public facilities permitted on the map?	
	831	422	What does urban/suburban terms mean? What densities?	
	832	422	What is maximum density in rural category? Commercial and industrial uses permitted? Low density golf course?	
	833	422	What does "limited intensification" mean?	
	834	422	What kind of compensation will be required in "development with compensation for wide ranging species"?	
	835	422	Preservation connotes complete absence of development. More appropriate label should be used.	
	836	422	Will mitigation standards be higher in preserve category than in development category?	
	961	481	Land use categories within Ensembles not sufficiently descriptive…	
	1390	1096	Suggest more definitive criteria for mapping of areas.	
763	**descriptions conflict with those in comp plan**			
	145	51	The land categories are inconsistent with the land use plan.	Dropped all descriptions of land use categories.
764	**designation of Preservation damages those landowners**			
	159	54	I think it really does a damage to those people that have their property designated as preservation.	Dropped designation of "preservation". Landowners still see their properties mapped with from zero to several natural resource issues but can be rebutted or addressed in design of project.
	415	123	Reduced value resulting from declaration of privately owned lands as "Preserve"	
	498	166	If mapping or imposing criteria influences property rights, how can Corps implement any changes to permit system?	
	588	223	Reduced value resulting from declaration of privately owned lands as "Preserve"	
	1214	948	Based on the questions in preserva ion designation, appears owners will be denied economically feasible use..	
	1400	1103	Clearly..indicates ..Corps will take postion of opposing permit issuance…	
765	**Use overlay of alternatives map**			
	163	55	If you have to map, use the overlay of alternatives map.	Retained Overlay of Alternatives map in body of EIS as areas where Corps intends to propose General Permits that include conditions to protect listed species, etc.
	531	182	DEIS talks of consensus of certain areas, but differences in maps between conserva ion & development interests	
	696	278	Overlay of alternatives map is better than the project review map.	
	1375	1082	Section 2.2.1: Concurrence in Overlays map included assumption impacts to listed species, etc., would not occur	
766	**Only show areas for wetland restoration**			
	185	60	Don't designate development, suburban, etc. but just show areas historically wet, the ones to be restored.	Areas valued for restoration will be adjacent to existing wetlands, so maps can be used to search opportunities.
767	**Use overlay of alternatives map and, by region, specify what environmental issues are**			
	341	94	Propose that take he areas of disagreement by region and call out specifically what he environmental issues are.	Can do this with revised set of maps.
	561	196	If Project Review Map retained, utilized the "overlay of alternatives map"	Decided to use overlay of natural resource issues.
768	**Use sample permit and hypothetical site to demonstrate the four categories**			
	384	115	Request a sample permit using a hypothetical piece of land going through the four categories.	Illustrations rewritten to match revision.
769	**Designate "Water Preserve Areas" to focus on connectivity.**			
	499	168	Designate Water Preserve Areas to focus on connectivity of water resources.	Added separate map for connectivity.
800	**Record of Decision (comments that generally speak to implementation of EIS after finalized)**			
810	**DEIS confirms need for Permit Reform**			
	1125	673	EIS confirms significant environmental degradation and confirms need for permitting reform to restrict impacts	Noted.

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	1126	673	Corps, through wetland losses, is significantly degrading the SW FL environment.	Noted.
	1127	675	Any additional development will contribute to additional WQ degradation..include action to stem the tide of degradation	Noted.
	1128	675	What remains of wetland-dependent habitat (wetlands) must be protected if these species are to survive	Noted.
	1129	676	Manatee populations are stressed and declining	Noted.
	1130	676	Florida panther is losing habitat essential to continued survival.	Noted.
	1131	676	Red-cockaded woodpecker and Florida scrub jay are losing habitat essential to continued survival.	Noted.
	1287	1008	By its own admission (public statements) the Corps has not (list of permitting shortfalls..)	EIS initiated in attempt to improve.
	1288	1009	during the proposed application review, applicant is clearly able to "negotiate favorable permits"	Noted.
	1295	1012	Seattle District protocol is more effective at balancing resource protection and growth than Jacksonville District.	Noted.
	1353	1078	Sequential evaluation being circumvented, preponderance of non-wetland dependent projects, always result in fill..	Noted.
	1354	1078	EIS should reiterate responsibilities under 404(b).	Included.
	1355	1079	EIS should provide additional guidelines..outline policy..alternative analysis, wetland dependency, avoidance, etc..	Topics included.
811	**Corps needs to deny permits.**			
	22	10	Corps deny permits.	Noted. Decisions on permits based on review of individual circumstances.
812	**EIS should be used only as a resource document and not be part of permit process.**			
	576	207	Believe EIS be utilized strictly as a resource document and that is not become part of the permitting process.	Permit Review Criteria intended to demonstrate how can utilize EIS information.
820	**Choose Alternative [also 130]**			
	16	9	I would choose Alterna ive S. PRC look good.	Noted.
	37	14	Which of the Ensembles would be considered most seriously when you make your decisions?	Ensembles presented to compare effects of difference acres of fill and criteria.
	306	88	Concerned that Corps did not select a preferred alternative because this give the public a reference point.	Noted. In no case will Corps designate land use. The Corps has identified the proposed action as its preferred alternative.
	386	115	A preferred alternative should be identified prior to issuance of the final report.	
	528	182	Corps should include a preferred alternative.	
	662	251	Choose a preferred alternative. Do not select the local comprehensive plans.	
	669	261	DEIS has no preferred alternative.	
	672	262	Ensemble S should be designated as the preferred alternative.	
	716	291	Does not identify a preferred alternative. Map referenced by questions cons itutes preferred alternative.	
	770	321	Should have a preferred alternative. Suggest project review map with our modifications.	
	892	461	Do not see a preferred alternative. Ensemble S as meeting more of the environmental needs then the others.	
	911	467	Preferred alternative should be existing comprehensive plans coupled with rational development assumptions.	
	1361	1080	Not clear what build-out may produce…determine "best" land use for environmental (&other) issues before permit	
830	**Very complex document**			
	128	47	How many people have actual read the document. Is a very complex proposal.	Have rewritten portions in attempt to clarify.
	151	52	I have read the document twice and I was still confused. Divide the study into three areas.	
	180	59	EIS document is very complex and difficult.	
	187	61	We are still attempting to understand the implica ions of the confusing 600-page document	
	395	120	Complexity of document and development process has made it virtually impossible to acquire a fair understanding	
	632	242	Document needs to be structured more concisely and clearly. Tables may help, especially in Appendix H.	
	782	331	Found EIS to be a very complicated document.	
	1065	537	DEIS will complicate permitting process instead of achieving goal of creating predictable&streamlined process	
	1089	583	The material you have put out is very involved. The lay person does not understand most of this. ..need to explain..	
831	**Ensembles should be presented following scientific methodology**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	653	250	Ensembles were not presented objectively…using scientific methodology.	Scientific methodology defines hypothesis and tests. EIS is presented estimates of potential impacts.
832	**Use matrix in Appendix H**			
	694	278	Appendix H needs to be reorganized. Start wi h matrix..	Rewritten to clarify. Matrix may not be suitable for this revision.
	746	308	PRC question, factors, and parenthetical comments confusing. Rewrite.	
	915	469	Reorganize Appendix H to make easier to understand….matrix would be very helpful.	
840	**Reform mitigation policies [also 251, assessment]**			
	1103	596	assess and significantly modify Corps mitigation policies to ensure full functional wetland replacement	Noted.
	1147	708	EIS must critically assess mitigation in permit decisions and reform mitigation policies (3pp)	Noted. Not purpose of this EIS.
850	**General Permit (Pro, Con, Where are?)**			
	217	73	Hopefully lead to general permits.	Added to implementation section note that Corps would like to develop General Permits based on information in the EIS. General Permits will be proposed in areas of common vision (based on the Overlay of Alternatives Map) but incorporate permit conditions that reflect the concerns in the Draft Permit Review Criteria. For example, in Lehigh Acres the Corps would like to pursue a General Permit that authorizes fill of the individual wetlands on single family lots but with a mechanism where a large area of replacement wetlands are provided. This would recognize the impracticability of preserving wetlands on a single lot, prevents the decline of wildlife habitat, and provides an abbreviated administrative process to keep permitting costs low.
	248	78	To streamline, a nationwide or general permit be applied. Permit Review Criteria only apply to Individual Permits.	
	274	83	Creates opportunities and rationale, strong arguments made for nationwide permit for some of older platted areas.	
	296	86	Do not try to have a general permit in this area.	
	430	124	To streamline, a nationwide or general permit be applied. Permit Review Criteria only apply to Individual Permits.	
	534	183	DEIS should address adverse ecological effects of nationwide and general permit authorizations.	
	547	186	Request Corps not issue permits 29 or 26 in the study area.	
	569	199	Promulgate nationwide, general permit, or similar where Federal interest has been determined to be protected.	
	603	225	To streamline, a nationwide or general permit be applied. Permit Review Criteria only apply to Individual Permits.	
	631	241	Does not address the appropriateness and development of regional or localized general permits.	
	678	263	The Council opposes General Permits until they are better defined.	
	717	291	How are secondary and cumulative impacts addressed in a general permit? Protection of resources weakened.	
	912	467	Only one reference to proposing a general permit. Five references propose limits. Clarify Corps stand.	
	1075	541	Add to DEIS recommending development of a NW or GP and adoption through formal rulemaking.	
	1148	711	EIS and ROD must assess and restrict the curse of General Permits.. (2pp)	
	1204	946	Fails to address what impact these new procedures will have on current and future general permits	
	1313	1027	Suggest Corps issue a general permit for area north of SR 82..	
851	**Assess and restrict use of**			
	479	152	General permit use bring heavy cost in wetland and little or no monitoring, review, or enforcement.	The Corps believes several General Permits, each focused to a particular area, would allow for better specificity in the conditions that protect natural resources since tailored to circumstances of area.
	867	441	Should assess and significantly reduce the use of nationwide and general permits.	
	1104	596	assess and significantly restrict its use of general permits in Lee and Collier County	
860	**Assess adequacy of staff and resources**			
	35	13	More staffing.	The Corps is attempting to improve permit reviews with existing staff and funding levels. For example, the Draft Permit Review Criteria is one idea of how to use the information in the EIS to prioritize staff time. To answer the question of qualifications, permit reviewers are biologists or engineers who prepare a decision document describing the basis for their recommendation to issue a permit. That recommenda ion is reviewed by the supervisor who signs the permit.
	55	19	What qualifications are necessary in education for the people who issue the permits?	
	262	80	Corps used to be more responsive to small landowners (visiting site). Need more staff in Naples.	
	388	115	Questions in the permit review criteria are subjective. Prefer work toward additional resources for Corps.	
	391	116	No budget for additional staffing and monitoring.	
	421	123	Additional requirements require additional staffing paid through permit fees.	
	481	152	Corps staffing is currently very inadequate.	
	537	184	Review current staffing and funding levels of Ft Myers office.	
	594	223	Additional requirements require additional staffing paid through permit fees.	
	714	288	If there is any hing we as ci izens can do to effect an increase in staff and funding, would be happy to assist.	
	718	291	Work toward additional resources for Corps to provide objective review of applicant's responses.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	721	291	Does not include a budget.	
	869	441	Assess need for and secure additional staff.	
	1105	596	assess the need for, and secure, additional permitting staff and resources to implement improvements	
	1149	713	Must carefully assess the adequacy of staff and resources to meet the Corps statutory obligations…	
	1289	1009	Request breakout of workload in FtMyers office compared to other offices in Corps	
	1290	1010	Only remedy if Ft Myers office is to handle rapid growth…is to upgrade staffing and related office support	
870	**Include Monitoring and Re-evaluation provisions**			
	34	13	More monitoring of permitted work.	Noted.
	63	22	EIS does not contain a plan for monitoring.	EIS is identifying issues. Monitoring will be developed based on decision how information is implemented.
	390	116	No monitoring plan for assessing success.	Noted.
	480	152	Include provisions for monitoring and re-evaluation on application and the EIS level.	Noted.
	543	185	How the EIS will be implemented? What procedures to ensure EIS is effective? Include process to revise the EIS.	Added narrative to implementation section. Anticipate will develop tracking of key habitat and other indices linked to Permit Review Criteria if those criteria implemented.
	652	250	Establish guidelines for monitoring programs for permit compliance and for mitiga ion projects.	Already a current enforcement program.
	671	261	Does not have a program for monitoring and/or enforcement of decisions based on this study.	See response for comment 543 above.
	720	291	No monitoring plan for assess success.	Noted.
	733	303	Although is difficult to develop implementation strategy when review process is mutational…measure effectiveness.	Noted.
	736	306	No mechanism to insure that the end result will be less placement of fill than without the EIS.	Cannot predict if will result in less fill.
	772	322	Indicate how progress toward meeting the goals will be monitored.	See response for comment 543 above.
	870	441	EIS should contain strategy to revise EIS if found resources are not being protected.	Corps expects to perform periodic review of activi ies.
	894	461	Would like to see specific plans for enforcement of permitting decisions as well as for monitoring.	Already a current enforcement program.
	951	477	Is there some mechanism that will update or revise its predictions?	No formal mechanism.
	1106	597	adopt a monitoring program to assess the implementation of the program changes adopted pursuant to the EIS	See response for comment 543 above.
	1150	713	EIS and ROD must include monitoring and re-evaluation provisions to update the…analysis with new information	Permit Review Criteria designed, by use of multiple maps, to allow each section to be revised as new information arrives.
	1192	944	EIS does not provide for periodic review and revision based on changing conditions	Corps expects to peform periodic review but details will be developed based on decision how EIS information implemented.
	1325	1038	Recommend that at regular intervals meeting of involved agencies be held to evaluate progress..changes to PRC..	Corps expects to peform such a periodic review.
	1363	1080	Plan monitoring and changes in actual land use should be closely followed and reflected in map used by Corps…	Permit Review Criteria maps revised to be based on a base map that is expected to be periodically revised. Will make revisions easier.
	1381	1083	Agree with recommendation to meet semi-annually to continually evaluate and modify the criteria and implementation	Semi-annually may be too frequent to iden ify trends.
	1388	1085	Section 4.29: recommend incorporate monitoring plan…	Narrative added.
871	**Sunsetting and revision provisions**			
	289	85	Document does not allow for any type of sunsetting or subsequent revision.	Permit Review Criteria designed to allow each section to be revised as new information arrives. Most current information will be used in permit reviews.
872	**Supplement every five years [also 161]**			
	312	89	Perhaps every five years have a supplemental EIS.	Too early to speculate on need.

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
880	**Implementation**			
	62	22	EIS does not contain a plan for implementation.	
	259	80	Corps adopt the word "prevention" much like it adopted the word "restoration" in the Everglades.	Section on implementation rewritten and clarified. Decision on implementation made at Record of Decision issued after public has opportunity to review Final EIS.
	281	84	Implement quickly. Positive method to sanely control the growth in this county.	
	297	87	Issue is not stopping growth…but is about quality of life just as much as how Corps goes about doing this.	
	298	87	I think message is pretty clear that people want a quality of life here that hey can enjoy.	
	428	124	Implementation deferred pending complete determination of the economic impacts.	
	601	224	Implementation deferred pending complete determination of the economic impacts.	
	651	250	Address ways the changes in the procedure will be implemented.	
	661	251	Should not implement regulatory process that results in an inordinate amount of negotiation.	
	670	261	Does not have an implementation plan or time line for initiation.	
	719	291	No timeline or strategy for implementation.	
	771	322	Indicate how criteria will be used by Corps staff.	
	893	461	Would like to see more discussion on plans for implementation.	
	1362	1080	Management entity to administer criteria should be clearly identified.	
881	**Postpone permits until complete EIS [also 898, moratorium until establish criteria]**			
	645	247	Five year permit moratorium to establish WQ flows, levels & standards. Then applicant prove not degrading.	There will be no moratorium. Most recent information will be used in permit reviews.
	713	288	Ask provision be made for interim protection while deliberations continue.	
	786	334	Issue moratorium on wetland permitting until clear guidelines set, then do not deviate when tempted by money.	
	871	442	Postpone issuance of 404 permits until completion of EIS.	
	1107	597	postpone issuance of 404 permits pending completion of the Final EIS…particular for outside consensus areas	
	1151	714	Corps must postpone permit authorizations pending completion of he EIS.	
	1277	1000	Agree to postponement of your report only to extent County Commissioners agree to a development moratorium	
	1284	1006	Request you immediately begin using all new or recently acquired information on applications…deny extending..	
882	**When will be implemented?**			
	12	9	When do you envision the application of the PRC to real life developments?	As stated in PRC, apply to new applications. Decision to implement PRC made after Final EIS published.
	389	115	Does not include timeline for implementation.	
883	**Reconcile with SFWMD process**			
	13	9	Reconcile Corps process with water management district process.	S ill many legal differences between State and Federal.
884	**Apply to all permits?**			
	26	12	Will PRC be applied to all permits or will nationwides, etc., be excluded?	For individual permits, to all applications. The PRC would be used in writing General Permits, and also to determine the nature and type of special conditions. For an individual landowner who is construc ing a project that meets the terms
	27	12	Will PRC be applied to individuals seeking general permits?	
	134	48	Are criteria going to be applied to na ionwide permits or only individual permits?	
	611	230	Will Permit Review Criteria be applied to all permits or will NWs be excluded?	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	612	230	Will Permit Review Criteria be applied to each project requesting a General Permit?	and conditions of a General Permit or a Nationwide Permit, the PRC will be considered to have already been taken into account and therefore will not be used on the landowner's application for a letter of verification. (The nuance here is that what is commonly referred to as "issuing a General Permit" is really the Corps issuing a letter verifying in advance that the landowner's plan matches the General Permit and so the landowner is assured has met requirements of law). The General Permit is actually "issued" by Jacksonville for a group of construction activities and is good for five years. Nationwide Permits are similar except the permits are issued by Army HQ and landowners receive their verifications from Jacksonville.) For nationwides, elements of the PRC may be useful in demonstrating compliance by a project with some of the Nationwide conditior
885	**Can change PRC without public comment in future?**			
	28	12	Can PRC be changed without public comment in future?	The proposed use of the PRC is by Corps staff. However, Corps expects others to find this useful so will keep public informed and give opportunity to comment.
	136	48	Can the Corps change the criteria later without public notice?	
	613	230	What assurance Review Criteria will not be changed in future without giving public opportunity to comment?	
886	**Will result in strict numeric limits on wetland impacts?**			
	29	12	PRC result in strict numeric limits on wetland impacts?	Will not result in a numeric limit on impact.
	135	48	Will there be specific acreage limits for impacts?	
	838	423	How will % figure be used. How will projects in excess of this figure be treated?	
887	**How interface with DCA's review of agricultural lands?**			
	50	17	How does Corps process and EiS interface with DCA looking at rural sectors of our region now and in long-term?	DCA may find information in the EIS useful to them.
888	**Match up county permits with state and federal requirements [also 116 and 610]**			
	80	36	If you get a permit from the County, somehow our plans match up with state and federal agencies	One of the goals of this EIS is to better coordinate with local and State processes. For example, both Counties refer the landowner to state and federal permitting programs. Therefore, landowner looks to other parts of the County Plans for criteria on density, type of activity, etc., and, we hope, will be able to look at the EIS for criteria on wetlands and wetland related issues. An overlay map is included in the Permit Review Criteria that shows where these issues overlap areas identified for development by the Comprehensive Plans. A potential conflict may occur if a project proposed in an area deemed appropriate by the Comprehensive Plan is determined by the Corps, after its review of the he application, to have not addressed the natural resource degradation. The Corps hopes that by publishing its concerns via the EIS, that this information can be used by other agencies in the administration of their programs or
	202	68	Be sure have a simpler process for permits, more consistent with local level, not jumping multiple hoops.	
	205	69	Make sure the local processes and the federal process are headed in the same direction and indeed streamlined.	
	209	71	Our concern is that the right planning is done so that in future people don't say where were we to allow problems.	
	244	78	Corps adopt the Lee and Collier comprehensive plans as the basis for permit process.	
	344	96	Integrate the EIS and the Corps into our local processes.	
	426	124	Corps adopt the Lee and Collier comprehensive plans as the basis for permit process.	
	500	168	Ensure consistency between federal and local governments.	
	599	224	Corps adopt the Lee and Collier comprehensive plans as the basis for permit process.	
	794	348	Should revolve how to make Corps process more efficient within the comprehensive plan framework.	
	817	414	Why not unify federal and state jurisdictional criteria in the study area?	
	819	414	How will federal and state decisions be reconciled if starting point and measuring unit is different?	
	914	468	Lee County requires FDEP permit for single family lots with wetland characteristics. Will EIS require change to this?	
	1039	519	Review of document reveals that regulatory issues…are more confusing than before the EIS.	
	1280	1001	Don't expect Collier Commissioners to agree to anything meaningful about saving our water quality or environment	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1309	1026	No reason to increase permitting requirements when already multiple fedl, state, regional, and local govt reviews	revision of their plans.
	1343	1074	Urge Corps utilize resources in our communities and the state.	
	1364	1080	Outline methods to know local land use ordinances and require and encourage compliance with those ordinances.	
889	**Ensure goals are achievable**			
	93	38	Whatever goals that are set for us here sciencewise have to be real and have to be able to be attained.	The Corps is not implementing via the EIS any particular construction or acquisition or other fix. Corps is describing information that can be used in permit reviews.
	99	41	We welcome you to come and help us improve things, but don't fix it where won't work	
	346	97	Whatever you do, hope its done after due deliberation and will be something we can work with and live with.	
	854	435	Fully look at the possible ramifications (desired results and negative) before any actions are taken.	
890	**Base decisions on ecosystem**			
	3	6	Foremost in decisions should be that ecosystem means that everything is connected to everything else.	Agree.
	44	16	Permitting decisions must be made with ecological systems in mind.	Agree.
	54	19	Why don't developers develop complete environmental impact plans for their developments?	An environmental assessment is prepared by Corps for effects of wetland fill in the project.
	503	169	Recommend holistic view of land use and permitting decisions rather than current piecemeal.	Corps does not have that authority.
	660	251	Permit ing process must allow time to answer impacts of loss of foraging habitat.	Noted.
	781	330	Corps must strengthen the (protection of wetlands, etc.)	Noted.
	887	459	Stop loss of wetlands. Consider cumulative impacts of permitting decisions. Protect..ecosystems…	Noted.
	1222	957	Maintain an objective and balanced perspective..don't cave in to radical agenda of some in environmental movement	Noted.
	1223	958	Permitting authorities must be required to consider cumulative impacts…	Noted.
	1266	990	Support a new way of permitting that will protect all areas vital to wildlife and wetlands…	Noted.
	1886	1008	Published findings of PEER confirms that Corps is becoming more reluctant to carry out its mandate..	Noted.
891	**Address protection of wetlands**			
	5	7	Hope final EIS will be adequate to address he protection of these invaluable resources (wetlands).	Noted.
	14	9	Biggest concern is the great loss of wetlands that is taking place.	
	66	23	We ask for greater protection of wetlands.	
	352	99	Don't let Audubon build a three-story building on wetlands.	
	453	143	Support Kris Thoemke for fighting for increased protection of wetland areas.	
	472	149	Urge you to protect the wetlands.	
	475	152	Too much wetland destruction is assumed in the DEIS. The goal should be much lower impacts.	
	513	172	We urge you to act to protect (our remaining wetlands).	
	554	191	Eliminate harvesting of old growth cypress.	
	557	193	Improve the EIS to protect wetlands.	
	607	226	Why is any development permitted in wetlands.	
	610	228	Urge Corps to halt we land loss and protect watersheds and wetlands ecosystems.	
	616	231	There should be no more development on wetlands.	
	628	240	Urge you to change the current system of permitting to one that protects wetlands.	
	691	273	Leave streams in their natural habitat.	
	692	274	The 15 foot buffer around wetlands is a joke.	
	700	280	Our wetlands need stronger protection.	
	701	281	I want to see a new way of permitting..one that protects wetlands.	
	702	282	Support for a stringent policy regarding wetlands protection.	
	703	283	We really need the Corp's new look at the impacts of future development on wetland areas.	

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	704	284	Preserve the SW Florida wetlands.	
	705	285	I want our wetlands protected from development.	
	708	288	Strong opposition to continued illegal degradation of wetlands here in our area.	
	788	342	Complete EIS process. 1000 sqmile here, 500 sqmile there, you are talking about some serious acreage lost.	
	790	344	Strengthen EIS to preserve wetlands.	
	800	352	Need a new way to issue permits, if we don't we won't have any wetland left.	
	804	356	Serious consideration must be given to the loss of wetland areas in Collier County.	
	876	446	Strengthen the EIS and stop the loss of wetlands.	
	880	452	We need action to stop wetlands development.	
	881	453	We cannot afford to lose any more wetlands.	
	882	454	Be very diligent about granting permits to allow degradation of wetlands in SW Florida.	
	883	455	Take whatever steps are needed to stop the rapid loss of wetlands.	
	884	456	Strengthen the EIS…future of what is left of the wetlands is crucial.	
	885	457	Begin implementing results of the eis in favor of protecting wetlands.	
	888	460	We need a new way of permitting..to protect Florida's wetlands.	
	973	491	Consider an alternative way of permitting and help save our wetlands.	
	1062	535	Please protect the wetlands.	
	1083	569	I wish you would put a hold on any building on it (wetland on my street).	
	1087	581	Urge Corps not to violate the CWA and ESA in filling more wetlands in SW Florida.	
	1090	584	Please save our wetlands…	
	1093	587	Please stop rapid loss of wetlands..	
	1098	591	Wetland loss must be drastically checked..	
	1154	720	Please utilize the "new way" of permitting to stop the loss of wetlands…	
	1155	721	Please…protect the wetlands	
	1231	960	Has to be a stop to the wholesale rape of the wetlands	
	1233	962	We are very concerned about the FL wetlands.	
	1263	985	We need to stop the loss of wetlands…	
	1271	993	Strengthen the EIS to consider the cumulative impacts of permitting decisions (wetlands)	
	1272	994	Tighten up permitting…preservation of wetlands	
	1273	996	EIS needs to be strengthened if it is to be successful in protecting wetlands…	
	1274	997	I am very concerned about the rapid loss of wetlands…	
	1275	998	We cannot afford to lose any more wetlands…	
	1283	1003	Stop the rapid loss of wetlands..	
	1297	1013	I want to support preserving south Florida wetlands…	
	1314	1028	We cannot afford to lose any more wetlands…	
	1331	1043	Implore you to insure the final position "once and for all" stop to the piecemeal loss of wetlands in our area…	
	1338	1068	Urge you to institute increased protection of wetland areas..concerned about destruction of habitat..	
892	**Take action to maintain and restore water quality**			
	86	36	Public works projects important to water resources be encouraged and streamlined in permit review process.	Noted.
	182	60	Cannot trust the Corps to tell us what is good for us now (water quality)	
	208	70	Is the Corps going to help save the aquifers and water resources of SW FL? (lists issues)	
	231	77	EPA says have concerns about issuing addi ional permits wi hout additional study. If hat is the position of EPA...	
	250	78	Delegate water quality and quantity analysis to the SFWMD and local governments.	
	301	87	No question in my mind that water quality is deteriorating.	
	377	113	How can State of Florida and Corps issue permits that will result in increasing the pollutant load from runoff?	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	432	124	Delegate water quality and quantity analysis to the SFWMD and local governments.	
	496	165	Commit to monitor, consider, and mitigate cumulative effects of development on WQ.	
	509	169	Include in the plan design lands deemed necessary for water quality preservation/enhancement.	
	546	186	Request Corps not issue permits in watersheds that have impaired waterbodies under 303(d)	
	605	225	Delegate water quality and quantity analysis to the SFWMD and local governments.	
	620	234	Mandate more buffer space between natural water bodies and development.	
	621	234	Mandate hat development does not increase the speed of rainwater flowing into these water bodies.	
	622	234	Mandate filter or settlement areas be made a part of any new large development.	
	681	263	In areas where development is taking place, employ stringent criteria for land uses that impact water quality.	
	724	292	Corps needs to make sure permitting process recognizes detrimental secondary&cumulative impacts.	
	791	345	Support concept of protecting lands which would allow opportunities for water resources management.	
	878	448	Water quality and quantity is the overriding concern and is the reason that federal regulation is needed in this area.	
	907	464	Public works projects that are designed to further goals of EIS should be streamlined through permit process.	
	1099	592	Corps must exercise its authority to deny permits that will worsen pollution and to mandate waters be cleaned up..	
	1134	679	None of the DEIS alternatives will stop water quality degradation.	
	1135	679	To maintain water quality, development must be limited and stormwater treatment requirements must be applied	
	1136	680	Improve water quality and stormwater treatment monitoring and analysis.	
	1137	681	EPA must take lead in improving water quality, stormwater monitoring, reporting, and treatment.	
	1138	683	Corps permit program must implement development limits and stormwater treatment limits.	
	1220	950	Like to see Corps take steps to assure the maximization of water safety (quality).	
893	**Take action to further limit adverse impacts**			
	45	16	Come up with an EIS so can evaluate permits so doesn't come down to the last straw.	Noted.
	207	69	Put out the ROD soon and add more science later on. Delay is buying time to get more development in.	
	220	75	Is bogus that we're going to be sneaking development in here in the meantime.	
	223	75	Rate of wetland destruction is increasing. This is irresponsible.	
	230	77	The permitting process is still as stringent at it always has been. I do not see any rush to permit willy-nilly.	
	252	79	Complete swiftly. Cumulative&secondary impacts to wetlands have already put Corps program in noncompliance.	
	254	79	Corps must make immediate and substantial changes to its procedures to protect the environment.	
	256	79	That the translation of this document into a meaningful permitting process will represent real change.	
	263	81	We have a moratorium in Collier County, but not all over the County (referring to comment 220).	
	278	84	I see population increasing beyond supply of the environment, of the water supply.	
	280	84	Put the most stringent plan in pace and err on the conservative side.	
	292	86	Looking to the Corps to protect citizens from the destruction of all the natural resources.	
	293	86	Collier County was not a self imposed moratorium (reference comment #220)	
	302	87	We have to preserve critical wildlife habitat. Corps needs to act now to deal with these cumulative impacts.	
	304	88	What we are setting us up for is a repeat of what happened in Southeast Florida with Dade and Broward Counties.	
	318	89	Stay in Collier County and stop this greedy bunch. Put a halt to it now.	
	324	90	This is not about acquifers…this is simply look out, I am here, shut the door behind me.	
	327	91	Corps should take action now. Cumulative impacts of projects resulting in unacceptable wetlands & habitat loss.	
	349	99	Move forward on EIS. Once you develop, can't go back. If spend next years doing what done in past, lost bat le.	
	378	114	Extension of time before Record of Decision seen as stalling tactic to allow permits to be grandfathered in.	
	473	150	Imperative that this growth be managed in a way that protects the invaluable natural resources.	
	548	187	Additional loss of upland&wetland is unacceptable. Future growth must be restricted to current urbanized areas.	
	556	192	Urge Corps to strengthen the EIS.	
	617	232	Very interested in any proposals that will slow the urbanization of the area.	

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	624	236	I support a new way of permitting, one that protects wetlands.	
	625	237	I urge you to continue with your original plans and to follow through laws and strict guidelines.	
	626	238	Please strengthen the DEIS by protecting the wildlife habitats…	
	627	239	Please help SW FL from becoming more overcrowded.	
	641	244	Strengthen the EIS draft..rapid loss of wetlands must be curtailed. Also protecting the watersheds and …	
	642	245	Please protect our system..wetlands, water quality and wildlife.	
	643	246	If extend comment period, request Corps immediately begin enforcing the permitting criteria now in place.	
	644	246	Request Corps begin conducting adequate surveillance of clearings for sing-family dwellings.	
	693	276	Place strict controls on the indiscriminate development of our irreplaceable resources in Lee County.	
	742	308	If Estero ABM map were adhered to in Corps permitting, watershed, resources and people would benefit.	
	784	332	Our quality of life depends on better management and permitting of future development.	
	785	333	We cannot afford to lose any more wetlands in southwest Florida.	
	802	354	Corps permit system must be strengthened to protect wetlands, water and wildlife.	
	822	419	Do what you can to curb growth or at least minimize the effect.	
	864	441	Adopt permitting reforms to reduce cumulative adverse environmental impacts.	
	874	444	Don't delay this study. Call this phase complete and move forward.	
	875	445	Like to see the EIS strengthened to protect wetlands, water quality, and wildlife.	
	1063	536	EIS must be strengthened to protect SW FL from excessive development.	
	1088	582	Now there is a chance to undo the damage..	
	1091	585	Strongly support the Corps plans to improve permitting process, protect wetlands, water quality,…	
	1092	586	Please help us (control negative impact on the environment)…	
	1094	587	Protect habitat of (listed) species by providing interim protective measures while gathering information for EIS	
	1095	589	Halt all further development in Collier County…	
	1100	592	Loss of habitat is harming our efforts to save the Florida panther…and other endangered species.	
	1140	684	Corps must revise the Project Review Map to limit cumulative adverse impacts.	
	1141	684	Put additional wetlands and wetland-dependent wildlife habitat in the "preservation" category in permit review map.	
	1142	685	Put additional coastal waters in "preservation" category in permit review map to maintain water quality and manatee	
	1143	685	Put in "preservation" in permit review map remaining habitat of Panther, RCW and Florida scrub jay.	
	1144	686	Put in "preservation" in permit review map additional historic flowways and groundwater recharge areas.	
	1232	961	Wetland loss must be reduced…habitat suitable for threatened and endangered species must be protected..	
	1268	991	The critical component of reducing cumulative losses is to stress avoidance in the permitting process.	
	1278	1000	So called moratorium is nothing more than a group..looking for a way to wait for you to go away…	
	1281	1001	You are our last hope for clean water and for the survival of many creatures..	
	1282	1002	Support strengthening of EIS to more fully protect our wetlands, water quality, wildlife	
	1317	1033	We are rapidly losing habitat…	
	1321	1036	Please protect our precious environment..	
	1328	1040	If you do not do this (implement Lehigh EIS) there will be no wild turkeys, deer, hogs, quail, etc., in Lee County at all	
	1329	1040	Come out against Del Prado extension. Daniels Road extension should not be built because...Panther habitat	
	1332	1044	Finish with all due speed the final EIS…time is of the essence to protect our environment…	
	1333	1045	We need you to…enforce all Federal laws pertaining to water quality and environmental issues..	
	1337	1067	We urge you to protect our environment…	
	1340	1073	These gems (wetlands and wildlife) need to be protected.	
894	**Protect the water supply**			
	172	57	We need to protect our water supply.	Noted.
	179	59	Lehigh Acres is sitting on the biggest acquifer in Lee County. It will never go dry.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
895	**Protect from flooding.**			
	186	60	Lehigh must be made to retain water in their community & take responsibility for impact to neighbors downstream.	Noted.
	666	256	Hope problem of Lehigh flooding my property has been address in your study and action taken to correct.	
	686	272	Address mitigaton of surface water problems of new construction filling land for flood but older at pre-flood elev.	
	1264	987	As we watch the growth in Lehigh, we are certain our flooding problems (downstream) will worsen.	
	1265	989	Lehigh must be made to retain water in their community and take responsibility for impact on neighbors downstream	
896	**Commit to MSRP and Closing Gaps in decisions [also 370 and 719]**			
	491	164	Must be commitment by Corps to incorporate the MSRP into its permitting decisions.	Noted.
	492	164	DEIS fails to commit to coordinate GAPS informa ion into future permitting decisions.	
897	**Integrate EIS with Restudy**			
	552	187	Integrate the EIS with he Everglades Restudy.	Restudy team has this EIS for their use.
900	**Other Interest**			
910	**Golden Gate Estates**			
	322	90	Are they (EPA) using you to take a shot at Northern Golden Gate Estates [to buy out like SGGE]?	No.
	345	97	Been 25 years since looked at GGE. Time to take another look, what's going on, what we can accommodate.	Noted.
	1252	967	What kind of impact you are going to have on my property, if any.	If you have we lands on your property, under current law you cannot fill those wetlands without a permit from the Corps. The wetlands in GGE also have a high potential for use by wildlife in he region, some of those species are listed under the Endangered Species Act. The Permit Review Criteria found as an appendix describes those species as well as other natural resource issues. If your wetland location intercepts the map, the Corps will spend more time in the review of your application than other applications and you will have more questions to answer. The Corps is working on and hopes to propose a General Permit for GGE to provide an abbreviated administrative process.
	1298	1014	We gladly accept this invitation (to participate in developing a general permit in GGE)…	Thank you.
911	**GGE Zone 2 map matches FEMA .. Indicates collusion with other groups**			
	444	140	GGE Zone 2 matches FEMA map, indicating prior knowledge of outcome or participant goals extremist groups.	FEMA map was not consulted when Zone delineated.
912	**No evidence to support Zone 2**			
	445	140	No scientific or historical evidence to support Zone 2	Zone 2 is less built out and generally has higher proportion of wetland.
	446	141	Difference in pine trees north and sou h of GGE Blvd yet no difference in map. Therefore, no science used.	Difference did not show up on maps used. Both are forested cover used by wildlife.
913	**Irresponsible to tell landowners go back to original seller for losses from regulatory**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	447	141	Inaccurate&irresponsible to tell current landowners to go back to original seller for loss due to regulatory dictates.	The requirement for a Corps permit to place fill in wetlands was ini iated by passage of Section 404 of the Clean Water Act of 1972. There are those who purchased lots before then that have been affected by this new law. Those who purchased after 1972 may unfortunately may not have been aware of this.
	715	289	Change location of GGE zones proposed.	Zones deleted in Permit Review Criteria. Are retained in EIS Ensembles since were ideas proposed and evaluated to reduce acres of wetland fill.
914	**Requiring Individual Permits is unwarranted intrusion by government**			
	448	141	Requiring Indiv Permits is unwarranted intrusion of government into private conduct of families in GGE	The requirement for a Corps permit to place fill in wetlands was ini iated by passage of Section 404 of the Clean Water Act of 1972.
920	**Property Rights [also 443 for economic, 620 for Lehigh specific]**			
920	**218**	73	Be very careful when taking away the rights of people in any form, limited or extension.	The Permit Review Criteria has been substantially revised. The Corps can and has asked these questions and analysis but now the landowner has better understanding of these in advance of application by a landowner for a permit authorizing fill of wetlands. The right to fill wetlands on a property is subject to Section 404 of the Clean Water Act. The revised Permit Review Criteria is not much diffferent from what would be discussed during intense pre-application meeting, only now the Corps is placing this information in the public arena for wider comment and use. The EIS reflects the Corps knowledge of on location and assessment of natural resource concerns prior to receipt of site-specific information. The permitting process is complicated and the Corps hope this removes some of the mystery.
920	**279**	84	I don't think is plan to hamper individual homeowners, is an issue with massive development.	
920	**347**	97	The green is not green…belongs to property owners..You do not have loss of wetlands&habitat..You have gain.	
920	**350**	99	Have not heard anything tonight about humans, preserving humans and their life.	
920	**358**	100	What will the ability be to use this property in the future?	
920	**511**	171	Where does EIS leave us and individual property owners in regards to our property rights?	
920	**664**	254	No place in EIS for any evaluation of "property rights" (see narra ive)	
920	**1152**	715	Those of us who own land downstream have right to peaceful enjoyment of our property…	
920	**1253**	967	Is it possible that the government can just ruin this property (purchased with set of deed rights) for us?	
921	**Gives undue weight to private property rights**			
	258	79	EIS exaggerates the effects of permit ing on private property rights.	The Corps must and will ensure its actions that restrict use of property are just those that are authorized by law. The presenta ion in Section 4 of the evaluation issues are not in any particular order of importance nor are they assigned a
	482	153	DEIS puts too much weight, in its analysis of alternatives, on private property factors.	
	680	263	Minimize the value of Property Rights factor or replace with criteria that do not omit individual/community goals.	
	1122	658	Gives undue weight to private property rights in alternatives evaluation, permit review map&criteria (10pp)	

Comments on Draft EIS

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1279	1000	Re: property rights..the greater good of society can cause..you..to intervene..contention landowner can do anything	weight. However, the Corps will, wi hin the limits of the law, fully consider the natural resource impacts that may result if a requested wetland fill is authorized. Section 404 of the Clean Water Act is a restriction of the right of a landowner. But that restriction is limited to placement of fill in wetlands on the property. (The Endangered Species Act and other laws also are restrictions within designate limits). The EIS does include the factors identified by the ADG subgroup (in the first paragraph of the Socio-economic section) but also includes many additonal pages of other factors.
922	**Compensate for loss of property rights due to regulations**			
	25	12	How persons compensated if property taken due to regulatory application of EIS?	The EIS is not pre-determining a Corps permit decision. The decision to issue or deny a permit can only be made after receipt of an application and a review of site-specific information. If an application is denied, the landowner can appeal.
	36	14	Compensate me for the property you take.	
	43	15	Protest the more complications on private property. If can't leave along, pay for it at fair market value.	
	56	20	How will the landowner be compensated for the loss of value caused by tightening/restricting land development?	
	247	78	The economic analysis must provide a strategy on how to compensate property owners.	
	429	124	The economic analysis must provide a strategy on how to compensate property owners.	
	602	224	The economic analysis must provide a strategy on how to compensate property owners.	
	608	227	What compensa ion will be made to property owners for any restrictions placed on properties?	
	857	436	If new rules not in effect when land was purchased, the owner should be compensated.	
	923	472	If restrictions on land use are intended to benefit society as a whole, then (consider) some form of compensation	
	987	501	Explain..the method..the owner of a lot for which a permit was denied will be compensated for loss of value..	
923	**Obligation to provide offsetting benefits.**			
	64	23	A win-win situation when developers convinced they had to provide infrastructure, offsetting benefits, etc.	Agree.
924	**Not adequately analyzed**			
	121	45	Property rights not adequately addressed in the analysis.	Expanded.
	122	46	How will goal to move people to central Lehigh, contrary to redevelopment plan, affect their property rights?	Is presented as one of many ideas. Recognize that implementation would need to provide compensation or other method to address rights of existing landowners.
	497	166	Perform more thorough legal analysis of regulatory takings. Weight given is too high.	Regulatory takings are beyond the scope of the EIS.
925	**Compensation ten cents on the dollar**			
	155	53	If land is seized, people are paid ten cents on the dollar.	Noted.
	158	53	Re: they pay ten cents on the dollar. That is a big lie.	Noted.
926	**Identify source of revenue and buy areas designated preservation**			
	165	56	Identify a source of revenue for the areas mapped preservation	Have removed designation of "preservation" from Permit Review Criteria. "Preservation" still found in five Ensembles but as ideas that if implemented would result in less wetland fill or greater wildlife benefits. Evaluations also note concern would cost money, reduce tax base, etc. to implement. Actual source of revenue not needed at this time since Corps does not intend to implement as a result of the EIS.
	194	62	If areas are to become part of additional wetlands areas that benefit their neighbors, then they should be bought.	
	288	85	How will private property in the EIS area would be acquired?	
	354	99	There are willing sellers out her also if you pay them enough to replace what we have.	
	417	123	Cost of purchase and maintenance of "preserve" lands must be addressed.	
	460	146	Fail to discuss mechanism to generate funds to compensate landowners for taking of lands designated preserve.	
	514	173	Land presently farmed identified preserve. Corps intends to purchase this property and create a different use?	
	571	199	Identify source of revenue allocated to land acquisition.	
	590	223	Cost of purchase and maintenance of "preserve" lands must be addressed.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	778	325	RE: flowways, coordinate efforts with FDOT but seek federal funding to cover costs of renovations/retrofits.	
	799	350	Effort should be placed to fund mitigation ideas (acquisition of lands for preservation)	
	886	458	Is it true you would pay for our land and how much would we receive?	
	969	482	Many ideas (in ADG process) were wish list..did not consider property rights nor funding to accomplish..	
	983	501	Explain who you envision will fund and perform the work to remove roads and canals.	
	1215	948	Discussion of mechanism for generating funds to compensate affected landowners is necessary…	
927	**Intend to confiscate through overregulation**			
	184	60	You don't intend to acquire that land, but you intend to confiscate it from us through overregulation	Questions in Permit Review Criteria can be and have been asked by the Corps in permit reviews. No increase. By making available to public in advance of application, hope to remove some of the burden of regulation.
928	**Corps is implementing United Nations Agenda 21**			
	348	98	EIS is implementing Agenda 21 of the United Nations. Looks like local input but they just mandated you do things.	Not working under UN mandate. Did not even know of this until comment made.
930	**Seminole Tribe**			
	1078	551	Tribe agrees with he inclusion of this language (regarding Immokalee Reservation) in the final EIS.	Noted.
	1079	551	Add that classification of surrounding land will not be considered when evaluating projects on tribal lands.	Have removed classification of "preservation" from Permit Review Criteria.
	1376	1082	Include Immokalee Reservation and the SWFI Airport in the "development" category.	Have removed classification of "development" from Permit Review Criteria.
940	**Corps role in hurricane preparedness**			
	40	14	Like to see more comment on Corps role in hurricane preparedness.	Comparison of Ensembles indicates that very little difference on hurricane preparedness results from changes in wetland fill so did not elaborate further.
941	**Hurricane shelters not provided for in EIS**			
	890	461	Problem of hurricane shelters is raised but no provision for providing them or roads to reach those shelters.	Provision to provide these not within authority of Corps Regulatory Program so did not elaborate further.
950	**Other agencies may mis-use the EIS**			
	124	46	Other agencies will cite the EIS as gospel in their decisions.	Noted.
960	**Bring revised EIS document back to public for comment.**			
	166	56	Bring changes to the Draft back to the public.	The focus of the comments dealt with the how or under what authority the Corps was implementing the information in the EIS. The Permit Review Criteria causes many of those comments and that has been
	251	79	Request review and comment period following revision of current draft.	
	606	225	Request a review and comment period following the revision of the DEIS	
	1060	522	Encourage Corps provide an additional draft with public review before proceeding to draft a final version.	

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	1344	1074	Provide a review and comment period if current document is revised.	substantially revised and the revision is attached to this EIS. However, the basic concept of permit review criteria remains unchanged. Comments will be considered and revisions may occur before implementation, if implemented. The Record of Decision will describe implementation and will be issued after the comment period closes on the EIS. O her revisions have been made to the other portions of the document but are not considered to be to the degree of needing to reissue the document as a Draft. The Corps wants to finish the EIS as a document that represents available knowledge
961	**Issue another Draft EIS before proceeding to final**			
	229	76	Come up with an additional draft for public comment before a final draft is issued.	See response immediately previous.
	469	147	Provide another draft document prior to publishing a final version.	
	558	195	Request a second public input period prior to DEIS being posted in Federal Register for final comment.	
	629	241	Recommend Corps incorporate comments into a second draft EIS, redistributed and comment period reopened.	
	910	467	Initial round of comments be incorporated into a second draft document due to complexity, volume and implications.	
	1219	949	Recommend an additional draft with appropriate comment period..	
	1257	973	Request the next version of the EIS also be considered a "draft" and issued for another public review.	
962	**Provide public review and comment on additional information to be provided by USFWS**			
	468	147	EIS says FWS providing additional information after comment period. Provide opportunity for public review.	Additional information provided by USFWS incorporated into this revision for public review and comment.
	1059	522	Reference FWS providing additional information on wildlife issues..inclusion without public review is inappropriate	
	1203	946	re: FWS providing additional information…(provide) opportunity for full public review and comment..	
	1379	1083	FWS appreciates Corps inclusion of affirmative actions in DEIS (language in Section 2.2 2, 2.2.3, and 2.2.4)	
963	**Involve public agencies in development of analytical tools (e.g., DOT)**			
	780	325	Include representatives from FDOT on interagency groups developing more detailed analytical tools.	Noted. Corps is also participating in a DOT interagency initiative related to permitting.
970	**Corps go to Bonita and solve their flood problem.**			
	168	56	Corps needs to go to Bonita and solve their flooding problem.	Subject of a separate Corps project.
980	**Port-Au-Prince**			
981	**How is it that the rich developers..are permitted to destroy property?**			
	316	89	How is it that the rich developers…are permitted to destroy property, water quality, wildlife and wetlands?	Issues are related to separate individual permits.
	317	89	Do they have to flood us out for 23 acres more (development)?	
990	**Other**			
991	**Reviewed air quality / respiratory problems from construction equipment exhausts?**			

Topic	Cmt#	Pg#	Synopsis or Extract of Comment	Response
	471	148	Number of increasing respiratory problems & cancer from particles in exhausts of construc ion vehicles?	Each permit application is analyzed for conformity applicability pursuant to regulations implementing Section 176(c) of the Clean Air Act. Typically the activities proposed under Corps permits will not exceed de minimis levels of direct emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. Also, predicting the cumulative effect of air emissions of projects placed on fill pursuant to a Corps permit would be sheer speculation.
992	**Analyze appropriate location of agriculture near residential.**			
	502	169	Analysis of appropriate location of agriculture in proximity to residential development to avoid zoning nuisances.	Corps authority not extend to zoning nuisance issues.
993	**Project Review Map shows flowway to Estero Bay severed.**			
	740	308	Both Project Review and Overlay maps show flowway connection between Rookery Bay and watershed severed.	Noted.
994	**Change "Florida Game…" to "Fish and Wildlife Commission…"**			
	769	321	Change Florida Game…to Fish & Wildlife Commission…	Where the old name was used when describing he author of a document, the old name was retained. Otherwise name was changed.
995	**Change name to "Florida Division of Historic Resources.."**			
	775	323	Page 82 name changed to Division of Historical Resources.	Changed.
996	**Suggestions for improving process (lessons learned)**			
	793	347	To get more County involvement, clearly state specific objectives.	Thank you for suggestions.
	795	348	Suggest a limited number of agency personnel in future ADGs	
	796	348	Jump-start future ADGs with specific goals.	
	798	350	ADG scope of effort was too broad, prevented accomplishing many tasks.	
997	**(spare)**			
998	**Global warming not addressed**			
	891	461	Hear about danger of global warming, but we do not see that problem addressed in the EIS.	The issue is larger than the study area and the Corps authority.
999	**Revise boundary of SWF International Airport**			
	972	484	Revise the SW Florida International Airport expansion boundary shown on the project review map.	Changed.
END OF DOCUMENT				

ALTERNATIVES FOR THE SOUTHWEST FLORIDA ENVIRONMENTAL IMPACT STATEMENT

FINAL REPORT

December 1998

ALTERNATIVES FOR THE SOUTHWEST FLORIDA ENVIRONMENTAL IMPACT STATEMENT

FINAL REPORT

by

Alternatives Development Group

with support from

Planning and Management Consultants, Ltd.

Report Submitted to

U.S. Army Corps of Engineers
Jacksonville District

December 1998

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LIST OF ACRONYMS

Acronym	Description
ABM	Estero Bay Agency on Bay Management
ADG	Alternatives Development Group
ARF	Acquire, Restore, and Fix
BCACSC	Big Cypress Area of Critical State Concern
BMP	Best Management Practices
Corps	U.S. Army Corps of Engineers
CREW	Corkscrew Regional Ecosystem Watershed
CRPA	Critical Resource Protection Area
DCA	Florida Department of Community Affairs
DEP	Florida Department of Environmental Protection
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
GFC	Florida Game and Freshwater Fish Commission
GIS	Geographic Information System
Hub	Zoom B of the study area
NEPA	National Environmental Policy Act
PMCL	Planning and Management Consultants, Ltd.
RPC	Southwest Florida Regional Planning Council
RRR	Restoration, Retrofit, and Redevelopment
SAIC	Science Applications International Corporation
SFWMD	South Florida Water Management District
SHCA	Strategic Habitat Conservation Area
Zoom	Section of the study area

I. ADG PURPOSE, MEMBERSHIP, AND REPORT

BACKGROUND

The Alternatives Development Group (ADG) was formed to support the U.S. Army Corps of Engineers (Corps) in the drafting of an Environmental Impact Statement (EIS) for a region that spans portions of Lee and Collier counties in southwest Florida (shown in Figure I-1). The increasing number, size, and complexity of development permit requests by the citizens and business interests of southwest Florida have created a condition where the Corps and other regulatory agencies are experiencing difficulty in, on a case-by-case basis, addressing their responsibilities under federal and state law. Thus, the Corps is at the point where permit processing is taking longer, permit denials become more frequent, and the environment may receive less protection than required by law. The subject EIS is designed to offer regulatory and planning-based remedies to these shortcomings, by seeking an effective balance between natural systems and economic stability through the examination of natural and social interactions that occur in the study area.

This EIS has many roots including (1) comments submitted by the public and community organizations on individual permit applications that expressed concerns on cumulative impacts, (2) other studies and work in region, and (3) initiatives to incorporate watershed and ecosystem-based principals into permit reviews. The Corps publicly shared some ideas on whether and how to perform a review of its regulatory program and received many letters and comments from the public, civic and industry associations, conservation organizations, and other agencies. Some supported and encouraged the review or aspects of the review, some advised of the potential detrimental effects of a change in the program or of the review itself, and most had questions or ideas on the scope of the review in relation to Corps authority. The Corps initiated and tailored the EIS process based on this input.

A unique dimension of this EIS is the formation of the ADG, which was tasked with the creation and evaluation of alternatives—a central component for the EIS. The nature of the EIS is to consider the range of important issues guiding the evolution of southwest Florida. Accordingly, the Corps initiated and sought participation from the ADG that consisted of key individuals representing the interests and vision of southwest Florida. The specific charge of the ADG as offered by the Corps was to:

Report on alternatives for improving the regulatory process to:

- X *Protect natural environmental values*
- X *Provide for sustainable economic growth*
- X *Manage appropriate changes in water flows and quality*
- X *Respect public involvement and private rights*

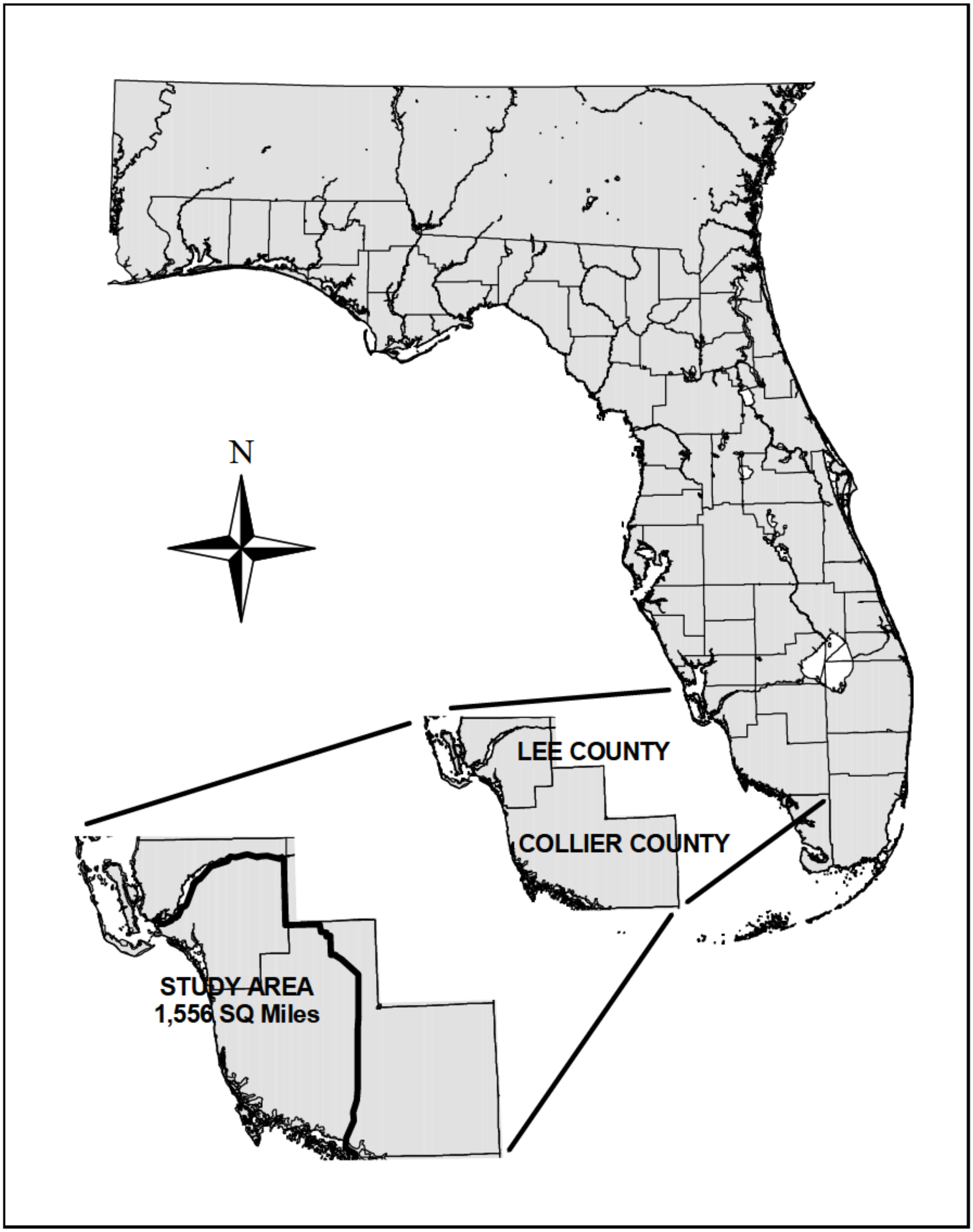

FIGURE I-1

ADG STUDY AREA

The ADG will collectively develop alternatives, evaluate the merits of each, and seek consensus on recommendations.

To effectively accommodate the charge and, more importantly, to create alternatives and evaluation factors that will bring added efficiency to regulatory activities in the future, it was imperative that this be a collaborative effort, drawing upon the perspectives of the key stakeholders in southwest Florida. The Corps worked closely with the Lee and Collier County Commissions and others in selecting, from a large number of interested persons, representatives to the ADG, which are listed in Appendix A. The list reveals a range of backgrounds and interest offering technical and political perspectives as well as interests that are driven by both environmental pursuits and economic development motivations. There was also representation of the general public on the ADG.

REPORT PURPOSE AND ORGANIZATION

This report summarizes the activities and results of the ADG. There was a significant amount of information—to include reports, data, presentations, maps—that was drawn upon during the ADG deliberations. Each of the ten core ADG meetings was documented with meeting notes that provided details of meeting activities. Supplemental process materials and data were provided in the attachments. These meeting notes and attachments and other materials numbered in the hundreds of pages of support materials provided to the ADG. While all of this information will be available to the Corps in the creation and management of the EIS, it was not practical or necessary to include all of that information in the ADG report. However, a listing of all the information presented to and utilized by the ADG is found in Appendix B.

The present document focuses on the results, summarizing the many hours of meeting activities and associated analyses embarked upon by the ADG. This report will be used directly within the EIS documentation to support the "alternatives" section of the EIS. The Corps will use the ADG report to support and guide the Corps in the development of EIS alternatives as required by the National Environmental Policy Act (NEPA). The other portions of the EIS documentation are being developed in parallel with ADG activities. The entire EIS will be assembled to completion and will be worked through standard review channels and public comment.

Following this introductory chapter there are five chapters that describe details of the ADG process and results. The final chapter of this report offers an interpretation of ADG results as compiled by the Corps and the facilitation team. The following is a brief summary of the remaining chapters.

Chapter II - Process Overview. Describes the general activities, style, and rules that guided the ADG=s deliberations.

Chapter III - Issues and Evaluation Factors. Presents the key issues that were raised by the ADG and how they were used to evaluate alternatives.

Chapter IV - Alternatives Developed. Describes how the alternatives were developed making reference to Appendix C, which contains profiles of each alternative.

Chapter V - Evaluation of Issues: Themes and Direction. Offers discussion of key points and trends that were revealed through the development and evaluation of alternatives.

Chapter VI - Concluding Remarks. Closes the report with summary remarks and identification of where additional analysis could be used.

Chapter VII - Interpretation of Results. Offers commentary of how the alternatives were aligned with one another and implications of permit activities.

II. PROCESS OVERVIEW

The ADG embarked upon a process that was designed to elicit the perspectives of a range of stakeholders in the development and analysis of a series of alternatives. A series of ten two-day meetings were held starting in April and ending in August of 1998. Over the course of these ten meetings, a very deliberate process was followed that was designed to satisfy the ADG=s charge given the spectrum of representation, the timeframe allowed, and available information. The basic tenets of the process are illustrated in Figure II-1. The meetings were designed, managed, and facilitated by a professional team with the goal of encouraging quality information exchange in an unbiased manner in support of the ADG charge. The meetings were open to the public and several people came to observe, as did members of the press.

This chapter provides an overview of the process defining the framework for the ADG activities. The results of these activities are provided in subsequent chapters. The present chapter also touches on some of the important dynamics of the ADG in terms of how they interacted and postured entering into this process. The overall "group attitude" about the activities is a key dimension of the progress of the ADG. Several points in this regard are made in this chapter.

CONTROVERSY AND COMMITMENT

A great deal of controversy surrounded the creation of the subject EIS and the ADG=s role in it. Some factions were supportive, while others were either opposed to the idea, reluctant, or skeptical. A significant portion of the first three meetings was dedicated to answering the question of why this initiative was needed and how it was in the Corps purview. Overall, most saw that examining the region in a systemic and holistic manner would improve the regulatory process in southwest Florida. The first meetings were instrumental in solidifying commitment from participants through hearing each other's concerns and defining issues.

Commitment consisted of two elements. First, they would be required to spend twenty working days (ten two-day meetings) over a five-month period plus special assignments and review time. Indeed, participation in the ADG was going to be a time-consuming venture. The second element was commitment to the nature of what was needed to occur within the ADG for it to be truly successful. This required complete and honest delivery of information during the process at all times. Rephrased: Bring everything to the table. Also, ADG members were expected to be able to represent and consider the opposing perspectives requiring creativity, compromise, and negotiations. Holding to positions with no room for compromise was counter to the spirit of what was being sought in the ADG. This commitment, as shown in Figure II-1, was the foundation on which the process could be built.

ISSUES, EVALUATION, AND RESULTS

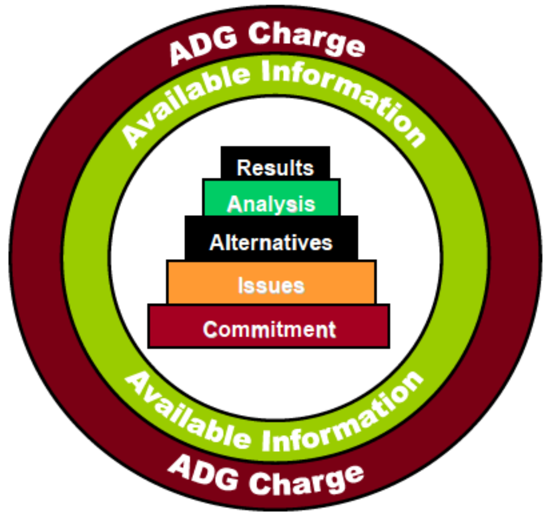

FIGURE II-1
ADG PROCESS

Information on issues associated with southwest Florida were brainstormed by the ADG. The ADG gained an understanding of each other's perspectives and learned details of the Corps and county regulatory processes. Further discussion of these issues formed the basis for creation of evaluation factors used to examine the merits of alternatives. All issues were reviewed by the ADG and resulted in twelve categories of issues. The ADG agreed that consideration of these twelve categories, as alternatives were analyzed, would accommodate the major areas of impact that could be addressed within an EIS setting.

The next stage of the process brought the ADG toward how these issue categories could be utilized to discriminate among proposed alternatives. The discriminators were referred to as evaluation factors. Each of the issue categories was analyzed by factor specialty groups, which were formed within the ADG. These factor specialty groups were tasked with closely considering how a series of measures could be used to represent the issues surfaced by the ADG. Representation in these factor specialty groups was driven by expertise and interest. Specific measures along with data sources were identified by each factor specialty group. Again, these were presented, reviewed, and accepted by the ADG in their entirety.

Alternatives were created for the entire study area by focusing on four subareas that the ADG termed zooms. For each zoom the ADG created a series of alternatives that were intended to represent the range of issues facing southwest Florida. Some alternatives utilized hydrologic features, while others applied selected management criteria. The result was the creation of twenty-eight alternatives. Each of these alternatives was examined according to measures and evaluation factors developed based upon the twelve issue categories.

This analysis of alternatives allowed the members of the ADG to explore the merits of each alternative as well as the motivation, or drivers, behind what made a particular alternative better or worse than its fellows. From this, the ADG was able to provide results to the Corps on a set of alternatives and used the factors to evaluate those alternatives, all of which will be used in the EIS.

AVAILABLE INFORMATION AND BEST PROFESSIONAL JUDGMENT

The ADG was going to be covering some highly sensitive topics, some of which would be based on scientific fact. However, much of what was being addressed in the ADG had to be approached from best professional judgment. Many participants in the ADG were generally uncomfortable with this situation but recognized that assumptions and judgments—sometimes crude—would be unavoidable in order for progress to be made on this initiative.

The concept of using available data as illustrated in Figure II-1 was very difficult to enforce, as the tendency of most members of the ADG was to do higher level, typically quantitative, analyses to support decisions. Fortunately, for many of the issue categories, a great deal of information was already available. For example, many of the layers of GIS data needed to evaluate ecosystem, and wildlife parameters were published and readily available.

In order for the ADG to have the best available information to support its analyses, several presentations were made by experts inside and outside the ADG. Each presentation was requested specifically by the ADG and was typically scheduled at the beginning of a pertinent session. Thus, the information offered would be fresh to the ADG participants. Typically, presenters would provide handouts to the ADG members and would utilize overheads/slides to support their remarks. All of this information was made part of the record, and technical reports provided were made part of the ADG's library of information. This information was frequently referred to during the analyses and deliberations of the ADG, and will be utilized further by the Corps as it develops other sections of the EIS. A full listing of the references brought to the ADG is found in Appendix B.

FACILITATION AND MANAGEMENT OF MEETINGS

The ADG meetings were professionally designed and facilitated and generally followed the design shown in Figure II-1. The meetings were structured to ensure efficient and effective communication of information in moving toward completion of the ADG charge. The process moved forward at a pace the group was able to handle, depending on progress. An iterative system of checks and balances was instituted with a steady push to completion of the ADG goals.

The facilitation team was commissioned to operate in an unbiased manner giving all involved parties an opportunity to offer ideas. All members of the ADG were given the opportunity to provide their perspectives in this process. Consensus was sought at critical junctures. Ground rules, designed specifically for and by the ADG, were established at the first meeting and governed all activities. For example, a policy for alternate members was established, and a system of showing thumbs up or down was used to quickly demonstrate agreement.

The facilitation team documented all activities and kept records of the proceedings. Each set of meeting notes was reviewed and subsequently approved by the ADG as an accurate reflection of what occurred at each meeting. The facilitation team with assistance from the Corps developed the present report, acting as a ghost-writer for the ADG.

III. ISSUES AND EVALUATION FACTORS

The identification of issues relevant to the study area is an important step in the development of alternatives. Also, all stakeholders are made aware of issues they may not have considered prior to this process. Thus, a varied group of stakeholders assures that relevant issues are identified and considered in the alternatives development and evaluation process. Issues addressed a myriad of perspectives such as economic, social, and environmental. This chapter presents the ADG's identification of issues and development of evaluation factors by which the ADG could ensure that the alternatives developed addressed the group's concerns.

ISSUES IDENTIFICATION

Each member of the ADG represents one or many perspectives. The affiliation(s) of the ADG members and alternates is presented in Appendix A. Given these different perspectives, members of the ADG identified and presented their own various key issues to the ADG. The thirty-three members of the ADG were divided into four subgroups to help find commonality in the issues presented by the members of that subgroup. The use of subgroups allowed the ADG to more quickly and openly discuss the key issues.

These small groups presented nearly one hundred issues to the ADG. There was much commonality among them. The task of the subgroups was to identify those issues that were common, thus significantly reducing the number of issues. Lastly, the ADG identified from the remaining issues those that were similar and categorized them. The ADG identified the following twelve issue categories.

1. Property rights
2. Water management
3. Water quality
4. Ecosystem function, wildlife habitat, and listed species
5. Regulatory efficiency and effectiveness
6. Economic sustainability
7. Local land use policy
8. Avoidance of wetland impacts
9. Mitigation
10. Cumulative/secondary impacts
11. Restoration/retrofit
12. Public lands management/use

The ADG identified two issues that did not fit within the twelve issue categories: (1) a holistic approach to management and (2) higher standards of data and information. The ADG concluded that these were goals to strive for in southwest Florida, not issues that could be addressed in the development of alternatives.

EVALUATION FACTORS BY ISSUE CATEGORY

To ensure that the alternatives developed for the study area addressed these twelve issue categories that encapsulate the key issues of the ADG, the group developed factors by which to evaluate the alternatives. These factors were both qualitative and quantitative. Thus, at minimum twelve evaluation factors, one for each issue category, had to be developed by the ADG. The purpose of the evaluation factors are to aid the ADG in discriminating among alternatives. The ADG divided again into four subgroups, factor specialty groups, to efficiently address the development of evaluation factors.

First, the ADG grouped the issue categories into four sets of three issue categories. These were grouped according to similarity among the issue categories and the expertise of the ADG. The twelve issue categories were grouped as follows;

1. Property rights, local land use policy, and economic sustainability
2. Regulatory efficiency and effectiveness, avoidance of wetland impacts, and mitigation
3. Water management, water quality, and restoration/retrofit
4. Ecosystem function, wildlife habitat, and listed species, cumulative/secondary impacts, and public land management/use

The factor specialty groups were formed based on member expertise or interest in the issue categories. Each factor specialty group developed factors for each of their three issue categories. The factor specialty groups defined the evaluation factors, determined the type of measurement, and identified the associated data sources and reference materials. All factors were reviewed by the ADG prior to their use in the evaluation of alternatives.

The ADG was reminded that they were directed by the ADG charge, time, and available data. Time was a significant constraint in the development and evaluation of alternatives. For instance, economic models were available to address the issue of economic sustainability. However, the complexity of the models discouraged the use of these models in the time frame in which the ADG was operating. The use of available geographic information system (GIS) data supported the ADG and added efficiency to some analyses. Also, driven by these constraints, is distinguishing between “need to know” and “nice to know” information in terms of evaluation factors. ADG members were encouraged to focus on data and issues that were central to the task at hand. The development of evaluation factors by issue category is described in the following sections and summarized in Table III-1.

TABLE III-1

SUMMARY OF EVALUATION FACTORS BY ISSUE CATEGORY

Issue Category	Number of Factors	Summary Points
Property Rights	3	Comprehensive plan established expectations
		Comprehensive plan is the standard to which all other alternatives were compared
Water Management	7	Improve flowways, reduce flood damages, and improve water supply
		Best professional judgment
Water Quality	5	Land use types used to estimate water quality
Ecosystem Function, Wildlife Habitat, and Listed Species	12	GIS assist qualitative judgement
		Current habitat and sighting maps compared to all alternatives to determine impacts
Regulatory Efficiency and Effectiveness	3	Many factors but hard to measure
		Use quantity and functionality of wetlands and habitat impacted as a surrogate for permit review time and level of effort
Economic Sustainability	7	Models identified but require greater detail and time than available
		Best professional judgment
Local Land Use Policy	2	Comprehensive plan is the local land use policy
		Comprehensive plan is the standard to which all other alternatives were compared
Avoidance of Wetland Impacts	2	GIS assisted
		Index of number of acres at risk calculated
Mitigation	2	GIS assisted
		Index of mitigation opportunities calculated
Cumulative & Secondary Impacts	10	Social and environmental impacts
		Best professional judgment used to rank the alternatives
Restoration/Retrofit	5	Flowways and habitat restoration
		Opportunities seen within residential and agricultural land
Public Lands Management/Use	1	Adjacent land use types indicate compatibility
		GIS utilized

Property Rights

The factor specialty group that addressed this issue described property rights as the right to use your property as you choose without harming others, subject to:

- Applicable law and regulation (local government land plan and state and federal permitting regulations)
- Timely compensation for value lost due to regulatory change
- Timely compensation for taking

The group cited the property owner's constitutional right as a given. However, the ADG recognized the local government's comprehensive plan generally sets forth the current expectation of land use and contributes significantly to expectations of land value.

The factor specialty group identified three factors to evaluate the extent to which the alternatives addressed the issue of property rights. These factors were (1) fair market value, (2) vested rights, and (3) reasonable expectation for use of land and return on investment.

The factor specialty group suggested means by which to measure these factors as well as data sources (i.e., property appraiser records, tax records, and independent appraisals). However, given the time available, the factor specialty group relied on the members best professional judgment. The group graded the alternatives by evaluation factor on a scale of one to four where one was worst and four was best in terms of property rights. The comprehensive plan was considered the standard from which to compare all alternatives.

Water Management

The factor specialty group that addressed this issue described that the purpose of water management is to provide adequate water supply for human consumption, agriculture, and commercial, recreational, and natural resource demands while balancing these with the need to provide flood protection.

The factor specialty group identified seven evaluation factors to ensure the alternatives addressed fully the issue of water management. The seven evaluation factors are as follows;

1. Infrastructure existence (stormwater utility/maintain and improve)
2. Home damage during storm events (level of flood protection)
3. Home construction to meet the one-hundred-year storm event
4. Flood depth and duration
5. Historic flow patterns (maintain and improve)
6. Adequate water storage (balance consumption with hydroperiods)
7. Groundwater data floors and ceilings (aquifer zoning)

To measure infrastructure existence, the group decided to compare the impact the alternatives would have on capital costs and maintenance costs. The group addressed home damage during storm events by estimating the number of homes affected. The group also evaluated whether the alternative increased, maintained, or decreased flood depth and duration. Also, alternatives were evaluated on whether they destroyed, maintained, or improved historical flow patterns, including the timing, direction, quantity, quality, and duration of these flows. Water supply was evaluated with respect to needs for natural resources, water storage, and groundwater floors and ceilings.

Given all of these possible means for measuring the impacts of the alternatives by evaluation factor, the group utilized the professional judgment of its members to aid in the evaluation of the alternatives. The factor specialty group applied a scoring method of +, 0, - to signify whether each alternative addressed, did not address, or negatively addressed the evaluation factor, respectively.

Water Quality

The factor specialty group that addressed this issue defined that the purpose of the water quality issue is to ensure the maintenance of surface- and groundwater quality.

Several presentations were made to the ADG concerning the status of water quality of the region's rivers and tributaries, estuaries, and bays. Presentations made it clear that there is a lack of data to answer some questions regarding water quality. The group first recommended that more data collection and monitoring are needed to fully understand water quality trends and related issues in southwest Florida.

The factor specialty group identified four factors that can be applied to evaluate whether the alternatives developed by the ADG address the issue of water quality. The identified factors are as follows:

1. Pollution loading
2. Freshwater pulses
3. Habitat loss
4. Groundwater impact

The group noted several items that the factors needed to address, such as establishing standards for point and nonpoint pollution, impacts on marine plant and animal communities, recreation, and health. All of these items are addressed in the four evaluation factors.

Groundwater impacts were estimated by analyzing acres of development in significant recharge locations. The number of acres converted to impermeable surfaces by alternatives was utilized to estimate the impact of freshwater pulses. Habitat loss was derived by the acres of alterations to wetlands and mangroves. Pollution loading was addressed utilizing a water quality index that was estimated for each alternative.

Pollutant-loading estimation was done based on land use types and land use criteria defined in the alternatives. Thus, the acreage of the different land use types defined by the alternatives drives the estimation of water quality. This screening method was developed and tailored to the ADG process by the consulting firm Science Applications International Corporation (SAIC), contracted by the U.S. Environmental Protection Agency (EPA). The pollutant ranges and definitions are based upon those utilized by the Florida Department of Environmental Protection (DEP). Given these calculations and best professional judgment, the factor specialty group equally weighted the factors during the ranking of alternatives.

Ecosystem Function, Wildlife Habitat, and Listed Species

The factor specialty group addressed upland, wetland, and aquatic habitat changes, effects of fragmentation on listed species and ecosystem functions, and the maintenance of ecological integrity and biodiversity.

The factor specialty group identified twelve factors that can be applied to evaluate whether the alternatives developed by the ADG address the topics of the issue category ecosystem function, wildlife habitat, and listed species. The twelve evaluation factors are listed below.

1. Effects on Florida Game and Freshwater Fish Commission's (GFC) Strategic Habitat Conservation Area (SHCA) habitat-planning objectives
2. Effects on Priority I and II Florida Panther habitat
3. Effects on Southwest Florida Regional Planning Council (RPC) resource regional significance goals
4. Effects on U.S. Fish and Wildlife Service (FWS) Multi-species Recovery Plan and the Florida Panther Habitat Preservation Plan
5. Effects on occurrences of listed species
6. Effects on occurrences of rookeries
7. Effects on loss of native plant communities (common and rare)
8. Effects on fragmentation and connectivity of plant and animal habitats
9. Effects on loss of seasonal wetlands
10. Effects on integrity of flowways (rivers, sloughs, and strands)
11. Effects on wetland dependant species
12. Effects on aquatic resources

Much of the information, primarily maps, utilized by the factor specialty group was available and able to be readily digitized for analysis using geographic information system (GIS) capabilities. Thus, digitized alternatives compared against digitized natural resource maps were able to generate acres or counts of impacted areas or species, respectively. As a result, the units impacted can be compared among alternatives to determine, with judgment, which is better or worse for that particular factor. However, the evaluation factor, effects on FWS Multi-species Recovery Plan and the Florida Panther Habitat Preservation Plan, was not GIS applicable.

Regulatory Efficiency and Effectiveness

The factor specialty group that considered this issue defined its intent as the effort to add certainty, consistency, clarity, and celerity to the permitting process while improving its integrity and effectiveness. The basis for analysis of this factor was the amount of area on the alternatives maps that was or was not filled. Areas not filled suggested that agreement could not be reached which reflected negatively on regulatory efficiency and effectiveness. The factor specialty group originally identified three factors that could be applied to evaluate whether the alternatives developed by the ADG addressed the issue category regulatory efficiency and effectiveness. These evaluation factors are listed below.

1. Permit review time and level of effort
2. Pre-identified impact/mitigation and preserve areas
3. FWS/GFC general concerns addressed

After applying these factors to several alternatives, the factor specialty group concluded that the means by which the factors were being measured did not discriminate among alternatives which was one of the main objectives of the evaluation activities. Thus, at the tenth meeting, the factor specialty group revisited the measures and created a series of measures that supported the three named factors. The first factor assesses the level of restrictions on an alternative land use legend. The second factor considered the degree of commonality between the alternatives as well as current regulatory processes. These two are in addition to the original measure that quantified the area of the alternative map that was filled in. For the third factor, measures were identified to reflect: potential need for section 7 coordination; potential that permit review will be slowed due to the sensitivity of natural resources within nonpreserve designations; effectiveness of the program to meet federal mandates and charges; and efficiency in the timelines and cost.

Economic Sustainability

The factor specialty group defined the purpose of this issue as the protection, enhancement, and expansion of the long-term economic viability of the region, including agricultural, commercial, construction, environmental, fisheries, industrial, residential, and recreational and tourism elements. Given these many purposes addressed by this issue category, the group had to develop a number of evaluation factors to adequately address these purposes.

The factor specialty group identified seven factors that were applied to evaluate whether the alternatives developed by the ADG address the purposes of economic sustainability. The seven evaluation factors are listed below.

1. Job creation
2. Home affordability

3. Cost of living
4. Property tax base
5. Cost to implement
6. Increased taxes
7. Environmental justice

The use of economic-based models and projections was discussed as an option to address several of these factors. However, given the time and data available, this was not a viable option. Although these models could not be applied at this time, they should be included in the Corps' conclusion of the EIS. Given that the factor specialty group did not apply these models, the group relied on their best professional judgment in the evaluation of alternatives utilizing the seven factors. The group scored the evaluation factor on a scale of one to four where one was worst and four was best in terms of economic sustainability. Since the comprehensive plan was created with economic sustainability as one of its primary objectives, it was considered the standard to compare all alternatives.

Local Land Use Policy

The factor specialty group that considered this issue wanted to ensure that alternatives recognized the local land use plans and regulations. To ensure this, the group evaluated each alternative's consistency with these plans and regulations. The Lee and Collier County Comprehensive Plans are the legally adopted local land use plans and establish regulations for unincorporated areas. Thus, all other alternatives are compared with these comprehensive plans making this a rather straightforward analysis.

The factor specialty group identified two factors that can be applied to evaluate whether the alternatives developed by the ADG address the issue category local land use policy. The two evaluation factors are (1) significance of conflicts with local land use plans and regulations and (2) hurricane preparedness (i.e., evacuation routes and shelter availability).

Avoidance of Wetland Impacts

The factor specialty group that considered this issue wanted to ensure that alternatives avoided to some degree impacts to wetlands. The group addressed both the acres of wetlands at risk as well as the functional importance of the wetland acres at risk by an alternative. The two evaluation factors identified by the group were (1) total acres at risk and (2) total wetland acres by functionality at risk by each alternative. Thus, this factor specialty group relied heavily on the outputs of GIS.

The basic premise behind the two factors is determining the number of wetland acres and functions at risk by an alternative. For instance, the acres at risk are the total wetland acres within a particular use type (i.e., agricultural, residential, and urban) multiplied by a risk factor.

The factor specialty group relied on their best professional judgment to determine risk factors by land use type. Likewise, those acres at risk are identified as having high, medium, or low wetland function. Each level of function has a multiplier representing the relative level of function associated with the acres within that level of function.

Mitigation

The factor specialty group that considered this issue wanted to ensure appropriate mitigation for unavoidable wetland impacts. The group addressed both the acres of wetland mitigation opportunity as well as the functional importance of the wetland acres available for mitigation by an alternative. The two evaluation factors identified by the group were (1) total acres provided for mitigation opportunity and (2) total wetland functional improvement opportunity provided. These evaluation factors were dependent upon GIS outputs of acres of opportunity.

The basic premise behind the two factors is designating lands for potential mitigation (opportunity) versus the number of wetland acres and functions at risk by an alternative. For instance, the number of acres proposed for preservation versus the number of wetland acres at risk by a given alternative provides a useful measure by which to compare other alternatives. The concept of risk is discussed under the topic of avoidance of wetland impacts.

Likewise, the level of wetland function of the proposed preservation acreage is taken into account. The factor specialty group, relying on best professional judgment, assigned factors indicating the functionality of the potential mitigation acres. Wetland areas were identified as either high-, medium-, or low-functioning wetlands within various levels of opportunity of mitigation identified based on geographical context. This weighted index is then compared with the index of wetland functions at risk. The concept of risk is discussed under the topic of avoidance of wetland impacts.

Cumulative/Secondary Impacts

The factor specialty group first defined the terms cumulative and secondary impacts as they apply to the study area. Cumulative impacts are the impacts on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal and nonfederal) or person undertakes such other actions. Secondary impacts are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

The factor specialty group developed ten factors by which to evaluate alternatives. These ten factors fall within two categories: (1) environmental and (2) social impacts. Below are the ten evaluation factors.

1. Impacts on infant mortality
2. Impacts on road needs

3. Impacts on air pollution loading
4. Impacts on water pollution loading
5. Impacts on crime rates
6. Impacts on hurricane vulnerability
7. EPA Index of watershed indicators
8. Impacts on wetlands only
9. Impacts on hydrology
10. Amount of lands in public and private ownership in protected status

To measure these factors, several models that could be driven by GIS were recommended. However, given the time and available data, in addition to GIS, the factor specialty group applied their best professional judgment to compare the alternatives for the study area by each of the ten factors.

Restoration/Retrofit

The factor specialty group defined restoration/retrofit as the act of mimicking natural functions and re-creating urban areas related to water management, water quality, and ecological systems, and to provide economic sustainability and quality of life by upgrading existing infrastructure to current standards. The factor specialty group recognized the benefit of a larger planning vision and investment in regional natural systems.

To address the items raised in the factor specialty group's definition of restoration/retrofit, the group identified five factors to evaluate the alternatives. The evaluation factors are listed below.

1. Natural functions maintained in natural systems (i.e., flowways)
2. Exotics control (percent and size of parcels treated and restored)
3. Percent of residents using self-supplied infrastructure (i.e., septic tanks)
4. Percent of agricultural land applying Best Management Practices (BMP)
5. Wildlife habitat restoration

Originally the group identified a factor that addressed quality of life. However, during the process of evaluation, it was concluded that this was an overall goal for the region and not a factor by which to evaluate alternatives. Given limited data, the factor specialty group applied professional judgment in the evaluation of alternatives using the five evaluation factors listed above. Using best professional judgment, the factors specialty group applied a scoring method of +, 0, - to signify whether each alternative addressed, did not address, or negatively addressed the evaluation factor, respectively. GIS outputs were utilized to aid the group in their determinations.

Public Lands Management/Use

The factor specialty group developed evaluation factors to ensure that the alternatives did not negatively impact the management and use of public lands. The two factors were (1) compatibility with land management plans and (2) degradation or improvement of resources on public lands. The compatibility of various on-site and adjacent land use was considered. The measure of whether an alternative negatively or positively impacted public lands was the land use type identified adjacent to the boundary of current public lands. Thus, an industrial park adjacent to public lands would be less compatible than agricultural activities. Also, the factor specialty group took into consideration indirect impacts of land uses not adjacent to public lands, such as activities upstream. The use of GIS was beneficial in allowing the factor specialty group to identify land use types and their extent of potential impact.

SUMMARY

The ADG identified twelve issue categories from nearly one hundred individual issues presented by the ADG members. These issues were important to consider in the development of alternatives. To ensure that the alternatives addressed these issues, the ADG developed evaluation factors by which to measure the extent to which alternatives addressed the issues, thus allowing the comparison of alternatives. The number of evaluation factors by issue category ranged from one to twelve. GIS maps and resulting tables played an important role in the graphical depiction and evaluation of the alternatives. Chapter IV presents the alternatives development process as well as the alternatives for the study area. Chapter V applies the evaluation factors to those alternatives.

IV. ALTERNATIVES DEVELOPED

The primary objective of the ADG was to create alternatives for the study area. These alternatives and the analysis of the alternatives are presented in the "alternatives" section of the Corps EIS. This section describes how the ADG proceeded in creating the alternatives. A map with a brief description of key features of each alternative is provided in Appendix C.

The ADG examined the study area in four subareas, or "zooms," as shown in Figure IV-1. The ADG first created alternatives for Zoom B, also referred to as the "hub." This term "hub" was brought into the process by the Corps to demonstrate the notion that this area, roughly the Estero Imperial Integrated Watershed boundary, was the central analytical focus of the EIS. This was not to suggest that the other portions of the study area would not be addressed by the ADG. The remaining areas were examined in the following sequence: C, D, and A.

An existing alternative for each of the four zooms was the respective county comprehensive plan(s). The comprehensive plans were provided to the ADG as the preferred alternatives by the participating county governments and Florida's Department of Community Affairs (DCA). The comprehensive plans were some of many alternatives evaluated by the ADG. The comprehensive plans were created using a planning process that received a great deal of input from the public on a wide range of issues. Thus, the future land use maps of comprehensive plans are accompanied by detailed documentation that supports certain features presented graphically.

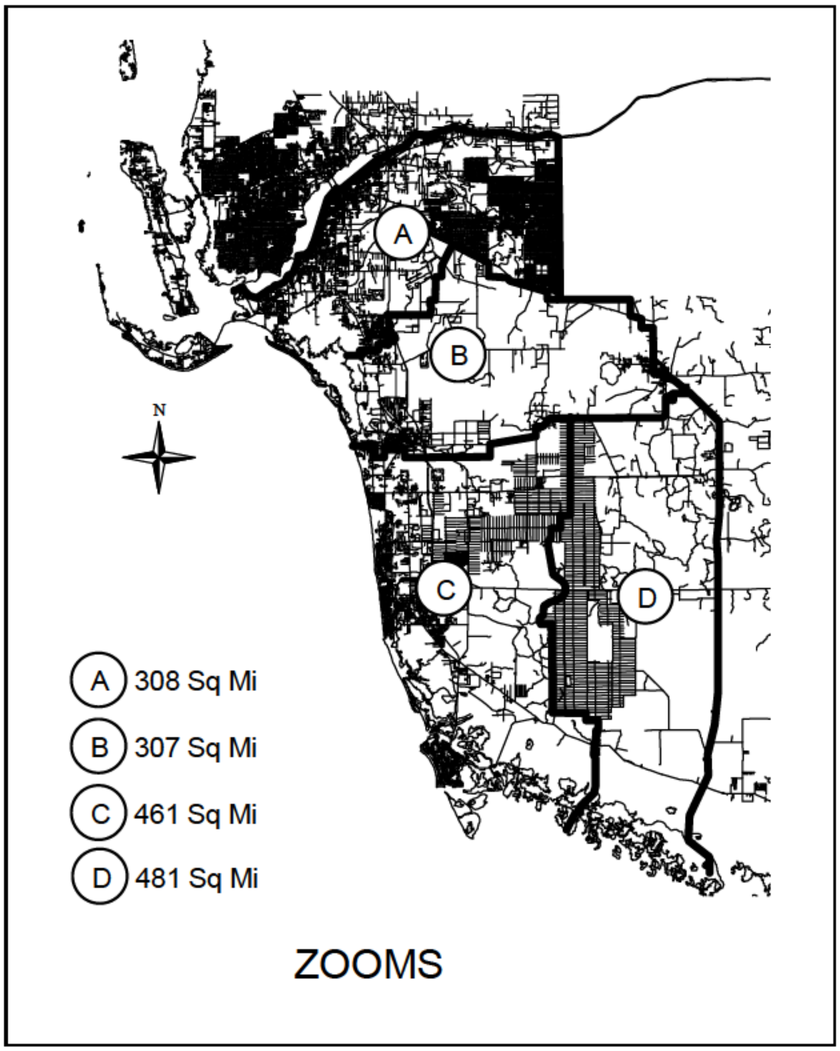

FIGURE IV-1

PROSPECTIVE ZOOMS

Additional alternatives for each zoom were created by dividing the ADG membership into four subgroups tasked with developing up to two alternatives for each area. The alternatives were to be created recognizing the range of issues described in Chapter III. The groups were formed randomly, with the objective of getting members representing a variety of interests in each subgroup. Likewise, the alternatives created by each subgroup would represent a range of interests. However, the way the process actually unfolded, some of the subgroups were dominated by particular interests, which resulted in alternatives that were more indicative of particular interests. In the end though, given the input of the different subgroups, the ADG had an adequate range of alternatives to evaluate for each zoom.

These alternatives were presented on maps where land use and hydrologic features and enhancements were shown. Many alternatives were supported with conditions and criteria that described land use designations. The alternatives were created by drawing features on maps, using different shading to represent selected aspects. Each alternative was presented to the ADG by the subgroup that authored the alternative. It should be noted that while appropriate for the level of analysis being conducted by the ADG, the resolution of some of the alternatives drawings varied in precision because of scale, tools used, and transfer of data to the GIS. The precise location of the lines drawn should be interpreted cautiously. Also, some existing land use features (e.g., existing rock mines) were not depicted on the maps.

Typically, descriptions of land features accompanied the alternatives maps. Early on, during the alternatives development phase of the process, many representatives of environmental interests collaborated on a set of permit conditions that was used to further elaborate standards and strategies deemed critical to the environmental perspective. Other sets of criteria were developed for certain areas such as Lehigh Acres and Golden Gate Estates. Both the land use configurations depicted on the alternative maps and associated narratives were considered in the evaluation of the alternatives. The evaluation of the alternatives is presented in Chapter V and Chapter VII.

V. EVALUATION OF ISSUES: THEMES AND DIRECTION

The ADG evaluated each of the alternatives developed for the four zooms in the study area. The factor specialty groups used the evaluation factors described in Chapter III to evaluate each alternative. The factor specialty groups placed the alternatives on a continuum from best to worst according to the factor they were considering. All twelve evaluation factors were presented to the entire ADG with the alternatives positioned on the continuum according the to deliberations of the factor specialty groups. Questions from the ADG on the evaluations presented were entertained and discussion, mainly in the form of clarification, was offered. This communicated the important aspects of each alternative in terms of the measures defined through the evaluation factors. The resultant continuums are shown in Appendix D by issue category.

As the results of these analyses were presented, certain themes based upon the trends in the analyses surfaced. These themes are central to what was being sought from the ADG in support of the EIS process. The resulting themes, organized by issue category, are presented in the remaining sections of this chapter.

PROPERTY RIGHTS

The comprehensive plans of Lee and Collier counties, while adding a layer of further restriction from the constitutional perspective, were viewed by the ADG's property rights advocates as acceptable, having been developed through an intensive participatory political process. The comprehensive plans have established landowner expectations of potential property values and land uses. Any alternative being more restrictive than the comprehensive plans was viewed as reducing property rights. The evaluation factors applied to the alternatives were (1) fair market value, (2) expectation of land use and value, and (3) vested rights.

At one end of the spectrum of property rights are the landowner's constitutional rights allowing the landowner to use his or her property as he or she chooses without harming others. But for the good of the community, government, using zoning and other means, has placed additional restrictions on property owners. The factor specialty group looked for alternatives that would minimize these types of restrictions.

The comprehensive plan is considered the standard by which all other alternatives must be compared. The comprehensive plan alternative, was generally regarded as the best alternative in terms of property rights. However, several alternatives were considered equal or better to the comprehensive plan by expanding the rights of the property owner. For instance, Alternative 4A of Zoom B showed a more realistic urban area designation for areas surrounding Immokalee than that estimated by the comprehensive plan. Those alternatives typically placed at the worst end of the continuum were those that presented restrictive criteria, expanded preservation areas, and decreased urban and agricultural areas. For example, Alternative 5 for Zoom A included detailed criteria and was considered over restrictive within the property rights category. Thus, the more restrictive the criteria the less appealing in terms of property rights.

WATER MANAGEMENT

The factor specialty group applied seven evaluation factors addressing flooding, flowways, and water storage. Several presentations were made to the ADG concerning water management issues in the study area. One such study was the South Lee County Watershed Plan coordinated by the South Florida Water Management District (SFWMD). This plan presented several proposed alternatives with respect to water management. Likewise, the Big Cypress Basin Watershed Study that addressed many of the same issues was conducted in Collier County. Also, the Estero Bay Agency on Bay Management (ABM) presented an alternative restoring and preserving the connectivity of habitats and flowways.

The concepts of these studies were included in a number of alternatives. Also, one member of the ADG presented a flowway concept that was referred to in many alternatives. This flowway concept emphasized recognition and preservation of historic flow patterns and isolated wetlands. The best alternatives typically provided flowway restoration and maintenance concepts. Alternative 4B for Zoom B raised much discussion during several meetings. This alternative applied South Lee County Watershed Study’s berm alternative. Although the berm was controversial, it was part of a proposed water management alternative.

WATER QUALITY

The factor specialty group applied four evaluation factors: (1) pollution loading, (2) freshwater pulses, (3) habitat loss, and (4) groundwater impacts. Several presentations were made to the ADG addressing water quality issues in the study area. All presenters stated that water quality is expected to continually decline in the study area. Water quality indicators such as vegetation and other marine life attest to decline that has already occurred. Freshwater pulses have impacts on certain fisheries. Heavy metals and other nutrient loadings impact marine habitats. Impervious surfaces such as parking lots impact groundwater recharge and pollution loading.

Land use was the basis for evaluating impacts to water quality. Alternatives that allowed more development were not favorable to water quality. Thus, the comprehensive plan was typically the worst alternative in terms of water quality impacts. Other alternatives proposed ways to decrease the duration and volume of freshwater pulses. Many alternatives suggested improving and maintaining isolated wetlands and the connectivity of habitats and flowways, all of which were perceived to improve water quality.

ECOSYSTEM FUNCTION, WILDLIFE HABITAT, AND LISTED SPECIES

The factor specialty group relied heavily on GIS outputs in their evaluation of alternatives. Many resource agencies such as the Florida Game and Freshwater Fish Commission (GFC), U.S. Fish and Wildlife Service (FWS), and the U.S. Environmental Protection Agency had data and maps that were applied to the alternatives. The use of GIS provided the group a relatively clear picture of the quantitative and spatial impacts of alternatives and allowed the group to use their best professional judgment to determine the qualitative impacts. The factor specialty group evaluated alternatives on such things as impacts to panther habitat, listed species, rookeries, seasonal wetlands, and native plant communities.

Natural resource agencies have collected data, conducted field surveys, written many plans, and drawn many maps. Examples of resource information utilized by the factor specialty group included the Closing the GAPs in Florida's Wildlife Habitat Conservation System (GFC), the Draft Multi-species Recovery Plan for South Florida (vol. 1) (FWS), the Florida Panther Habitat Preservation Plan (Florida Panther Interagency Committee), the Estero Bay Agency on Bay Management's Conservation Lands Map, and National Wetland Inventory Maps (FWS). All data and information were available and able to be compiled into maps that were GIS applicable. The outputs of the GIS were a foundation for the evaluations of this factor specialty group. However, the factor specialty group did not make decisions on numbers alone. Many of the alternatives and their respective land use types had criteria and standards associated with them. These criteria influenced the evaluations of this group. For example, criteria that called for non-intensification of agricultural activities was viewed as favorable to wildlife. This strategy was used to allow for continued agricultural activity while addressing wildlife concerns. An example of this type of criteria was found in Alternative 2B for Zoom B.

Alternatives that increased habitat preservation, addressed restoration of habitat areas, or considered criteria for existing land uses that would improve habitat were ranked high by the group. Alternatives that did not address these items were ranked low for ecosystem function, wildlife habitat, and listed species. Also, alternatives that expanded urban areas and did not propose habitat protection criteria on agricultural and residential areas east of Interstate 75 were ranked low in terms of this issue. Thus, the comprehensive plan was typically viewed as least favorable for this factor.

REGULATORY EFFICIENCY AND EFFECTIVENESS

The factor specialty group initially found the evaluation of this issue to be complex in terms of being able to evaluate alternatives. However, the ADG pressed forward, recognizing that regulatory efficiency and effectiveness are central and essential to the regulatory review and permitting process. This prompted the factor specialty group to offer some level of comparative analysis. The two evaluation factors applied by the factor specialty group were (1) permit review time and level of effort and (2) preidentified impacts. The factor specialty group anticipated that the alternatives maps would reflect areas of regulatory difficulty by locations of contention not being identified by any particular land use. This was not the case. All alternatives had all locations identified with some land use type as well as associated criteria. Thus, the methodology by which the factor specialty group had hoped to measure permit review time and level of effort was unable to distinguish among alternatives.

At the tenth meeting, the factor specialty group with the assistance of additional ADG members went to the drawing board to identify new means by which to more appropriately measure the issue of regulatory efficiency and effectiveness. Since the new measures were defined at the tenth meeting, the group applied a subset of these measures for which tabular information was available. The new approach was applied to Zoom B of the study area. An alternative that was considered the best in terms of regulatory efficiency and effectiveness for Zoom B placed the fewest acres of wetlands and panther habitat at risk.

ECONOMIC SUSTAINABILITY

The factor specialty group considered the comprehensive plan the standard to compare all alternatives. The seven factors applied to evaluate the alternatives were (1) job creation, (2) home affordability, (3) cost of living, (4) property tax base, (5) cost to implement, (6) increased taxes, and (7) environmental justice.

Several economic growth models were suggested for use in the evaluation of alternatives. However, data were not readily available for the development and use of such models. The composition of the factor specialty group allowed them to apply their best professional judgment in the evaluation of alternatives. Similar to the issue of property rights, the county comprehensive plans established some expectation of economic growth. The comprehensive plans and those alternatives that expanded upon the comprehensive plans growth potential were viewed as the most favorable for economic sustainability.

Alternatives that constrained the intent of the comprehensive plans were regarded as poor for economic sustainability. For instance, the criterion of nonintensification of agricultural activities was viewed as constraining job creation. The factor specialty group provided the ADG an example. The farming of row crops requires seasonal labor during the fall, winter, and spring but not in the summer. Whereas, citrus farming requires yearround labor. Thus, conversion to citrus would provide yearround employment rather than seasonal employment. Restricting the location of homes also constrains the potential number of homes that could be built, ultimately decreasing the ability to afford a home. A general theme of the evaluations is the more criteria and standards the less favorable for economic sustainability.

LOCAL LAND USE POLICY

The factor specialty group addressing the issue category of local land use policy evaluated the alternatives developed for zooms A, B, C, and D of the study area. The factor specialty group considered the comprehensive plan the standard by which all other alternatives are evaluated as noted in the evaluation factors. The factors applied in the evaluation of alternatives were (1) significance of conflicts with the local land use plans and regulations and (2) hurricane preparedness evacuation routes. The comprehensive plan is the local land use policy, thus, it is typically the best alternative. Alternatives with more restrictive land use criteria ranked lower than the comprehensive plan. Hurricane preparedness was discussed and brief presentations were made on this topic. This continues to be an important issue in southwest Florida, which has a deficit of shelters and long evacuation times. The alternatives offered typically did not present a great deal of variability with respect to hurricane preparedness. For instance, all the alternatives developed for Zoom B of the study area were all viewed to be equal in terms of addressing hurricane preparedness. None of them proposed any significant strategies for improving hurricane preparedness.

AVOIDANCE OF WETLAND IMPACTS

The factor specialty group applied two factors in the evaluation of alternatives for the study area: (1) total acres at risk from impact and (2) total acres at risk weighted by function. The factor specialty group relied on GIS maps and tables of the alternatives to determine the acres at risk. Those alternatives placing the least number of acres of highly functional wetlands at risk are favorable.

Using best professional judgment, the factor specialty group categorized wetlands by perceived functionality into the categories of high-, medium-, and low-functioning wetlands. Also, the group established risk factors based on land use types (i.e., agricultural, residential, and urban). Risk factors were typically higher for urban and residential land uses. Thus, alternatives proposing the greatest number of urban and residential land use acres were typically considered the worst in terms of avoiding wetland impacts. Alternative 5 for Zoom A was an example of an alternative with favorable characteristics relating to this factor. This alternative used both land use features and criteria to put relatively few high-functioning acres at risk. Typically, the comprehensive plans were among the alternatives that placed the most wetland acres as well as function at risk.

MITIGATION

The factor specialty group applied two factors in the evaluation of alternatives for the study area: (1) total acres of opportunity and (2) total acres of opportunity by level of wetland functionality. The factor specialty group relied on GIS overlays of the alternatives and wetlands to determine the acres at risk and the functionality of those wetland acres at risk. The wetland acres at risk were then compared with the acres of opportunity for mitigation (proposed preservation acres). Also, the functionality of the wetland acres at risk was compared with the functionality of the wetland acres being proposed for preservation.

Those alternatives placing less acres of highly functional wetlands at risk are favorable. This is addressed specifically by the issue category of avoidance of wetland impacts. However, the values derived in the calculations for avoidance of wetland impacts are utilized in the calculations performed for mitigation. Mitigation is somewhat reliant upon the issue of avoidance of wetland impacts. Also, those alternatives that provide for greater acres of wetland mitigation to offset those impacted were favored by the factor specialty group. The functionality of those mitigation acres was also very important. The comprehensive plans in certain zooms were among the alternatives that placed the most wetland acres at risk and proposed the least amount of acres for mitigation opportunities.

CUMULATIVE/SECONDARY IMPACTS

The factor specialty group applied ten factors in the evaluation of alternatives for the study area. The ten evaluation factors addressed both social and environmental impacts. Social impacts included (1) infant mortality, (2) road needs, (3) crime rate, and (4) hurricane vulnerability. Environmental impacts included (1) air pollution, (2) water pollution, (3) watershed, (4) wetlands, (5) hydrology, and (6) amount of lands in protected status.

As the dominant land use type shifts from preservation to agriculture to residential to urban, infant mortality typically rises. Likewise, the crime rate increases but the nature of the crimes between rural and urban areas is different. Increased development requires more infrastructure. The increased development, depending on the location, may increase vulnerability of citizens to hurricane-related damages.

Similarly, increased development depending on how and where it occurs may have negative environmental impacts. One of the main reasons the Corps initiated the ADG was to address cumulative environmental impacts in southwest Florida. For instance, the permits of singular projects may have merit on their own, but as they accumulate, the result is cumulative and secondary impacts. This issue reflects the cumulative impacts realized by several other issue categories such as water quality, water management, and avoidance of wetland impacts. The comprehensive plan was generally associated with more negative cumulative and secondary impacts than the other alternatives for the majority of the study area.

RESTORATION/RETROFIT

The factor specialty group applied five factors in the evaluation of alternatives for the study area. These factors addressed the natural system of southwest Florida by restoring natural functions, through removing exotics, decreasing septic tanks, increasing the use of best management practices, and restoring wildlife habitat and historic flowways.

These concepts of restoration/retrofit were addressed throughout the study area. Many of the alternatives discussed restoring flowways, wetlands, and the connectivity of habitats. The greatest debates and ingenuity of the restoration/retrofit concepts were related to Lehigh Acres and Golden Gate Estates. Alternatives 1, 3A, and 5 of Zoom A proposed strategies of restoration for Lehigh Acres, such as the Three R's (restoration, retrofit, and redevelopment) and ARF (acquire, restore, and fix), respectively. Alternative 2A of Zoom D proposed that east Golden Gate Estates be used for mitigation to help restore flowways and wildlife habitat. Landowners would be able to build rural residences in west Golden Gate Estates while utilizing east Golden Gate Estates for mitigation and restoration purposes. These alternatives received the favor of the factor specialty group.

PUBLIC LANDS MANAGEMENT/USE

The factor specialty group applied one composite factor in the evaluation of alternatives for the study area. This factor evaluated each alternative's compatibility with public land management plans, compatability of adjacent land use with public land management plans, and whether the alternative improved or degraded the resources and public use on public lands.

The factor specialty group determined whether an alternative improved or degraded public lands by viewing the land use type adjacent to the boundary of current public lands. For instance, a residential area adjacent to public lands that need to be managed with prescribed burning would be less compatible than adjacent agricultural activities. The idea is that some land use types buffer public lands better than others. For example, public lands near Belle Meade and CREW Trust were viewed as relatively well protected by Alternatives 1A and 2 in Zoom C because they showed the least amount of development adjacent to these lands. Likewise, the factor specialty group took into consideration indirect impacts of land uses not adjacent to public lands, such as agricultural activities upstream. Criteria associated with land use types (e.g., agriculture) were considered important attributes to differentiate alternatives in considering both direct and indirect impacts. The use of GIS was beneficial in allowing the factor specialty group to identify land use types and their extent of potential impact.

VI. CONCLUDING REMARKS

The ADG, through a series of eleven two-day meetings, has addressed the charge set forth by the Corps to support the creation of an EIS for southwest Florida. Specifically, the ADG was tasked with developing a series of alternatives that accommodate the range of environmental and socioeconomic interests in the region. In addition, the ADG developed a series of evaluation tools that embody the critical issues being faced in southwest Florida. These tools were used by the factor specialty groups to evaluate and rank the proposed alternatives. The alternatives and evaluation tools should be used to serve the appropriate section of the EIS. Thus, the ADG successfully completed its charge.

The ADG was successful in developing and evaluating alternatives. Given the evaluation tools created and the dialogue offered, it appears that a smaller set of alternatives is within reach. This smaller set of alternatives will be developed by the Corps and made part of the EIS. After public comment on the draft EIS, the ADG will reconvene to assist the Corps in responding to public comments on the alternatives.

The accomplishments of the ADG go beyond contribution to the standard EIS process. The activity of communicating the various perspectives and issues of a very environmentally complex region is an important by-product of the ADG. It is essential as southwest Florida continues to grow that it be done in a way that environment and economy are mutually supported and sustained. This can most readily be accomplished if collaborative examination of the issues, in a systemic way, continues to be conducted in the future.

VII. INTERPRETATION OF RESULTS

The ADG was tasked with fully exploring and evaluating a series of alternatives for southwest Florida. The ADG was not directly tasked with identifying a consensus-based, preferred alternative. While the spirit of consensus and seeking agreement was certainly apparent at the ADG meetings, the time frame for this process did not allow for the delivery of one fully defined alternative that the Corps could use in the EIS. Some argued that coming to a single consensus alternative would nearly be impossible. Others within the ADG thought that it might be possible, suggesting that the twenty-eight alternatives could at least be reduced in number through compromise and negotiation.

Thus, the interpretation of analysis and results does not lead to a single alternative. However, as the alternatives are reviewed in aggregate, selected inferences can be made from the ADG's deliberations. This chapter provides selected observations that define overall trends in terms of specific alternatives. These observations are further processed to offer concluding remarks about how the ADG's results may be used to solidify permit improvements. **The analyses, methodology, and conclusions presented in this chapter are authored solely by the facilitation team and the Corps**. Based on the ADG's products, this chapter presents one interpretation of the synthesis of alternatives and analysis provided by the ADG.

EXAMINATION OF ALTERNATIVES: AREAS OF AGREEMENT

A significant amount of work went into the development of alternatives. The intent of the ADG was not to necessarily bring out "the best" alternative or identify a consensus alternative. However, as the alternatives were offered, it was very clear that the alternatives were in agreement for a majority of the study area. That is, all four subgroups designated that land for the same purposes/strategy to support their vision for southwest Florida. In total, approximately 67 percent of the study area analyzed by the ADG was characterized by full agreement at the general level of land use. However, there were many areas for which ADG members had varying ideas. The value of the work from the ADG is where there is disagreement; the Corps has a very good understanding of the nature of disagreement.

To get to these general statements of inference, a fair amount of analysis of the alternatives was required. The following sections describe this analysis leading to a graphical portrayal of the areas of agreement and disagreement. A synopsis of each alternative is presented in Appendix C.

Description of Alternative Families and Subfamilies

The ADG prepared twenty-eight alternatives. A list of all the legends finds a total of 137 names. This is too large a number to begin comparing and contrasting the alternatives. Further study shows 59 unique names. For example, one unique name is "Urban and Industrial" that was used by ten alternatives as-is without any additional remarks. However, two other alternatives used this designation but with the additional proposal for flowway improvements. So this would be a second unique name. On the other hand, the name "Rural Residential" in Zoom A in Lee County and "Rural Residential" applied to Golden Gate Estates in Collier County do not imply the same review and permitting standards.

The Corps developed two indices to cross-reference each of the legends to a uniform set of names. This retains the original legends as written by the members of the ADG and also provides for a systematic analysis. The first index is referred to as Families. Each of the 137 legends are cross-referenced to one of eight Families.

The second index is referred to as Subfamilies. Each of the 137 legend names are cross-referenced to one of thirty-eight Subfamilies. Although this is a large number of Subfamilies, in many cases there does not appear to be a major difference between Subfamilies within their parent Family. A complete list of Families, Subfamilies, and respective legends are provided in Appendix E.

Development (100)

Family 100 is called Development. Legend names that are cross-referenced to 100 are Development, Urban and Industrial, Urban, Airport, Urban Land Uses, Transition, Industrial, and Rural Residential (for Zoom A).

Within the Development (100) Family are six Subfamilies: 110 is indexed to those names that added no additional modifiers; 120 is indexed to legends that proposed flowway improvements; 130 indexed to the Zoom B (hub) Alternative 2A legend proposing off-site compensation for wide-ranging species; 140 to the proposal for regional/comprehensive stormwater management; 150 to the Zoom C Alternative 1B proposal to replumb Henderson Canal and for culverts under Tamiami Trail; 160 to the criteria found in <u>Attachment S of meeting 8</u> for the urban area. Three of these directly speak to flowway improvements and could be combined.

Lehigh Acres (200)

Family 200 is called Lehigh Acres. Legend names that are cross-referenced to 200 are Urban Zone (Lehigh Acres); Restoration, Retrofit, Redevelopment; Acquire, Restore, Fix;

Redevelopment; Lehigh Acres Zone; Lehigh Acres Greenway; and Water Storage. The 200 Family was created distinct from the 100 Family to highlight the level of discussion given this area by the ADG.

Within the Lehigh Acres (200) Family are seven Subfamilies: 210 is indexed to the “Urban (Lehigh Acres)” name that had no additional modifiers; 220 is unassigned; 230 through 270 are indexed to the various names by which several Zoom A alternatives proposed various ideas for redevelopment and restoration within Lehigh Acres.

Golden Gate (300)

Family 300 is called Golden Gate. Legend names that are cross-referenced to 300 are Golden Gate Estates, Golden Gate Estates Zone 1, Golden Gate Estates Zone 2, Estates (Rural Residential), and Rural Residential (from Zooms C and D). This Family was created to highlight the unique characteristics of this area. In Zoom C, Alternatives 1A, 1B, 2, 3A, and 3B used the various Golden Gate names for the same area named in Alternative 1 as “Rural Residential.” Alternative 1 used the name “Rural Residential” over a portion of this footprint and “Urban” over the rest. In Zoom D, Alternatives 2A and 2B used Golden Gate names for the same area named “Rural Residential” in Alternatives 1 and 4. Alternatives 1A and 3 used Golden Gate names over a portion of this footprint and “Preservation Lands” over the rest.

Within the Golden Gate (300) Family are five Subfamilies: 310 is indexed to the names that had no additional modifiers; 320 is unassigned; 330 through 360 are indexed to the various names by which several alternatives in Zooms C and D proposed various criteria to be applied to projects within Golden Gate Estates.

Agriculture (400)

Family 400 is called Agriculture. Legend names that are cross-referenced to 400 are Agriculture, Agricultural Preserve, Agriculture (Limited Intensification), Agriculture - Maintain Intensity; Agriculture - go to preserve, Agriculture (BCACSC), Mining, and Mining Lands. Only three alternatives actually designated mining. Some of the other alternatives indicated in their remarks that mining was an authorized land use within their agricultural designation.

Within the Agricultural (400) Family are Seven Subfamilies: 410 is indexed to the names that had no additional modifiers; 420 is indexed to names designating areas for mining; 430 is indexed to the names proposing nonintensification of agriculture, while 440 is indexed to those names proposing limited intensification; 450 is indexed to the Zoom D Alternative 2B proposal to remove the exemption from the Big Cypress Area of Critical State Concern; 460 is indexed to the proposal that if agricultural activity ends, the land reverts to preservation; 470 is indexed to the criteria found in Attachment S of meeting 8 for agriculture. Three of these directly speak to degrees of intensification and could be combined.

Rural (500)

Family 500 is called Rural. Legend names that are cross-referenced to 500 are Rural, Rural Development, and Rural Cluster (Agriculture). These legends could almost be placed in the Agriculture (500) Family. In Zoom B (hub), Alternative 2A assigns two names, “Rural” and “Agriculture,” to approximately the same lands assigned a single “Agricultural” name in Alternatives 1, 1A, 3B, and 4A. Note the use of the word “approximately” as these alternatives include subareas designated with various mining and urban names. In Zoom C, Alternatives 1A, 1B, and 2 assign “Rural” and “Agricultural” names to approximately the same area as the single “Agriculture” in Alternative 1. Alternative 3B names “Rural Cluster” and does not have a separate agriculture name. Alternative 3A does not use the term rural. Alternatives 1 and 4 apply “Rural Residential” to the Golden Gate Estates proper. In Zoom D, Alternatives 2A and 2B assign “Rural” and “Agricultural” names to approximately the same area as the single “Agriculture” of Alternative 1. Alternatives 1A and 3 do not use the term “Rural.” Alternatives 1 and 4 apply “Rural Residential” to the Golden Gate Estates proper. However, in Zoom A, all the alternatives clearly name approximately similar areas using various “Rural” names. The impression is that most of the rural names reflect a view of a mixture of existing ranchette, nursery, and similar uses in a fabric of natural vegetative cover. Therefore, the Rural Family was created in the interest of capturing the alternatives in Zoom A but with the recognition of the overlap with the Agriculture (400) Family in the other zooms.

Within the Rural (500) Family are Seven Subfamilies: 510 is indexed to the “Rural Residential” or “Rural Development” names in Zoom A that had no additional modifiers; 520 through 560 are indexed to the various names by which several alternatives proposed various ideas for rural development criteria, including clustering and provision for maintenance of historic flowways. In addition, a detailed draft for clustering criteria was presented and found in Attachment E of meeting 9.

Preserve (600)

Family 600 is called Preserve. Legend names that are cross-referenced to 600 are Preservation Lands, Preserve (Existing and Proposed), Preservation/Conservation, Preservation, and Conservation Lands.

Within the Preserve (600) Family are five Subfamilies: 610 is indexed to those names that had no additional modifiers; 620 is indexed to those names that proposed improvement of flowways; 630 is indexed to the name “Preserve (Existing and Proposed)” of Alternatives 2A and 3B of Zoom B (hub) that noted their delineation was based on the Land Conservation/Preservation Strategy Map adopted July 13, 1998, by the Estero Bay Agency on Bay Management; 640 is indexed to the criteria found in Attachment S of meeting 8 for preserves.

Permit Standards (700)

Family 700 is called Permit Standards. Legend names that are cross-referenced to 700 are Critical Resource Protection Area, Preservation Zone, Buffer Transitional Zone, Agricultural Zone, and Urban Zone (two names, one in Zoom A and one in Zoom B (hub)). These are proposed criteria and standards to be used in permit review. In Alternative 4B of Zoom B (hub), these criteria were described as an overlay on the underlying designations: in other words, the "Agricultural" designation of Alternative 4A is used, but in addition the criteria for "Critical Resource Protection Area (CRPA)" would be applied. In Alternative 4B, CRPA overlaps areas designated as "Agricultural," "Preservation Lands," and a sprinkling of others. In Zoom A, Alternative 5 subdivides the criteria between agricultural and preservation and other uses, but there remains the fundamental premise that these criteria are focused on the permitting process. This separate Family has been created to capture the unique thoughts presented by these alternatives and how they were evaluated. However, note that Zoom C's Alternative 2 and Zoom D's Alternatives 1A, 2A, 2B and 3 included in their definition of "Golden Gate Estates Zone 2" the criteria for the Buffer Transition Zone. These were cross-referenced to the Golden Gate (300) Family, since these were mixed with other criteria clearly identified with Golden Gate.

Within the Permit Standards (700) Family are six Subfamilies: 710 is unassigned; 720, 730, and 740 are assigned to the criteria proposed by Alternatives 2C, 3A, and 4B in Zoom B (hub) and are found in Attachment E of meeting 7; 750, 760, and 770 are assigned to various criteria proposed by Alternative 5 in Zoom A and are found in Attachment W of meeting 9.

Nonagreement (800)

Family 800 is called nonagreement. Legend names that are cross-referenced to 800 are Pending Review and Berm. Alternative 4A of Zoom B (hub) and 3A of Zoom C both identified areas where the groups preparing the alternatives could not agree whether to designate the location as development or preservation. Alternative 4B of Zoom B (hub) identified a Berm that the group could not agree to add to Alternative 4A. This Family was to capture these three circumstances that did not fall cleanly into any of the other alternatives.

Within the Non Agreement (800) Family are two Subfamilies: 810 is unassigned; 820 is indexed to the Berm proposed by Alternative 4B of Zoom B (hub); 830 is indexed to the name "Pending Review" where the group developing the alternative could not agree.

Agreement Map Structure

These Family and Subfamily indices were then added to the geographic information system (GIS) maps of the alternatives. The alternatives were then stacked on top of each other using the GIS software.

The steps of the GIS process were (1) dividing each alternative's map into a grid of squares measuring approximately 90 feet wide; (2) transferring the index value from the map into the grid cell; (3) comparing the Family and Subfamily indices found in the grid cells at the same geographic location for each of the alternatives; (4) creating two maps showing the number of different Family and Subfamily, respectfully, index values at a grid cell location; (5) checking the "slivers" of cell locations where the mapping of alternatives did not exactly line up and adjusting the maps accordingly; and (6) producing a final map.

The resulting map, "Overlay of Alternatives," shows for a large portion of the study area that the alternatives assigned the same Families. The various crosshatching shows the Family designation in those areas where the alternatives assigned the same Family. This overlay did not include the Permit Standards (700) nor the Non Agreement (800) Families.

The solid gray shows areas where there were two different Families assigned by the alternatives. For example, if four alternatives assigned Preserve (600) Family and the fifth assigned Agriculture (400), then there were two different Families and the area would be shaded gray. Typically, the two Families within the gray area can be determined by looking at the Families indexed adjacent to the gray. For example, a gray area found sandwiched between an area designated as "Preserve" and another as "Agricultural" is typically reflecting that some alternatives assigned the Preserve Family and the others the Agriculture Family.

The white areas, unshaded and not crosshatched, are those with more than two families. These areas of disagreement are a very small proportion of the total area.

The number of Subfamilies is strongly correlated to the zoom. For example, whenever all of the alternatives indexed the Development (100) Family within Zooms C and D they also agreed on the Subfamily. In Zoom B (hub), there were two Subfamilies, and in Zoom C, three Subfamilies. There are six Subfamilies in the Development (100) Subfamily. The number of Subfamilies is probably a combination of the (1) characteristics of each zoom and (2) the creativity of the group when the alternatives were developed.

IMPLICATIONS FOR PERMIT STRATEGIES

The agreement map shown in Figure VII-1 provides a basis for subsequent analysis and application to the permit program. The following are some examples picked out from the large mass of information represented by this map.

Within Zoom D, there was agreement to designate the center of Camp Keais Strand as "Preserve." However, there was a difference in how wide the Preserve should be. One alternative delineated as Preserve only those areas that are covered with natural vegetation. The adjoining farmlands were designated "Agriculture." Other alternatives included in their delineation of Preserve some of these adjoining farm fields. The farm fields that are delineated as Preserve in one alternative and Agricultural in the others are colored gray on the map. The next task would be to study the evaluations of the one alternative and compare it with the

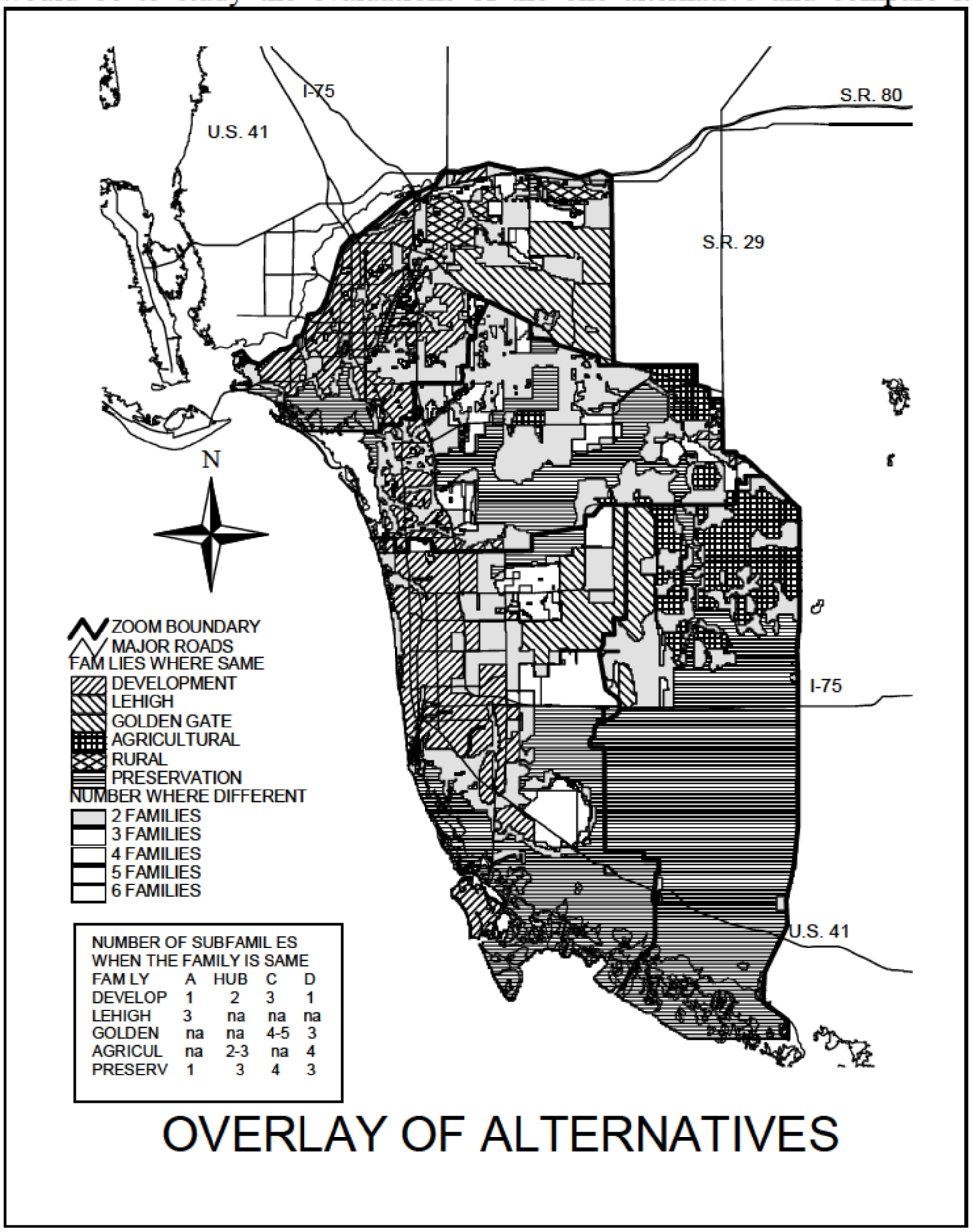

FIGURE VII-1

evaluations of the other alternatives to understand the ramifications of choosing one width over the other.

Potential Permit Implications: Zoom D

Within Zoom D, all of the alternatives delineated Southern Golden Gate Estates as Preserve. For Northern Golden Gate Estates, the alternatives did not agree for the portion of the Estates adjacent to I-75. Two alternatives delineated that portion as Preserve to show the historic assemblage and interconnection of the wetlands. The other three alternatives delineated continued residential development. This area is shown in gray. However, one of the three alternatives included criteria to preserve these wetlands but did not explicitly map them. For the remainder of Northern Golden Gate Estates, all the alternatives agreed to residential development. The area of agreement is crosshatched on the map as Golden Gate. Three of these alternatives proposed additional criteria for project review. The next task would be to compare the evaluations of those alternatives proposing preservation with the evaluations of the other alternatives to understand the benefits and impacts of adopting one or a combination of the preservation proposals.

Potential Permit Implications: Zoom C

Three patches of white are mapped within Zoom C. These are areas where the alternatives did not agree. One location of disagreement is on Immokalee Road; one is in Belle Meade; and the third is off of I-75. All three areas are just outside (east of) the urban boundary. Within all three areas, alternatives delineated a wide variety of project types. For example, in the Immokalee area: one alternative delineated part of the area as Agriculture and part as Urban; three alternatives delineated part Rural with varying amounts of Preserve and Urban; one alternative delineated a part of the area as Transition and the rest either Urban or Mining; and the group that prepared one alternative could not agree whether to delineate it as Development or Preserve. All three of these white areas are expected to be the locations of future development, yet there is no agreement that development is appropriate. One can anticipate contentious permit reviews in these areas.

Within Zoom C, an area along Tamiami Trail south of Naples is shaded gray. South of the gray area (along the coast), all of the alternatives agreed on Preservation. North of the gray area all of the alternatives agreed on Development. The alternatives delineated various proportions of the gray area as Preserve and Development. This indicates the appropriate boundary between the Preserve and Development is unclear. A study of the evaluations may provide insight into the ramifications of the different boundaries.

Potential Permit Implications: Zoom B (Hub)

Within Zoom B (hub), the majority of the area west of I-75 is delineated Development. The streaks of gray through the Development crosshatching follow existing waterways. Two alternatives delineated these areas simply as Development. Four alternatives proposed various widths and extents of flowways through developed areas and delineated them as Preserves. Three other alternatives proposed permitting criteria that would require these flowways with development. None of the groups attempted to draw exact boundaries between the flowways and development. A comparison of the evaluations between the Alternatives may validate the concept with the details to be addressed during individual project review.

Within Zoom B (hub), all of the alternatives agreed on delineating an area centered on the Corkscrew Swamp as Preserve. However, the lands surrounding that Preserve are shaded gray. One alternative delineates this gray area as Agriculture. One delineates a portion as Agricultural and the rest as mining. Two alternatives delineate a part as Agriculture and the rest as Preserve or Mining. Two delineate part as Preserve and the rest as Rural or Agriculture with a limitation on the intensification of current activity. Three alternatives overlay permit criteria that preclude expansion into existing natural areas. Essentially, each Alternative selects one of three approaches: current Agricultural and other uses; explicitly map an expansion of the Corkscrew Preserve; or impose constraints on project activity to maintain the existing natural areas.

Potential Permit Implications: Zoom A

Within Zoom A, all of the alternatives gave special attention to Lehigh Acres. All but one of the alternatives described a variety of ideas for redevelopment. This presents an opportunity to discuss these ideas now before their implementation is precluded as houses are built.

Within Zoom A, several gray areas are shown around the perimeter of Lehigh Acres. In each gray area, the alternatives delineated two types of projects. The combination of which two varied: for two patches the difference is between Development and Preservation and in the others between Development and Rural. The Development includes not only the "Urban" legend but also the various ideas for redevelopment. The differences reflect three broad categories of ideas for the fringe around Lehigh Acres: establish Preserves surrounding the remaining natural areas at the headwaters of various waterways; limit to Rural; or develop as Urban.

Permit Generalizations

In conclusion, three generalizations can be made.

Within the crosshatched areas, there is fundamental agreement on the appropriate type of future projects but variations in the criteria to be applied to their review. The next step should be to review what the evaluations reported for the range of criteria. This will improve the understanding of which criterion or combination of criteria could be incorporated into review processes to increase permitting efficiency.

Within the shaded areas, there is disagreement on the appropriate type of future projects, but generally the disagreement is where to locate the geographic boundary between the two types. The next step should be to review the evaluations that bracket the range of disagreement. This will improve the understanding of which issues are most affected by permitting decisions that cumulatively will establish this boundary.

Within the white areas, the disagreement indicates that any individual project review will be very challenging. These evaluations would provide a starting point if an opportunity arises to open discussions prior to formal project review.

APPENDIX A

ADG MEMBERS, ALTERNATES, AND SUPPORT TEAM

LIST OF MEMBERS ALTERNATIVES DEVELOPMENT GROUP	
NAME	**AFFILIATION**
Baker, Bob	Council of Civic Associations
Barber, Rick	Lee and Collier County Commissions
Beck, Tom	Department of Community Affairs
Cassani, John	Lee County Hyacinth Control District
Daltry, Wayne	SW FL Regional Planning Council
Davenport, Claudia	Big Cypress Basin Board
Douglas, David	David Douglas Assoc., N Ft. Myers Chamber of Commerce
Dryden, Kim	U.S. Fish and Wildlife Service
Durham, Tim	Wilson, Miller, Barton & Peek, Inc.
Folks, John	Department of Agriculture and Consumer Services
Graham-Elliott, Clara Anne	League of Women Voters of Lee County
Griffith, Ed	WCI Communities
Guggenheim, David	The Conservancy of Southwest Florida
Hall, John R.	U.S. Army Corps of Engineers
Hammond, Bill	South Florida Water Management District
Hartman, Bradley J.	Florida Game and Fresh Water Fish Commission
Highsmith, Peggie	Department of Environmental Protection
Inge, Ronald	Lee County Horizon Council, Harper Bros., Inc.
Kain, Wallace	City of Sanibel
Kegg, Earl	Collier County
Klaas, Richard	Florida Real Estate Consultants
Kranzer, Bonnie	Governor’s Commission for Sustainable South Florida
Lucas, Al	U.S. Environmental Protection Agency
Merriam, Chip	South Florida Water Management District
Montgomery, Neale	Pavese, Garner, Haverfield, Dalton, Harrison & Jensen
Mulhere, Bob	Collier County Planning
O'Connor, Paul	Lee County: Planning Division
Roth, Robert H.	Barron Collier Partnership/Silver Strand Division
Stallings, Fran	General Public – Several Environmental Organizations
Strain, Mark P.	Gulf Bay Communities, Inc.
Thoemke, Kris	National Wildlife Federation
Uhle, Matthew D.	Economic Dev. Coalition of Lee Co.
Ward, Whit	Collier Building Industry Association, Inc.

LIST OF ALTERNATES ALTERNATIVES DEVELOPMENT GROUP	
NAME	**AFFILIATION**
Barron, Bob	U.S. Army Corps of Engineers
Beardsley, Gary	League of Women Voters of Lee County
Beever, Jim	Florida Game and Fresh Water Fish Commission
Brundage, Daniel	Lee and Collier County Commissions
Burr, David	SW FL Regional Planning Council
Dolan, Terrance	WCI Communities
English, Katherine	Pavese, Garner, Haverfield, Dalton, Harrison, and Jensen
Gauthier, Charles	Department of Community Affairs
Goldman-Carter, Jan	National Wildlife Federation
Hasty, Collum	General Public – Several Environmental Organizations
Hayden, Tracy L.	Harper Bros., Inc.
Johnson, Karen	South Florida Water Management District
Jolly, William	Department of Agriculture and Consumer Services
Loflin, Rob	City of Sanibel
Maier, Gary	Department of Environmental Protection
Morton, Mark	Barron Collier Partnership
Noble, Matt	Lee County, Division of Planning
Olds, W. Tom	U.S Fish and Wildlife Service
Rhodes, Jeff	Science Applications International Corporation (SAIC) (EPA)
Rice, Terry	Science Applications International Corporation (SAIC) (EPA)
Rietmann, Michael	Collier Building Industry Association, Inc.
Roeder, Mike	Economic Dev. Coalition of Lee Co.
Simonik, Michael	The Conservancy of Southwest Florida
Tears, Clarence	South Florida Water Management District

ADG SUPPORT TEAM ALTERNATIVES DEVELOPMENT GROUP	
NAME	**AFFILIATION**
Feather, Timothy	Planning and Management Consultants, Ltd.
Brown, Dale	Planning and Management Consultants, Ltd.
Beezhold, Michael	Planning and Management Consultants, Ltd.

APPENDIX B

REFERENCE LIST

Reference List

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APPENDIX C

PROFILES AND MAPS OF ADG ALTERNATIVES

ZOOM A–COMPREHENSIVE PLAN

This alternative represents Lee County's Comprehensive Plan (Ordinance 89-02 with amendments), including the implementing policies and procedures for approval of projects.

The Lee County Ordinance at Chapter II (Future Land Use), states the first goal is "To maintain and enforce a Future Land Use Map showing the proposed distribution, location, and extent of future land uses by type, density, and intensity..." Under this first goal are listed approximately 22 categories. Other goals in this chapter and other chapters in the Ordinance provide specific policies for evaluation of proposed development designs or rezoning. Chapter XIII (Procedures and Administration) states "...all development and all actions taking in regard to development orders shall be consistent with the plan..." The Ordinance also provides for a Year 2010 Overlay which divides the County into 105 Subdistricts. Within each district is assigned an acreage for each land designation within that district. The number of acres are those proposed for the year 2010. No development orders will be issued exceed these acreage numbers. This overlay is being replaced by a Year 2020 Overlay which divides Lee County into 20 Planning Communities. Therefore, the Future Land Use Map shows "build-out" acres for each designation, but the acres projected for the year 2020 will be something less. The Ordinance itself states "With the exception of Cape Coral and Lehigh Acres, the county's urban areas will be built out by 2020." Due to the difficulty of mapping these 2020 projections, the alternative was created using the "build-out" map. It appears the evaluations were generally performed using "build-out" although at least one sub-group discussed the 2020 overlays while preparing their evaluations.

The alternative uses five land use legends: Agricultural; Industrial; Preservation; Rural Residential; Urban; and Urban (Lehigh Acres). The Lee County Future Land Use Map shows 22 land use designations. These designations were collapsed into six simply to ease the preparation of other alternatives and for convenience in evaluation. Agricultural represents Density Reduction/Groundwater Resource. Industrial represents Industrial Development, Industrial Interchange, and Industrial Commercial Interchange. Preserve represents Wetlands and those portions of Density Reduction Groundwater Resource, Wetland and Suburban that currently are or are proposed to be preserved and managed to maintain natural resource values. Rural Residential represents Rural and Rural Community Preserve. Urban represents Intensive Development, Central Urban, Urban Community, Suburban, Outlying Suburban, the Interstate Highway Interchange designations except for the Industrial and the Industrial Commercial types, Public Facilities, New Community, and the various Airport areas. Urban (Lehigh Acres) is portions of Central Urban and Urban Community within Lehigh Acres.

ZOOM A–ALTERNATIVE 1A

This alternative generally seeks to provide greater interconnection of existing natural areas.

Within Lehigh Acres, this alternative proposes a Restoration, Retrofit, and Redevelopment (3 R's) approach for those areas least built-out. Strategies to implement would include use of clustering and multi-family to create areas of high density to provide opportunity for restoration in other portions. This would require retrofitting and redevelopment of the existing roads and other infrastructure.

In Urban and Industrial areas, this alternative proposes adoption of regional stormwater management. This approach would: develop a plan for each watershed; identify the location of a single stormwater detention facility to serve a region (several development projects); provide channel improvements; use non-structural measures (such as acquiring parkland or floodproofing) to supplement structural control measures; and coordinate infrastructure improvements with point and non-point source management.

In Rural Residential, the alternative proposes development of greater planning detail to identify existing flowways, forested habitats, and seasonal wetlands that are large or contiguous to each other. This information would then be used to protect these areas in a connected landscape as the area develops.

The area of Conservation Lands was drawn to emphasize connections between the Rural Residential to the Six Mile Cypress Slough and between the Slough and Estero Bay.

ZOOM A–ALTERNATIVE 2

This alternative emphasizes restoration within Lehigh Acres and maps interconnection of natural areas.

A Lehigh Acres Greenway is proposed for the eastern two miles of Lehigh Acres. The remainder of Lehigh Acres would be designated Lehigh Acres Zone. A list of specific development criteria is found at <u>Attachment V of Meeting Minutes 9</u>. The criteria calls for: the mapping of wetlands, flowways, xeric oak scrubs, and development concentrations; reassign densities and provide transfer of development rights to cluster residences toward the central area of Lehigh Acres where the highest elevation and fewest wetlands are located; and create regional stormwater and water storage facilities.

In Rural Residential, this alternative adds development of greater planning detail to identify existing flowways, forested habitats, and seasonal wetlands that are large or contiguous to each other. This information would then be used to protect these areas in a connected landscape as the area develops.

Other areas of Preservation Lands were drawn to emphasize connections between the Rural Residential and Airport preservation areas to the Six Mile Cypress Slough and between the Slough and Estero Bay. The Preservation Lands were also drawn in wetland areas in the Rural areas between Lehigh Acres and the Caloosahatchee River.

ZOOM A–ALTERNATIVE 3A

This alternative generally seeks to "fix" Lehigh Acres and enlarge the value of some wetland features.

Within Lehigh Acres, this alternative proposes an Acquire, Restore, Fix (ARF) Restoration, Retrofit, and Redevelopment (3 R's) approach, particularly noting the Halfway Pond feature.

The Preservation Lands mapping included providing filter marshes along Ten Mile Canal, canals leading from Lehigh Acres. In addition, lands south of the Airport are proposed to be preserved.

ZOOM A–ALTERNATIVE 4

This alternative generally emphasizes restoration of flowways and addition of storage.

Within Lehigh Acres, this alternative suggests Lee County, using Greenbriar as a model, should consider redevelopment alternatives such as curvilinear streets and the retention of natural areas to restore flowways for the rest of Lehigh Acres. An area in southeast Lehigh Acres was identified as potential use for water storage.

Preservation Lands included lands surrounding Ten Mile Canal and certain flowways leading to Six Mile Cypress Slough and others leading to the Caloosahatchee River.

ZOOM A–ALTERNATIVE 5

This alternative focuses on the Corps permit review process by proposing particular criteria.

The geographic map is the same as for Alternative 3A. The criteria and rationale in detail is found at Attachment W of Meeting Minutes 9.

Within the Preservation Zone, denial of all permits. The proposal states the vision is, in part, that these areas would be "...off limits to future development activity."

For the Acquire, Restore, Fix Zone within Lehigh Acres, the alternative proposes that the "Corps strictly applies the Section 404(b)(1) Guidelines, including: (1) a strong presumption that practicable alternatives exist outside of the ARF Zone to dredge and fill activities (except restoration/retrofit activities)..." The proposal also describes numerous criteria for the Corps to apply during permit review, for example, certain limits to the use of nationwide and general permits, application of the criteria of the Big Cypress Area of Critical State Concern regulations, and restoration of flowways. The proposal states the vision is, in part, to "...protect and restore critical resources..."

For the Urban Zone, the alternative proposes…" a presumption that alternatives exist to locating dredge and fill activities in creeks, rivers, other historic flowways and adjacent wetlands; and to locating dredge and fill activities in isolated wetlands identified as important to wading birds, other species of concern, water quality, groundwater recharge or flood control." The proposal also describes numerous criteria for the Corps to apply during permit review, for example, certain limits to the use of nationwide and general permits, promotion of the restoration of flowways, and restoration of buffer zones. The proposal states the vision is, in part, to "..direct development into this zone...while maintaining watershed integrity within the zone."

The proposal provides criteria for an Agricultural Zone and a Buffer Zone. This would be applied to the Rural Residential designation of this alternative. The proposal provides "...a strong presumption that alternatives exist outside.." either the Buffer Zone or Agricultural Zone and includes numerous criteria for the Corps to apply during permit review. The proposal states the vision is, in part, that agricultural "…should remain in agricultural use, compatible with conservation purposes..." and to "...discourage urban expansion in and through..." the Buffer Zone.

These criteria are an update and refinement of those presented for Zoom B (hub) by Alternatives 2C, 3A, and 4B.

ZOOM B (HUB)–COMPREHENSIVE PLAN

This alternative represents Lee County's Comprehensive Plan (Ordinance 89-02 with amendments) and Collier County's Future Land Use Element of the Growth Management Plan (Ordinance 97-67), including the implementing policies and procedures for approval of projects. For a discussion of these ordinances, see the second paragraph at Zoom C – Comprehensive Plan (Collier County) and Zoom A – Comprehensive Plan (Lee County).

The alternative uses five land use legends: Agricultural; Industrial; Preserve; Rural;

and, Urban. The Lee County Future Land Use Map shows 22 land use designations and the Collier County Future Land Use Map shows 12. These 34 designations were collapsed into five simply to ease the preparation of other alternatives and for convenience in evaluation. For this zoom: Agricultural represents Density Reduction/Groundwater Resource (Lee) and Agricultural/Rural Mixed (Collier); Industrial represents Industrial Development (Lee) and Industrial District (Collier); Preserve represents Wetlands (Lee) and portions of Density Reduction Groundwater Resource (Lee), Wetland (Lee) and Agricultural/Rural Mixed Use District (Collier) that currently are or are proposed to be preserved and managed to maintain natural resource values; Rural represents Rural (Lee); Urban represents Suburban (Lee), Outlying Suburban (Lee), Urban Community (Lee), University Community (Lee), the various Interstate Highway Interchange areas (Lee), Public Facilities other than certain parks that were placed in the preserve legend (Lee); and Mixed Use Activity Center SubDistrict (Collier).

ZOOM B (HUB)–ALTERNATIVE 1A

This alternative defined the Preservation Lands overlapping maps from other efforts.

Preservation lands were identified by overlapping the Strategic Habitat Conservation Areas, the Land Conservation/Preservation Strategy Map adopted by the Estero Bay Agency on Bay Management, the boundary of the Corkscrew Regional Ecosystem Watershed (CREW), and the Environmental Protection Agency map of priority wetlands.

The Agricultural designation is the same as for comprehensive plan.

Within the Urban and Industrial, the alternative proposes flowway improvements such as those described in the South Lee Watershed Plan presented by the South Florida Water Management District .

ZOOM B (HUB)–ALTERNATIVE 2A

This alternative give particular emphasis to the needs of wide-ranging species.

The mapping of Preserve used the Land Conservation/Preservation Strategy Map adopted by the Estero Bay Agency on Bay Management, and added connections to the boundary of the Corkscrew Regional Ecosystem Watershed (CREW) for wide-ranging species. The alternative also proposes riparian corridors through the urban areas.

For Agriculture, the alternative "assumes limited intensification of use, that is, no changes that require additional loss of native habitat, no changes (such as intensification of citrus) that would lower hydrology. For example, range and improved range stay the same, vegetable crops change or go to fallow field and back again."

In Rural, the alternative proposes development of greater planning detail to identify existing flowways, forested habitats, and seasonal wetlands that are large or contiguous to each other. This information would then be used to protect these areas in a connected landscape as the area develops.

The alternative did not separately identify mining as a category but classified mining as either Rural or Preserve depending on the ultimate use.

An area is mapped for Development with a requirement for off-site compensatory mitigation for wide-ranging species.

The alternative proposes flowway improvements for the Development area.

ZOOM B (HUB)–ALTERNATIVE 2B

This alternative builds on the mapping of natural resources by others.

The mapping of Preserve started with the Preserves shown in comprehensive plan, then added the following: all proposed acquisitions; the Strategic Habitat Conservation Area mapping for the Florida Panther; and the Priority 1 and 2 areas of the Florida Panther Habitat Preservation Plan. Found that within these areas were found all mapped eagle nests, rookeries, rare native plant communities, seasonal wetlands and flowways, and various coastal resources of interest.

The alternative proposes area Agricultural would remain agricultural but also delineated a sub-area where there would be no intensification in activity. Mining is considered in the Agricultural category to the extent consistent with the comprehensive plan.

The alternative notes that whatever the mapping shows, existing Development Orders remain vested.

ZOOM B (HUB)–ALTERNATIVE 2C

This alternative focuses on maintaining a mix of natural areas, urbanization, and agriculture through use of certain criteria to be applied in project review.

The detailed description of the mapping of each designation and of the criteria proper are found at Attachment E of Meeting 7.

Within the Critical Resource Protection Area, the alternative proposes that projects: meet the Big Cypress Area of Critical State Concern Development Criteria and Standards (with agriculture not exempted); result in no net loss of wetland acreage and function; result in no net loss of active agricultural area; meet total maximum daily loads set for the area of the watershed; improve water quantity, quality, timing and direction; protect on-site wetlands with an easement; do not fragment or sever a wetland system; and meet the criteria of the Buffer Transitional Zone. Also, agricultural activities would remain but with no intensification. Existing mining is captured under the Agricultural zones. However, there are restrictions on new mines.

Within the Buffer Transitional Zone, the alternative proposes that projects: result in no net loss of wetland acreage and function; result in no net loss in historical water table height and recharge area; do not alter water sheet flow characteristics; contribute to the restoration of historic flowways; preserves buffer zones around wetlands, flowways, natural streams, rivers, and creeks; do not impact water quality; do not contribute to hurricane shelter deficit nor increase evacuation times; and implement the principals adopted by the Estero Bay Agency on Bay Management.

Within the Urban Zone, the alternative proposes that projects: restore flowways; retrofit residential septic systems and package treatment plants; provide adequate hurricane shelters and evacuation routes; restore or retrofit buffer zones around wetlands, flowways, natural streams, rivers and creeks; and meet Pollution Reduction Goals when set.

ZOOM B (HUB)–ALTERNATIVE 3A

The developers of this alternative emphasized that the large area mapped Critical Resource Protection Area was not Preserve, but a mix of preserve and other uses.

The detailed description of the mapping of each designation and of the criteria proper are found at Attachment E of Meeting 7.

Within the Critical Resource Protection Area, the alternative proposes that projects: meet the Big Cypress Area of Critical State Concern Development Criteria and Standards (with agriculture not exempted); result in no net loss of wetland acreage and function; result in no net loss of active agricultural area; meet total maximum daily loads set for the area of the watershed; improve water quantity, quality, timing and direction; protect on-site wetlands with an easement; do not fragment or sever a wetland system; and meet the criteria of the Buffer Transitional Zone. Also, agricultural activities would remain but with no intensification.

Within the Buffer Transitional Zone, the alternative proposes that projects: result in no net loss of wetland acreage and function; result in no net loss in historical water table height and recharge area; do not alter water sheet flow characteristics; contribute to the restoration of historic flowways; preserves buffer zones around wetlands, flowways, natural streams, rivers, and creeks; do not impact water quality; do not contribute to hurricane shelter deficit nor increase evacuation times; and implement the principals adopted by the Estero Bay Agency on

Bay Management.

Within the Urban Zone, the alternative proposes that projects: restore flowways; retrofit residential septic systems and package treatment plants; provide adequate hurricane shelters and evacuation routes; restore or retrofit buffer zones around wetlands, flowways, natural streams, rivers and creeks; and meet Pollution Reduction Goals when set.

ZOOM B (HUB)–ALTERNATIVE 3B

This alternative built on the work of the Estero Bay Agency on Bay Management.

The areas designated Preserve were based on the Land Conservation/Preservation Strategy Map adopted by the Estero Bay Agency on Bay Management. Included are flowways through the urban areas and within existing agricultural areas. Agriculture would remain with no intensification. Development would by guided by the principles of the Estero Bay Agency on Bay Management.

The alternative also maps mining lands with no comment.

ZOOM B (HUB) - ALTERNATIVE 4A

This alternative builds on comprehensive plan.

In this alternative, Mining lands are shown separate from Agriculture. The definition for Agriculture is the same as comprehensive plan.

This alternative proposes implementation of flowways through the urbanized areas and, within Preservation Lands, removal or culverting of various roads to restore flowways. These are as described in the South Lee Watershed Plan presented by the South Florida Water Management District.

Two areas are designated Pending Review as the group preparing the alternative could not agree whether to designate the location as development or preservation.

ZOOM B (HUB)–ALTERNATIVE 4B

This alternative builds on Alternative 4A by adding criteria and a water control berm.

The alternative proposes the construction of a berm as described in the South Lee Watershed Plan presented by the South Florida Water Management District. The berm will store water when downstream conveyances are at capacity. All of the evaluations were performed using the berm located as mapped. Three of the evaluations also included evaluations of two other possible alignments, described in Attachment AG of Meeting #10.

The detailed description of the mapping of each designation and of the criteria proper are found at Attachment E of Meeting 7.

Within the Critical Resource Protection Area, the alternative proposes that projects: meet the Big Cypress Area of Critical State Concern Development Criteria and Standards (with agriculture not exempted); result in no net loss of wetland acreage and function; result in no net loss of active agricultural area; meet total maximum daily loads set for the area of the watershed; improve water quantity, quality, timing and direction; protect on-site wetlands with an easement; do no fragment or sever a wetland system; and meet the criteria of the Buffer Transitional Zone. Also, agricultural activities would remain but with no intensification.

Within the Buffer Transitional Zone, the alternative proposes that projects: result in no net loss of wetland acreage and function; result in no net loss in historical water table height and recharge area; do not alter water sheet flow characteristics; contribute to the restoration of historic flowways; preserves buffer zones around wetlands, flowways, natural streams, rivers, and creeks; do not impact water quality; do not contribute to hurricane shelter deficit nor increase evacuation times; and implement the principals adopted by the Estero Bay Agency on Bay Management.

Within the Urban Zone, the alternative proposes that projects: restore flowways; retrofit residential septic systems and package treatment plants; provide adequate hurricane shelters and evacuation routes; restore or retrofit buffer zones around wetlands, flowways, natural streams, rivers and creeks; and meet Pollution Reduction Goals when set.

ZOOM C–COMPREHENSIVE PLAN

This alternative represents Collier County's Future Land Use Element of the Growth Management Plan (Ordinance 97-67), including the implementing policies and procedures for approval of projects.

The Collier County Ordinance states the goal is "To guide land use decision-making..." and provides several objectives and policies. The ordinance also defines approximately twelve land use designations that "...generally indicate the types of land uses for which zoning may be requested." For each designation, the ordinance describes the uses and standards to be applied and shows the properties affected on the Future Land Use Map. Note that Ordinance 97-67 is the amendment of the current Future Land Use Element and is not in effect (as of May 11, 1998) while concerns raised by the Florida Department of Community Affairs are resolved. The Land Development Code (Ordinance 91-102) implements applicable portions of the Growth Management Plan. Article 2, Zoning, includes, among other things, a requirement for open space and for special requirements in areas of environmental sensitivity designated as Special Treatment Overlay District. Article 3, Development Requirements, includes, among other things, a requirement for an Environmental Impact Statement for certain projects, and various requirements for protection of natural vegetation and endangered species.

The alternative uses five land use legends: Agricultural; Industrial; Preservation/ Conservation; Rural Residential; and Urban Land Uses. The Collier County Future Land Use Map shows 12 land use designations. These designations were collapsed into five simply to ease the preparation of other alternatives and for convenience in evaluation. Agricultural represents Agricultural/Rural Mixed Use District; Industrial represents Industrial District; Preservation/ Conservation represents portions of the Agricultural/Rural Mixed Use District that are or are proposed to be preserved and managed to maintain natural resource values; Rural Residential represents the Estates Designation and the Rural Settlement Area District. Urban represents the various Urban and Commercial subdistricts under the Urban Designation except for the Industrial District.

ZOOM C–ALTERNATIVE 1A

This alternative is particularly concerned with the nature of development in the rural areas.

Within areas designated Rural Development Criteria, the alternative proposes application of the criteria drafted for the Twin Eagles project. These areas are found in southern Belle Meade and the Immokalee Road corridor.

The Preservation Lands area is larger than comprehensive plan.

For Golden Gate Estates, the alternative suggests a flowway program though without details.

ZOOM C–ALTERNATIVE 1B

This alternative emphasizes need for flowway improvements along Tamiami Trail.

This alternative proposes designating a portion of the existing agricultural area in Belle Meade as Rural Development. The balance would be Urban and Industrial, along with flowway improvements to direct water from Henderson Creek into sheet flow across Tamiami Trail.

ZOOM C–ALTERNATIVE 2

This alternative expands preserves beyond comprehensive plan and provides criteria for project design and review.

The criteria for each land use designation are summarized below. The detailed list is described in Attachment S of Meeting 8.

Preservation Lands include some lands in Belle Meade north of I-75 as well as lands around Naples Bay. The alternative proposes additional criteria. These include: No public utilities; no new or expanded transportation; no wellfield expansion; restoration or retrofit of certain areas with hydrologic problems; and use as mitigation receiving areas only those portions of Preservation Lands that are currently not in public ownership.

The alternative proposes two sets of criteria for Golden Gate Estates. Zone 1, the more densely developed western Golden Gate Estates includes: avoid/minimize and mitigate wetland impacts; culverting entrance roads; address listed species concerns; development of a educational pamphlet on resource issues; and implementation of a Florida Yards and Neighborhood program. Zone 2, toward Picayune Strand, criteria includes: no more than 10 percent fill; no more than 50 percent fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. Zone 2 would also be designated a receiving area for mitigation.

The alternative shows two areas as Rural, one north and the other south of Golden Gate Estates. For the north, the criteria includes: avoiding and minimizing impacts to wetlands; protecting nesting areas; mitigating wide-ranging species including fox squirrels off site; and, maintain or improve hydrology (for example, weirs in Cocohatchee Canal. For the south, the criteria includes: avoiding and minimizing impacts to wetlands; protecting Red cockaded woodpecker habitat or mitigating off-site when viability affected; mitigating off-site for wide ranging species (bear); and maintaining or improving hydrology (for example, the depth of the I-75 canal). For both north and south, the alternative also adopts the Buffer Transition Zone criteria as described in Alternative 4B of Zoom B (hub), described in detail at Attachment E of Meeting 7.

For lands designated Agricultural, the alternative states no golf course or ranchettes as these are not associated with true agriculture. The alternative also “assumes limited intensification of use, that is, no changes that require additional loss of native habitat, no changes (such as intensification to citrus) that would lower hydrology. For example, range and improved range stay the same, vegetable crops change or go to fallow field and back again.”

For lands designated Urban and Industrial, the alternative proposes encouraging planting of emergent and shoreline planting in stormwater retention lakes and continuation of the Corps standards for wetland protection. The alternative also adopts the Urban Zone criteria as described in Alternative 4B of Zoom B (hub), described in detail at Attachment E of Meeting 7.

ZOOM C–ALTERNATIVE 3A

This alternative recognizes continued expansion of development to the west.

The area designated Golden Gate would continue under the current processes but with additional protection afforded isolated wetlands by proposing: no general permits; determination of wetland jurisdiction prior to Collier County permitting; reconnection of wetlands along historic flowways; and, limitations on the clearing of the lot.

Within the Urban and Industrial, provide flowway improvements along the Cocohatchee Canal, Golden Gate Canal, and sloughs in eastern Naples, coordinated with improvements within Preservation Lands.

Two areas are designated Pending Review as the group preparing the alternative could not agree whether to designate the location as development or preservation.

ZOOM C–ALTERNATIVE 3B

This alternative seeks to maintain 50 percent of the rural landscape in natural area.

Within the Rural Cluster designation, the alternative proposes preserving 100 percent of the wetland, maintain 50 percent as natural area, maintenance of corridors and flowways to interconnect wetlands, and provide facilities to protect water quality. The alternative proposes applying this criteria also to the Golden Gates Estates, which is designated Estates (Rural Residential).

Within the Urban and Industrial Area, the alternative proposes restoration of flowways through acquisition, though no detail was presented.

ZOOM C–ALTERNATIVE 4

This alternative describes various areas east of the current urban area that are in transition from current uses.

The areas designated Transition are those lands currently in agriculture that will likely change to the Urban designation.

The western end of Golden Gate Estates was included in the Urban designation. The alternative proposed no increase in density within Golden Gate City. The rest of Golden Gate Estates would retain the same Rural Residential designation as found in the comprehensive plan.

Within the Urban areas, flowways improvements were shown in various locations and connected to the Preservation areas.

The alternative proposed, within the Preservation/Conservation designation, improvements to culverts under I-75 and Tamiami Trail for sheetflow.

ZOOM D–COMPREHENSIVE PLAN

This alternative represents Collier County's Future Land Use Element of the Growth Management Plan (Ordinance 97-67), including the implementing policies and procedures for approval of projects. See the second paragraph at Zoom C – Comprehensive Plan for a discussion of this Ordinance.

The alternative uses five land use legends: Agricultural; Industrial; Preserve; Rural; and, Urban. The Collier County Future Land Use Map shows 12 land use designations. These designations were collapsed into five simply to ease the preparation of other alternatives and for convenience in evaluation. Agricultural represents Agricultural/Rural Mixed Use District; Industrial represents Industrial District; Preserve represents portions of the Agricultural/Rural Mixed Use District that are or are proposed to be preserved and managed to maintain natural resource values; Rural represents the Estates Designation. Urban represents the Urban Residential Subdistrict.

ZOOM D–ALTERNATIVE 1A

This alternative proposes no intensification of the development with existing agricultural and Golden Gate areas.

This alternative proposes to include as Preservation Lands historic flowways within Golden Gate Estates and along Camp Keais Strand. However, current activities would remain.

For the Agricultural Preserve designation, current agricultural activities would continue but intensification would be limited.

Within Golden Gate Estates, the alternative proposes criteria that includes: no more than 10 percent fill; no more than 50 percent fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. This area would also be designated a receiving area for mitigation. The criteria for each land use designation is summarized below. The detailed list is described in Attachment S of Meeting 8.

ZOOM D–ALTERNATIVE 2A

This alternative applies additional criteria for the review of projects in the non-urban areas.

For Agriculture, the alternative assumes limited intensification of use, that is, no changes that require additional loss of native habitat, no changes (such as intensification to citrus) that would lower hydrology. For example, existing range and improved range use stay the same, vegetable crop uses could change or go to fallow field and back again. The alternative assumes rotation of crops but no additional clearing.

Within Golden Gate Estates, the alternative proposes criteria that includes: no more than 10 percent fill; no more than 50 percent fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. This area would also be designated a receiving area for mitigation. The criteria for each land use designation is summarized below. The detailed list of criteria is described in Attachment S of Meeting 8.

For areas designated Preservation, the alternative proposes criteria that include: no public utilities; no new or expanded transportation; no wellfield expansion; restoration or retrofit of certain areas with hydrologic problems; and use as mitigation receiving areas only those portions of Preservation Lands that are currently not in public ownership. The detailed list of criteria is described in Attachment S of Meeting 8.

A small area is designated Rural to reflect the low density mix of current land uses.

ZOOM D–ALTERNATIVE 2B

This alternative is identical to Alternative 2A except it adds restrictions to certain areas currently in agriculture.

> Certain areas of agriculture are within the boundaries of the Big Cypress Areas of Critical State Concern and are currently exempt from the implementing criteria. This alternative proposes removing that exemption.

ZOOM D–ALTERNATIVE 3

This alternative envisions most of the area ultimately going to preserve.

For the Agricultural areas, the alternative proposes that current agriculture would continue with limited intensification but if agriculture ceases then the lands would be placed in preservation.

Within Golden Gate Estates, the alternative proposes criteria that includes: no more than 10 percent fill; no more than 50 percent fill in pervious areas; no impeding sheet flow; elimination of exotics; develop pamphlet on resource issues; Florida Yards and Neighborhood program; and culverting entrance roads. This area would also be designated a receiving area for mitigation. The criteria for each land use designation is summarized below. The detailed list of criteria is described in <u>Attachment S of Meeting 8</u>.

Within areas designated Preservation, the alternative proposes culverts within Camp Keais Strand and across Tamiami Trail to improve flowways.

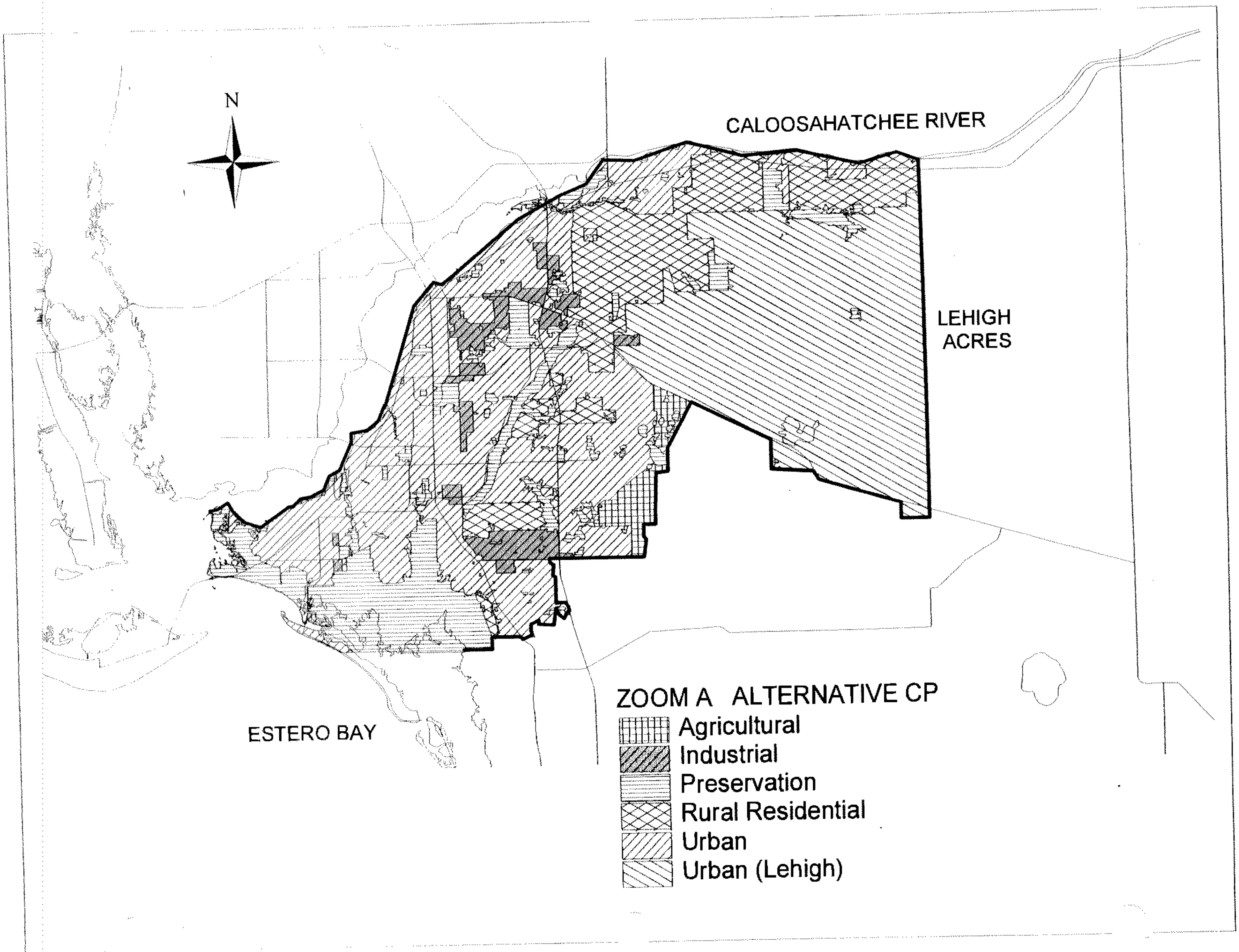
One area of Industrial is designated to reflect the current land use (Ford Test Track).

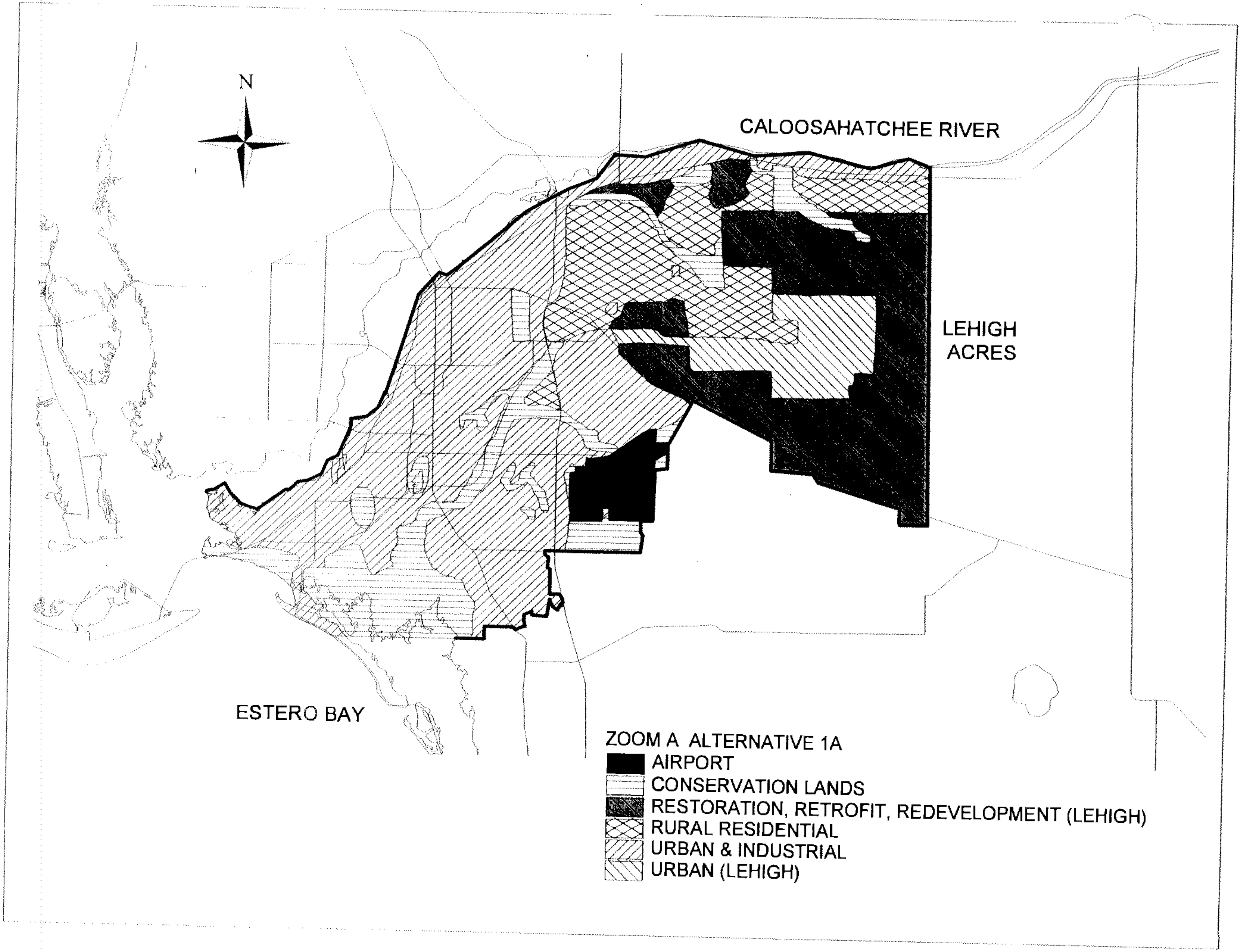
ZOOM D–ALTERNATIVE 4

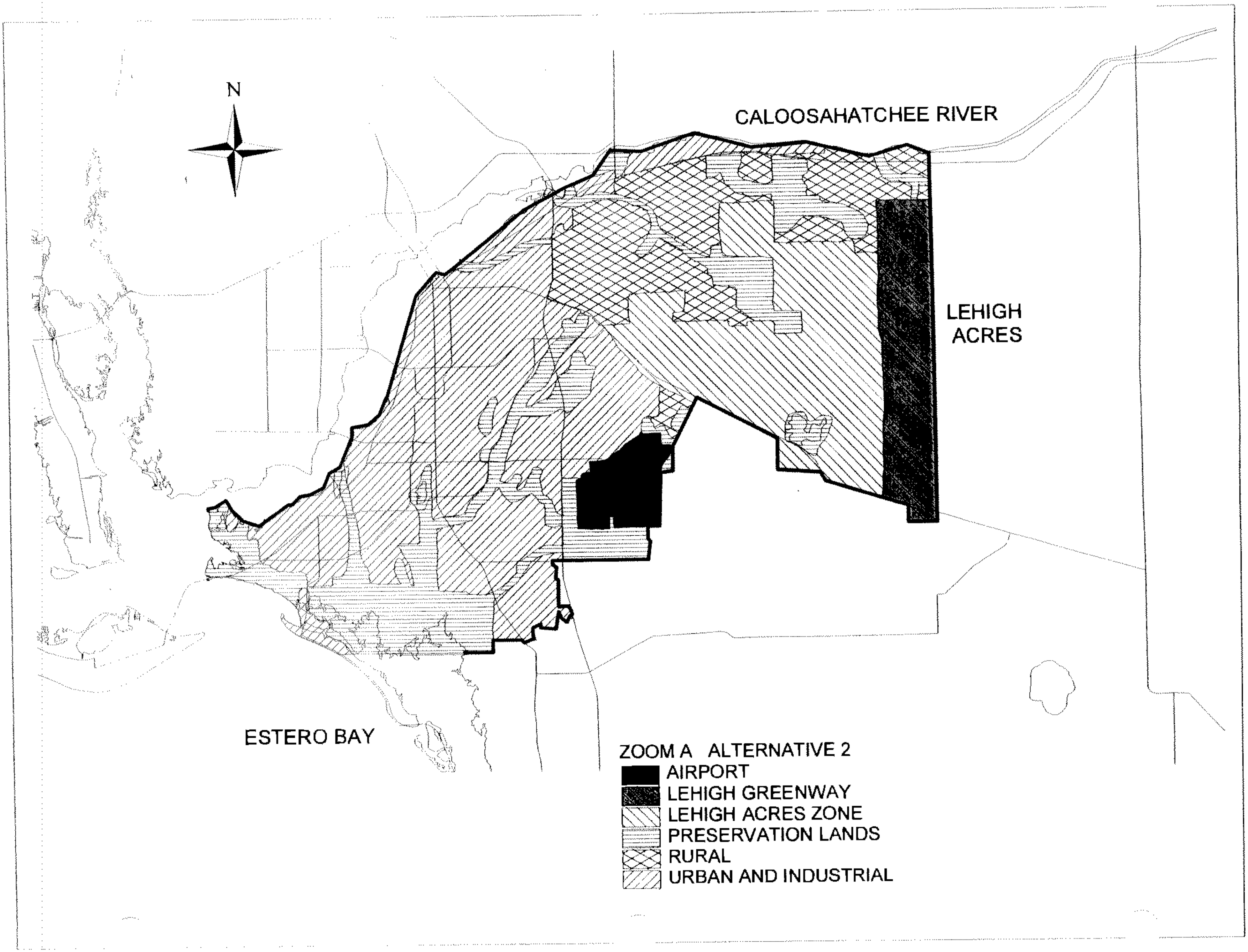
This alternative preserves the status quo for current land uses.

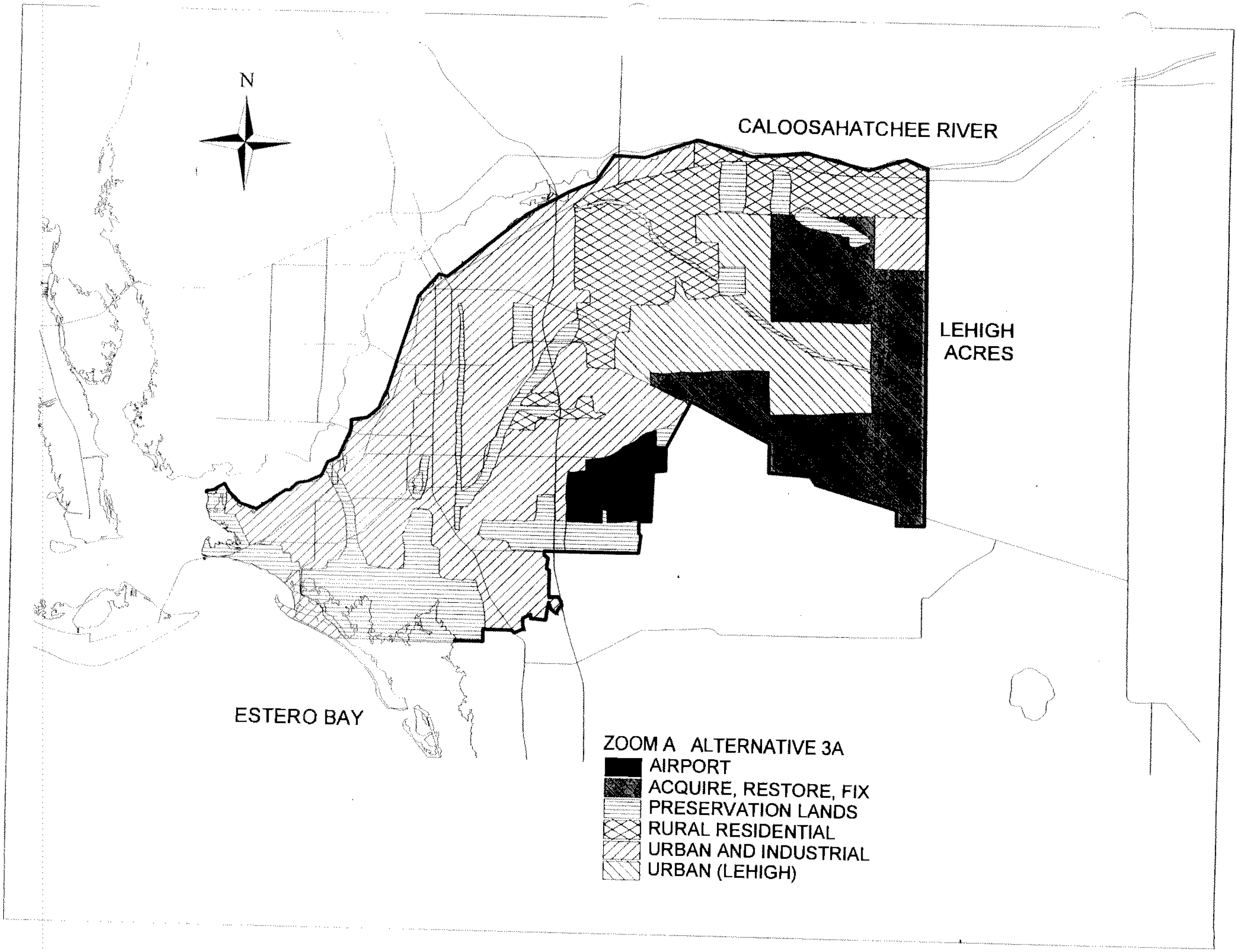
Of the alternatives, this one proposes the narrowest footprint for Preservation Lands within Camp Keais Strand, restricting it to areas not currently under agriculture. The alternative does propose culverts under existing road crossing in the Strand to improve flowways.

One area of Industrial is designated to reflect the current land use (Ford Test Track).

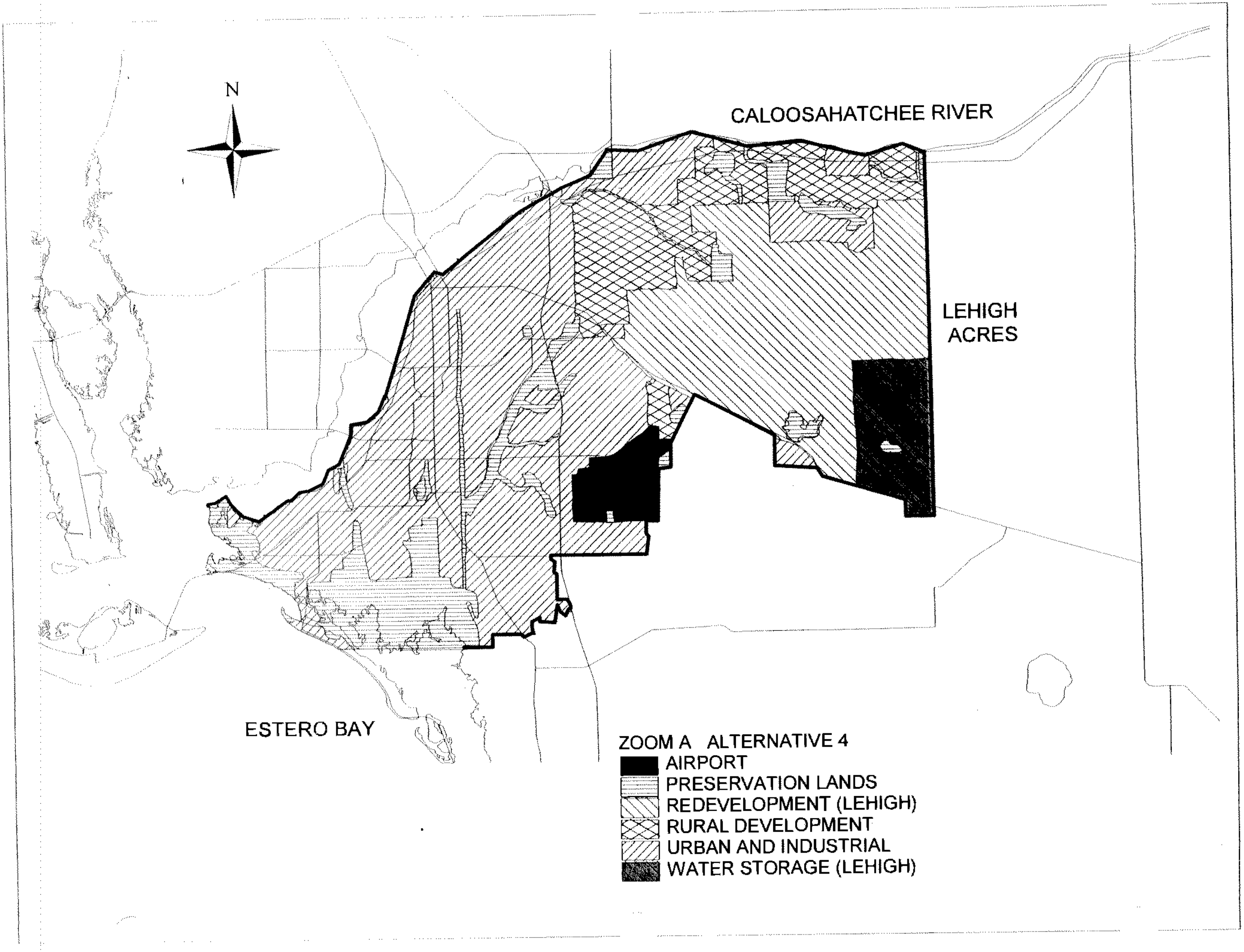

N
CALOOSAHATCHEE RIVER
LEHIGH ACRES
ESTERO BAY
ZOOM A ALTERNATIVE CP
Agricultural
Industrial
Preservation
Rural Residential
Urban
Urban (Lehigh)

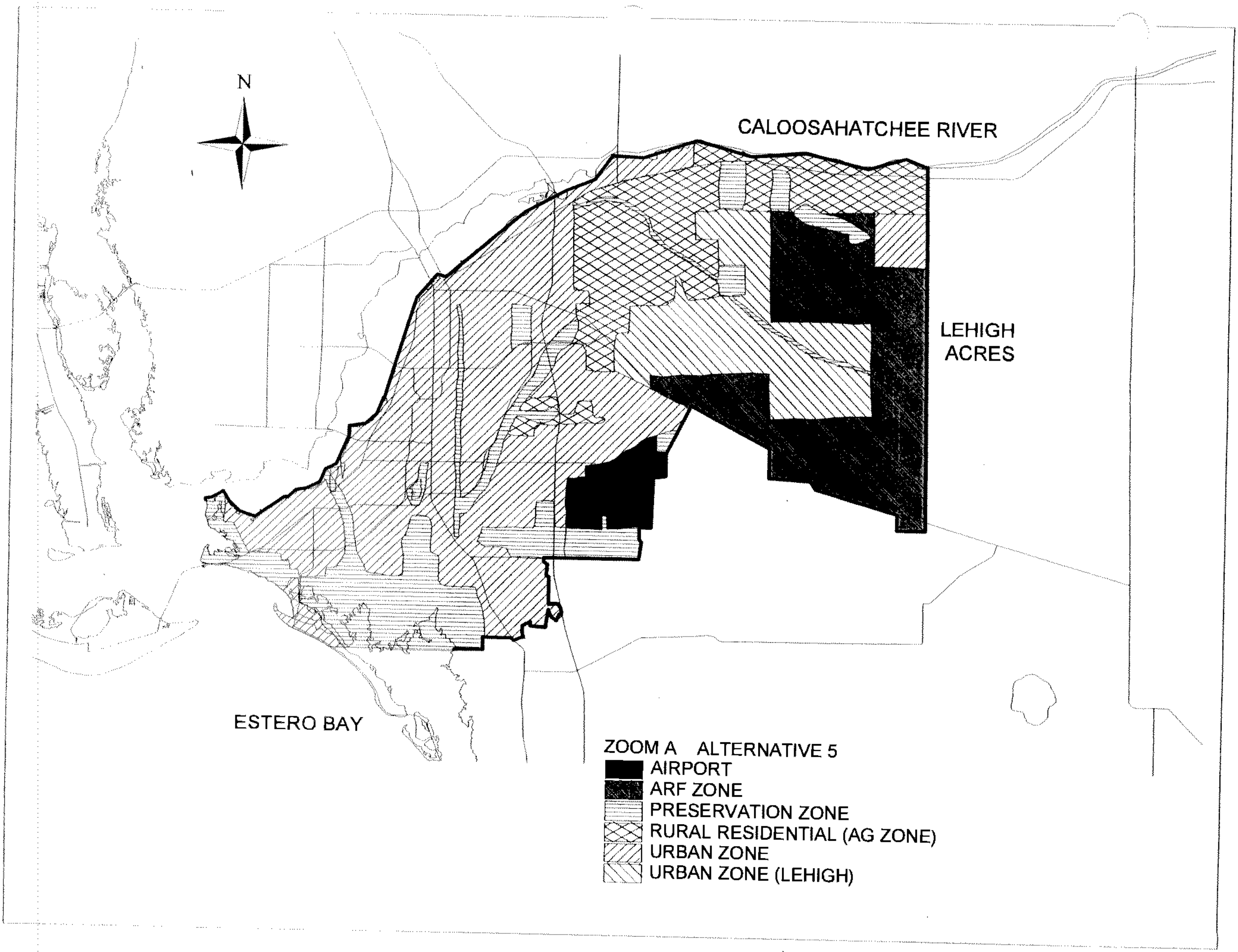

N
CALOOSAHATCHEE RIVER
LEHIGH ACRES
ESTERO BAY
ZOOM A ALTERNATIVE 1A
AIRPORT
CONSERVATION LANDS
RESTORATION, RETROFIT, REDEVELOPMENT (LEHIGH)
RURAL RESIDENTIAL
URBAN & INDUSTRIAL
URBAN (LEHIGH)

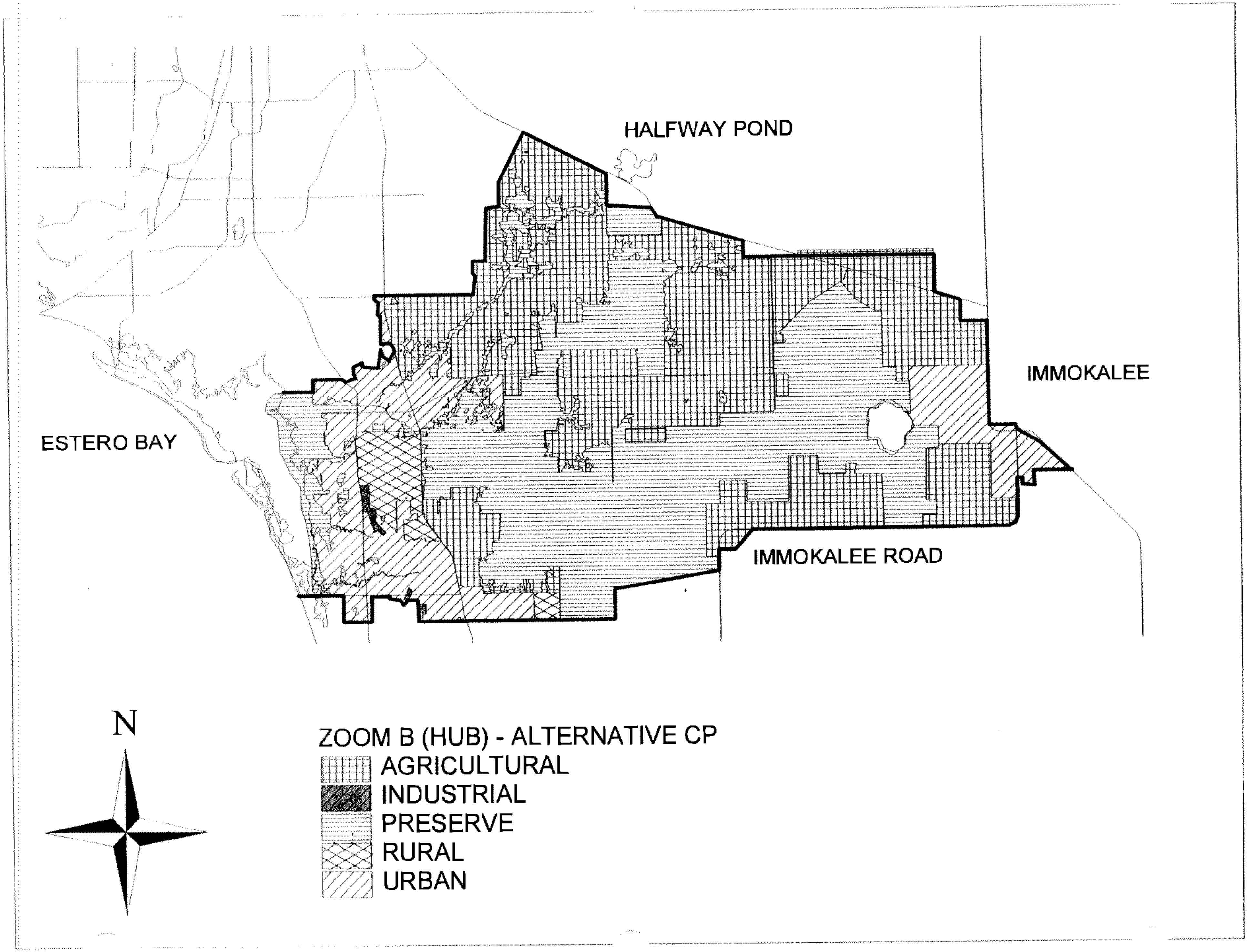

N
CALOOSAHATCHEE RIVER
LEHIGH
ACRES
ESTERO BAY
ZOOM A ALTERNATIVE 2
AIRPORT
LEHIGH GREENWAY
LEHIGH ACRES ZONE
PRESERVATION LANDS
RURAL
URBAN AND INDUSTRIAL

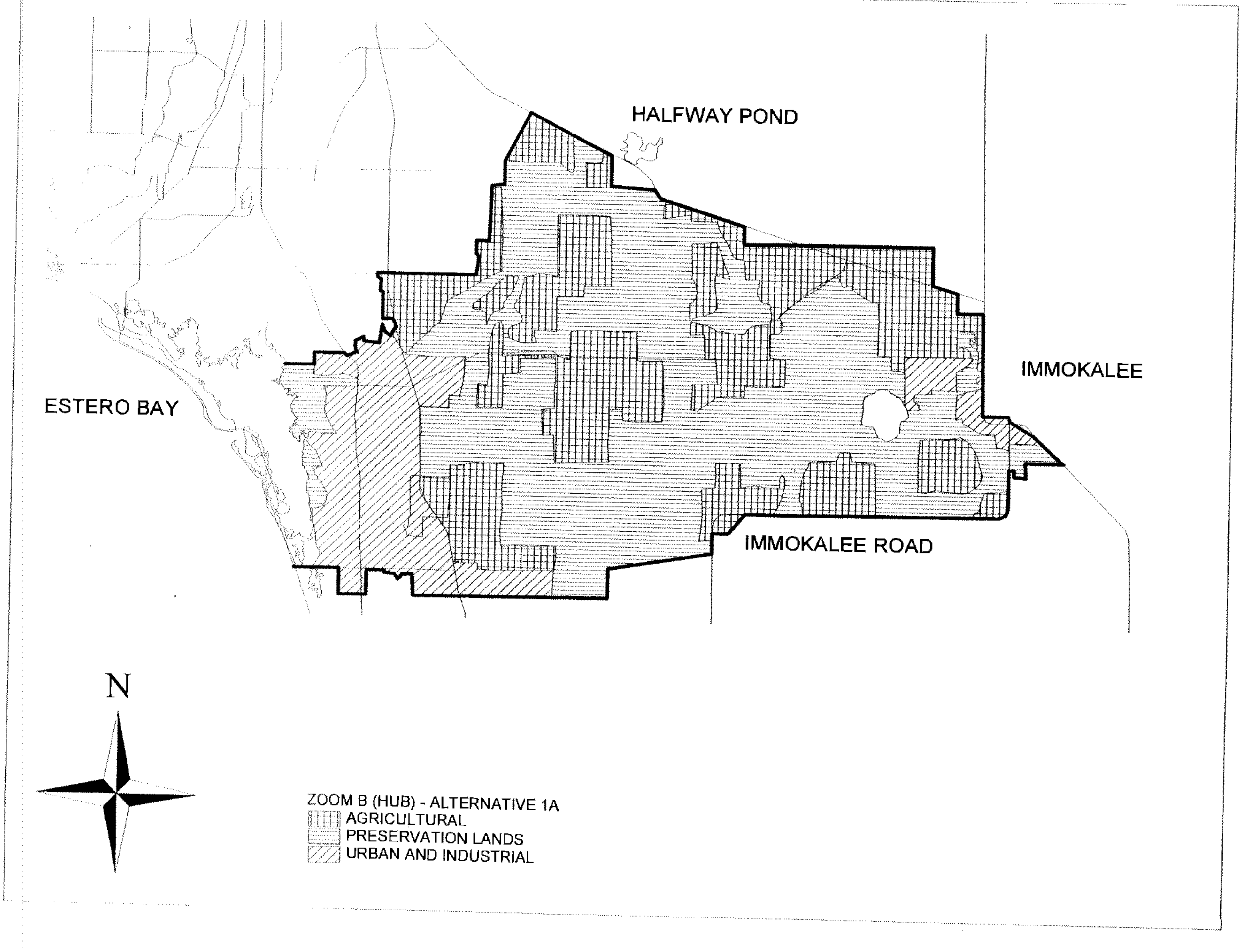


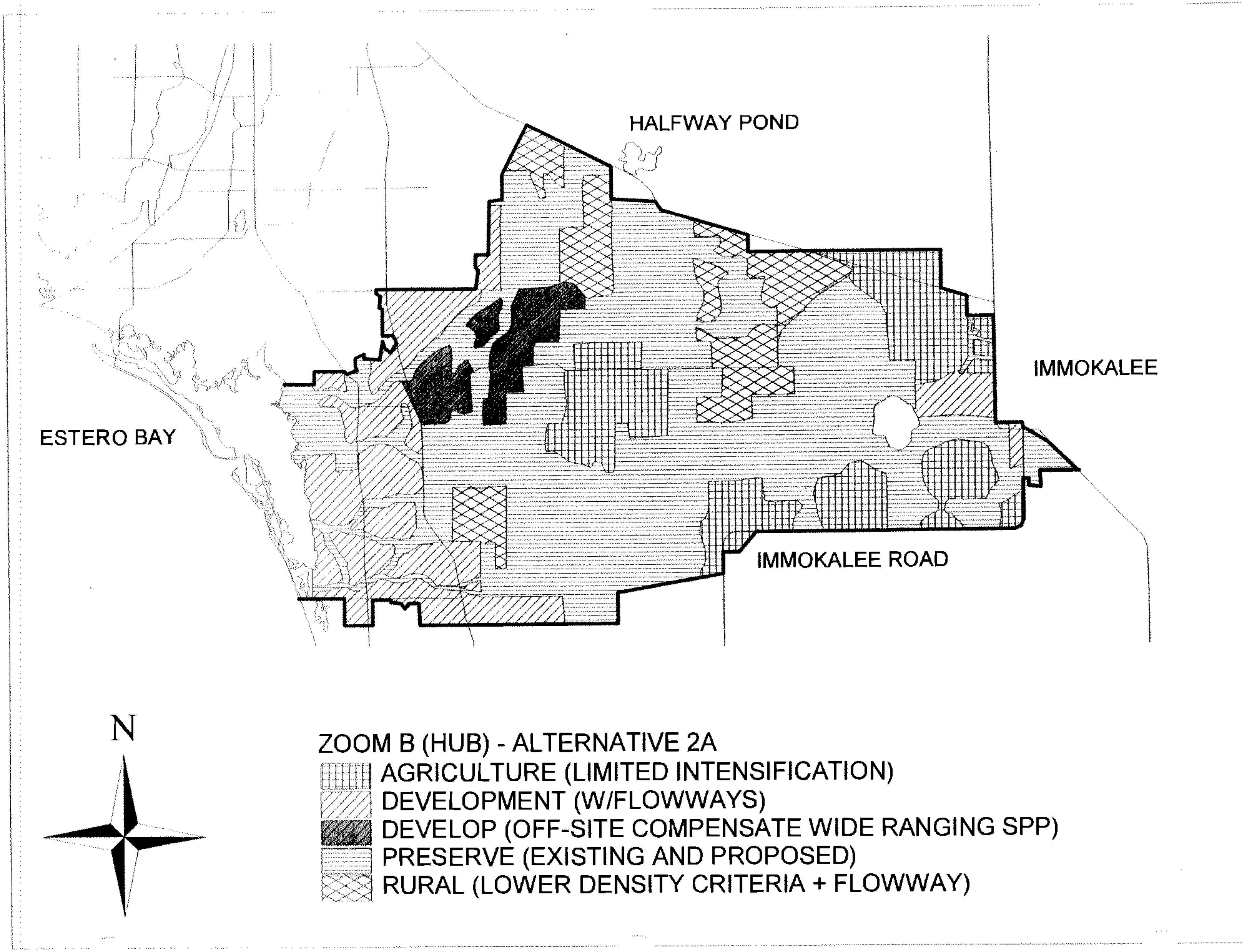
N
CALOOSAHATCHEE RIVER
LEHIGH ACRES
ESTERO BAY
ZOOM A ALTERNATIVE 3A
AIRPORT
ACQUIRE, RESTORE, FIX
PRESERVATION LANDS
RURAL RESIDENTIAL
URBAN AND INDUSTRIAL
URBAN (LEHIGH)

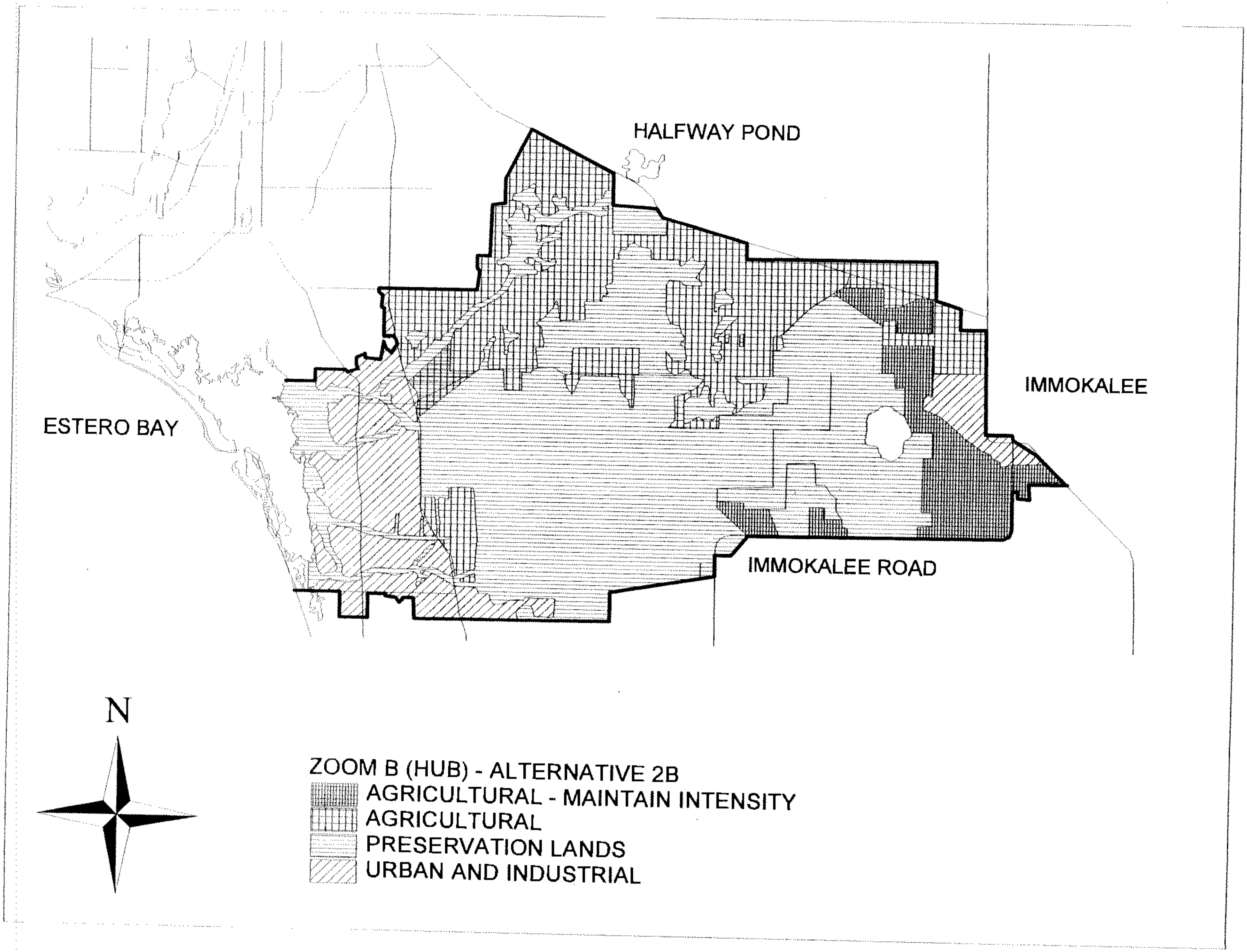

N
CALOOSAHATCHEE RIVER
LEHIGH
ACRES
ESTERO BAY
ZOOM A ALTERNATIVE 4
AIRPORT
PRESERVATION LANDS
REDEVELOPMENT (LEHIGH)
RURAL DEVELOPMENT
URBAN AND INDUSTRIAL
WATER STORAGE (LEHIGH)


N
CALOOSAHATCHEE RIVER
LEHIGH ACRES
ESTERO BAY
ZOOM A ALTERNATIVE 5
AIRPORT
ARF ZONE
PRESERVATION ZONE
RURAL RESIDENTIAL (AG ZONE)
URBAN ZONE
URBAN ZONE (LEHIGH)

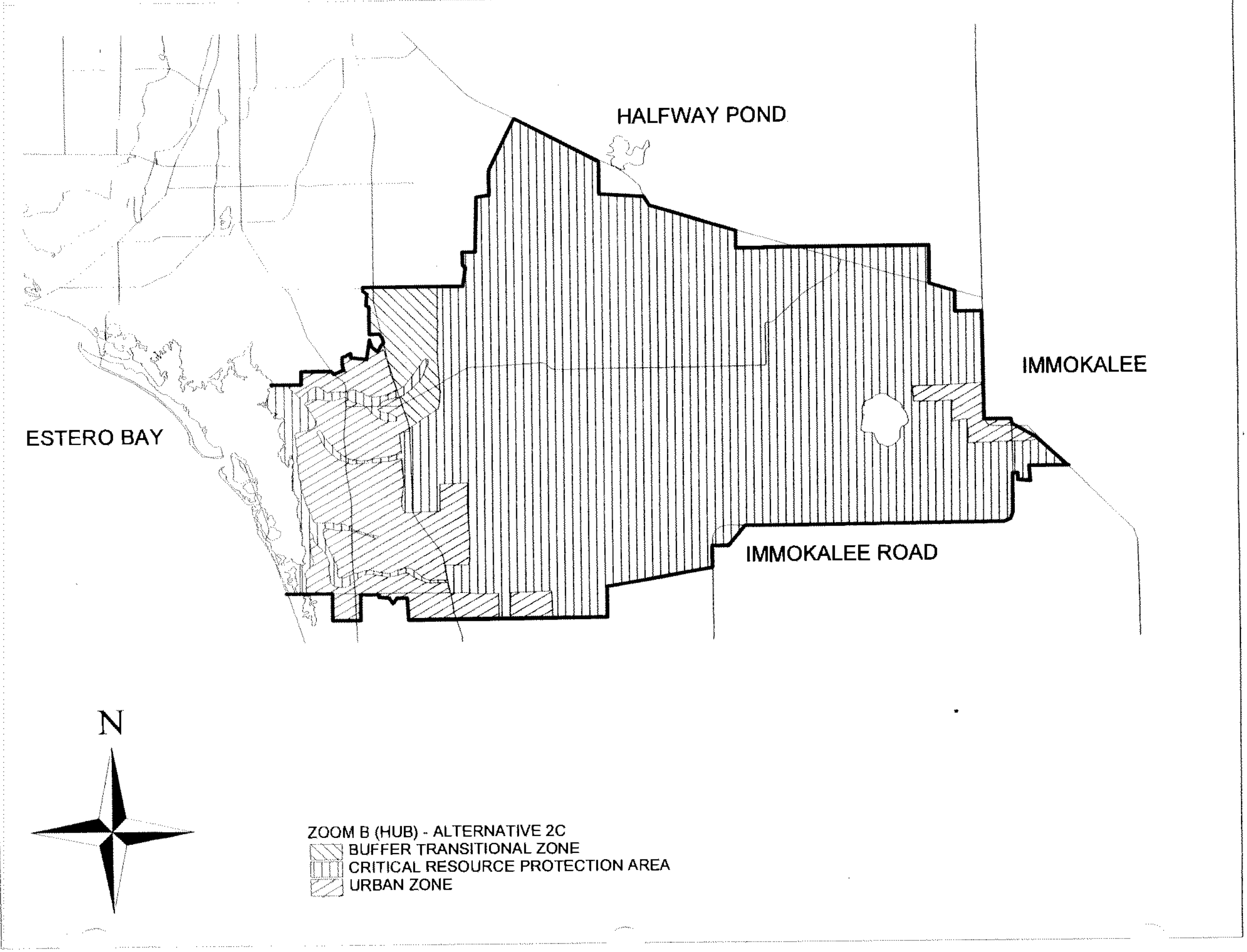

HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE CP
AGRICULTURAL
INDUSTRIAL
PRESERVE
RURAL
URBAN

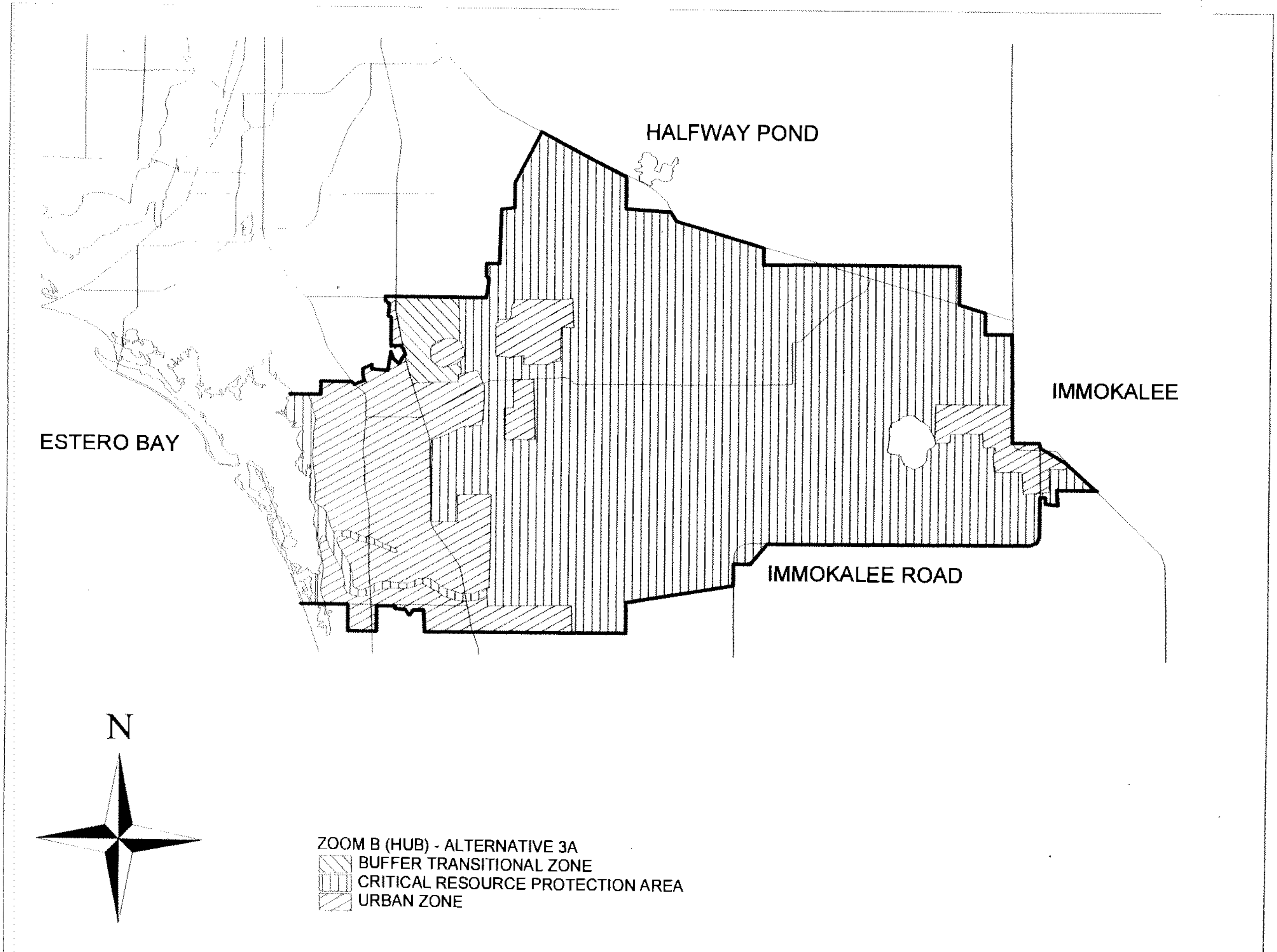

HALFWAY POND
ESTERO BAY
IMMOKALEE
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 1A
AGRICULTURAL
PRESERVATION LANDS
URBAN AND INDUSTRIAL

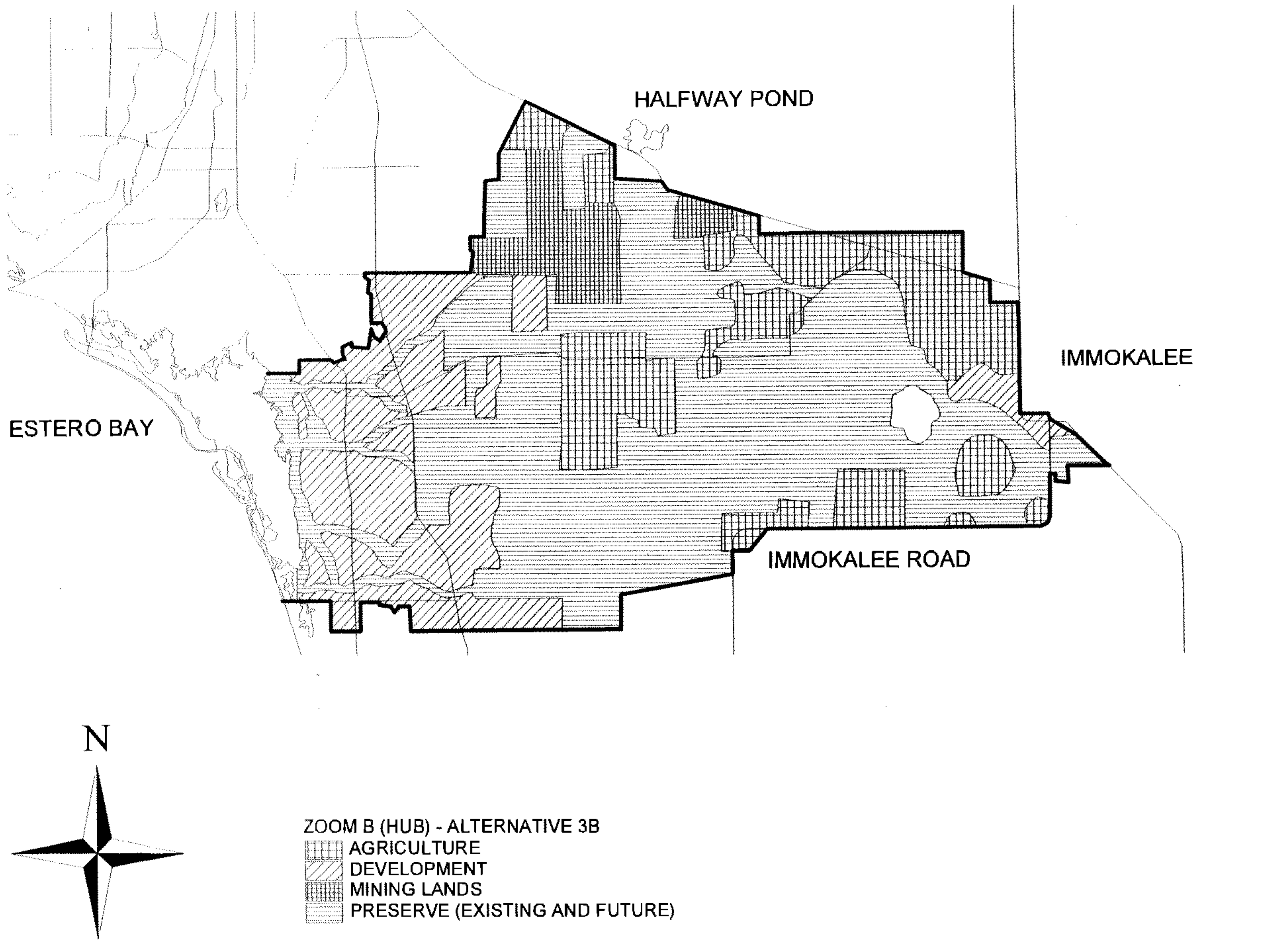

HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 2A
AGRICULTURE (LIMITED INTENSIFICATION)
DEVELOPMENT (W/FLOWWAYS)
DEVELOP (OFF-SITE COMPENSATE WIDE RANGING SPP)
PRESERVE (EXISTING AND PROPOSED)
RURAL (LOWER DENSITY CRITERIA + FLOWWAY)

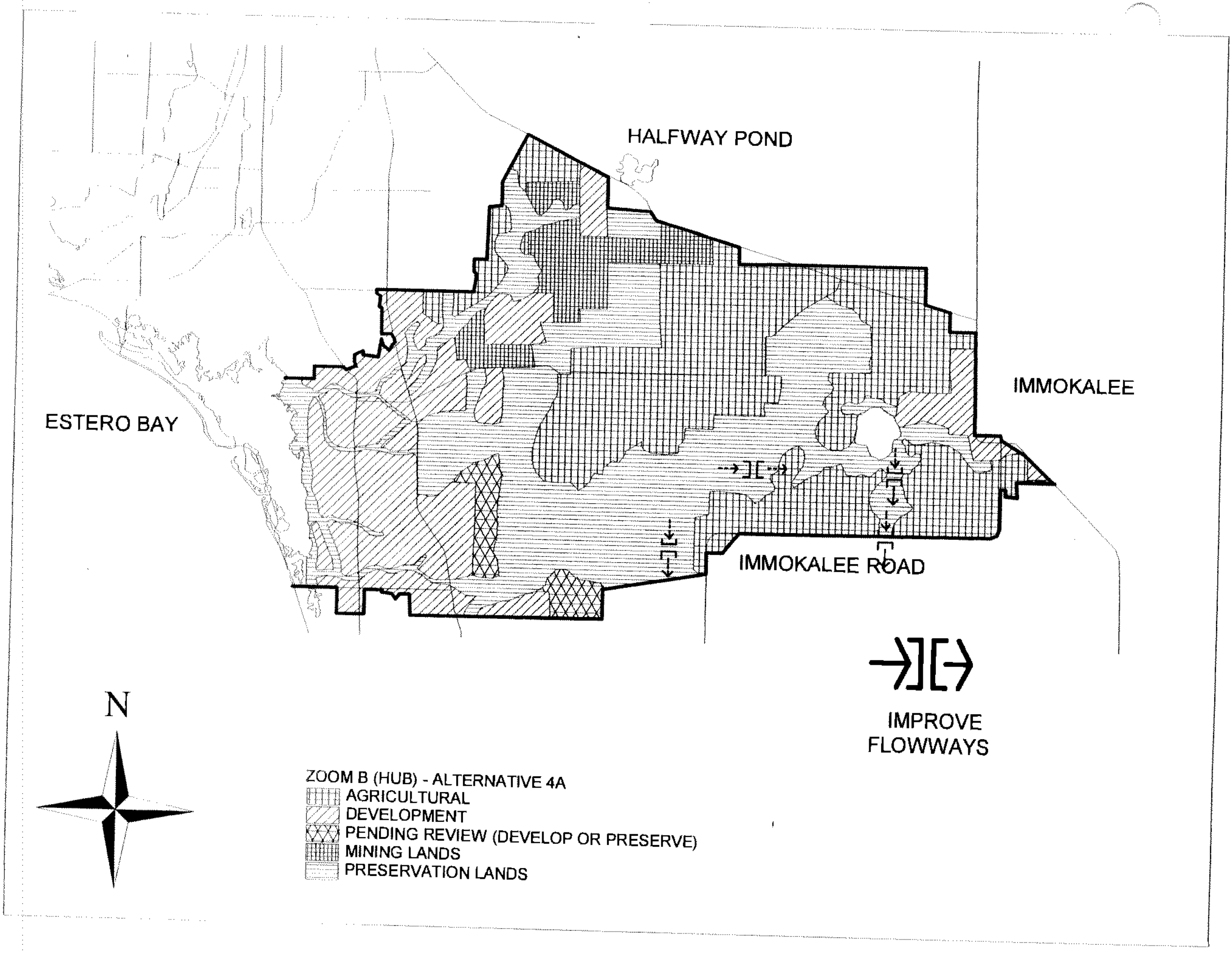


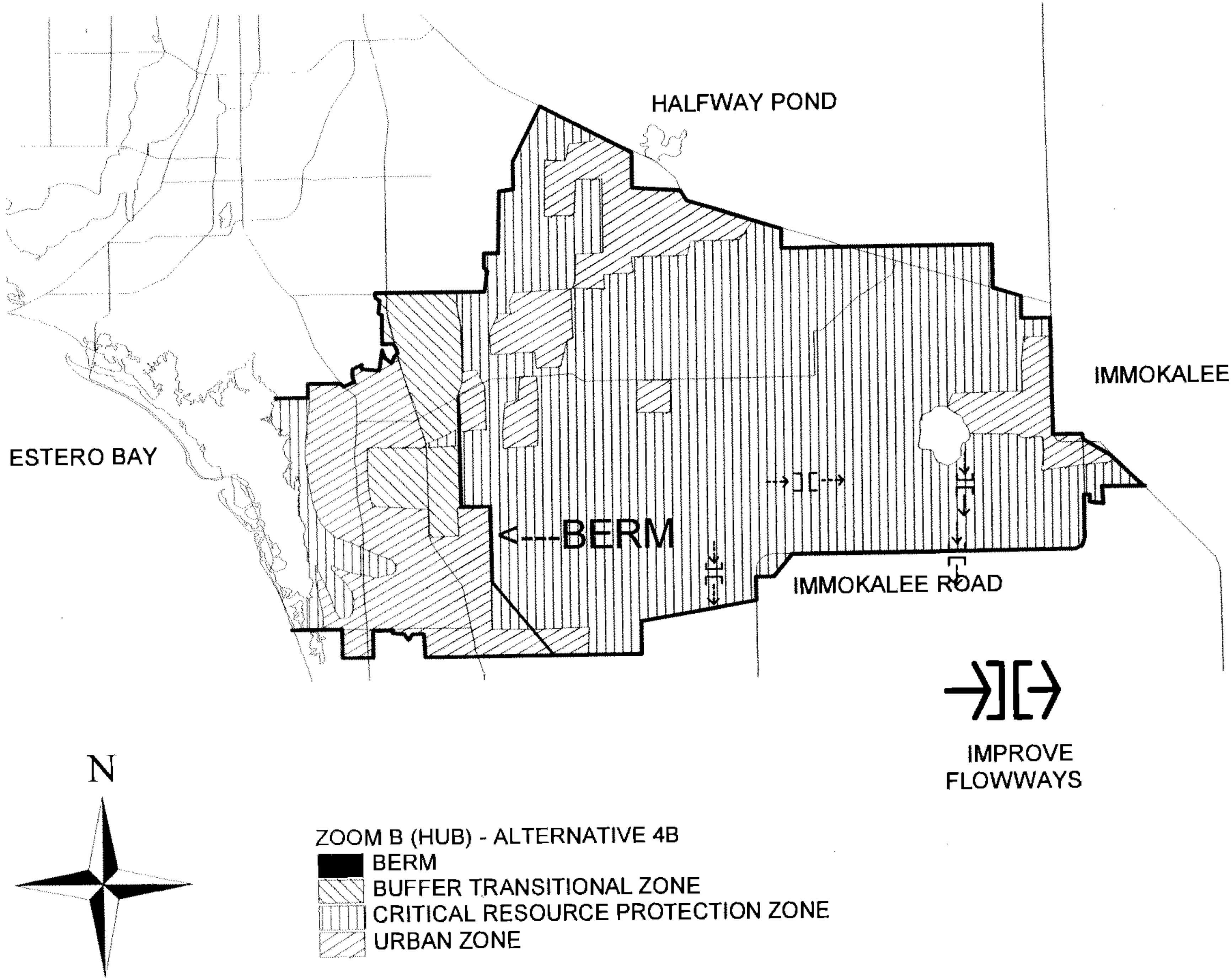
HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 2B
AGRICULTURAL - MAINTAIN INTENSITY
AGRICULTURAL
PRESERVATION LANDS
URBAN AND INDUSTRIAL

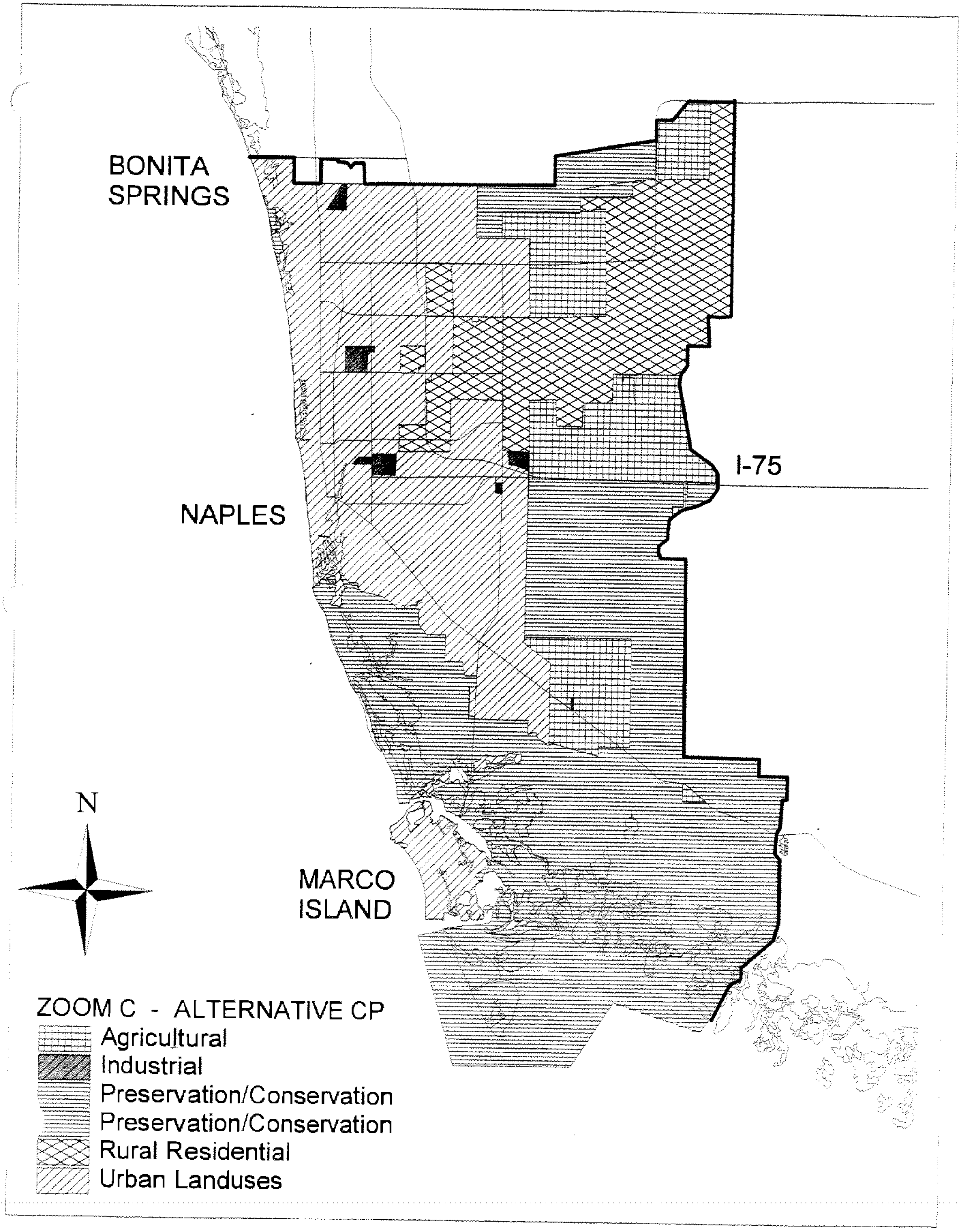

HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 2C
BUFFER TRANSITIONAL ZONE
CRITICAL RESOURCE PROTECTION AREA
URBAN ZONE

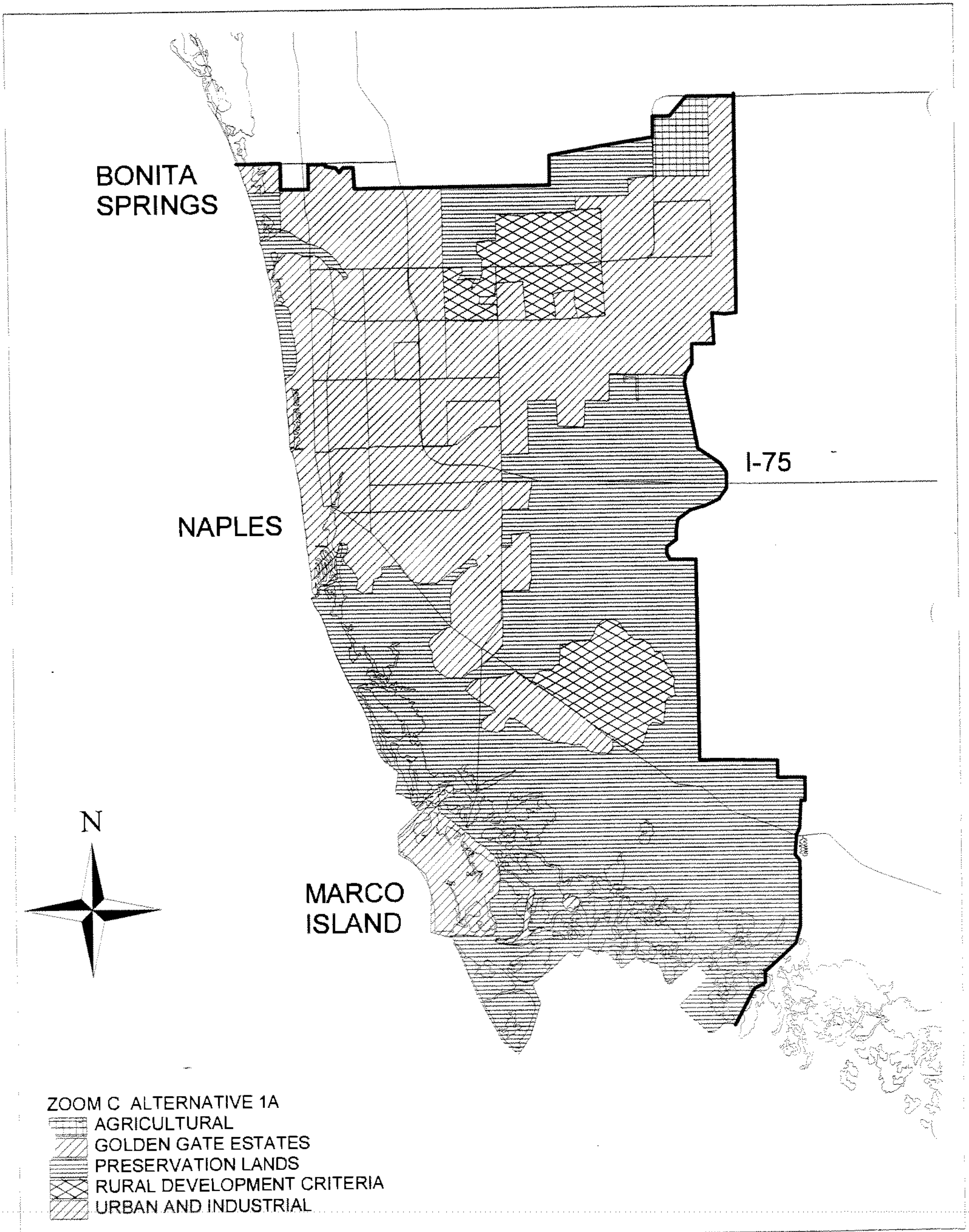

HALFWAY POND
ESTERO BAY
IMMOKALEE
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 3A
BUFFER TRANSITIONAL ZONE
CRITICAL RESOURCE PROTECTION AREA
URBAN ZONE

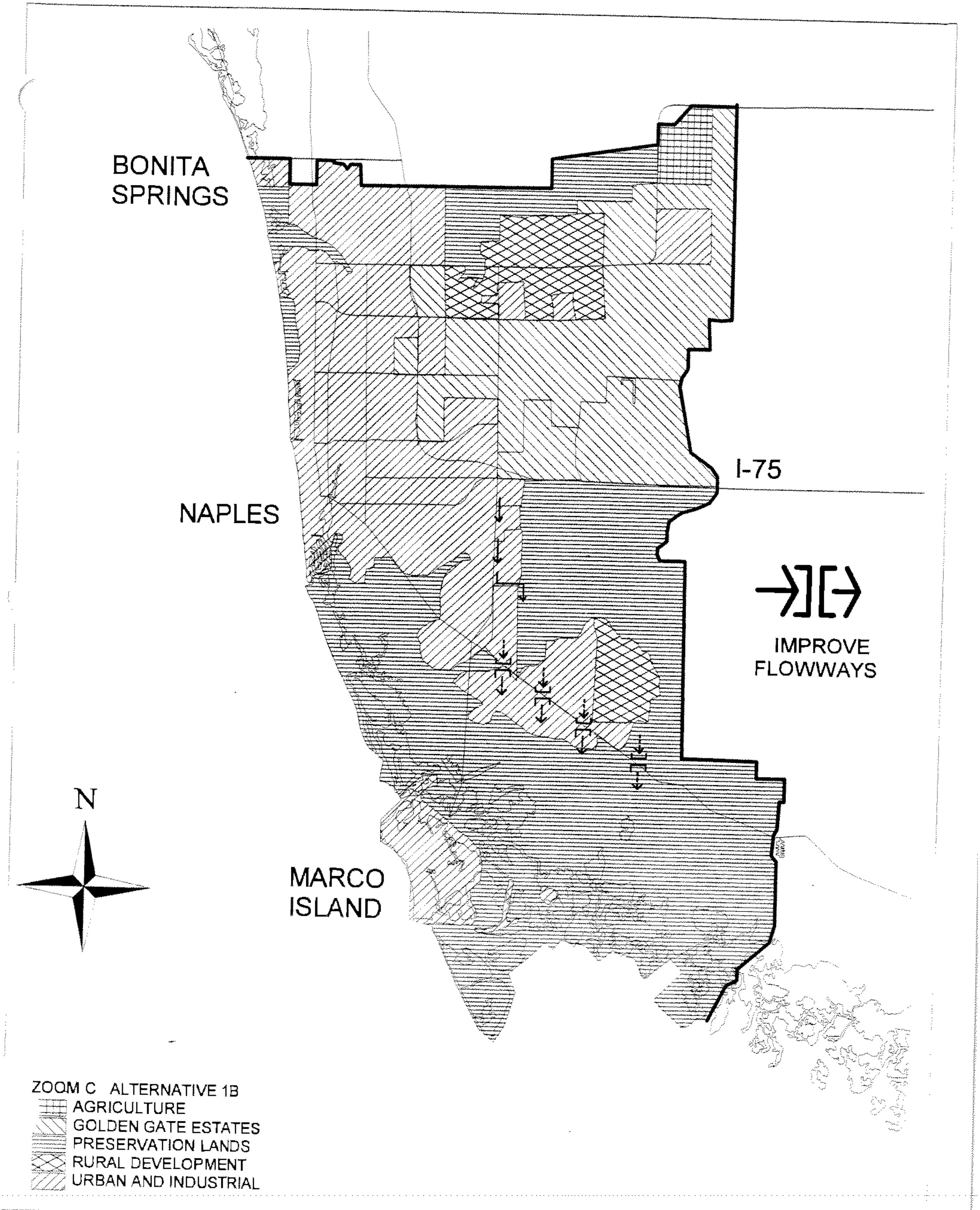

HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
N
ZOOM B (HUB) - ALTERNATIVE 3B
AGRICULTURE
DEVELOPMENT
MINING LANDS
PRESERVE (EXISTING AND FUTURE)


HALFWAY POND
IMMOKALEE
ESTERO BAY
IMMOKALEE ROAD
IMPROVE FLOWWAYS
N
ZOOM B (HUB) - ALTERNATIVE 4A
AGRICULTURAL
DEVELOPMENT
PENDING REVIEW (DEVELOP OR PRESERVE)
MINING LANDS
PRESERVATION LANDS

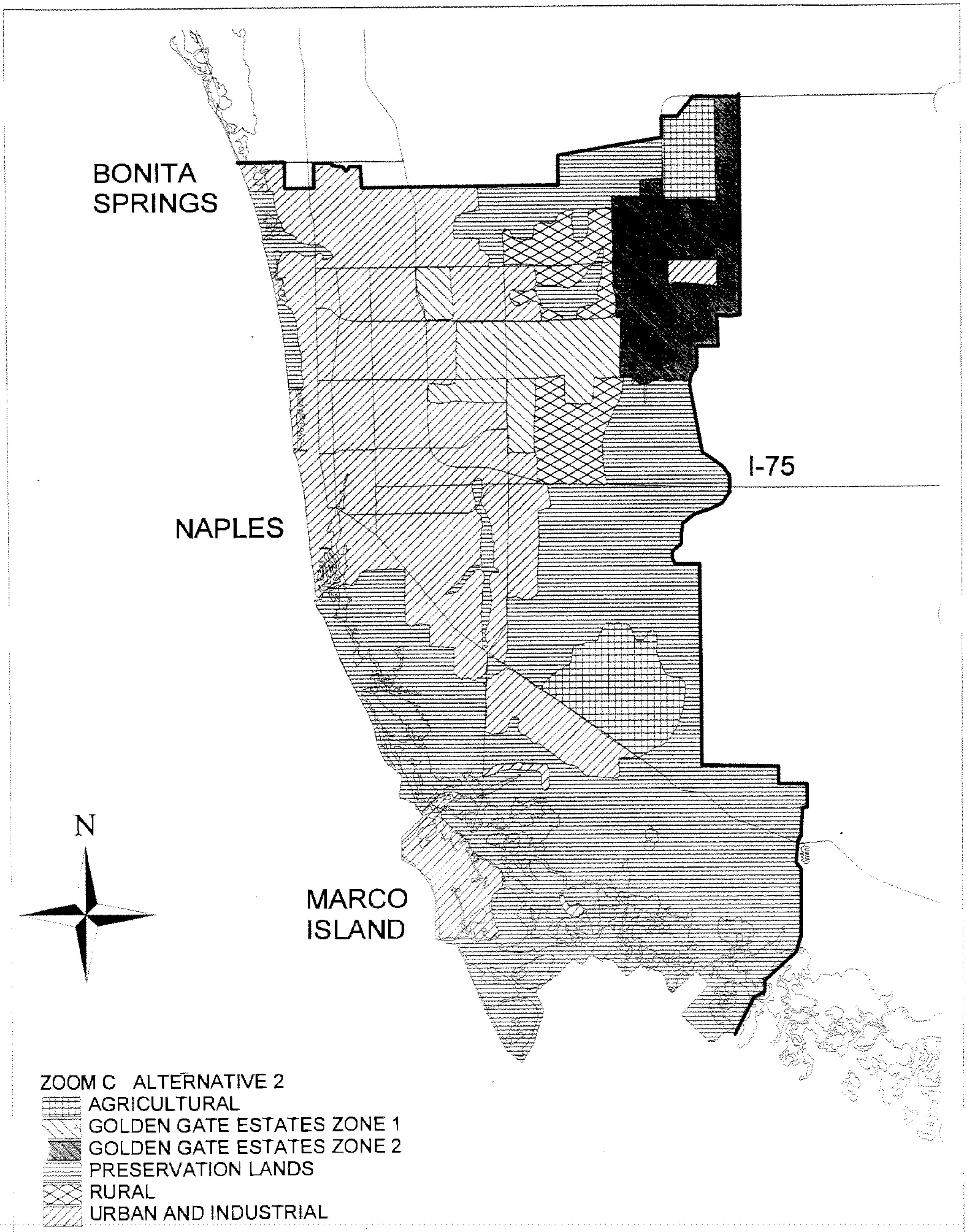

HALFWAY POND
IMMOKALEE
ESTERO BAY
<---BERM
IMMOKALEE ROAD
IMPROVE
FLOWWAYS
N
ZOOM B (HUB) - ALTERNATIVE 4B
BERM
BUFFER TRANSITIONAL ZONE
CRITICAL RESOURCE PROTECTION ZONE
URBAN ZONE


BONITA
SPRINGS
NAPLES
I-75
MARCO
ISLAND
N
ZOOM C - ALTERNATIVE CP
Agricultural
Industrial
Preservation/Conservation
Preservation/Conservation
Rural Residential
Urban Landuses


BONITA
SPRINGS
I-75
NAPLES
MARCO
ISLAND
N
ZOOM C ALTERNATIVE 1A
AGRICULTURAL
GOLDEN GATE ESTATES
PRESERVATION LANDS
RURAL DEVELOPMENT CRITERIA
URBAN AND INDUSTRIAL



BONITA
SPRINGS
NAPLES
I-75
IMPROVE
FLOWWAYS
MARCO
ISLAND
N
ZOOM C ALTERNATIVE 1B
AGRICULTURE
GOLDEN GATE ESTATES
PRESERVATION LANDS
RURAL DEVELOPMENT
URBAN AND INDUSTRIAL


BONITA
SPRINGS
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I-75
MARCO
ISLAND
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ZOOM C ALTERNATIVE 2
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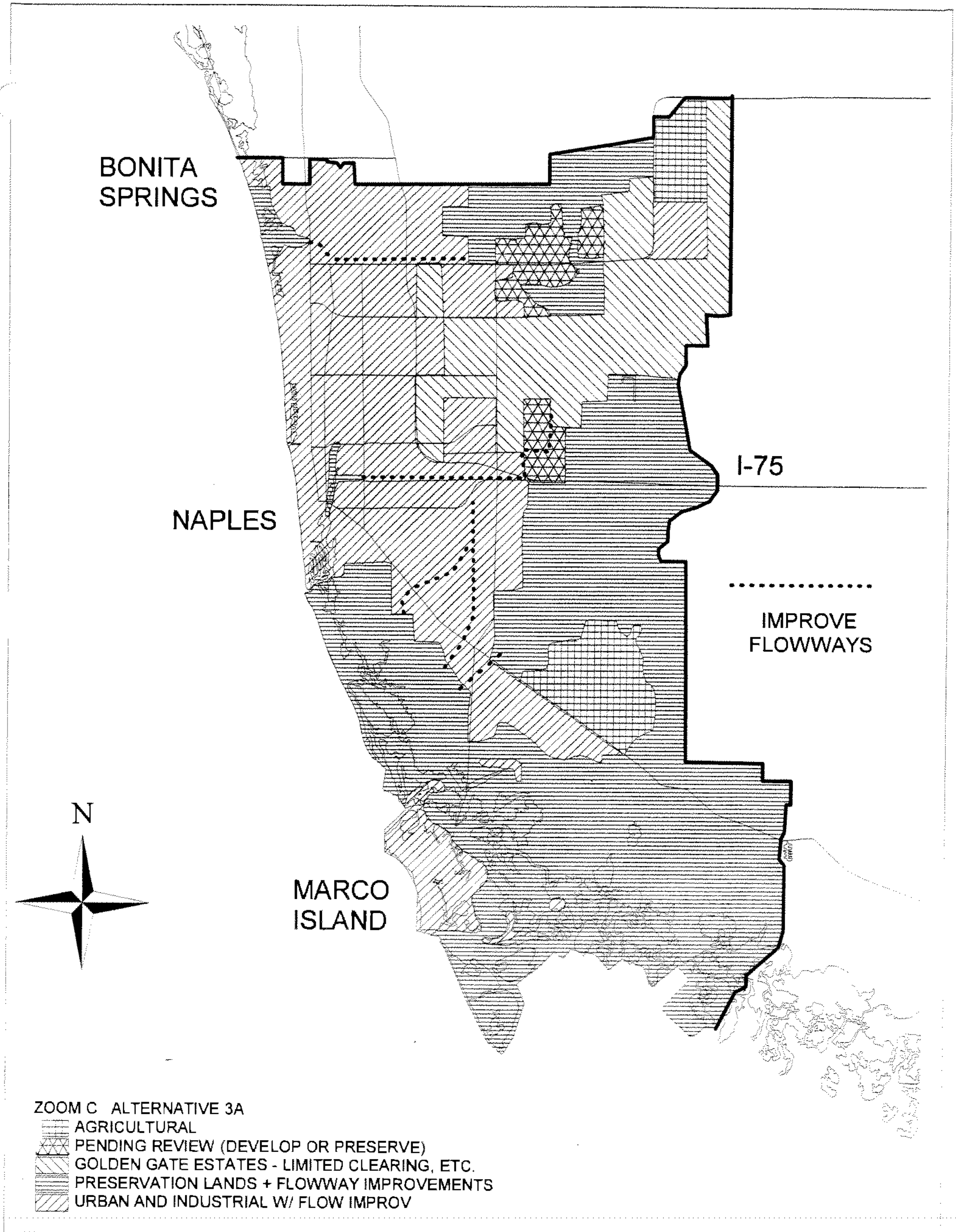
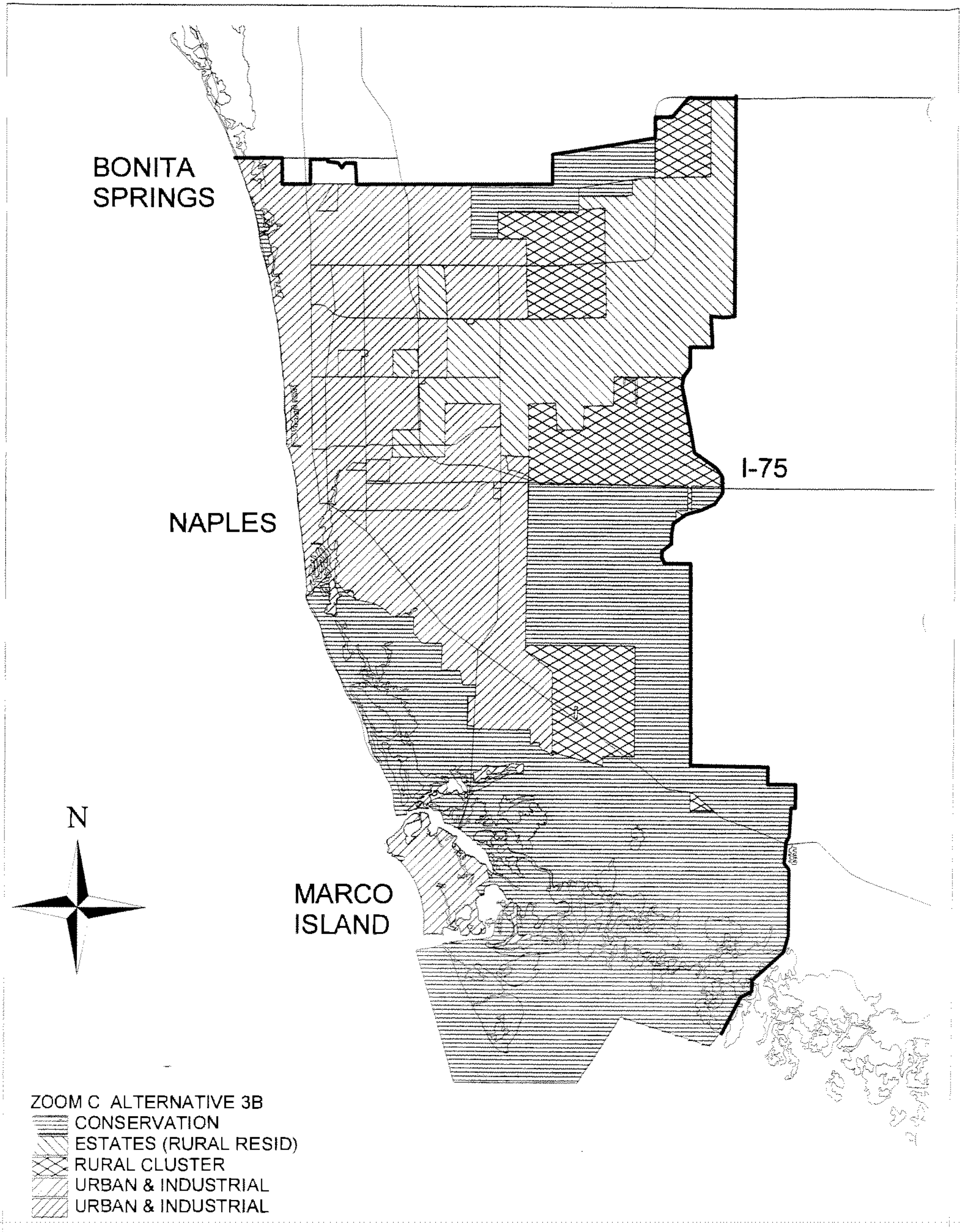
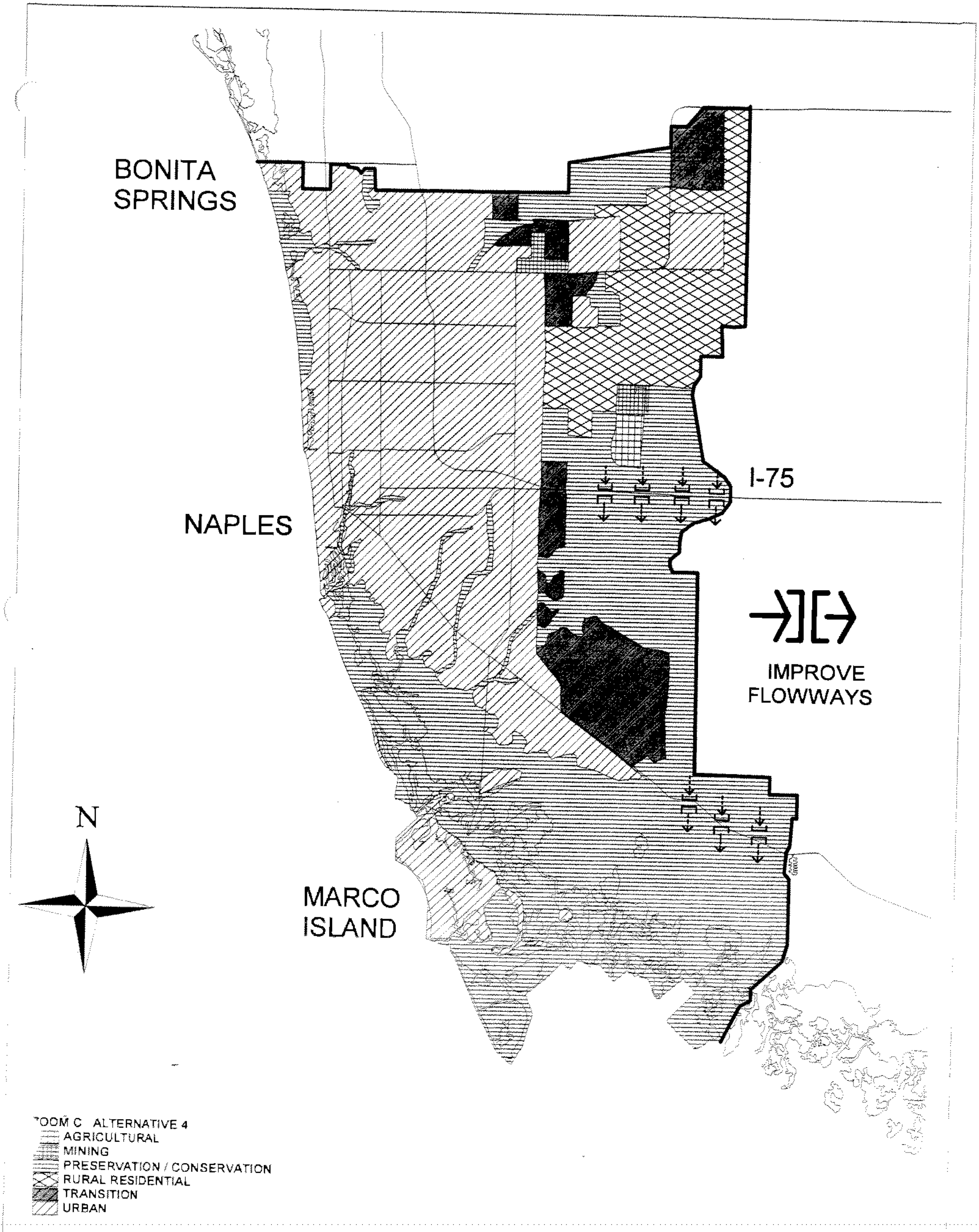
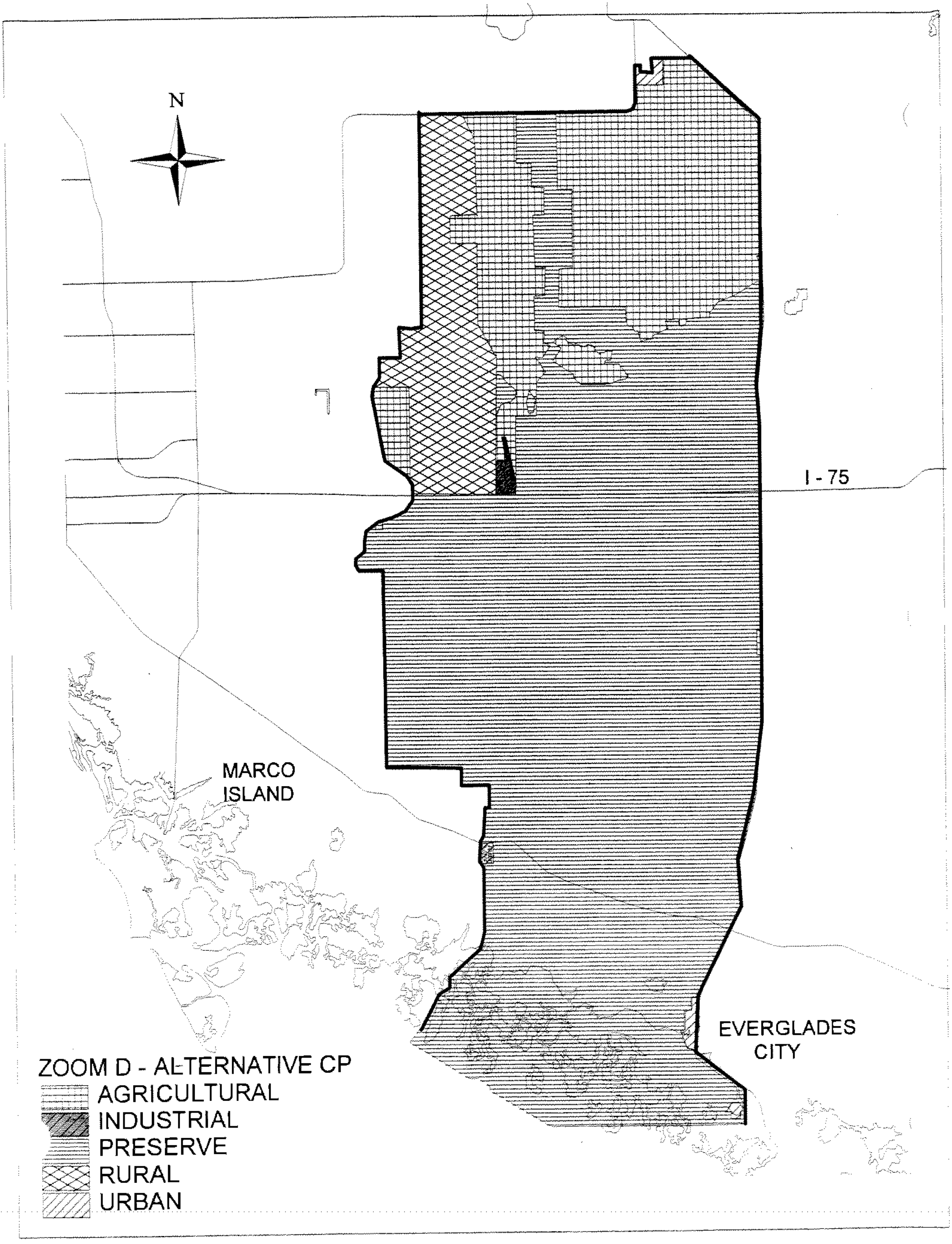
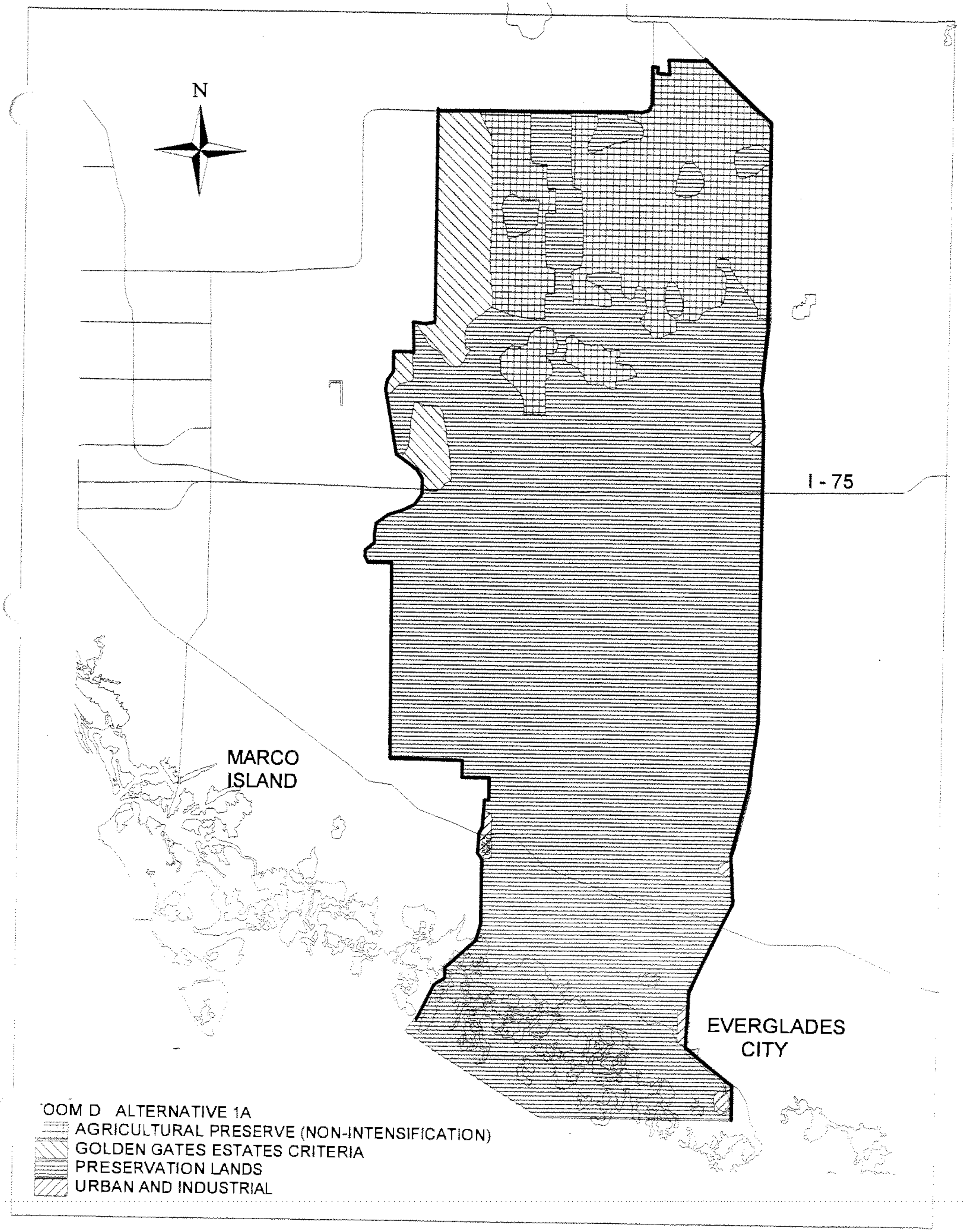
GOLDEN GATE ESTATES ZONE 1
GOLDEN GATE ESTATES ZONE 2
PRESERVATION LANDS
RURAL
URBAN AND INDUSTRIAL

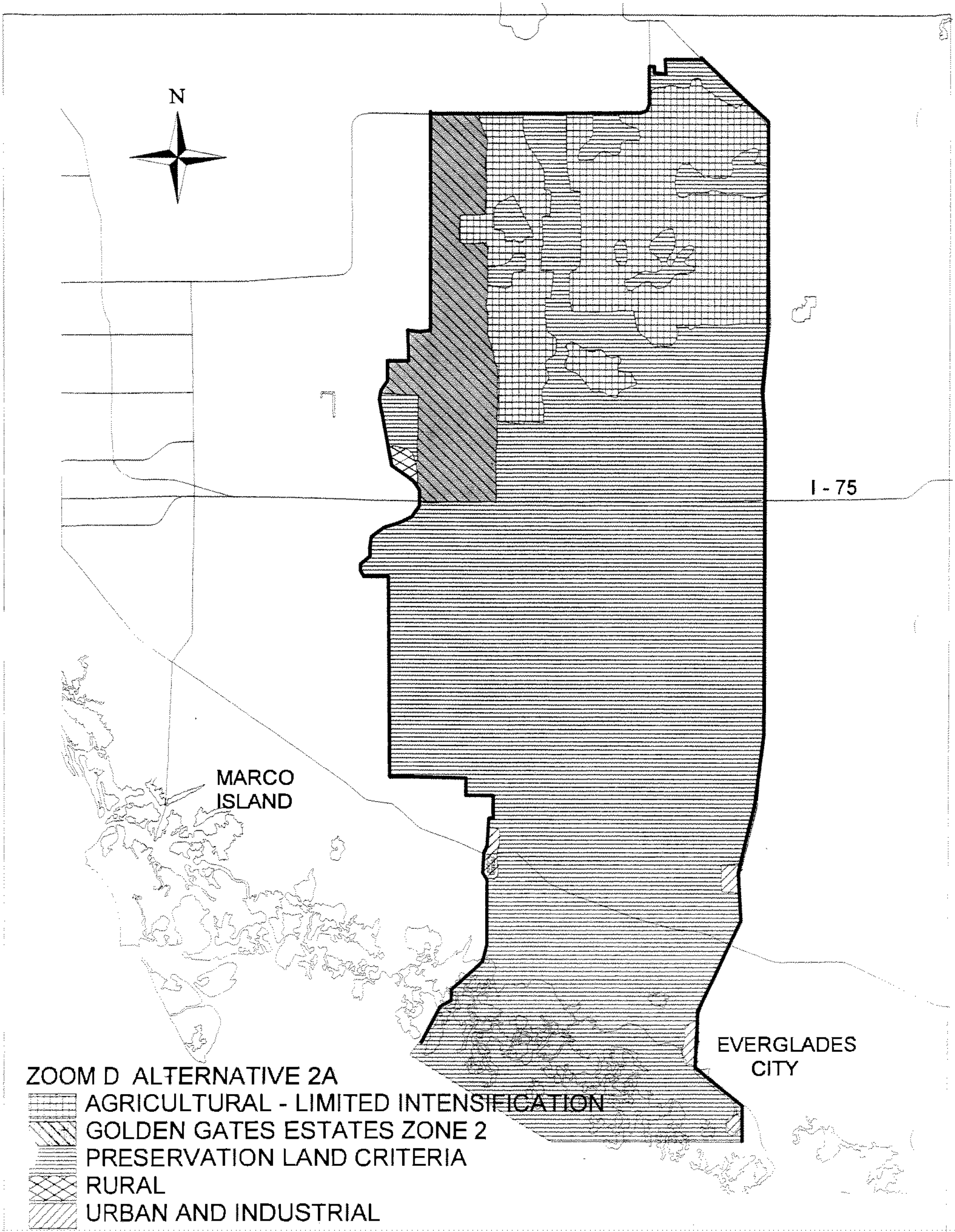

BONITA SPRINGS
NAPLES
I-75
IMPROVE FLOWWAYS
MARCO ISLAND
N
ZOOM C ALTERNATIVE 3A
AGRICULTURAL
PENDING REVIEW (DEVELOP OR PRESERVE)
GOLDEN GATE ESTATES - LIMITED CLEARING, ETC.
PRESERVATION LANDS + FLOWWAY IMPROVEMENTS
URBAN AND INDUSTRIAL W/ FLOW IMPROV

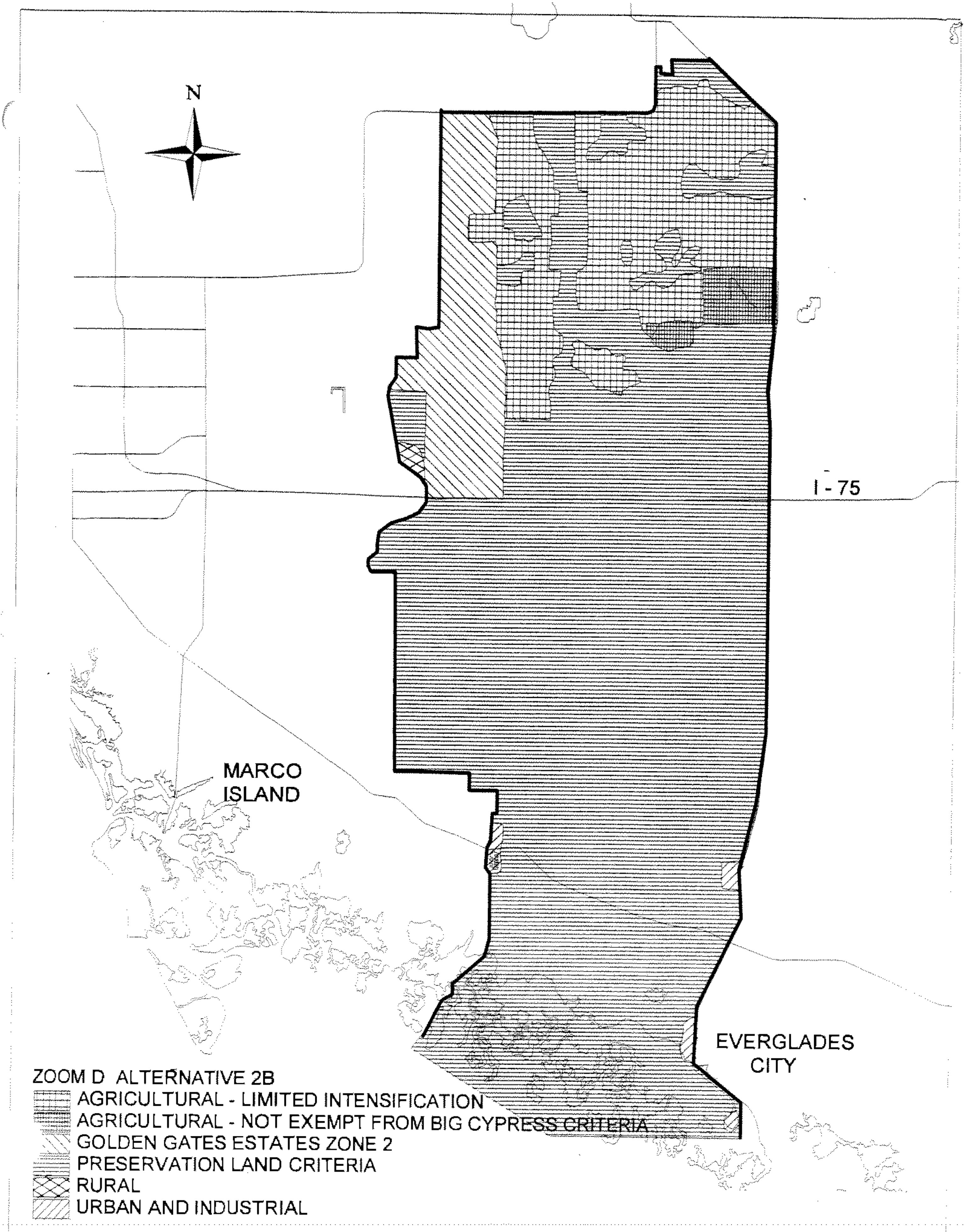

BONITA
SPRINGS
NAPLES
I-75
MARCO
ISLAND
N
ZOOM C ALTERNATIVE 3B
CONSERVATION
ESTATES (RURAL RESID)
RURAL CLUSTER
URBAN & INDUSTRIAL
URBAN & INDUSTRIAL

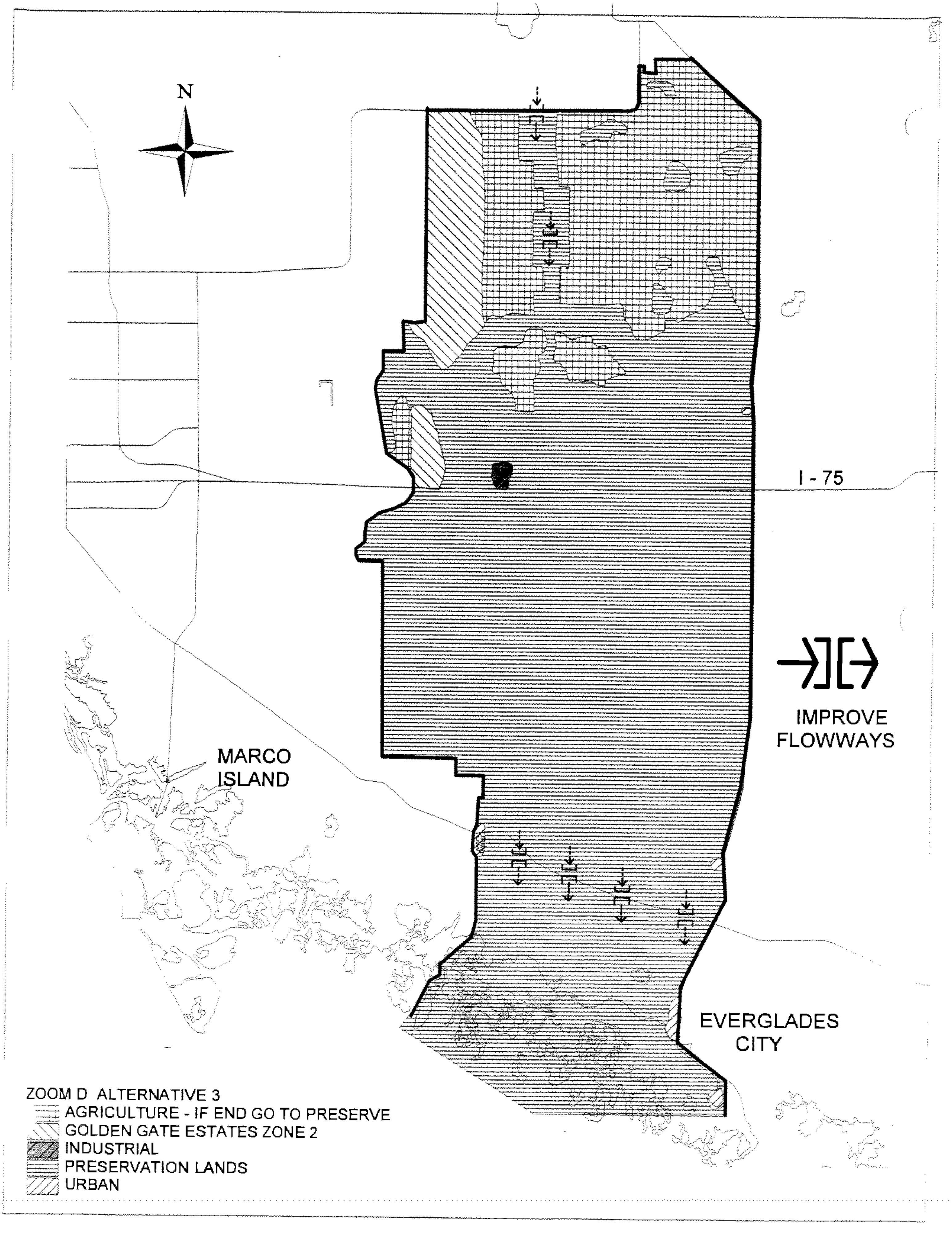

BONITA
SPRINGS
I-75
NAPLES
IMPROVE
FLOWWAYS
N
MARCO
ISLAND
OOM C ALTERNATIVE 4
AGRICULTURAL
MINING
PRESERVATION / CONSERVATION
RURAL RESIDENTIAL
TRANSITION
URBAN

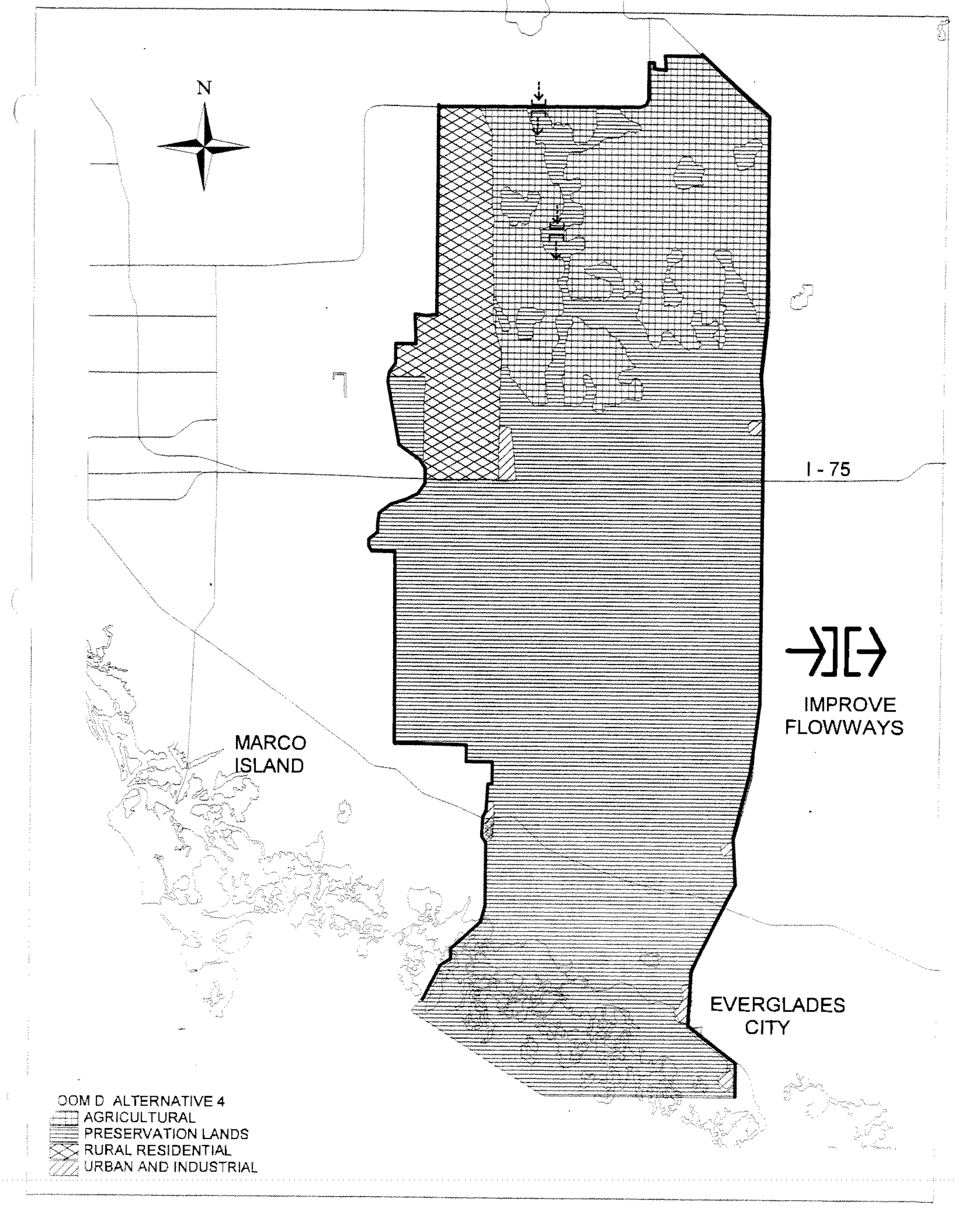

N
I - 75
MARCO
ISLAND
EVERGLADES
CITY
ZOOM D - ALTERNATIVE CP
AGRICULTURAL
INDUSTRIAL
PRESERVE
RURAL
URBAN


N
I - 75
MARCO
ISLAND
EVERGLADES
CITY
'OOM D ALTERNATIVE 1A
AGRICULTURAL PRESERVE (NON-INTENSIFICATION)
GOLDEN GATES ESTATES CRITERIA
PRESERVATION LANDS
URBAN AND INDUSTRIAL


N
I - 75
MARCO
ISLAND
EVERGLADES
CITY
ZOOM D ALTERNATIVE 2A
AGRICULTURAL - LIMITED INTENSIFICATION
GOLDEN GATES ESTATES ZONE 2
PRESERVATION LAND CRITERIA
RURAL
URBAN AND INDUSTRIAL


N
I - 75
MARCO ISLAND
EVERGLADES CITY
ZOOM D ALTERNATIVE 2B
AGRICULTURAL - LIMITED INTENSIFICATION
AGRICULTURAL - NOT EXEMPT FROM BIG CYPRESS CRITERIA
GOLDEN GATES ESTATES ZONE 2
PRESERVATION LAND CRITERIA
RURAL
URBAN AND INDUSTRIAL


N
I - 75
IMPROVE
FLOWWAYS
MARCO
ISLAND
EVERGLADES
CITY
ZOOM D ALTERNATIVE 3
AGRICULTURE - IF END GO TO PRESERVE
GOLDEN GATE ESTATES ZONE 2
INDUSTRIAL
PRESERVATION LANDS
URBAN



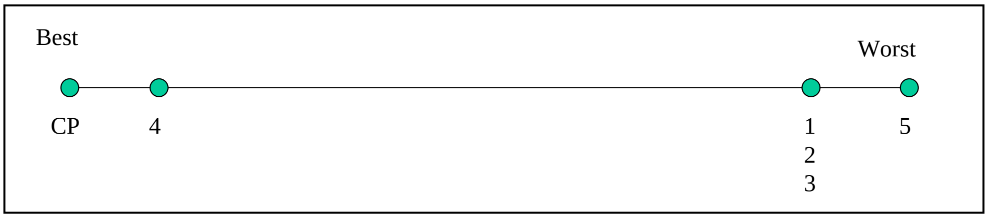
N
I - 75
IMPROVE
FLOWWAYS
MARCO
ISLAND
EVERGLADES
CITY
OOM D ALTERNATIVE 4
AGRICULTURAL
PRESERVATION LANDS
RURAL RESIDENTIAL
URBAN AND INDUSTRIAL

APPENDIX D

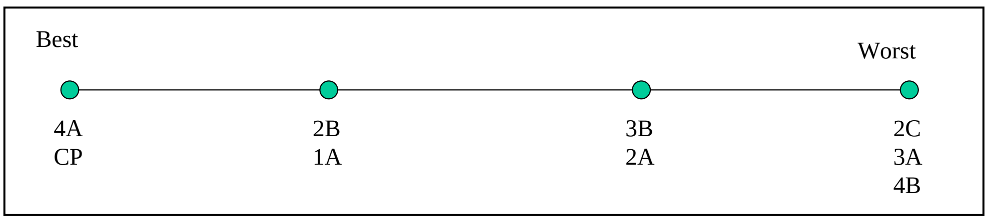
CONTINUUM OF ALTERNATIVES BY ISSUE CATEGORY

PROPERTY RIGHTS

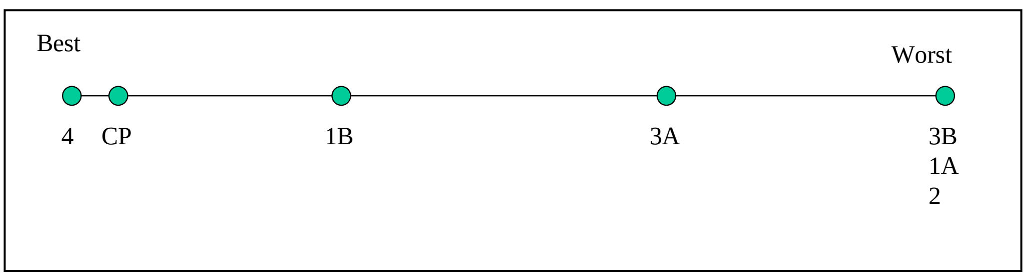
ZOOM A



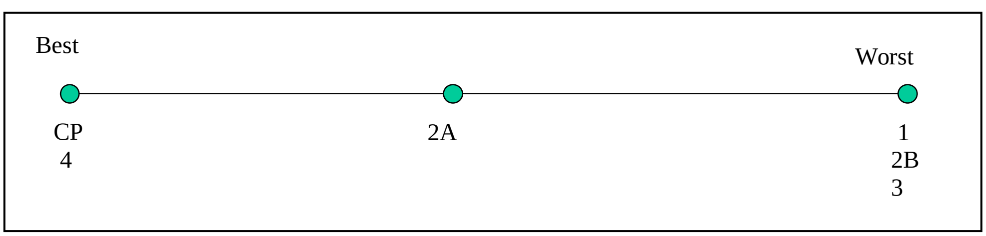
ZOOM B



ZOOM C

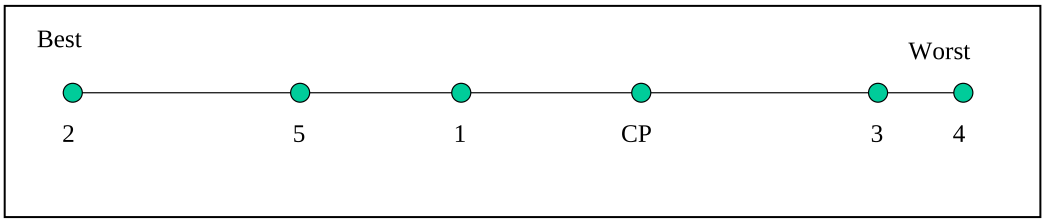


ZOOM D

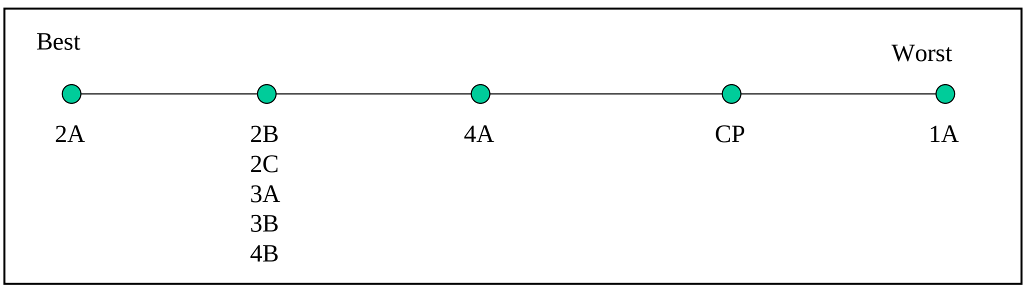


WATER MANAGEMENT

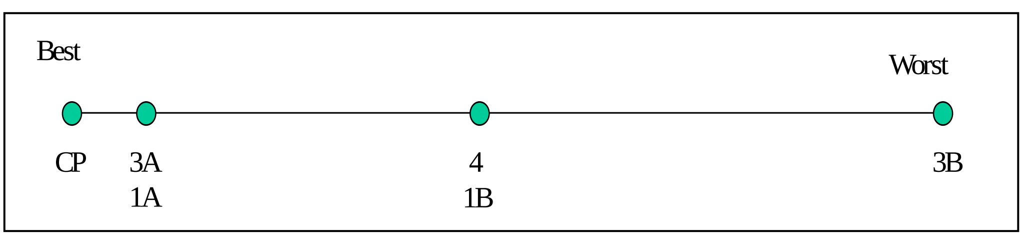
ZOOM A



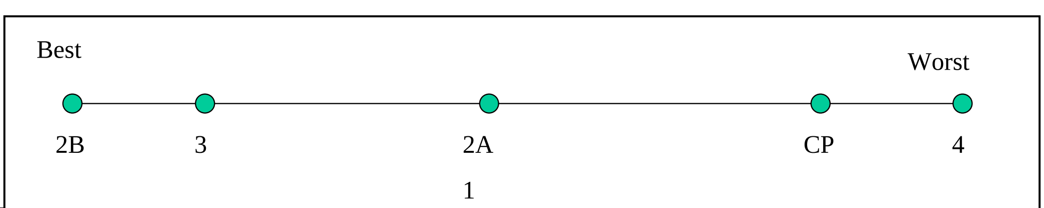
ZOOM B



ZOOM C



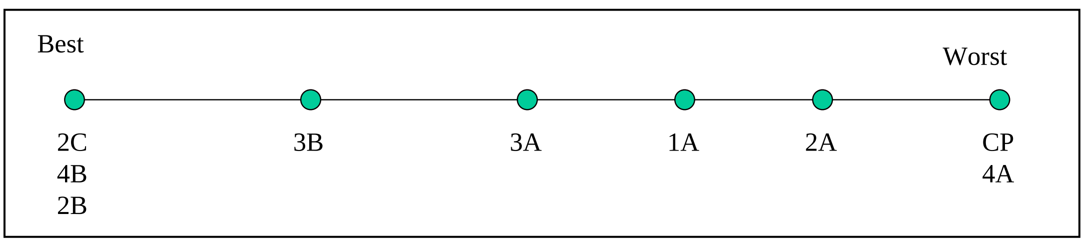
ZOOM D



WATER QUALITY

ZOOM A

ZOOM B



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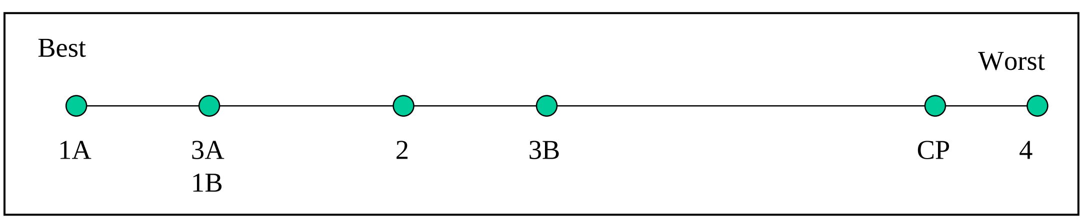

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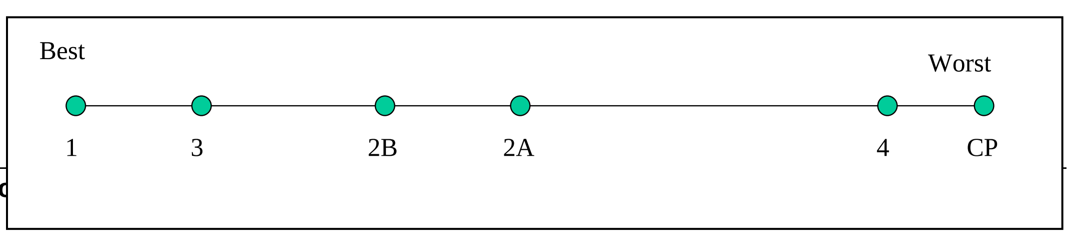
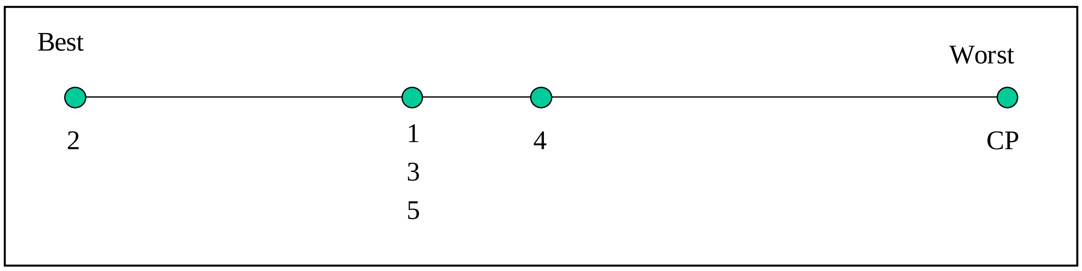


ECOSYSTEM FUNCTION, WILDLIFE HABITAT, AND LISTED SPECIES

ZOOM A



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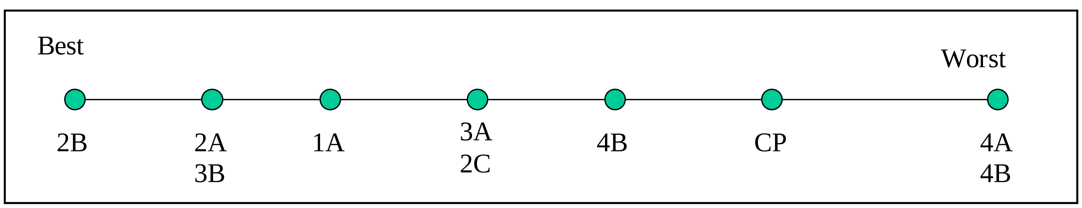

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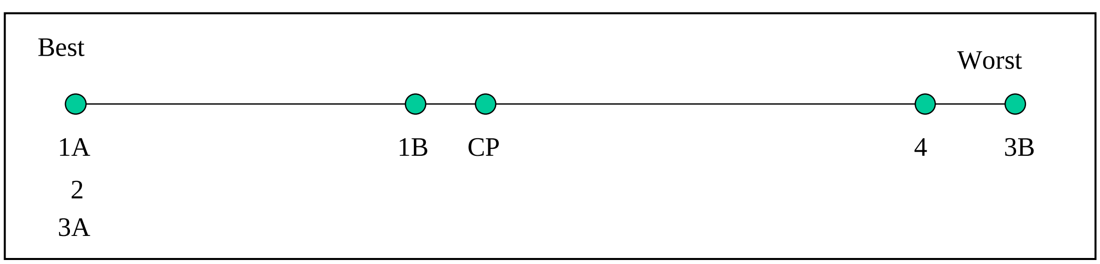

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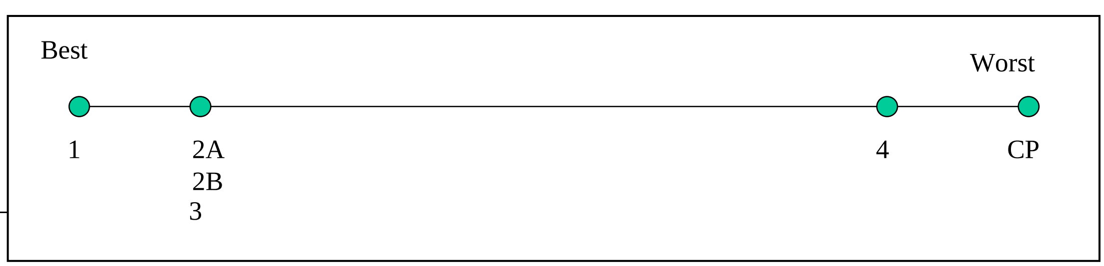
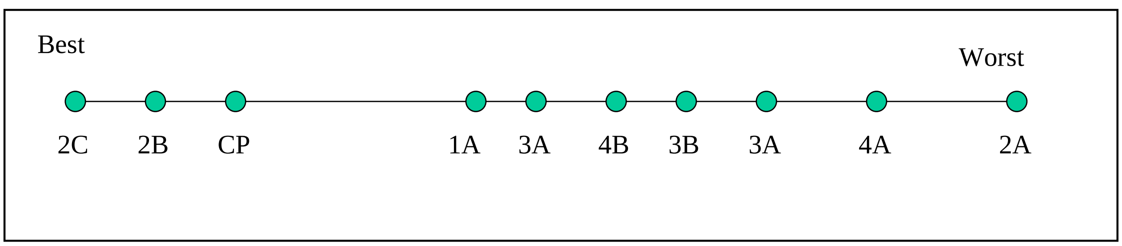


REGULATORY EFFICIENCY AND EFFECTIVENESS

ZOOM A

ZOOM B



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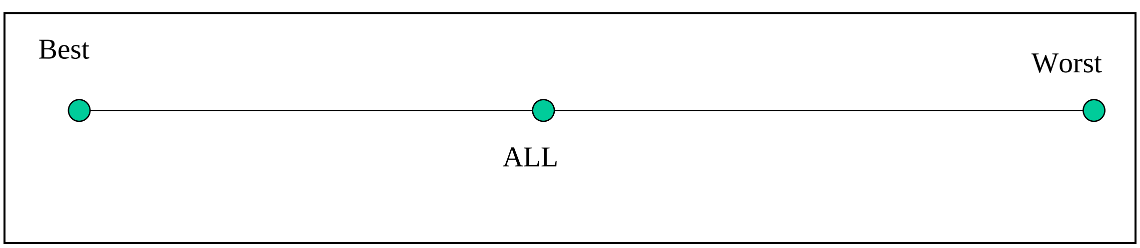

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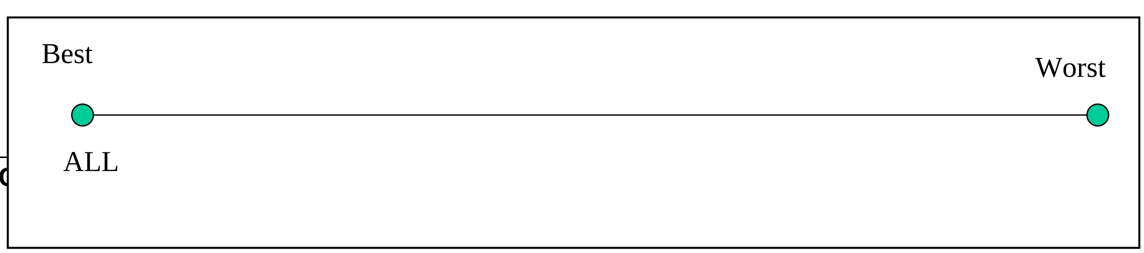
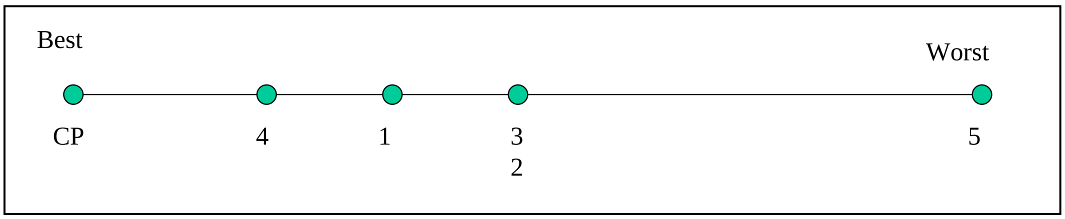
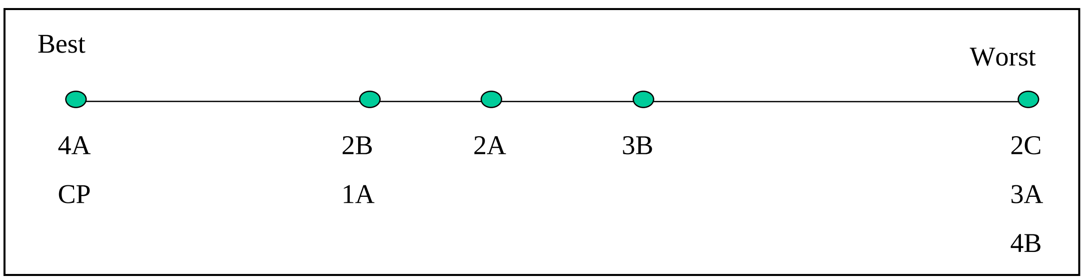


ECONOMIC SUSTAINABILITY

ZOOM A



ZOOM B



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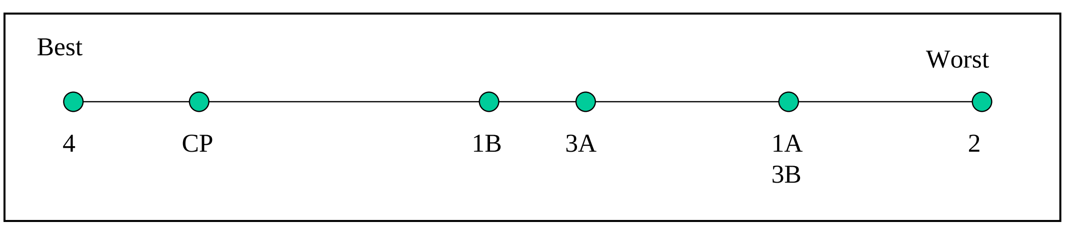

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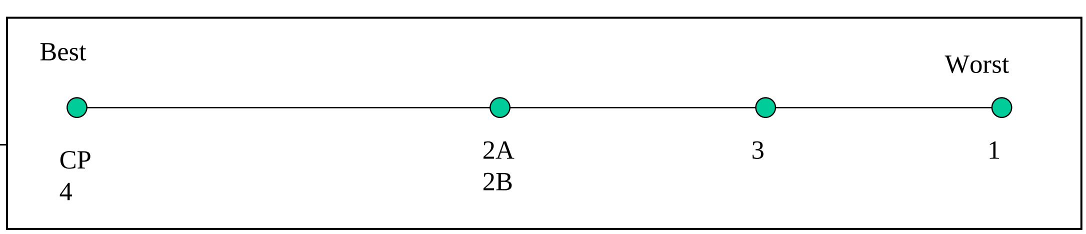
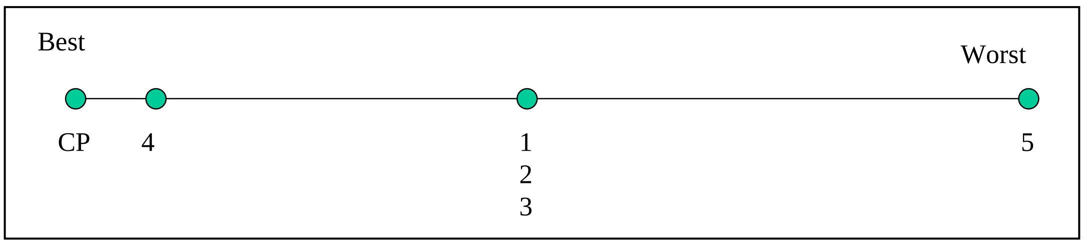


LOCAL LAND USE POLICY

ZOOM A



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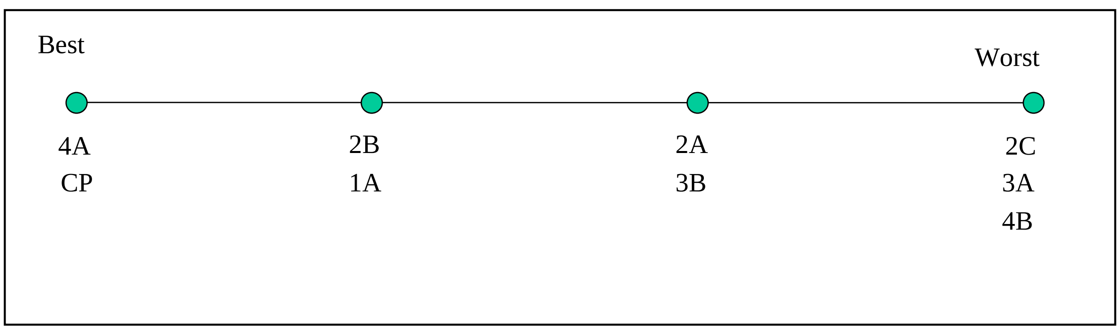

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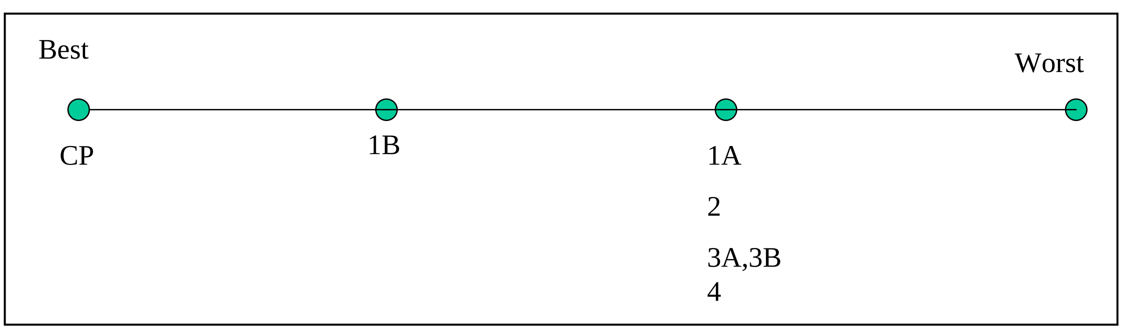
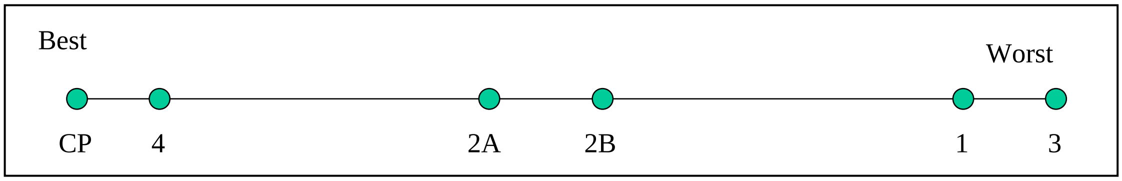
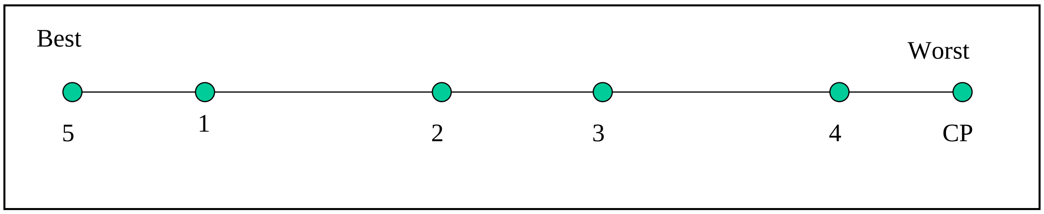


ZOOM D

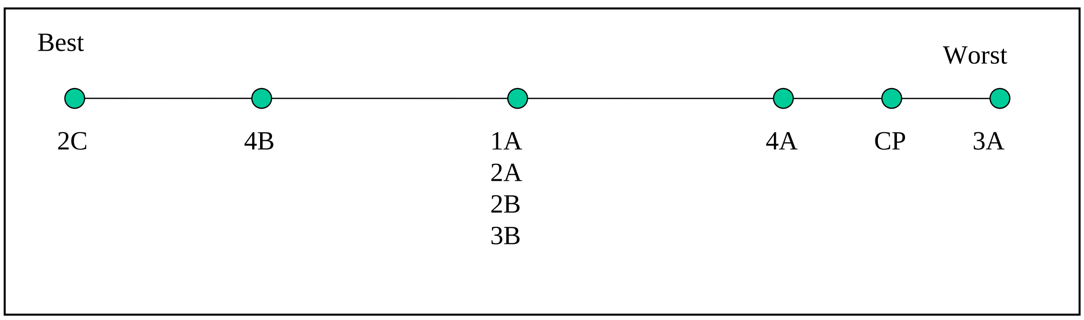


AVOIDANCE OF WETLAND IMPACTS

ZOOM A



ZOOM B



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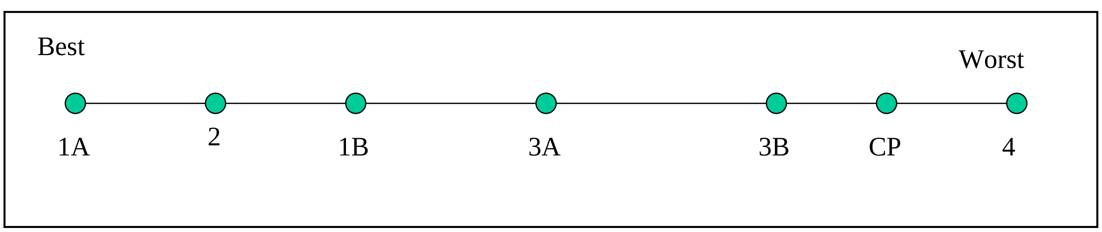
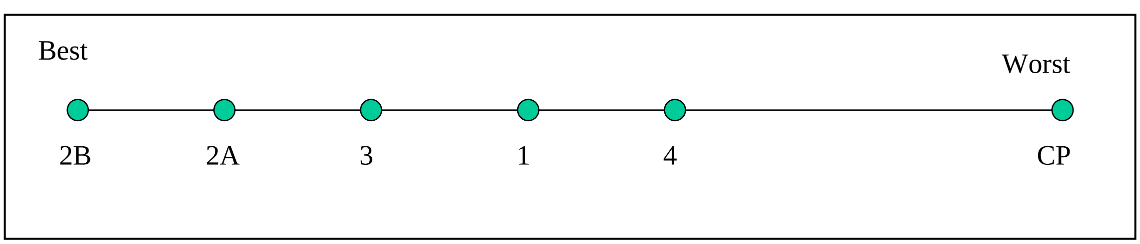
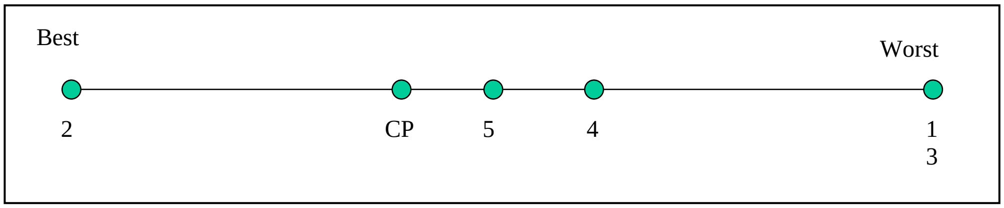


ZOOM D
ZOOM D

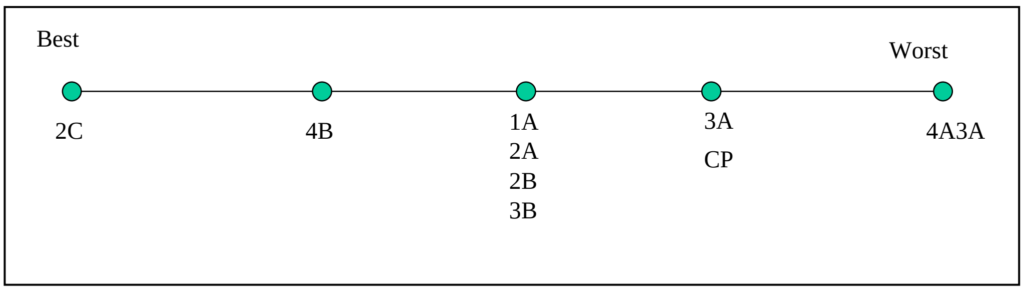


MITIGATION

ZOOM A



ZOOM B



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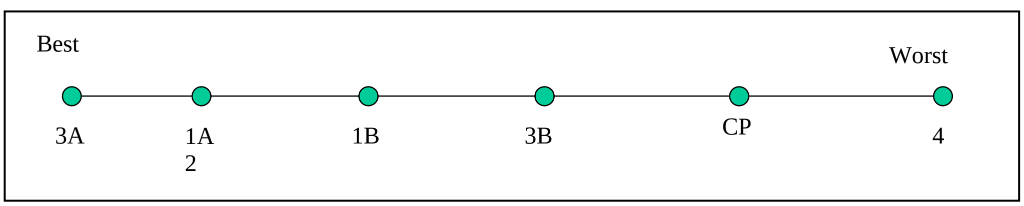

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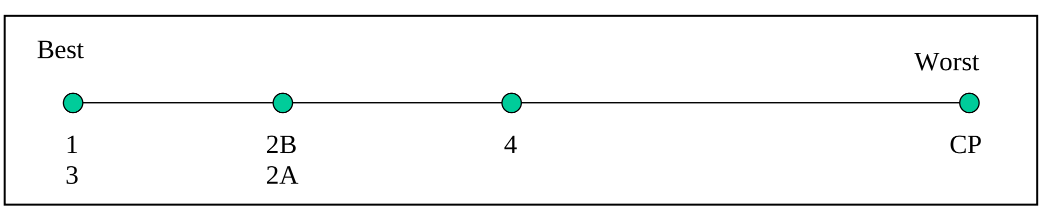
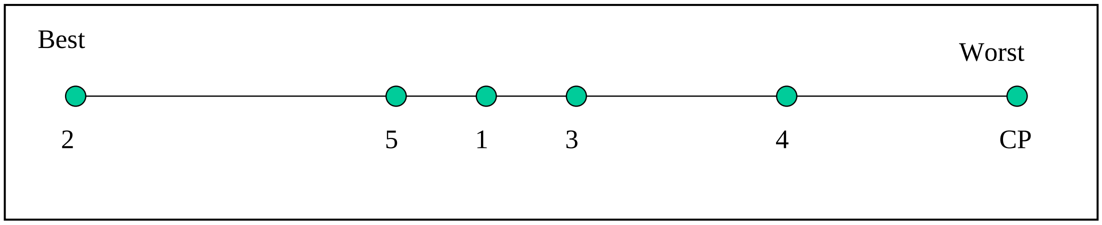


CUMULATIVE/SECONDARY IMPACTS

ZOOM A



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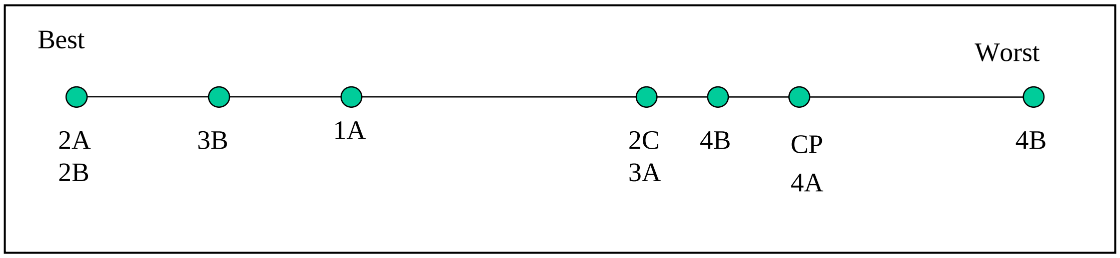

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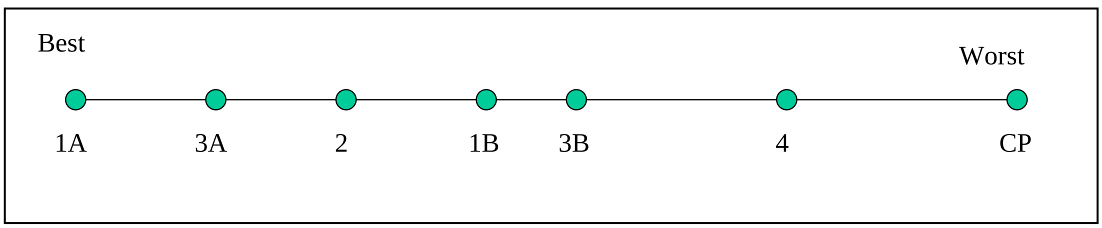

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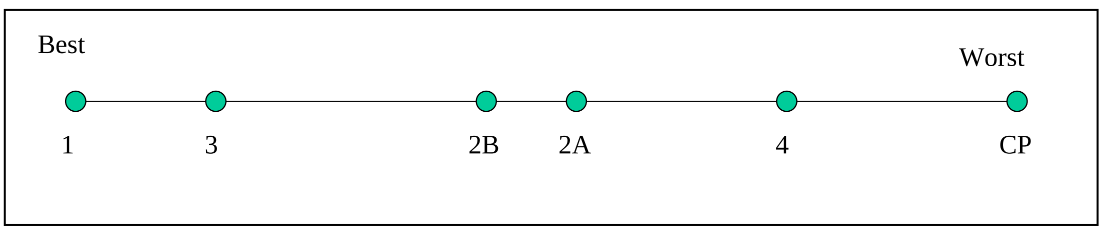
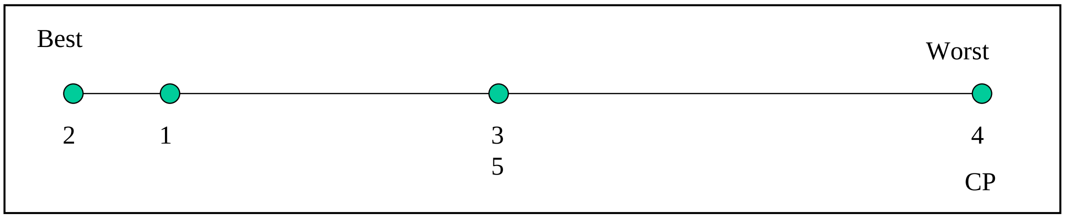
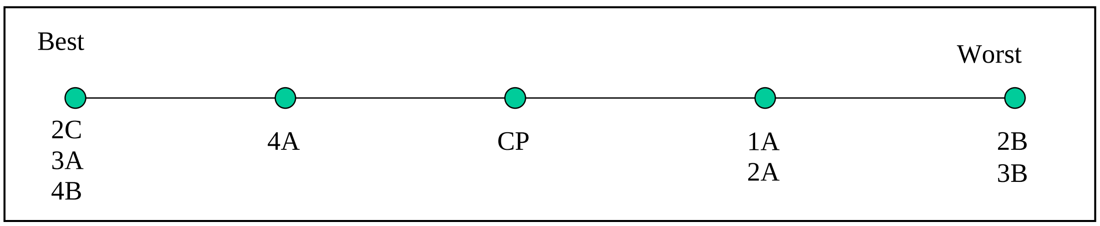


RESTORATION/RETROFIT

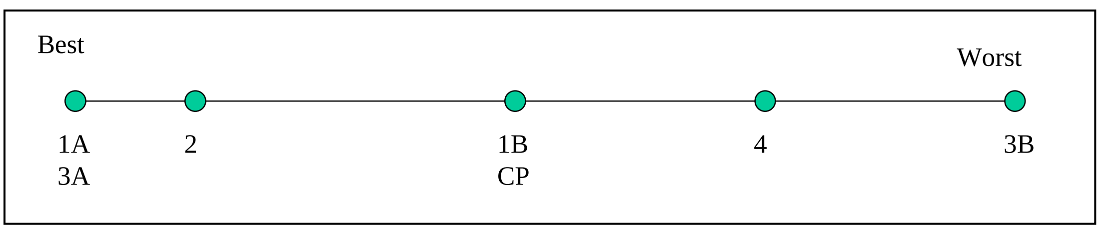
ZOOM A



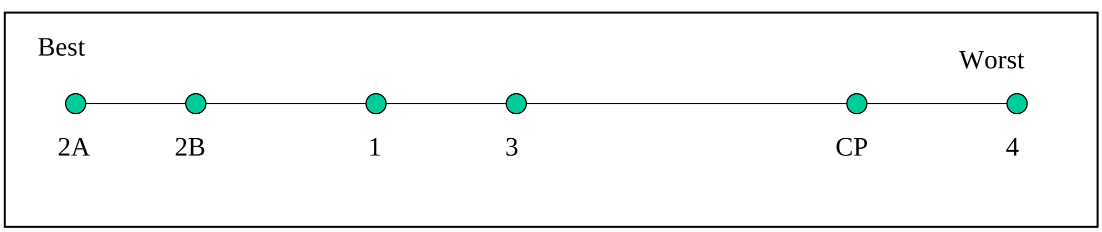
ZOOM B



ZOOM C



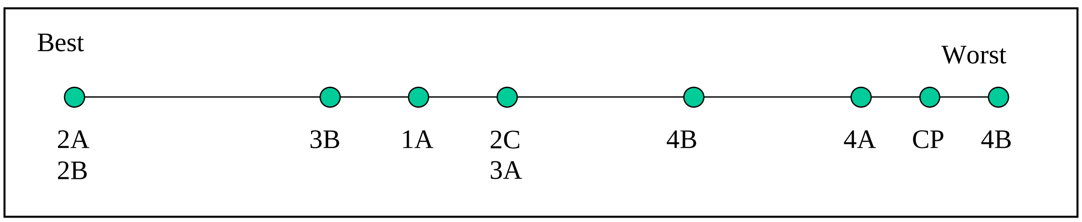
ZOOM D



PUBLIC LANDS MANAGEMENT/USE

ZOOM A

ZOOM B



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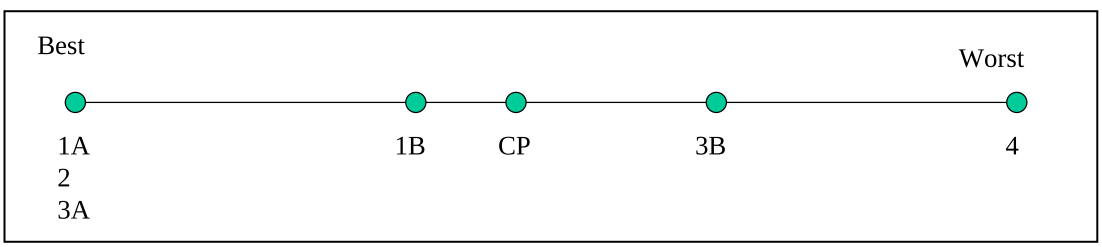
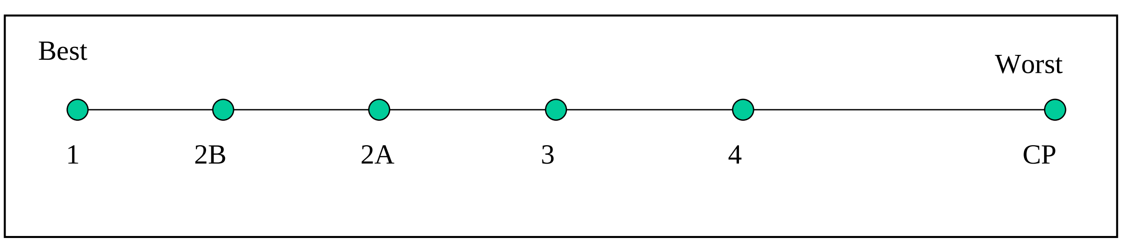


ZOOM D



APPENDIX E

FAMILY AND SUBFAMILY DESIGNATION

Hierarchy from Family to SubFamily to Legend

Fam	Family Name	SUBFAM	SubFamily Name	Zoom	ALT	Legend
100	Development	110		A	CP	Industrial
100	Development	110		A	CP	Urban
100	Development	110		A	1A	Airport
100	Development	110		A	2	Airport
100	Development	110		A	2	Urban & Industrial
100	Development	110		A	3A	Airport
100	Development	110		A	3A	Urban & Industrial
100	Development	110		A	4	Airport
100	Development	110		A	4	Urban & Industrial
100	Development	110		A	5	Airport
100	Development	110		C	CP	Industrial
100	Development	110		C	CP	Urban Landuses
100	Development	110		C	1A	Urban & Industrial
100	Development	110		C	4	Transition
100	Development	110		D	CP	Industrial
100	Development	110		D	CP	Urban Landuses
100	Development	110		D	1A	Urban & Industrial
100	Development	110		D	2A	Urban & Industrial
100	Development	110		D	2B	Urban & Industrial
100	Development	110		D	3	Urban
100	Development	110		D	3	Industrial
100	Development	110		D	4	Urban & Industrial
100	Development	110		Hub	CP	Urban Landuses
100	Development	110		Hub	CP	Industrial
100	Development	110		Hub	CP	Rural Residential
100	Development	110		Hub	2B	Urban & Industrial
100	Development	110		Hub	3B	Development
100	Development	110		Hub	4A	Development
100	Development	120	Flowway Improvements	C	3A	Urban & Industrial
100	Development	120	Flowway Improvements	C	3B	Urban & Industrial
100	Development	120	Flowway Improvements	C	4	Urban
100	Development	120	Flowway Improvements	Hub	1A	Urban & Industrial
100	Development	120	Flowway Improvements	Hub	2A	Development (w/ Flowways &tc)
100	Development	130	Compensate off-site for wide ranging species	Hub	2A	Off-site Compensation

Hierarchy from Family to SubFamily to Legend						
Fam	**Family Name**	**SUBFAM**	**SubFamily Name**	**Zoom**	**ALT**	**Legend**
100	Development	140	Regional/Comprehensive Stormwater Mgmt	A	1A	Urban & Industrial
100	Development	150	Replumb Henderson/Culverts Tamiami	C	1B	Urban & Industrial
100	Development	160	S Criteria for Urban	C	2	Urban & Industrial
200	Lehigh	210		A	CP	Urban (Lehigh)
200	Lehigh	210		A	1A	Urban (Lehigh)
200	Lehigh	210		A	3A	Urban (Lehigh)
200	Lehigh	220	Urban Zone Updated	A	5	Urban Zone (Lehigh)
200	Lehigh	230	Lehigh - Restore, Retrofit, Redevel (3R)	A	1A	Restoration, Retrofit, Redevelopmt
200	Lehigh	230	Lehigh - Acquire, Restore, Fix (ARF)	A	3A	Acquire, Restore, Fix
200	Lehigh	230	Lehigh - Redevelopment	A	4	Redevelopment
200	Lehigh	240	Lehigh - Lehigh Acres Zone	A	2	Lehigh Acres
200	Lehigh	250	Lehigh - Lehigh Greenway	A	2	Greenway
200	Lehigh	260	Lehigh - Water Storage	A	4	Water Storage
200	Lehigh	270	ARF Zone	A	5	Acquire, Restore, Fix
300	GoldenGate	310		C	CP	Rural Residential
300	GoldenGate	310		C	1A	Golden Gates Estates
300	GoldenGate	310		C	1B	Golden Gates Estates
300	GoldenGate	310		C	4	Rural Residential
300	GoldenGate	310		D	CP	Rural Residential
300	GoldenGate	310		D	4	Rural Residential
300	GoldenGate	330	S Criteria for Golden Gate Estates ZONE 1	C	2	Golden Gates Estates Zone 1
300	GoldenGate	340	S Criteria for Golden Gate Estates ZONE 2	C	2	Golden Gates Estates Zone 2
300	GoldenGate	340	S Criteria for Golden Gate Estates Zone 2	D	1A	Golden Gates Estates
300	GoldenGate	340	S Criteria for Golden Gate Estates ZONE 2	D	2A	Golden Gates Estates
300	GoldenGate	340	S Criteria for Golden Gate Estates ZONE 2	D	2B	Golden Gates Estates
300	GoldenGate	340	S Criteria for Golden Gate Estates ZONE 2	D	3	Golden Gates Estates
300	GoldenGate	350	Estates (Rural) Standards	C	3B	Estates (Rural Residential)
300	GoldenGate	360	GGE: limit clear+protect isolated wet+connect	C	3A	Golden Gate Estates
400	Agriculture	410		A	CP	Agricultural
400	Agriculture	410		C	CP	Agricultural
400	Agriculture	410		C	1A	Agricultural

Hierarchy from Family to SubFamily to Legend						
Fam	**Family Name**	**SUBFAM**	**SubFamily Name**	**Zoom**	**ALT**	**Legend**
400	Agriculture	410		C	1B	Agricultural
400	Agriculture	410		C	3A	Agricultural
400	Agriculture	410		C	4	Agricultural
400	Agriculture	410		D	CP	Agricultural
400	Agriculture	410		D	4	Agricultural
400	Agriculture	410		Hub	CP	Agricultural
400	Agriculture	410		Hub	1A	Agricultural
400	Agriculture	410		Hub	2B	Agricultural
400	Agriculture	410		Hub	3B	Agriculture
400	Agriculture	410		Hub	4A	Agricultural
400	Agriculture	420	Mining Lands	C	4	Mining
400	Agriculture	420	Mining Lands	Hub	3B	Mining Lands
400	Agriculture	420	Mining Lands	Hub	4A	Mining Lands
400	Agriculture	430	Non-intensification	D	1A	Agricultural Preserve
400	Agriculture	430	Maintain Intensity	Hub	2B	Agricultural - Maintain Intensity
400	Agriculture	440	Limited Intensification	D	2A	Agricultural
400	Agriculture	440	Limited Intensification	D	2B	Agricultural
400	Agriculture	440	Limited Intensification	Hub	2A	Agriculture (Limited Intensification)
400	Agriculture	450	Big Cypress ACSC: Agriculture non-exempt	D	2B	Agriculture (BCACSC)
400	Agriculture	460	If Agriculture ends then goes to preserve	D	3	Agricultural - Go To Preserve
400	Agriculture	470	S Criteria for Agriculture	C	2	Agricultural
500	Rural	510		A	CP	Rural Residential
500	Rural	510		A	3A	Rural Residential
500	Rural	510		A	4	Rural Development
500	Rural	520	Rural Low Density Mix	D	2A	Rural
500	Rural	520	Rural Low Density Mix	D	2B	Rural
500	Rural	530	Rural Criteria (Mtg 7 Append E)	A	1A	Rural Residential
500	Rural	530	Rural Criteria (Mtg 7 Append E)	A	2	Rural
500	Rural	530	Lower Density Rural uses+Hammond Flowway	Hub	2A	Rural
500	Rural	540	Rural Development Criteria ("Twin Eagle")	C	1A	Rural Development
500	Rural	550	Rural Development Criteria	C	1B	Rural Development
500	Rural	560	Rural Clustering Standards	C	3B	Rural Cluster (Agriculture)
500	Rural	570	Rural Low Density Mix	C	2	Rural

Hierarchy from Family to SubFamily to Legend

Fam	Family Name	SUBFAM	SubFamily Name	Zoom	ALT	Legend
600	Preserve	610		A	CP	Preservation
600	Preserve	610		A	1A	Conservation Lands
600	Preserve	610		A	2	Preservation Lands
600	Preserve	610		A	3A	Preservation Lands
600	Preserve	610		A	4	Preservation Lands
600	Preserve	610		C	CP	Preservation/Conservation
600	Preserve	610		C	1A	Preservation Lands
600	Preserve	610		C	1B	Preservation Lands
600	Preserve	610		C	3B	Conservation
600	Preserve	610		D	CP	Preservation/Conservation
600	Preserve	610		D	1A	Preservation Lands
600	Preserve	610		Hub	CP	Preservation
600	Preserve	610		Hub	1A	Preservation Lands
600	Preserve	610		Hub	2B	Preservation Lands
600	Preserve	620	Flowway Improvements	C	3A	Preservation Lands
600	Preserve	620	Culverts	D	3	Preservation Lands
600	Preserve	620	Flowway Improvements	D	4	Preservation Lands
600	Preserve	620	Flowway Improvements	Hub	4A	Preservation Lands
600	Preserve	630	ABM Conservation/Preservation Strategy Map	Hub	2A	Preserve (Exist&Prop)
600	Preserve	630	ABM Conservation/Preservation Strategy Map	Hub	3B	Preserve (Exist&Future)
600	Preserve	640	S Criteria for Preserve	C	2	Preservation Lands
600	Preserve	640	S Criteria for Preserve	D	2A	Preservation Lands
600	Preserve	640	S Criteria for Preserve	D	2B	Preservation Lands
600	Preserve	650	Culverts under Tamiami and I-75	C	4	Preservation/Conservation
700	PermitStds	720	Critical Resource Protection Area	Hub	2C	Critical Resource Protection Area
700	PermitStds	720	Critical Resource Protection Area	Hub	3A	Critical Resource Protection Area
700	PermitStds	720	Critical Resource Protection Area	Hub	4B	Critical Resource Protection Area
700	PermitStds	730	Buffer Transitional Zone	Hub	2C	Buffer Transitional Zone
700	PermitStds	730	Buffer Transitional Zone	Hub	3A	Buffer Transitional Zone
700	PermitStds	730	Buffer Transitional Zone	Hub	4B	Buffer Transitional Zone
700	PermitStds	740	Urban Zone	Hub	2C	Urban Zone
700	PermitStds	740	Urban Zone	Hub	3A	Urban Zone
700	PermitStds	740	Urban Zone	Hub	4B	Urban Zone

Hierarchy from Family to SubFamily to Legend						
Fam	**Family Name**	**SUBFAM**	**SubFamily Name**	**Zoom**	**ALT**	**Legend**
700	PermitStds	750	Preservation Zone (Updated from CRPA)	A	5	Preservation Zone
700	PermitStds	760	Agricultural Zone (Updated from CRPA)	A	5	Rural Residential
700	PermitStds	770	Urban Zone Updated	A	5	Urban Zone
800	NonAgree	820	Berm	Hub	4B	Berm
800	NonAgree	830	Pending Review (Develop or Preserve)	C	3A	Pending Review
800	NonAgree	830	Pending Review (Develop or Preserve)	Hub	4A	Pending Review

WATER QUALITY

1.0 INTRODUCTION

This section provides descriptions of the methodology, terminology, and rationale used to characterize the affected environment of surface and ground water quality within the study area. The status of historical and current water-quality conditions for the study area are described by means of water-quality parameters, Florida state water classifications, water-quality indices, and exceedences of Florida state water-quality criteria. Data for many parameters are sparse or missing entirely for certain years and in some cases decades. In short, they are inconclusive with respect to water quality trends for many watersheds discussed in the following sections. A discussion of parameters used to describe the watersheds within the study area follows. It is generally useful to have an understanding of each of these items prior to assessing water quality.

1.1 Water Quality Parameters

Water-quality parameters may be physical, chemical, or biological in nature, or a combination of the three. Understanding water quality through the use of measurable water-quality parameters provides a means of recording how a particular water body (lake, stream, canal, bay, nearshore water or estuary) responds to environmental and anthropogenic changes, as well as an indicator to specific water-quality problems. A brief description of some of the key water-quality parameters and their utility are discussed in the following sections:

Biochemical Oxygen Demand (BOD)
BOD is the amount of oxygen that is consumed by bacteria "feeding" on decomposable organic matter under aerobic conditions. Measures of BOD in rivers, lakes, and estuaries are used to predict potential negative impacts that stormwater runoff and other wastewater sources may have on natural waters (Sawyer and McCarty, 1978).

Chemical Oxygen Demand (COD)
COD is the amount of oxygen used by a strong oxidizing chemical during the decomposition of organic and inorganic matter (Water Quality Association, 1997). COD testing is often used as a substitute for BOD measurements, and is useful for determining the oxygen demand of polluted waters.

Chlorophyll a
Chlorophyll a is a plant pigment most responsible for the green color in plants including phytoplankton. The amount of chlorophyll a in the water column is an indicator of the abundance of free-floating. An increase in algae of this type can cause a reduction in light penetration through the water column, and a decline in BOD. In some estuaries, declines in seagrass acreage have been attributed to reduced light penetration attributed to increased algae concentrations in the water column. Nutrients, such as nitrogen, can trigger rapid algal growth known as blooms. Depending on the species,

large blooms of algae may release toxins into the water such as those that cause the red tide phenomenon (Boyer and Jones, 1996; Rice University, 1998).

Color

"True" color in water results from the contact of water with decomposing organic matter (leaves, pine needles, wood, etc.), and is mainly caused by the tannins, humic and fulvic materials, and humates which leach from these materials. Suspended sediments, such as red clay alter water color, but this type of color is termed "apparent" color. As color may normally increase with pH, it is important to record pH when measuring color. Wastewaters, particularly those from textile industries and pulping operations can increase water color as well. Aside from appearance, natural water coloring materials are generally not considered harmful. However, chlorination of naturally colored waters can result in the formation of harmful constituents such as chloroform (Sawyer and McCarty, 1978).

Conductivity

Conductivity is a measure of the ability of water to conduct an electrical current and is used to approximate salinity and total dissolved solids (Lee, 1992).

Dissolved Oxygen (DO)

It is commonly understood that most organisms depend on oxygen in some form. The solubility of oxygen or the amount of this gas that can be dissolved in water depends directly on the temperature and salinity of the water. Oxygen is less soluble in seawater than in freshwater, and is less soluble in warm than in cold water. Unpolluted water normally contains more oxygen than polluted water (Sawyer and McCarty, 1978). Municipal and industrial discharges, sewage leaks and overflows, and agricultural and urban stormwater runoff can deplete oxygen in surface waters. Aquatic plants produce oxygen through photosynthesis, and waters are aerated through movement such as wave action and surface ripples (Smith et al., 1994).

Fecal Coliform Bacteria

Fecal coliform bacteria are an important indicator of water quality because their presence indicates fecal contamination from warm-blooded animals. Such contamination in waters where people swim or harvest shellfish introduces serious potential risks of infection from disease causing organisms associated with fecal contamination (Smith et al., 1994). The acceptable limit for fecal coliform density in fresh and marine recreational waters is an average of 200 bacterial colonies/100 ml of water per month or that no more than 10% of samples exceed 400 colonies per 100 mls or no more than 800 colonies on any given day (FDEP, 1996b).

Nutrients (Total Nitrogen, Total Phosphorus)

Nitrogen is an important element in all living things, and is one of the nutrients essential to algal growth. Excess amounts of nitrogen in aquatic systems can lead to algal blooms. Phosphorus is another important nutrient in aquatic systems. It is usually the least available of all nutrients in freshwater systems, and because of this, it is termed a "limiting" nutrient with respect to algal growth. In marine environments, nitrogen is usually limiting. When phosphorus is available in larger quantities, algae increase such that light is blocked out and dissolved oxygen levels decrease, a detriment to animal life. This condition is known as eutrophication. Phosphorus sources include decomposing organic matter and phosphates from fertilizers and detergents. Sewage treatment discharges, industrial discharges, and agricultural and urban runoff are some point and non-point sources of these nutrients (Smith et al., 1994).

pH

The term for expressing the intensity, strength, or activity of hydrogen ions in an aqueous solution is pH. The pH measurement scale is expressed as a negative logarithm, where the lower the pH value, the more acidic a substance. The scale ranges from 0 to 14, with 0 the most acidic, 14 the most alkaline, and 7 being neutral (Sawyer and McCarty, 1978). Increased acidity in freshwater systems can upset the balance between plant and animal life, and many fish species cannot tolerate a pH below 5.0 (Lehninger, 1982). Estuarine and marine systems tend to contain higher amounts of pH stabilizing compounds, such as carbonates, than freshwater, and are not as subject to changes in pH as are freshwater systems (Lerman, 1986).

Salinity

Salinity is defined as the total amount of dissolved inorganic ionic material in water and is used primarily to reflect the salt content of water (Lerman, 1986). In estuaries, salinity can be an indicator of circulation, as well as certain aspects of the ecology. In fresh surface and ground waters, high salinity can be an indicator of saltwater intrusion into the aquifer. Salinity can be determined by measuring the electrical conductivity or by determining the degree of light refraction of water with a refractometer. Salinity is generally expressed in parts per thousand (ppt) (Rice University).

Total Suspended Solids (TSS)

Suspended solids are small particles floating in the water column usually consisting of sediments, organic matter, or plankton. The dry weight of these particles after filtration represents the total amount of suspended solids. Materials small enough to pass through the filter are the total dissolved solids and often include constituents such as ions of iron, chloride, sodium, sulfate, and others. There is a direct relationship between suspended solids and turbidity (Rice University, 1998).

Turbidity

Turbidity is the amount of suspended matter in water that interferes with the passage of light and visibility. Origins are organic and inorganic materials from soil, domestic and industrial wastewater, and runoff. Bacteria in the water feed on organic material, multiply, in turn supporting the growth of other microorganisms, thus further increasing turbidity. Nutrients such as phosphorus and nitrogen stimulate the growth of algae, another contributing factor to turbidity. Turbidity in domestic water drinking water supplies, e.g. East Caloosahatchee, can be difficult and costly to filter. High turbidity is often associated with wastewater pollution. Further, disease organisms can be shielded within suspended particles and be protected from disinfectant (Sawyer and McCarty, 1978).

1.2. Classification of Surface Waters and Designated Use

According to Florida Surface Water-quality Standards (F.A.C. 62-302), all surface waters in Florida are classified by a usage designation. These designations categorize the intended use of surface waters for specific water bodies within the state of Florida and are identified as follows:

Class I:
Potable water supplies

Class II:
Shellfish propagation or harvesting

Class III:
Recreation, propagation, and maintenance of a healthy, well-balanced, population of fish and wildlife

Class IV:
Agricultural water supplies

Class V:
Navigation, utility, and industrial use

Class I has the most stringent water-quality requirements, and Class V has the least. Classification by use does not preclude other types of use of a certain water body. Most state waters are classified as Class III unless otherwise stated in F.A.C. 62-302. Additional classification titles may be assigned to Class I, II, and III waters such as Outstanding Florida Waters (OFW), or Outstanding National Resource Water (ONRW). Outstanding Florida Waters are “deemed worthy” of special protection because of their natural attributes. Some examples of Outstanding Florida Waters may be waters in national parks, preserves, memorials, wildlife refuges, and wilderness areas. Other examples include waters in the state park system, waters on conservation lands obtained by donation through various state programs such as the Conservation and Recreation Lands (CARL) program or the Florida Scenic and Wild Rivers program, and waters in aquatic preserves. Outstanding National Resource Waters are of “such recreational or ecological significance that water quality should be protected under all circumstances” (FDEP, 1996b). No Outstanding National Waters occur within the study area, but the Everglades National Park, part of which lies in Collier County, is one of two such waters in the state. **Table 1** lists the classification of waters within Collier and Lee County. Water-quality criteria for selected parameters for Class I, II, and III waters are presented in **Table 2**.

TABLE 1. CLASS I AND CLASS II WATERS OF COLLIER AND LEE COUNTY. ALL OTHER WATER BODIES WITHIN COLLIER AND LEE COUNTY ARE DESIGNATED CLASS III

Collier County			**Lee County**		
Class I	**Class II**	**OFW**	**Class I**	**Class II**	**OFW**
None	Cocohatchee River	Waters within Florida Panther Wildlife Refuge	Caloosahatchee River from east Lee County line to Structure 79	Charlotte Harbor	Waters within Caloosahatchee Wildlife Refuge
	Connecting waterways from Wiggins Pass south to Outer Doctors Bay	Waters within Collier-Seminole State Park		Matanzas Pass, Hurricane Bay, and Peckney Bay	Waters within J.N. “Ding” Darling Wildlife Refuge
	Dollar Bay	Delnor-Wiggins Pass State Recreation Area		Matlacha Pass: Charlotte Harbor to San Carlos Bay	Waters within Matlacha Pass Wildlife Refuge
	Inner and Outer Clam Bay	Waters within Fahkahatchee Strand State Preserve		Pine Island Sound: Charlotte Harbor to San Carlos Bay	Waters within Pine Island Wildlife Refuge
	Little Hickory Bay	Barefoot Beach		San Carlos Bay from Point Ybel to Bodwitch Point to Punta Blanca Creek to Big Shell Island to Pine Island Sound	Waters within Cayo Costa State Park
	Tidal Bays and Passes: Naples Bay south and east through Rookery Bay and Ten Thousand Islands to Monroe County Line	Rookery Bay: Aquatic Preserve, Conservation Program, and National Estuarine Research Reserve			Waters within Gasparilla State Recreation Area
	Wiggins Pass	Waters within the Save Our Everglades Program			Waters within Lovers Key State Recreation Area

(Continued)

TABLE 1 (continued).

Collier County			Lee County		
Class I	**Class II**	**OFW**	**Class I**	**Class II**	**OFW**
		Cape Romano-Ten Thousand Islands Aquatic Preserve			Waters within Koreshan State Historic Site
		Waters within Big Cypress National Preserve			Estero Bay: Conservation Program Area, Aquatic Preserve
					Josslyn Island
					Cape Romano-Ten Thousand Islands Aquatic Preserve
					Gasparilla Sound-Charlotte Harbor Aquatic Preserve
					Matlacha Pass Aquatic Preserve
					Pine Island Sound Aquatic Preserve
					Estero Bay tributaries: Hendry Creek, Estero River, Spring Creek, and Imperial River
					Wiggins Pass Estuarine Area and Cocohatchee River System

Source: FDEP, 1996b

TABLE 2. WATER-QUALITY CRITERIA FOR CLASS I, II, AND III WATERS

Parameter	Units	Class I	Class II	Class III	
				Fresh	Marine
Turbidity	NTU	$\leq$29 above background	$\leq$29 above background	$\leq$29 above background	$\leq$29 above background
Dissolved Solids	mg/L	$\leq$500 monthly average, $\leq$1000 maximum	None	None	None
PH	pH units	No change more than one unit above or below background	No more than one unit change for coastal waters or 0.2 unit change for open waters	No more than one unit change above or below background	No more than one unit change for coastal waters or 0.2 unit change for open waters
Chlorides	mg/L	$\leq$250	No increase >10% above background	None	No increase >10% above background
Fluorides	mg/L	$\leq$1.5	$\leq$1.5	$\leq$10.0	$\leq$5.0
Conductivity	Micromho	No increase above 50% of background or 1275	None	No increase above 50% of background or 1275	None
Dissolved Oxygen	mg/L	Not less than 5.0	No average less than 5.0 and never less than 4.0	Not less than 5.0	No average less than 5.0 and never less than 4.0
BOD	mg/L	No increase such that DO drops below limit for any class			
Nutrients: Total Phosphorus, Total Nitrogen		No alteration in nutrients such that an imbalance in natural populations of aquatic flora or fauna results			
Total Coliform	#/100 ml	$\leq$2,400 in any one sample	No more than 10% of samples exceed 230	$\leq$2,400 in any one sample	$\leq$2,400 in any one sample
Fecal Coliform	#/100 ml	$\leq$800 in any one sample	$\leq$800 in any one sample	$\leq$800 in any one sample	$\leq$800 in any one sample
Copper	μg/L	$\leq$(.8545[In hardness] – 1.465)	$\leq$2.9	$\leq$(.8545[In hardness] – 1.465)	$\leq$2.9
Iron	mg/L	$\leq$0.3	$\leq$0.3	$\leq$1.0	$\leq$0.3
Lead	μg/L	(1.273[In hardness] – 4. 705)	$\leq$5.6	(1.273[In hardness] – 4. 705)	$\leq$5.6
Zinc	μg/L	(0.8473[In hardness] + 0.7614)	$\leq$86	(0.8473[In hardness] + 0.7614)	$\leq$86
Mercury	μg/L	$\leq$0.012	$\leq$0.025	$\leq$0.012	$\leq$0.025

Source: FDEP, 1996b

1.3. Assessing Water Quality Through Indices

Streams, lakes and estuaries are evaluated by the Florida Department of Environmental Protection (FDEP) using two indices that combine data from selected water-quality parameters into single numeric values. Two indices are used because streams typically are flowing, and lakes and estuaries are more static. Normal conditions for one system may not be so for the other. The two indices are the United States Environmental Protection Agency (USEPA)-developed Water-Quality Index (WQI) for streams modified by the FDEP to fit Florida streams and the FDEP Trophic State Index (TSI). For this study, the FDEP WQI was further modified using data solely from south Florida waters.

FDEP: WQI

To assess water quality in streams, a Florida WQI was developed based on measurements of six categories: clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients, and biological diversity. Some categories have sub-categories. The yearly average data collected for streams is converted into percentile values ranging from 0 to 99 (**Table 3**). WQI values for a particular stream correspond to the percentile distribution of all Florida surface water-quality data. The 70th percentile level is used by FDEP to identify particular problem parameters and is termed the "screening level". Data from STORET surface water locations from 1980 to 1995 were used to determine percentile distributions for various water-quality parameters. The overall WQI is an average of the six main categories. As an additional qualitative assessment measure, Good, Fair, and Poor water-quality data ratings were developed and assigned to water bodies that conformed to USEPA's WQI for Florida data. Good water quality ranged 0 to less than 45; fair water quality ranged from 45 to less than 60; and poor water quality ranged from 60 to 99 (FDEP, 1996a). Over time, changes in water quality become evident through comparisons of yearly average WQIs. Much of the discussion within this report reflect data extracted from the FDEP's 305b report (WQIs: Good, Fair, Poor) as well as valuable studies conducted by the water management district, universities, counties, and private organizations.

Study Area: Water-Quality Index

To evaluate more recent and geographically specific water-quality data available within the study area, supplemental data were gathered (including STORET) through June 1998 from various sources and water-quality indices were revisited. In a nearly identical manner, water-quality indices were again based on measurements of six water-quality categories: clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients, and biological diversity. To assess historical and current water-quality trends for the study area surface waters, WQIs were recalculated for the following time periods: 1970-1980, 1980-1990, and 1990-1998. Similarly, annual average data collected for surface waters were converted into values ranging from 0 to 99 (**Table 4**). Recognizing the potential geographic water-quality differences of South Florida, WQI values correspond to the percentile distribution of only South Florida water-quality data. The WQ data that was used to create a South Florida distribution was that of the HUCs that extended south of Lake Okeechobee. The qualitative assessments of Good, Fair, and Poor water quality were not assigned to these WQI's, as these values were developed solely as a measure to compare potential changes in water quality with future land use alternatives.

TABLE 3. FDEP'S FLORIDA WATER-QUALITY INDEX CRITERIA (percentile distribution of STORET data)

Parameter	**Best Quality**				**Median Value**			**Worst Quality**		
	Unit	10%	20%	30%	40%	50%	60%	**70%***	80%	90%
Category: Water Clarity										
Turbidity	NTU	1.50	3.00	4.00	4.50	5.20	8.80	12.20	16.50	21.00
Total Suspended Solids	mg/L	2.00	3.00	4.00	5.50	6.50	9.50	12.50	18.00	26.50
Category: Dissolved Oxygen										
Dissolved Oxygen	mg/L	8.00	7.30	6.70	6.30	5.80	5.30	4.80	4.00	3.10
Category: Oxygen Demand										
Biochemical Oxygen Demand	mg/L	0.80	1.00	1.10	1.30	1.50	1.90	2.30	3.30	5.10
Chemical Oxygen Demand	mg/L	16.00	24.00	32.00	38.00	46.00	58.00	72.00	102.00	146.00
Total Organic Carbon	mg/L	5.00	7.00	9.50	12.00	14.00	17.50	21.00	27.50	37.00
Category: Nutrients										
Total Nitrogen	mg/L as N	0.55	0.75	0.90	1.00	1.20	1.40	1.60	2.00	2.70
Nitrate plus nitrite	mg/L as N	0.01	0.03	0.05	0.07	0.10	0.14	0.20	0.32	0.64
Total Phosphorus	mg/L as P	0.02	0.03	0.05	0.07	0.09	0.16	0.24	0.46	0.89
Category: Bacteria										
Total Coliform	#/100/Ml	100.0	250.0	250.0	425.0	600.0	1100.0	1600.0	3700.0	7600.0
Fecal Coliform	#/100/mL 2	10.0	20.0	35.0	55.0	75.0	135.0	190.0	470.0	960.0
Category: Biological Diversity										
Diversity Index—Natural Substrate	Index	3.50	3.10	2.80	2.60	2.40	2.15	1.95	1.50	1.20
Diversity Index—Artificial Substrate	Index	3.55	3.35	3.20	3.05	2.90	2.65	2.40	1.95	1.35
Beck's Biotic Index	Index	32.00	28.00	23.00	18.50	14.00	11.00	8.00	5.50	3.50

*Screening level

TABLE 4. SOUTH FLORIDA WATER-QUALITY INDEX CRITERIA (percentile distribution of data)

Parameter			**Best Quality**			**Median Value**			**Worst Quality**
	Unit	10%	20%	30%	40%	50%	60%	70%	80%	90%
Category: Water Clarity										
Turbidity	NTU	1.0	1.60	2.00	2.60	3.00	4.00	5.00	6.80	10.30
Total Suspended Solids	Mg/L	na	Na	na	na	na	na	na	na	na
Category: Dissolved Oxygen										
Dissolved Oxygen	Mg/L	8.70	7.90	7.20	6.70	6.10	5.50	4.80	3.90	2.50
Category: Oxygen Demand										
Biochemical Oxygen Demand	Mg/L	0.80	1.00	1.20	1.50	1.80	2.00	2.50	3.00	4.40
Chemical Oxygen Demand	Mg/L	25.85	36.70	42.60	46.30	51.05	55.75	61.00	68.45	81.25
Total Organic Carbon	Mg/L	na	Na	na	na	na	na	na	na	na
Category: Nutrients										
Total Nitrogen	Mg/L as N	0.59	0.82	1.02	1.20	1.39	1.59	1.84	2.22	3.12
Nitrate plus nitrite	Mg/L as N	na	Na	na	na	na	na	na	na	na
Total Phosphorus	Mg/L as P	0.01	0.03	0.04	0.06	0.09	0.14	0.22	0.38	0.74
Category: Bacteria										
Total Coliform	#/100/mL	4.00	18.00	79.00	100.00	200.00	400.00	900.00	1700.00	3100.00
Fecal Coliform	#/100/mL	2.00	5.00	10.00	30.00	69.00	100.00	120.00	300.00	920.00
Category: Biological Diversity										
Chlorophyll <u>a</u>	µg/L	1.74	3.10	4.77	6.84	9.60	13.20	18.74	27.20	43.30
Diversity Index—Natural Substrate	Index	na	Na	na	na	na	na	na	na	na
Diversity Index—Artificial Substrate	Index	na	Na	na	na	na	na	na	na	na
Beck's Biotic Index	Index	na	Na	na	na	na	na	na	na	na

na - not available

Trophic State Index
The Florida TSI is nutrient based in its approach. Lakes and estuaries are classified according to analysis of chlorophyll levels and nitrogen, and phosphorus concentrations. A ten unit change in the index represents a doubling or halving of algal biomass. Data from 313 Florida lakes were used to develop the lake criteria (FDEP, 1996a).

1.4. The Watershed Unit

The watershed is the hydrologic unit which was selected for this study to analyze water-quality impacts that may potentially result from changes in land use; primarily since water quality is influenced by many factors occurring throughout the surrounding watershed. By one definition, a watershed is "the land area that drains to a waterbody and affects its flow, water level, and loadings of pollutants" (USEPA, 1996). Within the study area, the very boundaries of the watersheds can be affected by the activities occurring within. This is largely due to the flat topography and the tendency for water to flow in sheets rather than through channels. Subtle changes in topography can cause directional changes in the sheet flow. Such changes have historically occurred within the study area as a result of development and wetland draining projects. In addition, man-made alterations such as drainage canals, dams, and other structures have impacted natural flow characteristics.

Multiple watershed boundaries have been developed by numerous agencies (USGS, SFWMD, and FDEP) in south Florida. To further complicate this issue, these watershed delineations have been dynamically changing through time, primarily a result of improved understanding of the watershed hydrology. Watershed boundaries within the study area include portions of the larger national watershed system (Caloosahatchee [HUC: 03090205] and Big Cypress Basin [HUC: 03090204]) as defined by the USGS, as well as the smaller hydrologic watersheds and basins as defined by the South Florida Water Management District (SFWMD) (**Figure 1**).

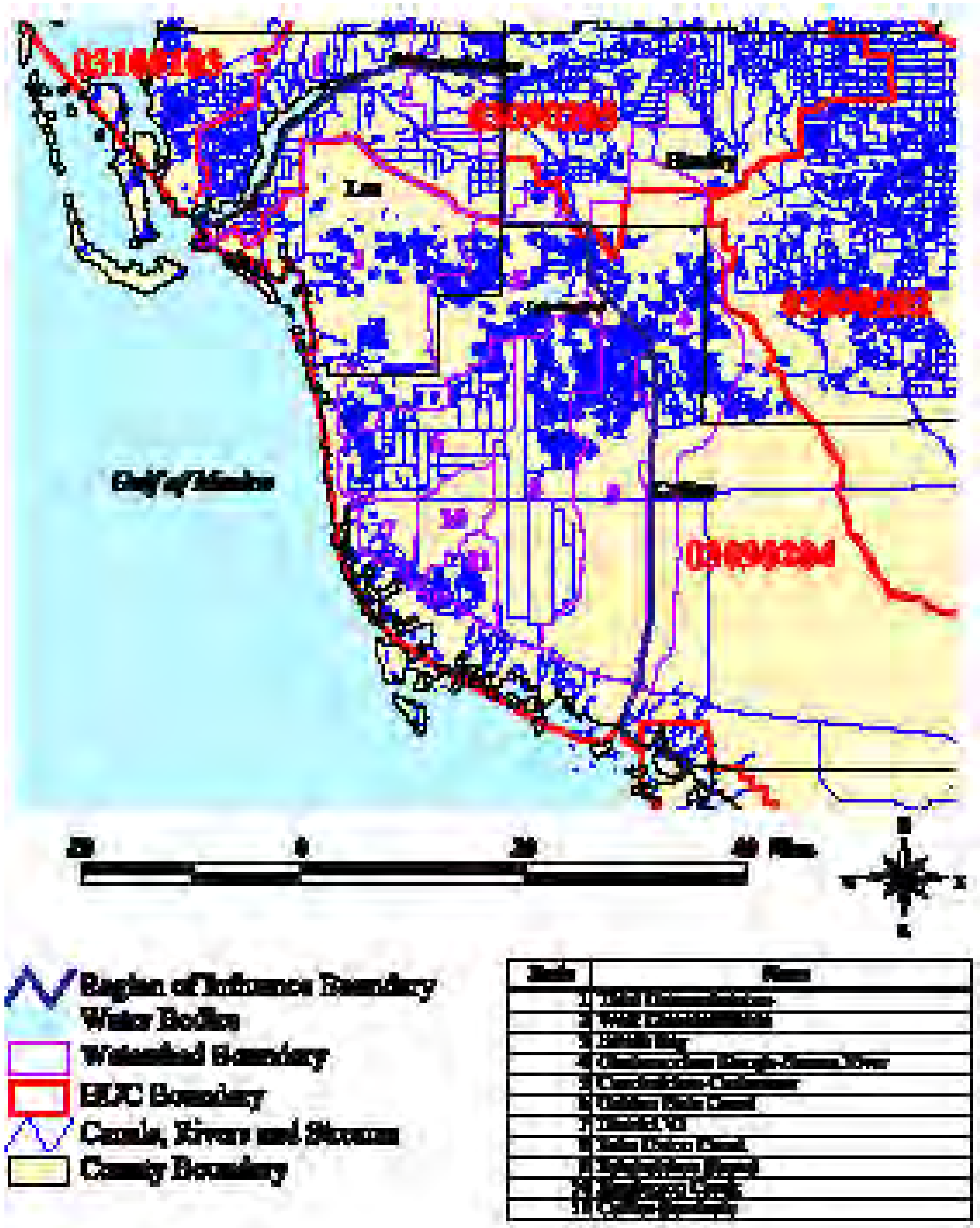


Figure 1. USGS and SFWMD Watersheds and Basins within the Study Area.

2.0 SURFACE WATERS

This section describes surface water quality as defined by physical and biological parameters, flow characteristics, pollutants, nutrients, and if known, biological indicators. The descriptions of water quality are largely based on STORET data summaries for individual watersheds within the larger study area watersheds. STORET is an Environmental Protection Agency (EPA) database of water-quality information collected by numerous agencies. Other water-quality studies were consulted as well (CDM, Inc., 1995; Gibson, 1997). Geography, topography, rainfall, evaporation, man-made alterations within the watershed such as hydrographic modifications (drainage canals, dams), development, and agriculture affect the quality of water. EPA and FDEP use STORET data to assess water-quality trends in watersheds by condensing certain parameters into one of two indices thereby facilitating year to year comparisons. Non-point source pollution, contaminant information, and exceedences of water-quality standards are also evaluated for trend determination. In the following sections, water quality of rivers, creeks, bays, canals, and swamps will be discussed for the three watersheds of interest to this study (**Table 5**).

TABLE 5. WATERSHEDS AND RECEIVING WATERS OF THE STUDY AREA

WATERSHED	DRAINAGE BASIN	RECEIVING WATER BODY	ULTIMATE ENDPOINT
Caloosahatchee Watershed	Tidal Caloosahatchee Basin	Tidal Caloosahatchee River	San Carlos Bay
	West Caloosahatchee Basin	West Caloosahatchee River	West Caloosahatchee River
Estero-Imperial Watershed	Estero Bay Basin	Estero River, Spring Creek	Estero Bay
	Imperial River Basin	Imperial River	Estero Bay
Big Cypress/West Collier Watershed	Corkscrew-Cocohatchee River Basin	Cocohatchee River, Corkscrew Swamp	Wiggins Pass/Gulf of Mexico
	Golden Gate Canal Basin	Golden Gate Canal	Naples Bay
	District VI Basin	Lely Canal	Gulf of Mexico
	Fahka-Union Canal Basin	Fahka-Union Canal	Fahka-Union Bay
	Henderson Creek Basin	Henderson Creek	Rookery Bay
	Collier-Seminole Basin	CR92 Canal	Gullivan Bay
	Fahkahatchee Strand Basin	Fahkahatchee Strand	Ten-Thousand Islands

For purposes of description and analyses, the study area watersheds have been identified as the Caloosahatchee, the Estero-Imperial Integrated, and the Big Cypress/West Collier, with various associated watershed basins as indicated in **Table 5**. Introductory information on the physical setting, surrounding land use, natural habitats, and physical characteristics of the various watershed systems have been provided to better assess historic and current water quality within the study area.

2.1 Caloosahatchee Watershed

The study area (**Figure 2**) incorporates portions of the Tidal Caloosahatchee and West Caloosahatchee watershed basins and sections of the Caloosahatchee River. The East Caloosahatchee River is also discussed since it drains into the study area impacting the water quality of the western and tidal sections of the Caloosahatchee.

The East and West portions of the freshwater segment of Caloosahatchee River have been restructured into a canal known as C-43. There are about 60 tributaries of varying water quality with respect to FDEP indices within the Caloosahatchee River watershed.

Physical Description

To accommodate navigation, flood control, and land reclamation needs, the Caloosahatchee River has been radically altered from its natural state. One of the most dramatic changes was the dredging that connected the Caloosahatchee to Lake Okeechobee in 1881, in order to lower the water level of Lake Okeechobee. In 1882, the channelization of the lower reaches of the river began. Due to intensive canal construction by 1910, shallow draft navigation from the Gulf of Mexico to the Atlantic Ocean was possible. Canal locks at Moore Haven were completed in 1918, and the locks at Ortoona were completed in 1937. The W. P. Franklin Lock was completed in 1969, preventing saline water from flowing upstream of Olga (Kimes and Crocker, 1998).

The discharge from Lake Okeechobee can vary greatly depending upon water needs of the Everglades Agricultural Area and precipitation levels. The 2-in-10 dry year discharge to the river is 106 million cubic feet (cu.ft.) while the 2-in-10 wet year discharge to the river is 29.3 billion cu.ft. All of this water is in addition to that naturally occurring in the river.

In addition to the alteration of the main channel, many canals have been constructed along the banks of the river. These canals were constructed for both water supply and land reclamation in order to support the many agricultural communities along the river.

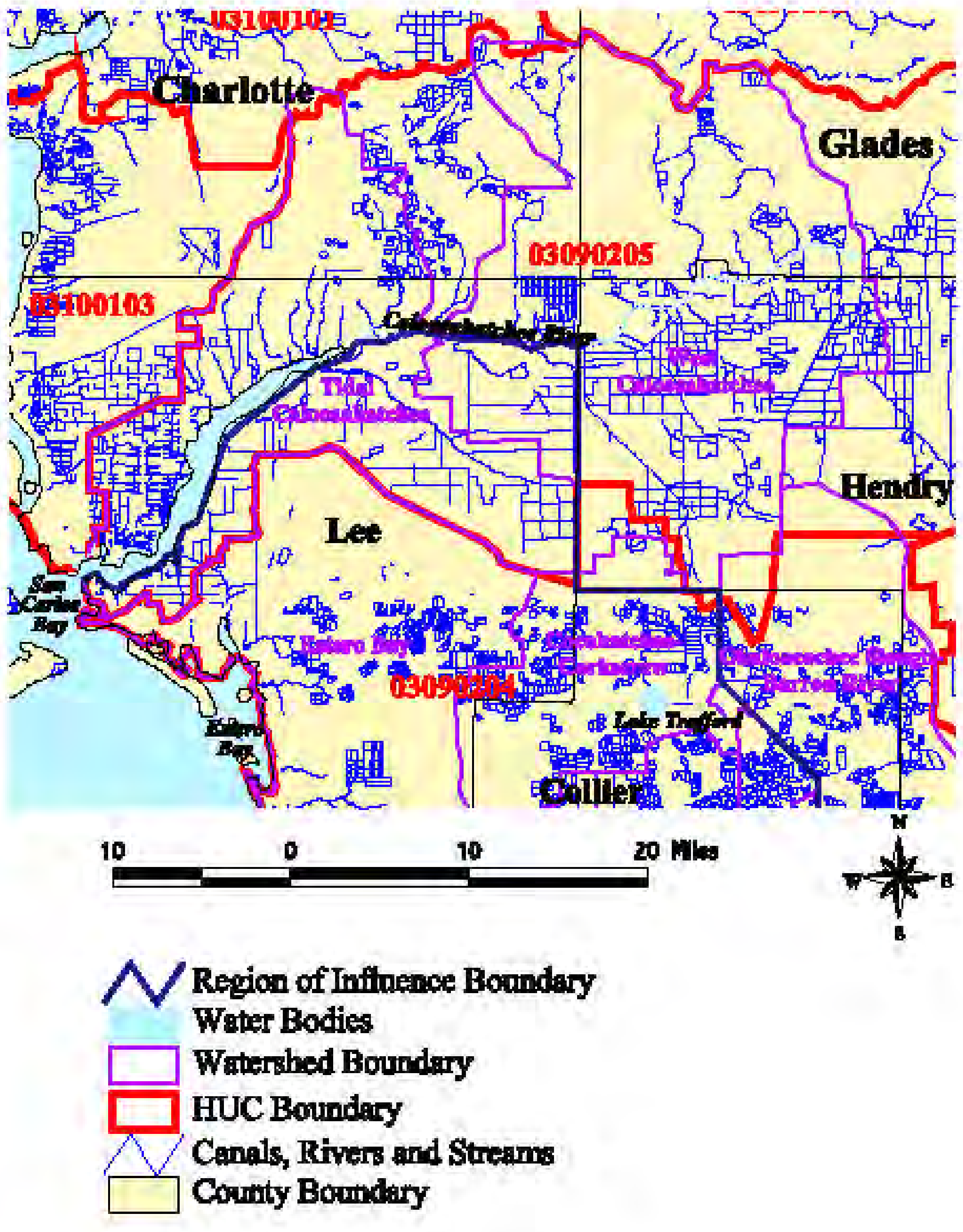


Figure 2. The Caloosahatchee watersheds and basins within the study area.

Land use within the Caloosahatchee watershed is dominated by rangeland and agriculture, particularly in the upper part of the basin (FDEP, 1996a). The major urban areas that occur along the tidal Caloosahatchee watershed basin are Ft. Myers, and across the river the large residential areas of Cape Coral and North Ft. Myers.

The primary habitat types of the Caloosahatchee watershed are pine flatwoods, dominated by slash pine (*Pinus ellioti* var. *densa*), cabbage palm (*Sabal palmetto*), and saw palmetto (*Serenoa repens*) (Drew and Schomer, 1984). Soils are predominantly Pamlico Formation, which consists of marine quartz sands and some hardened sandstone, and an estimated 25% Penholoway Formation, also consisting of marine quartz sands, but occurring at higher elevations than does the Pamlico (42 to 70 feet as opposed MSL to 25 feet) (Drew and Schomer, 1984).

Flow and stage height in the Caloosahatchee River is controlled by a series of locks. Agricultural practices and navigation channels have for many years dictated the patterns of surface water drainage. Canal, lock, and spillway construction and dredging have been occurring since the late 1800s, altering the natural watercourse of the Caloosahatchee River. Today, three primary locks function to regulate water level, usage, and saltwater intrusion. One, at Moore Haven, regulates Lake Okeechobee waters. The Ortoona Lock delineates the east river basin from the west and controls water on the adjoining land areas. The Franklin Lock at Ft. Myers prevents saltwater intrusion from the tidal Caloosahatchee River segment from proceeding eastward. The pattern and period of flow of the Caloosahatchee River is highly variable, based on demand. River flows are negative (from west to east) for a majority of the year, possibly resulting from heavy irrigation usage or losses to groundwater and/or evapotranspiration (Drew and Schomer, 1984).

Historical Description

Camp, Dresser and McKee (CDM), Inc. (1995) compared monitoring results of a 1993-94 study on the freshwater Caloosahatchee River with data from 1973-1980. Their conclusions are the basis for this historical description of water quality in the East and West Caloosahatchee River. CDM concluded that historical water quality differed from current water quality only with respect to small differences in nutrient concentrations. The report stated dissolved oxygen was historically low, as were suspended solids. Total phosphorus was comparable to other Florida water bodies, but nitrogen and chlorophyll a were generally high. Decreasing trends in total nitrogen were observed westward from Lake Okeechobee. Measurements of DO, pH, conductivity, and total phosphorus generally increased westward from Lake Okeechobee. FDEP nutrient indices indicated “poor” water quality but the WQI values are very close to “fair”. Algal blooms and high chlorophyll a measurements during the 1970s and 1980s were generally thought to result from agricultural runoff.

Historical information on the tidal Caloosahatchee from 1975-76 was available from Drew and Schomer (1984). Previous surveys indicated some aspects of water quality improved as one moved downstream away from the urbanized areas, such as DO. Seasonal water quality fluctuations have also been observed, with DO decreases in October and December. Chlorophyll a increased during the wet summer season as nutrient inputs increased from surface runoff and regulatory releases from Lake Okeechobee. Salinity measurements decreased with increases in freshwater flow. During winter, salinity increased, temperatures declined, and chlorophyll a decreased. DO stabilized in February, possibly allowing for an increase in oxygen demanding particulates to settle to the bottom, thus increasing the BOD values. During the 1970s, pollution was attributed to the following major sources: downstream flow from the Franklin Lock; Orange River inflow; the wastewater treatment plant (WWTP) effluent from the cities of Cape Coral and Fort Myers; and the residential development, Water Way Estates (Drew and Schomer, 1984).

Freshwater Systems

The freshwater systems of the Caloosahatchee River are discussed as the Eastern and Western Caloosahatchee (**Figure 2**). The Western Caloosahatchee begins at the point where Franklin Lock separates the tidally influenced waters from the upland waters. The Eastern Caloosahatchee begins at Ortoona Lock and extends to Lake Okeechobee. Before reaching Lake Okeechobee, the Eastern Caloosahatchee encounters Lake Hicpochee which is a small waterbody and historically (within the last twenty years) poor in water quality (FDEP, 1996a).

For data that has been extracted from STORET, water-quality parameters are expressed as annual averages and include physical and biological parameters, nutrients, and contaminants. Sediment quality data, if available, are also briefly discussed. Biological indicators such as important habitats, protected species, and pollution indicators may also be included under water quality. Known impaired usage of the basins is presented last. The majority of the current data discussion represent data collected from 1990 to 1995.

Eastern Caloosahatchee Basin

Eastern Caloosahatchee waters are usually above neutral in pH (>7), but tend towards low DO (<4.8 mg/L). CDM (1995) recorded seasonal lows from May through October. Water clarity is characterized by low turbidity and mostly low TSS, although color is higher than average (>71 PCUs) for Florida waters. Conductivity is above average for Florida waters (>335 micromhos), usually measuring above 500 for most stations in the Eastern Caloosahatchee (FDEP, 1996a). Ninemile Canal, which feeds into Lake Hicpochee, is of historically poor water quality having high color (120 PCUs), high conductivity (1195), and exceeding FDEP standards for DO (0.6 mg/L) (FDEP, 1996a).

The chlorophyll a content was high (32 μg/L), which is above 90% for other typical Florida waters. Average BOD concentrations (2.8 mg/L) also exceeded the screening level. Low diversity, pollution-tolerant species, and algal blooms have been reported from Ninemile Creek (FDEP, 1996a). Coliform bacteria levels are low in the Eastern

Caloosahatchee. However, Goodno Canal, a tributary with otherwise excellent water quality exceeds FDEP standards for fecal coliform.

The annual median total nitrogen was high (>1.89 mg/L) in the river and in the tributaries while phosphorus measured 0.08 mg/L (FDEP, 1996a). In 1993-94, total nitrogen values ranged from 1.1 to 2.2 mg/L and were highest from August through December. Total phosphorus was also highest during the summer with a range of 0.05 to 0.25 mg/L (CDM, 1995). Lake Hicpochee exhibits "poor" water quality due to excessive nutrient concentrations. The lake rated a TSI value of 74 due to high nitrogen (2.6 mg/L) and low DO. Ninemile Canal near Lake Hicpochee also exceeds the screening level for total nitrogen. The total nitrogen screening level is set at >1.6 mg/L as an exceedence.

Biological indicators are habitats, plants or animals that noticeably respond to environmental stresses such as changes in water quality. Loss of habitat acreage, changes in species diversity, and appearance of pollution tolerant species are examples of indicators. Habitat types within the East Caloosahatchee basin are dry prairie, pineland, freshwater marsh, and hammock (SFWMD, 1995). Agricultural runoff has been identified as a contributing to elevated nutrient concentrations in this area. (CDM, 1995).

West Caloosahatchee Basin

The western basin of the Caloosahatchee appears overall to have good water quality, but has been in a "degrading" trend for areas north of Townsend Canal (FDEP, 1996a). Reductions in pH and increased suspended solids are partially responsible for this observed trend. Chlorophyll a levels are improving and most other parameters are holding steady. Other areas of the basin rate "good" on the WQI scale.

Physical water-quality parameters throughout most of the basin are characterized by relatively neutral pH, DO readings mostly above 7.0 mg/L, good water clarity (i.e. low turbidity, low color, low TSS), and specific conductance between 500 and 700. No state standards for physical water quality are exceeded.

Biological oxygen demand is low (<2.3 mg/L) in the West Caloosahatchee and chlorophyll a ranges from 2-8 µg/L, an improvement over previous years.

Nutrients generally do not exceed screening levels, but at most basins are slightly higher than average for state waters. All waters in the West Caloosahatchee are rated "good" on the WQI scale.

Fecal and total coliform bacteria counts are low and do not exceed state standards. However, mercuryis present (FDEP, 1996a).

Approximately 41% of the West Caloosahatchee Basin are agricultural lands. Wetlands and pine forests make up 12% and 16%, respectively. Water quality impacts in this basin primarily results from agricultural runoff.

Table 6 provides a summary of the water quality in the West Caloosahatchee Basin by decade for several water-quality parameters. The data from which Table 6 was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a)

TABLE 6. SUMMARY OF WATER-QUALITY DATA FOR THE WEST CALOOSAHATCHEE BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	115	2.331	0.4	17	0.87	36	55	1.294	0	3.4	0	14.9	7	1.379	0.5	2.2	0	15.8
PH	pH	149	7.628	6.55	8.6	0		40	7.737	6.4	9.65	0		212	7.42	6.5	8.0	0	
Salinity	ppt	N/A						N/A						4	0	0	0	0	
Temperature	deg. C	189	25.05	12	33	0		46	25.6	17.6	3.4	0		212	23.99	14	31.0	0	
Chlorides	mg/L	184	85.12	35	990	1.6		45	121.1	26.1	360	15.6		210	49.218	12	162	0	
Fluorides	mg/L	35	0.224	0	0.31	0		31	0.247	0.17	0.43	0		N/A					
Conductivity	micromho	206	712.6	456	3850	1.5		51	798.1	390	1840	13.7		7	524.3	436	745	0	
DO	mg/L	142	6.419	2	11.4	12.7	46	33	6.325	2.2	11.9	18.2	47	212	4.507	2.2	8	69.34	70
BOD	mg/L	16	1.294	0.5	4.1	12.5	30.9	6	1.083	0.4	1.6	0	22.8	205	1.454	0.05	6.4	15.6	42.5
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	153	1.426	0.21	6.49	56.9	52	27	1.602	0.71	3.15	66.7	60.5	207	.561	.005	2.14	10.15	13
Tot-P	mg/L	164	0.069	0	0.36	52.4	42	37	0.112	0	10	37.8	54	212	0.116	.005	.95	39.6	58.5
Tot-C	mg/L	17	9.271	2.4	15	0		2	6.5	3	10	0		N/A					
Tot-coli	/ 100 ml	2	120	108	132	100	46.5	N/A						N/A					
Fecal-coli	/ 100 ml	1	54	54	54	0	48	4	144.5	30	292	25	72.5	2	545	390	700	100	86.1
Cu	ug/l	2	2	2	2	0		3	10	2	20	66.7		207	49.22	12.0	162.0	23.7	
Fe	ug/l	65	8.246	0.07	490	1.5		27	23.89	0.05	350	3.4		207	0.783	0.5	25.0	1.5	
Pb	ug/l	2	3	3	3	0		3	3.667	0	9	33.3		N/A					
Zn	ug/l	2	10	0	20	0		3	93.33	10	240	33.3		207	9.807	5.0	600	1.5	
Chlor a	ug/l	N/A						6	0.833	0	1	0		N/A					
WQI	%						41.4						42.9						50.0

Estuarine Systems

Tidal Caloosahatchee Basin

The tidal Caloosahatchee extends 28 miles from Franklin Lock to San Carlos Bay, and is so named because its waters are subject to tidal forces (Drew and Schomer, 1984). Tributaries of the tidal Caloosahatchee include Billy Creek, Whiskey Creek, Orange River, Hickey Creek, Roberts Canal, and Daughtrey Creek (**Figure 2**).

Physical water quality of the tidal Caloosahatchee is represented by pH, DO, conductivity, and water clarity. pH ranges slightly above neutral at 7.3 – 7.8. Except for Deep Lagoon and Manuel Branch, the average DO of the tidal Caloosahatchee and its tributaries ranges from 6.5 to 7.4. The overall DO trend is stable. Conductivity is usually above 10,000 micromhos, which is typical for estuarine waters. The freshwater tributaries are lower in conductivity. Orange River is the lowest at 508 micromhos. Water clarity varies along the river and tributaries. Deep Lagoon color was highest at 130 PCUs. A low of 33 PCUs occurs in the lower tidal basin. TSS are generally low at 1-10 mg/L. The highest TSS occurs in Manuel Branch. Turbidity is generally low ranging between 1.3-6.3. The most turbid waters occur in Manuel Branch. Overall physical chemistry is stable (FDEP, 1996a).

Measured values of key biological parameters indicate degraded water quality in parts of the tidal Caloosahatchee and tributaries. Biochemical oxygen demand (BOD), fecal coliform bacteria, and chlorophyll a levels exceeded the screening level at several locations. Fecal coliform bacteria were above state standards in 1992 at Manuel Branch (2195 MPN/100 ml) and Billy Creek (1839 MPN/100 mlChlorophyll a was high (27 µg/L) in Deep Lagoon and Billy Creek (57 µg/L). Due to the poor biological parameters, the tidal Caloosahatchee only partially meets its designated use as a Class 2 water, suitable for shellfish harvesting (FDEP, 1996a).

Nutrient measurements for total nitrogen and total phosphorus in the tidal Caloosahatchee were highest at or east of Ft. Myers. Total nitrogen levels were exceeded in the Caloosahatchee at a station adjacent to Ft. Myers with an average measurement of 1.64 mg/L in 1991. Total nitrogen exceedences (>1.22 mg/L) were also observed east of Ft. Myers in the Caloosahatchee, and at Billy Creek and Deep Lagoon. Averages for total phosphorus exceeded screening levels (i.e. were >0.07) in most cases, with the exception of Orange River. The nutrient status as indicated by the TSI is “poor” for Deep Lagoon, “poor” for Billy Creek, and “fair” but close to “poor” for the tidal Caloosahatchee. The WQI for freshwater streams and rivers rated Orange River water quality “good” (FDEP, 1996a). **Table 7** provides a summary of the water quality in the tidal Caloosahatchee Basin by decade for several water-quality parameters. The data from which **Table 7** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a). **Table 8** additionally provides a summary of the water quality by decade for various water-quality parameters of the Tidal Caloosahatchee Coastal Area (San Carlos Bay) region.

Important natural habitats remaining within the tidal Caloosahatchee drainage basin include mangrove, saltmarsh, tidal ponds, and according to one 1988 assessment, a small percentage of rare/unique slash pine/midstory oak (Godschalk and Associates, 1988). The West Indian manatee (*Trichechus manatus*) is a federally endangered species that frequents the tidal Caloosahatchee River and winters in the Orange River (FDEP, 1996a).

Increased nutrient loading occurs from wastewater inputs from Ft. Myers WWTPs, high nutrient waters from upriver, inputs from tributaries, and stormwater runoff from cities. Algal blooms occur frequently because of excess nutrients (FDEP, 1996a).

TABLE 7. SUMMARY OF WATER-QUALITY DATA FOR TIDAL CALOOSAHATCHEE BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	93	3.14	0.1	22	2.2	50.5	33	1.78	13	31.8	0	22.8	23	3.09	1	8.7	0	50.5
PH	pH	121	7.61	6.4	8.5	0		32	1.6	0.8	2.2	0		314	7.56	4.6	N/A	0	
Salinity	ppt	20	0.9	0	4	0		N/A				0		6	0	0	0	0	
Temperature	deg. C	460	26.96	2	38	0		12	25.98	13	31.8	0		316	24.94	7.6	38.7	0	
Chlorides	mg/L	60	785.5	38	6000	50		27	1234	36.5	8200	59.3		303	241.39	6	8.500	20.1	
Fluorides	mg/L	N/A						6	0.21	0.17	0.31	0		2	0.16	0.15	0.16	0	
Conductivity	micromho	82	4226	0.1	38500	42.7		43	3502	420	21500	53.5		24	5179	378	21800	37.5	
DO	mg/L	108	5.46	0.6	9.9	41.7	61.5	34	5.61	1.5	9.1	32.4	59	316	4.8	0.6	11	56	75.2
BOD	mg/L	80	1.65	0.3	5.7	17.5	45.5	7	1.6	0.8	2.2	0	42	303	1.58	0.05	8.0	18.5	42.8
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	25	1.46	0.38	5	52	54	24	1.83	0.42	3.56	62.5	51.3	295	1.12	0.005	26.0	29.2	42
Tot-P	mg/L	90	0.21	0	2.37	78.9	69	32	0.11	0.01	0.8	46.9	54	316	0.20	0.005	1.96	54.1	69.5
Tot-C	mg/L	26	12.35	8	19.7	0		22	12.57	9.3	18.5	0		N/A					
Tot-coli	/ 100 ml	28	21663	10	99990	64.3	97.7	N/A						2	270	270	270	100	54.3
Fecal-coli	/ 100 ml	32	15676	2	99990	21.9	100	5	88.6	28	195	20	53.4	18	703.8	10	3505	55.6	88.1
Cu	ug/l	N/A						N/A						292	5.19	0.5	130	60.3	
Fe	ug/l	4	0.4	0.22	0.64	0		5	85.27	0.12	425	20						5.8	
Pb	ug/l	N/A						N/A						292	3.52	0.5	110		
Zn	ug/l	N/A						1	17	17	17	0		292	9.28	5.0	80	1.0	
Chlor a	ug/l	N/A						8	4.5	0	12	0	29	7	15.27	1	57.2	28.6	
WQI	%						63.5						46.0						59.1

TABLE 8. SUMMARY OF WATER-QUALITY DATA FOR THE TIDAL CALOOAHATCHEE COSTAL AREA (SAN CARLOS BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI
Turbidity	NTU	N/A						5	5.64	3.6	8	0		15	3.07	1.7	4.4	0	
PH	pH	7	7.82	7.41	8.1			5	8.1	7.9	8.2			68	8.13	7.15	9.18		
Salinity	ppt	N/A						N/A						16	30.44	15	36.3		
Temperature	deg. C	7	26.5	23	29.8			22	26.7	19.1	30.4			74	25.52	15.3	32.3		
Chlorides	mg/L	2	4525	1350	7700			22	16220.9	10000	20000			N/A					
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	7	36857.14	5000	50500			22	43480	29900	51900			15	47097.6	37434	54544		
DO	mg/L	5	6.33	5.3	8.8	0		18	6.62	5.6	8	0		65	6.71	1.5	8.6	4.6	
BOD	mg/L	2	1	0.1	1.9	0		N/A						N/A					
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						1	0.44	0.44	0.44		38.9	N/A					
Tot-P	mg/L	2	0.05	0.04	0.06	0		22	0.08	0.04	0.16	54.5	62	15	0.04	0.02	0.07	0	
Tot-C	mg/L	N/A						22	5.4	2.5	11			5	5.82	3.5	8.6	0	
Tot-coli	/ 100 ml	2	10	10	10	0		N/A											
Fecal-coli	/ 100 ml	2	10	10	10	0		N/A											
Cu	ug/l	N/A						3	1	1	1	0		N/A					
Fe	ug/l	N/A						2	210	210	210	0		N/A					
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						2	25	20	30	0		N/A					
Chlor a	ug/l	N/A						N/A						15	3.36	1	15.3	0	
TSI		TSI NOT CALCULATED											42	TSI NOT CALCULATED					

2.2. Estero-Imperial Integrated Watershed

Introduction

The Estero-Imperial Integrated Watershed is comprised of the Estero Bay Watershed and northern portions of the Big Cypress Watershed. The Caloosahatchee River Watershed to the north, the Golden Gate Canal Watershed to the south, and the Gulf of Mexico to the west border the area. Interstate 75 runs north to south through the westernmost portion of the Estero-Imperial Integrated Watershed and divides the more developed coastal areas from the less developed interior. Most of the watershed lies in Lee County with a small percentage located in Hendry County (**Figure 3**). The Estero and Imperial Rivers, and Spring Creek, though small, are the major tributaries within the Estero-Imperial Integrated watershed that drain into Estero Bay. Warm, slow moving, estuarine water bodies such as the Estero and Imperial Rivers have some naturally low water-quality characteristics such as low DO. Therefore, these may be more susceptible to water-quality impacts resulting from changes in land use.

Physical Description

Population centers include the towns of Bonita Springs and Immokalee with 13,600 and 14,120 persons, respectively (U.S. Department of Commerce, 1992). Bonita Springs is south of the Imperial River and above the Lee-Collier County border, and Immokalee is located along the eastern edge of the Estero-Imperial Integrated Watershed. Rapid growth is occurring in Bonita Springs where the population more than doubled from 1980 to 1990. Residential areas, cattle, and vegetable farms occupy the landscape, and except for the coastal areas, the population is low (FDEP, 1996a).

Native Estero River coastal habitats include abundant tidal wetlands consisting primarily of mangrove and some saltmarsh (Godschalk and Associates, 1988). Freshwater wetlands are dominated by sawgrass with patches of cypress or hardwoods (FDEP, 1996a). Palmetto prairie and pine flatwoods exist further upland. Rare and unique upland habitats include sand scrub and slash pine/midstory oak (Godschalk and Associates, 1988). Soils are mostly of the Pamlico formation, which are comprised of marine quartz sands and hardened sandstone (Drew and Schomer, 1984).

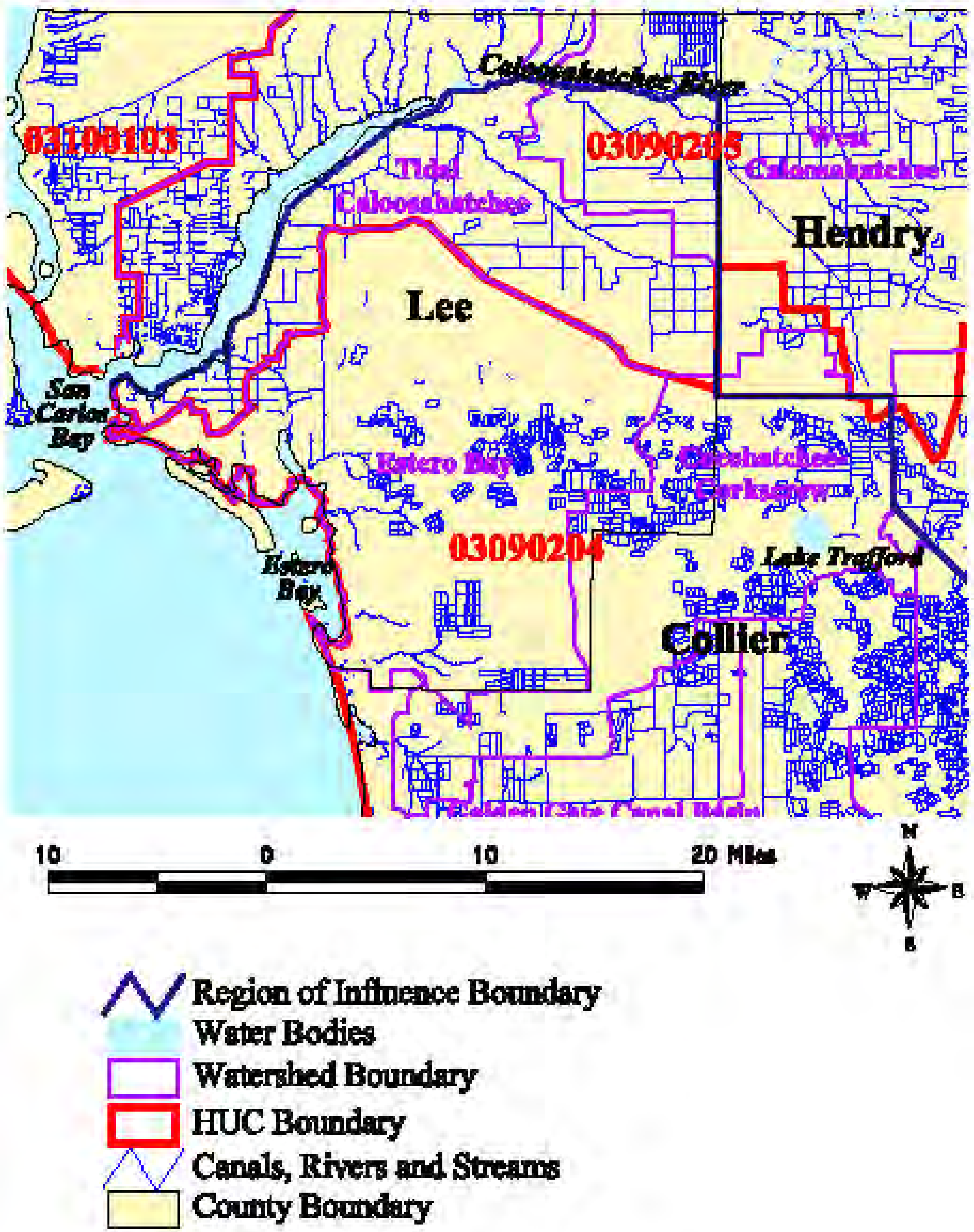


Figure 3. Estero-Imperial Watershed within the Study Area.

The Estero and Imperial Rivers, and Spring Creek provide minor freshwater flow into Estero Bay. The naturally low flow characteristics of these tributaries make Estero Bay notably susceptible to altered upland drainage water quality, volume, and seasonal inputs (Gissendanner, 1983). The topography of the watershed is relatively level thus accounting for the "sluggish" water movement in this part of the basin (FDEP, 1996a).

The highest freshwater inflows into Estero Bay occur in September with great variation in volume observed over the course of the year (Kenner and Brown, 1956; Drew and Schomer, 1984). At one time, tidally induced flows in Estero Bay exceeded the amount of freshwater inflow (Jones, 1980). Estero Bay tides are mixed and average about 0.54 m (1.75 ft) (Estevez et al., 1981), with velocities in the three major Bay-Gulf passes ranging from 0.64 m/s (ebb tide) to 1.52 m/s (flood tide). Flood tides can reach 1.07 m (3.5 ft) in height with volumes of 819 million cubic feet (measured for one pass in 1976) (Drew and Schomer, 1984). The low freshwater inflow into Estero Bay allows for generally high saline conditions year-round (around 34 ppt in the dry season), yet is high enough to prevent hypersaline conditions. Salinity seldom falls below 10 ppt even in the wet season (Tabb et al., 1974). Saltwater intrusion into local aquifers has resulted from inadequate recharge of groundwater. This occurrence has been attributed to surface hydrology modifications such as drainage canal construction. The construction of canals has increased surface water flow such that aquifers are not recharging, thereby allowing saltwater to infiltrate (Daltry and Burr, 1998). The Ten Mile Canal was constructed about 1920 to drain a 70 square mile area for agricultural uses. The canal directs this water into Mullock Creek a tributary of Estero Bay. Generally, this watershed does not have the extensive drainage network of the surrounding areas, but the construction of roads and other berms has still significantly altered the hydrology of the area. These changes have resulted in extensive flooding along the Imperial River. In addition, where flows from the Imperial and Estero Rivers into Estero Bay were once approximately equal, the proportional flow from the Estero River is now much less than that of the Imperial River (Johnson Engineering, Inc. et al., 1998). Surface water from the more interior areas of Flint Pen Strand and Bird Rookery Swamp are drained into Estero Bay and the Wiggins Pass/Cocohatchee River Estuarine System through the Imperial River, Spring Creek, and the Cocohatchee Canal (SFWMD, 1998a).

Historical Description

The Estero-Imperial Integrated Watershed was and in many areas still is typical of low, flat south Florida lands dominated by wetlands and characterized by slow, sheet-flow drainage patterns. In the past, the naturally dispersed water patterns served to distribute nutrients over broad areas of wetland vegetation. Thus, nutrient levels remained low in undrained areas of this watershed (Haag et al., 1996a). Seasonal fluctuations in flow due to rainfall created the necessary salinity regime in Estero Bay for good estuarine productivity. Estero Bay was recognized many years ago for it's natural qualities and became the state's first aquatic preserve in 1966 (Alleman in CHNEP, 1997). In 1983, the Estero Bay Aquatic Preserve Management Plan was implemented with emphasis placed on "enhancing the existing wilderness condition" (Gissendanner, 1983). Increasing development in the 1960s led to changes in the natural river systems around Estero Bay (Alleman in CHNEP, 1997). Changes in water quality and quantity have been observed. For example, the Imperial and Estero Rivers historically delivered less fresh water to Estero Bay. From 1940 to 1951, the maximum discharge from the Imperial River was 2,890 cu ft. Low flows were common and no flows occurred on occasion. Periodically, the rivers would flood (Kenner and Brown, 1956).

Freshwater Systems

Currently, physical water quality in the coastal areas of the Estero and Imperial Basins is characterized by clear water with neutral pH (7.1 to 7.3) but relatively high conductivity values (>16,000 micromhos). DO is slightly lower in the Imperial Basin (4.9 mg/L compared to 5.7 mg/L) than in the Estero Basin. Estero and Imperial Basin water clarity is characterized by low turbidity at <5.0 NTU/NTUs, generally low suspended solids at <10 mg/L, above average Secchi disc depths of 0.9 m to 1.5 m, and low color at 43 to 55 PCUs. Chloride measurements are not available, but conductivity indicates high dissolved mineral content in the Estero and Imperial Rivers. Biological parameters of chlorophyll a and 5-day biochemical oxygen demand (BOD-5) are of slightly lower quality in the Imperial River than in the Estero River. To clarify, BOD in the Imperial River is higher (2.4 mg/L over 1.4 mg/L) than in the Estero River; chlorophyll a is higher in the Imperial (12 μg/L over 2 μg/L), but generally, the two systems are comparable with respect to water quality. Water from the Estero and Imperial Rivers has a “residency time in the Bay of at least several days during the wet season” (Clark, 1987).

The TSI for the Estero and Imperial Rivers was evaluated as “fair” water quality by FDEP based on their nutrient status as determined by chlorophyll a, total nitrogen, and total phosphorus measurements. The TSIs for the Estero and Imperial Rivers were 52 and 53 respectively where scores below 50 rated “good” and scores above 59 rated poor. Spring Creek was also rated as 52 (FDEP, 1996a).

Metals have been detected from limited sampling of the waters of the Estero-Imperial Integrated Watershed (Table 9). In addition, elevated levels of cadmium, chromium, lead, mercury, and zinc have been found in the sediments of Estero Bay and River, Imperial River, and Spring Creek as recently as 1986 (Clark, 1987). In general, analysis of metals, pesticides and PCBs is lacking for the Estero-Imperial Watershed, with metals having only been sampled six times (with the exception of iron) within the last 30 years.

The Imperial River is classified in terms of usage as a Class 3 water body, suitable for wildlife and recreation. Due to low DO, nonpoint pollution, and conventional pollutants, water quality only partially supports the Imperial River for this type of use (FDEP, 1996a). Likewise, Estero River and Spring Creek are only in partial support of use: Spring Creek because of conventional pollutants and low DO, and Estero River for low DO and fecal coliform.

Important biological data useful in understanding and interpreting water quality are indicator species, species diversity information, and concentrations of chlorophyll a and fecal coliform bacteria. Indicator species may be sensitive to degraded water quality or they may be tolerant of degraded water quality. Certain species of polychaete and oligochaete worms become dominant under degraded water quality conditions. In south Florida wetlands, decreasing wading bird populations such as the endangered wood stork often reflect changes in hydrology. Species diversity will decline with declines in habitat quality and thus can be a potential water quality indicator. Increased chlorophyll a concentrations can indicate algal blooms and high nutrient levels, a condition which can eventually lead to eutrophication.

Table 9 provides a summary of the water quality in the Estero-Imperial Basin by decade for several water quality parameters. The data from which Table 9 was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a "good", "fair" or "poor" basis; as typically included in the Florida's 305b water quality report (FDEP, 1996a).

Estuarine Systems

Estero Bay

Recent STORET data were not available, but Estero Bay waters are described as shallow, turbid, and of "fair" quality. Nutrients at levels that exceed screening levels tend to drive water-quality ratings down. Consequently, this water body only partially meets its Class 3 use designation (FDEP, 1996a). Measurements were available for one station at Big Carlos Pass in the Bay and therefore may not be indicative of other areas of the Bay.

Water clarity, as indicated by turbidity, TSS, and color (8.5 NTU/NTUs, 28 mg/L, 25 PCUs, respectively) is low. Waters were well oxygenated with mean DO levels at 6.5 mg/L. Conductivity was 37800 micromhos (FDEP, 1996a).

Low chlorophyll a and low BOD were observed in the past. The mean for chlorophyll a was 8 mg/L, and the mean BOD was 1.6 mg/L.

Historically, Estero Bay rated a TSI of 50, even with phosphorus levels that exceeded FDEP screening criteria, which is still "fair" but approaching "good". Estero Bay phosphorus levels were above FDEP screening concentrations. Phosphorus screening levels are >0.07 mg/L and Estero Bay concentrations were 0.10 mg/L. Total nitrogen measured 0.81 mg/L, which is considered low for estuaries.

Estero Bay has not had a problem with high bacterial counts as indicated by the low total and fecal coliform analyses.

Some contamination by cadmium, chromium, lead, mercury, and zinc in Estero Bay sediments has been observed. Concentrations of pesticides and PCBs were below minimum detection limits (Clark, 1987).

Table 10 provides a summary of the water quality in the Estero/Imperial Basin Coastal Area (Estero Bay) by decade for several water-quality parameters. The data from which

Table 10 was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a).

TABLE 9. SUMMARY OF WATER-QUALITY DATA FOR THE ESTERO/IMPERIAL BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	**Units**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**WQI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**WQI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**WQI**
Turbidity	NTU	87	2.69	0	10	0	41	245	2.9	0.2	62	2.0	44	536	2.38	.18	48	2.1	38.8
PH	pH	90	7.33	5.95	8.3	0		237	7.52	6.0	10.73	0		1979	7.41	4.9	9.55	0	
Salinity	Ppt	10	1.8	0	8	0		N/A						10	5.48	0	31	0	
Temperature	Deg. C	53	25.7	20.5	31	0		90	25.80	15.0	35	0		1979	24.86	10.9	44	0	
Chlorides	Mg/L	32	1819	7.7	22300	56.3		305	403.64	5.8	17251.7	17.7		1903	802.2	1.5	75,500	15.7	
Fluorides	Mg/L	N/A						3	0.12	0.1	0.17	0.0		N/A					
Conductivity	Micromho	79	6133	200	51000	36.7		339	1589	56	46700	16.2		540	3657.7	83	54,800	13.0	
DO	Mg/L	84	4.68	0.8	11.2	53.6	72	242	6.06	0	20	37.6	51.4	1979	4.11	0.3	18.1	70.7	74.9
BOD	Mg/L	44	1.86	0.1	4	25	51.8	33	2.05	0	6	21.2	61.5	1942	2.01	0	16.5	26.1	62.1
COD	Mg/L	N/A						N/A						N/A					
Tot-N	Mg/L	42	1.42	0.5	4.33	56.2	51.5	236	1.16	0.24	5.11	33.5	37.5	1885	1.12	0.005	192	26.2	42
Tot-P	mg/L	78	0.03	0	0.17	5.1	20	249	0.04	0	0.5	8.8	30	1909	0.12	0.005	2.96	40.0	58.5
Tot-C	mg/L	44	12.82	3.4	27.9	4.5	N/A	71	14.58	8.2	25.2	2.8		2	15.98	6.1	25.85	50.0	
Tot-coli	/ 100 ml	13	295.1	6	1120	61.5	54.9	N/A						7	95.36	1.5	420	28.6	30.9
Fecal-coli	/ 100 ml	21	154.3	1	720	28.6	72.6	4	114.3	68	205	25	69.4	198	119.3	4	2600	20.2	68.9
Cu	ug/l	N/A						15	9.31	0.47	10.0	93.3		19.4	4.93	.500	130	55.9	
Fe	ug/l	6	0.58	0.19	1.04	0		181	0.36	0.02	1.32	0		4	213.5	136	304	25.0	
Pb	ug/l	N/A						20	9.04	0.4	10	90.0		1895	2.47	0	220	6.4	
Zn	ug/l	N/A						15	13.86	10	37.9	0.0		1904	10.55	5	260	1.6	
Chlor a	ug/l	N/A						2	1	1	1	0.0		29	10.65	1.10	44.90	17.2	
WQI	%						52.5						52.0						55.2

TABLE 10. SUMMARY OF WATER-QUALITY DATA FOR THE ESTERO / IMPERIAL COASTAL AREA (ESTERO BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	**Units**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**
Turbidity	NTU/NTU	93	8.06	1	45	13.5		38	12.98	2.6	65	26.3		2	5.9	2.6	9.2	0	
PH	pH	96	8.05	7.1	8.7			36	7.95	7	8.3			2	7.75	7.6	7.9		
Salinity	ppt	36	30.9	20	40			2	25.5	20	31			N/A					
Temperature	deg. C	95	24.98	13.25	32			38	24.7	11	31			2	.5	24	25		
Chlorides	mg/L	21	19245.62	18	23700	95.2		1	20.8	20.8	20.8			N/A					
Fluorides	mg/L	14	0.9	0.78	1.12	0.0		10	0.74	0.17	0.91			N/A					
Conductivity	micromho	68	41491.3	28	57000	95.6		32	40621.9	23000	50000	100		1	49000	49000	49000	100	
DO	mg/L	98	6.64	0.2	10.6	8.2		38	6.6	3.9	8.6	10.5		2	6.7	6.1	7.3	0	
BOD	mg/L	16	3.40	2.4	4.4	100		1	1.6	1.6	1.6	0		2	1.5	1.4	1.6	0	
COD	mg/L	1	0.29	0.29	0.29	0.0		N/A						N/A					
Tot-N	mg/L	1	0.06	0.06	0.06	0.0		N/A						62	1.38	0.86	1.95	69.4	
Tot-P	mg/L	55	0.06	0	0.23	25.5		16	0.12	0.05	0.29	68.8		65	0.03	0	0.1	1.5	
Tot-C	mg/L	57	5.65	0	16	0.0		10	5.4	3	11	0		N/A					
Tot-coli	/ 100 ml	55	7.3	0	68	0.0		10	13	2	40	0		N/A					
Fecal-coli	/ 100 ml	70	8.65	0	210	1.4		17	16.2	2	120	0		2	3	2	4	0	
Cu	ug/l	10	10.9	5	17	100		4	33.8	10	50	100		N/A					
Fe	ug/l	40	2757.3	50	100000	32.5		4	282.8	84	724	25		N/A					
Pb	ug/l	27	1309.8	0	35000	88.9		4	33.8	10	50	100		N/A					
Zn	ug/l	29	3588.9	30	100000	86.2		4	25.8	25	28	0		N/A					
Chlor a	ug/l	38	9.05	0	67	5.3		12	7.64	0.0	19.0	0		64	46.5	2.18	78	98.4	
TSI							23.8	TSI NOT CALCULATED											64.3

Decreases in important estuarine habitats such as marine grassbeds, saltmarsh, and oyster bars may indicate declining water-quality trends (Clark, 1987; Gissendanner, 1983). Species with protected status may also provide an indication of improved or degraded water quality. Some of these include the Atlantic green turtle, Atlantic hawksbill, Atlantic Ridley, leatherback, Atlantic loggerhead, wood stork, West Indian manatee, southeastern snowy plover, eastern brown pelican, bald eagle, southeastern kestrel, least tern, and mangrove fox squirrel (Gissendanner, 1983; Wood, 1994).

Nutrient inputs from agricultural runoff (fertilizers) are cited as the source of high phosphorus. Habitat alteration through possible destruction of forests and wetlands, water flow changes, and pollution are listed as other impairments to use (Alleman in CHNEP, 1997).

2.3. Big Cypress/West Collier Watershed

Physical Description

The physical description of the Big Cypress/West Collier watershed includes brief descriptions of land use, habitat, soils, and water flow characteristics.

The Big Cypress/West Collier Watershed portion of the study area is situated in Big Cypress preserve, an area of low flat lands of cypress trees, pine forests, and wet and dry prairies. Agriculture and urban are the main types of human land use. However, it should be noted that lands that are zoned as agricultural may in actuality be swamp. Major urban areas situated along the coastal area of the watershed are Naples, East Naples, North Naples, Naples Park, Marco Island, and Golden Gate. The single most conspicuous feature of the area is the expansive system of roads and canals constructed during the 1960s for the Golden Gate Estates (GGE) land development project. The Golden Gate Estate canals channel drainage from approximately 200,000 acres into the Gordon River, Naples Bay, and the Fahka Union Bay (U.S. COE, 1980). Impacts from the Golden Gate Canal include overdrainage of surface waters, lowering of groundwater levels, altered traditional drainage patterns, reduction of habitats, and declines in agriculture potential (U.S. COE, 1980). Thus, the existing condition of water quality in the rivers and bays is undoubtedly linked to the major hydrological changes that have occurred in the past. Historically, the Big Cypress Basin was dominated by sheet flow but several land reclamation projects starting at the beginning of the century have dramatically changed the hydrology. The majority of Collier County inside of the study area has been drained through the construction of canal networks. The first of such projects was the creation of the Tamiami Trail during the earlier part of the century. The GGE project had the largest impact on the hydrology of the area. This area consists of hundreds of miles of large canals that drain approximately 300 square miles. The construction of GGE has dramatically lowered the groundwater table and changed salinity regimes of coastal areas of the Big Cypress/West Collier watershed.

Soil types are Pamlico formation sands and marl deposits with peat. Marls are silty calcium carbonate deposits, often with shell fragments, formed from eroded limestone (Drew and Schomer, 1984).

Cocohatchee River, Naples Bay, Gordon River, Blackwater River, Fahka Union Bay, Fahkahatchee Bay, Marco Bay, and Rookery Bay are the major natural water bodies within the study area. Barron Canal, Golden Gate Canal, Cocohatchee River Canal, Fahka Union Canal, Gordon River Canal, and Henderson Creek Canal are the major artificial drainage systems within this watershed. Flow direction and areas drained by canals are dependent upon rainfall amount. For example, the Cocohatchee River Canal drains an area southwest of Lake Trafford during dry periods and may have no flow during very dry years. During the rainy season, the Cocohatchee River Canal along with Henderson Creek Canal serves to collect excess drainage from the Golden Gate area (**Figure 4**).

Fahka Union Canal collects drainage from a series of smaller canals and discharges into the Ten Thousands Islands area. The Golden Gate Canal and Gordon River drain into Naples Bay, the periphery of which is lined with an extensive network of finger canals and residential developments. The Barron River Canal, built as a source of fill to make roads, drain strands and sloughs of the Big Cypress National Preserve (Drew and Schomer, 1984).

Historical Description

Without pre-canal water-quality data, little can be said about the original water quality within the Big Cypress/West Collier Watershed. In addition, it is recognized that good water quality can exist within areas of severely altered hydrology. However, there are some basic factors to consider related to the channelization of wetlands. Canal construction, which began in the 1920s, undoubtedly led to increased drainage of freshwater from wetlands into the estuaries and a subsequent increase in dissolved minerals. Possible changes in salinity, sedimentation, turbidity, and nutrients likely resulted. In lieu of more detailed pre-canal water quality descriptions, STORET data from the 1980s provides a historical description of post-canal water quality of the Golden Gate Watershed for comparison with the present day. Physical water quality was characterized by neutral pHs, DO levels that were on the average low (>5.0) at stations sampled in Naples Bay, Barron River Canal, Blackwater River, Gordon River, and Gordon River Canal, and conductivity above >1275 in some of the freshwater bodies (Cocohatchee River, Blackwater River). BOD and chlorophyll a were high in the Gordon River Canal and in the Blackwater River. Fecal coliform counts were high (>190 MPN/100 ml) in the Gordon River. Water quality in the Fahka Union canal was excellent, rating a very low 16 on the WQI scale. Naples Bay rated “fair” in terms of nutrient conditions according to the FDEP TSI with a 53. In general, the areas along the Blackwater River have the worst water quality.

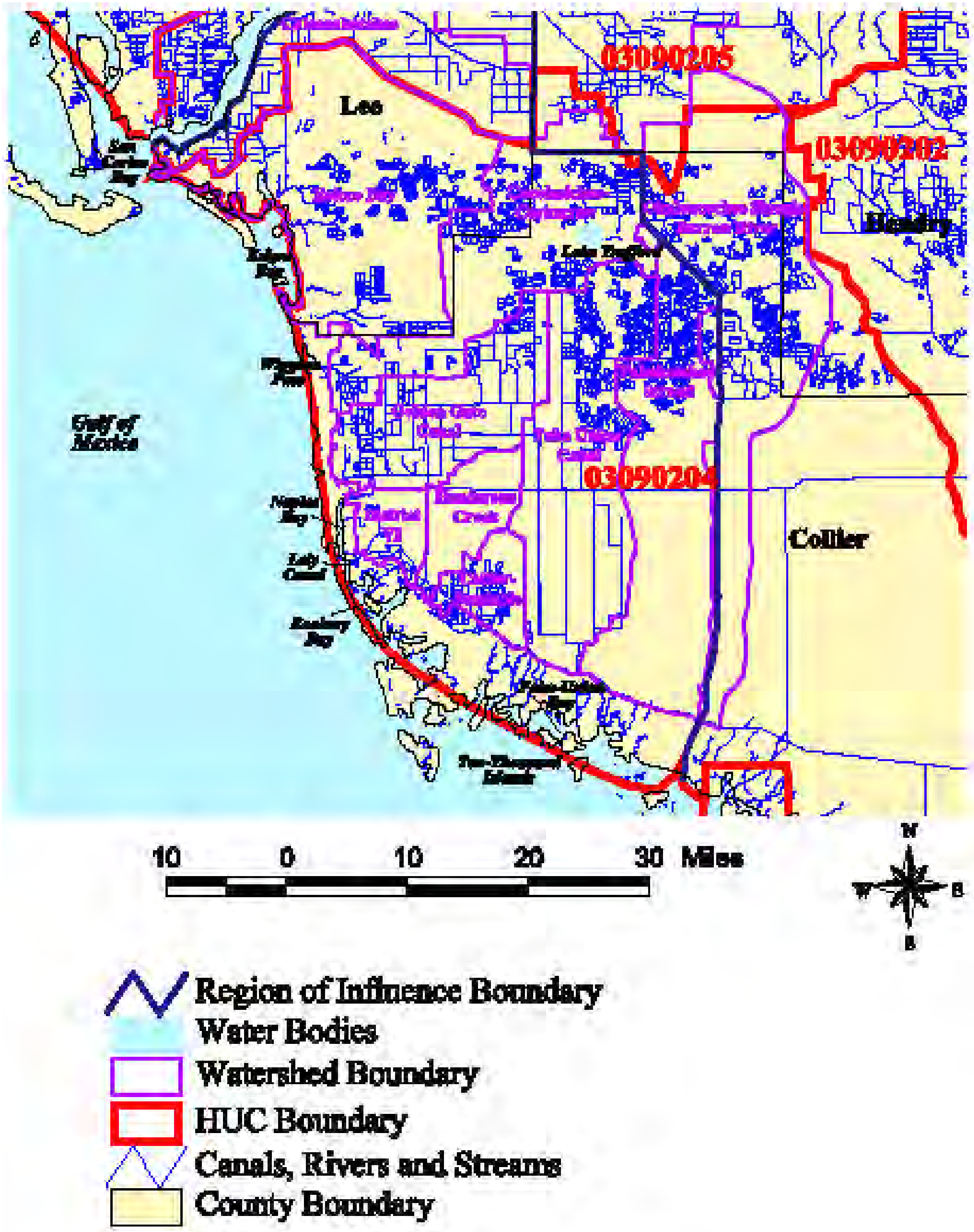


Figure 4. Big Cypress Basin Watershed within the Study Area.

Freshwater Systems

Corkscrew Swamp

Portions of Corkscrew Swamp are described as pristine due to its status as a National Audubon Society sanctuary. The Corkscrew Swamp Regional Ecosystem Watershed is a Southwest Florida Water Management District (SWFWMD) project that encompasses the sanctuary with goals to restore hydrologic conditions in impacted areas (Bird Rookery Swamp) and maintain flows and water quality in undisturbed areas of Corkscrew Swamp (SFWMD, 1998a). Lake Trafford, north of Corkscrew Swamp is of historically good to fair water quality that fully supports use designation as a Class 3 water.

Cocohatchee River

Current physical water quality of the Cocohatchee River is characterized relative to typical state waters by low turbidity (2.9-3.5 NTU/NTUs), low TSS (2 –10 mg/L), higher than average color (85 –100 PCUs), neutral pH, variable DO (3.2 to 7.0 mg/L), and variable conductivity (675 – 2650 micromhos (FDEP, 1996a). The low DO results from excessive aquatic vegetation in the canals using up more oxygen than what is produced through photosynthesis (Kirby et al., 1988).

Chlorophyll a levels were well below screening levels with a mean concentration of 5 μg/L. BOD was, at one location, higher than average for typical Florida waters but just shy of exceeding state criteria. BOD averaged between 1.6 and 2.0 for two stations in the Cocohatchee River. Total coliform bacteria levels were higher than average for state waters, and fecal coliform counts exceeded state standards with 2650 MPN/100 ml.

Nutrient levels are lower than average, with phosphorus and nitrogen levels below state screening levels. The WQI modified by FDEP from a similar EPA index, currently rates the river as “fair” with a rating of 48, and historically rates the Cocohatchee River canal as “good” with a rating of 33. Scores between 45 and 59 are classified as “fair”. Values below 45 are “good” and values above 59 are “poor”. Low DO (5.1 mg/L) and high fecal coliform counts (381 MPN/100 ml), averaged from two locations, drive the WQI rating for the Cocohatchee River down. The TSI for the Cocohatchee River also classified the river as “fair” with ratings of 50 and 58 for two sections. The Cocohatchee River is a Class 2 water, suitable for shellfish harvesting, which partially meets its designated use.

Cocohatchee River Canal

According to STORET data, the Cocohatchee River Canal has not been sampled since 1988. Therefore, a current account of water quality is not possible. Historical data collected from 1980 to 1988 provide the basis of the following description. The Cocohatchee River Canal is about 13 miles long and less than 5 feet deep with better water quality than its natural counterpart. Compared to other state waters, physical water quality is better than average for most state waters.

Biological data for the Cocohatchee River Canal are absent from STORET for 1980-1988. Therefore, no BOD, coliform, or chlorophyll a information is presented.

Nutrients are present in amounts higher than average for most estuaries, but do not exceed screening levels. Total nitrogen measured between 0.99 and 1.08 for two stations, and total phosphorus measured 0.03 for both stations.

No contaminants have been recently detected according to STORET data. However, the database compiled for this study indicate copper and zinc exceeded state standards in 23% and 14% of samples respectively from 1990-1998 (**Table 11**). Water quality is exhibiting a stable trend, and fully supports designated use for a Class 3 water body (FDEP, 1996a). Sediment quality information is not available for the Cocohatchee River Canal.

Table 11 provides a summary of the water quality in the Corkscrew/Cocohatchee Basin by decade for several water-quality parameters. The data from which **Table 11** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a).

Golden Gate Canal:
Current water-quality data were not available for the Golden Gate Canal from the STORET database. However, historical STORET water-quality data from 1980-1989 are available. Physical water quality in the 1980s was characterized by relatively low turbidity (3.5-4.3 NTU/NTUs), low TSS (2-3 mg/L), higher color content than average (50-99 PCUs), neutral pH, and low to moderate levels of DO (4.8-6.0 mg/L). Conductivity was higher than average for typical state waters (572-650 micromhos).

BOD exceeded screening levels with an average of 2.4 mg/L at one canal sample location. The screening level is 2.3 mg/L. One location was sampled for chlorophyll a and was higher than average for typical state waters with 19 µg/L. Fecal coliform bacteria were lower than average (55 MPN/100 ml).

Total nitrogen and total phosphorus were below their screening levels and overall were lower than average for other state waters. Total nitrogen ranged from 0.81-1.07 and total phosphorus ranged from 0.02-0.03 for three locations along the Golden Gate Canal. The WQI for the Golden Gate Canal ranged from 36 to 40, an indication of “good” water quality (FDEP, 1996a). Sediment quality information was not available.

Table 12 provides a summary of the water quality in the Golden Gate Canal Basin by decade for several water-quality parameters. The data from which Table 12 was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a). **Table 13** provides a summary of the water quality in the Golden Gate Canal Coastal Area by decade for several water-quality parameters.

TABLE 11. SUMMARY OF WATER-QUALITY DATA FOR THE CORKSCREW/COCOHATCHEE BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	81	6.37	1	75	8.6	79.7	271	4.7	0.3	127	3.0	66.5	38	12.81	0.6	70	31.6	92.5
PH	pH	119	7.57	4.6	10.25	0		280	7.38	2.5	9.1	0		37	7.09	6.4	8.5	0	
Salinity	ppt	3	1.17	0	2.5	0		3	12.1	1.1	31.0			N/A					
Temperature	deg. C	172	26.77	14	240	0		133	24.6	0.24	34	0		293	25.89	16.8	35.35	0	
Chlorides	mg/L	70	154.38	5.8	3400	4.3		277	374.54	9.2	18,300	19.1		129	906.14	2.03	21500	17.8	
Fluorides	mg/L	N/A						9	0.24	0.17	0.44	0		89	0.13	0.025	0.59	0	
Conductivity	micromho	150	1943.43	70	51000	8.7		282	1767.62	80	46000	17.4		38	3173.92	179	36400	13.2	
DO	mg/L	106	6.22	1.1	14.4	34.0	44	280	4.19	0.1	14.3	62.1	71	3.4	6.21	0.1	20	43.3	43.9
BOD	mg/L	63	2.19	0.2	8.6	38.1	64j	15	1.89	0.8	4.1	26.7	52	239	5.56	0.5	43.3	67.4	94
COD	mg/L	5	7.6	0	20	0	2.8	N/A						N/A					
Tot-N	mg/L	45	0.96	0.01	5.52	33.3	27	258	1.15	0.1	3.95	33.3	37	113	1.28	0.02	3.76	39.8	50
Tot-P	mg/L	89	.25	0	2.64	44.9	74	373	0.51	0	8.3	45.3	85.8	319	.57	.005	10.35	60.8	87.5
Tot-C	mg/L	35	16.34	7.1	70	17.1	N/A	53	15.63	9.8	23.5	3.8	N/A	5	24	18	30	25.9	N/A
Tot-coli	/ 100 ml	31	88.9	1	1056	25.8	30.9	19	1181.11	0	11,000	68.4	75.8	88	430.86	0.75	3250	76.5	61.2
Fecal-coli	/ 100 ml	42	30.7	0	600	2.4	40	14	64.21	0	360	7.1	49.5	13	308.77	10	2224	30.8	81
Cu	ug/l	2	1	0	2	0		5	5.73	0.05	25	20.0		22	6.06	0.5	90.75	22.7	
Fe	ug/l	9	276.92	0.24	1700	11.1		233	1.21	0.04	157	0		118	0.68	0.043	8.62	0	
Pb	ug/l	7	7.71	0	19	57.1		5	0.64	0	2	0		110	1.78	0.5	4.0	0	
Zn	ug/l	N/A						4	31.03	23.1	43.8	0		109	8.930.013	421	2.8	13.6	
Chlor a	ug/l	N/A						11	14.75	5	33	27.3		6	47.4	2	147.7	50	
WQI	%						48.6						62.7						74.1

TABLE 12. SUMMARY OF WATER-QUALITY DATA FOR THE GOLDEN GATES CANAL BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	227	8.47	0	140	10.6	86.2	372	4.41	0.3	101	2.7	65	2	2.35	2.2	2.5	0	36.5
pH	pH	248	7.67	6	79.5	0		278	7.44	2.3	8.93	0		279	7.32	6.43	8.69	0	
Salinity	ppt	5	3.8	0	11	0		N/A						157	11.22	0	39	0	
Temperature	deg. C	276	24.14	13.8	32.5	0		15	24.1	7.5	31	0		320	25.97	3.3	37.1	0	
Chlorides	mg/L	188	639.05	16	17000	11.7		344	185.67	4	8171.9	7.3		89	1523.6	3.0	17,200	20.2	
Fluorides	mg/L	N/A						3	0.17	0.17	0.17	0		89	0.15	0.025	0.52	0	
Conductivity	micromho	301	2003.58	61	41500	10.6		370	1181.06	170	29900	9.5		59	38488.39	700	64465	96.6	
DO	mg/L	237	4.65	0.2	14.4	55.7	72	284	4.49	0.4	9.9	61.6	74	316	5.54	0	15.8	41.1	65.5
BOD	mg/L	113	1.72	0	7.3	16.8	48.2	7	1.74	0.7	3.8	14.3	48.4	220	2.84	0.500	39.6	34.5	76.4
COD	mg/L	N/A						0	N/A	N/A	N/A	N/A		N/A					
Tot-N	mg/L	135	1.09	0.37	7.88	22.2	33.5	362	1.22	0.37	7.18	36.5	41	89	1.63	0.02	27.3	32.6	66.5
Tot-P	mg/L	188	0.04	0	0.75	8	26	368	0.04	0	0.34	9	26	265	0.06	0.005	0.45	20.8	40.5
Tot-C	mg/L	160	322.15	0	17000	19.4		79	17.8	10.4	33.2	20.3		132	15.35	1.7	58.0	18.9	
Tot-coli	/ 100 ml	125	5251.12	4	65000	84	28.1	N/A						100	303.9	18.0	1600	75.7	56.1
Fecal-coli	/ 100 ml	117	98.35	0	800	16.2	54.5	6	202	8	480	50	76.1	3	297.33	12	824	33.3	79.9
Cu	ug/l	84	5.91	0	20	64.3		7	1.91	0.06	6	28.6		55	3.46	0.01	300	30.9	
Fe	ug/l	129	855.13	0.23	4800	61.2		339	2.4	0.02	320	0.3		90	8.52	0.002	717	1.1	
Pb	ug/l	79	12.02	0	85	64.6		7	3.05	0.4	11	28.6		144	2.53	0.5	13.15	7.6	
Zn	ug/l	86	71.63	0	1700	16.3		5	33.28	21	55.7	0		144	272	0.002	77	0.7	
Chlor a	ug/l	N/A						7	9.173	3	34	14.3		2	7.2	2.4	12	0	
WQI	%						55.5						59.4						60.0

TABLE 13. SUMMARY OF WATER-QUALITY DATA FOR GOLDEN GATES CANAL COASTAL AREA

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	N/A						N/A						N/A					
pH	pH	1	7.1	7.1	7.1			1	7.85	7.85	7.85			12	8.05	7.825	8.21		
Salinity	ppt	2	32.3	32.2	32.4			1	33.7	33.7	33.7			355	24.89	0.0	38.2		
Temperature	deg. C	3	24.87	23.9	26.0			1	25.0	25.0	25.0			356	26.08	13.5	35.00		
Chlorides	mg/L	N/A						N/A						N/A					
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	N/A						N/A						345	38710	0.0	66072	96.5	
DO	mg/L	3	5.5	1.4	8.1	33.3	60	1	4.5	4.5	4.5	100		345	5.12	0.0	12.8	34.3	66
BOD	mg/L	N/A						1	2.65	2.65	2.65	100		3	1.88	1.5	2.45	33.3	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						N/A					
Tot-P	mg/L	N/A						1	0.055	0.055	0.055			11	0.31	0.03	1.269	72.7	
Tot-C	mg/L	N/A						N/A						6	8.15	4.20	18.67	0.0	
Tot-coli	/ 100 ml	N/A						N/A						N/A					
Fecal-coli	/ 100 ml	N/A						N/A						N/A					
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	N/A						1	0.040	0.040	0.040			3	0.05	0.04	0.07	0.0	
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						N/A						N/A					
Chlor a	ug/l	N/A						N/A						N/A					
WQI	%																		

Henderson Creek/Blackwater River

Henderson Creek appears to be of good water quality until it intersects Blackwater River, of historically fair to poor water quality, depending on which index is applied. The TSI rated Blackwater River a 61, which is "poor", while the WQI rated the river a 46, which is "fair", and close to "good". Low DO (3.5 mg/L) and high BOD (2.8) drive the index down. Because of these factors, FDEP states that Blackwater River only partially meets its use designation. However, the overall status (derived from a combination of indices, contaminant information, nonpoint source assessments, and expert opinion) of the Blackwater River is represented as "poor" in the 1996 305b report (FDEP, 1996a).

Fecal coliform bacteria counts from STORET data were 3 MPN/100 ml, averaged over five observations. The study area database compiled for this report indicates average fecal coliform levels from 1980 to 1990 was closer to 111 MPN/100 ml. No total coliform counts were available from STORET records for this period, but data summarized for Table 13 indicate high total coliform levels in Henderson Creek, averaging 1830 MPN/100 mls. Chlorophyll a levels measured 40 µg/L, which is higher than 90% of similar state waters. However, total nitrogen and total phosphorus levels remained low at 0.98 mg/L and 0.03 mg/L, respectively.

Sediment quality data was not available.

Table 14 provides a summary of the water quality in the Henderson Creek Basin by decade for several water-quality parameters. The data from which **Table 14** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a "good", "fair" or "poor" basis; as typically included in the Florida's 305b water quality report (FDEP, 1996a).

The literature provided very little historical or current water-quality data for the District VI Basin. **Table 15,** however, provides a summary of the water quality from the STORET database by decade for various water-quality parameters of the District VI Basin.

TABLE 14. SUMMARY OF WATER-QUALITY DATA FOR THE HENDERSON CREEK BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	9	8.33	1	25	22.2	85.4	59	3.25	0	29	3.4	52.3	36	2.22	.3	10.2	0	35.2
pH	pH	13	7.95	7.2	9.2	0		93	7.22	5.1	9	0		121	7.32	6.64	8.29	0	
Salinity	ppt	N/A						23	8.25	0	35.8	N/A		115	9.51	0.0	35.9	N/A	
Temperature	deg. C	51	25.1	14	31	0		96	26.58	17.5	33	0		126	26.47	16.7	33.3	0	
Chlorides	mg/L	20	94	11	250	0		17	97.01	27	334.7	5.9		24	4244.8	37.0	31,390	54.2	
Fluorides	mg/L	N/A						2	0.17	0.17	0.17	0		24	0.15	0.025	0.50	0	
Conductivity	micromho	47	1012.98	230	1750	12.8		96	308.87	.3	9500	3.1		94	31.36	.24	1350	1.1	
DO	mg/L	2	11.5	9.9	12.4	0	8.5	80	4.09	.7	9.85	70.0	78.1	123	4.83	0.53	9.00	50.4	65.7
BOD	mg/L	15	4.56	1.6	10.4	73.3	90.8	14	3.65	0.3	8.8	64.3	88.9	25	3.08	0.3	6.0	48.0	81.4
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	11	2.3	1.16	3.62	90.9	81.5	10	4.1	1.33	9.51	100	94.1	24	1.08	0.09	2.51	33.3	39.5
Tot-P	mg/L	7	0.06	0.02	0.14	28.6	37	14	0.05	0.02	0.13	35.7	32	33	0.07	0.002	0.54	15.2	44.5
Tot-C	mg/L	4	26.0	17.0	30.0	75		N/A						N/A				10.7	
Tot-coli	/ 100 ml	8	5650.24	2	22999.95	75	93.6	8	1830	100	6000	100	97.4	20	169.65	9.0	450.0	58.	48.0
Fecal-coli	/ 100 ml	8	1350.25	2	9399.98	37.5	91.7	13	111.54	0	300	38.5	69.1	1	135	135	135	0	70.5
Cu	ug/l	5	4.0	0	8	40		1	1.0	1.0	1.0	0		1	5.0	5.0	5.0	100	
Fe	ug/l	3	286.67	40	500	66.7		N/A						25	9.86	0.52	237	0	
Pb	ug/l	5	10.8	5	17	60		1	1.0	1.0	1.0	0		25	2.37	1.0	6.0	4.0	
Zn	ug/l	3	23.33	0	50	0		N/A						25	0.22	0.013	5.0	0	
Chlor a	ug/l	N/A						3	62.33	6	107	66.7		1	6.23	6.23	6.23	0	
WQI	%						67.3						73.1						56.7

TABLE 15. SUMMARY OF WATER-QUALITY DATA FOR THE DISTRICT VI BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	5	3.2	1	6	0	51	4	3.05	1.6	5.2	0	50.2	3	2.73	1	5.9	0	41
pH	pH	6	7.49	7	7.8	0		14	7.42	6.5	8.0	0		3	7.6	7	8.1	0	
Salinity	ppt	3	10.33	0	25	0		N/A						N/A					
Temperature	deg. C	8	25.73	21.1	29	0		15	25.61	13.2	34.0	0		74	26.04	13.9	32.65	0	
Chlorides	mg/L	6	3229.67	75	12800	66.7		8	109.6	55.0	165.0	0		22	3486.8	61	19400	54.5	
Fluorides	mg/L	N/A						N/A						19	0.20	0.025	0.54	0	
Conductivity	micromho	2	960	880	1040	0		4	23275	1600	39000	100		3	8481.33	444	13000	66.7	
DO	mg/L	6	5.08	1.9	7.1	33.3	67	15	5.20	1	10.2	46.7	60.5	73	5.03	0.4	10.8	49.3	62.7
BOD	mg/L	6	1.13	0.3	2.2	0	23	4	2.03	1.4	3.2	25	55	34	3.56	1.0	21.6	50.0	19.6
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						19	1.30	0.21	2.57	36.8	51
Tot-P	mg/L	4	0.03	0.02	0.05	0	20	15	0.07	0.01	0.22	40	44.5	74	0.12	0.005	1.25	43.2	58.5
Tot-C	mg/L	N/A						N/A						N/A				7.9	
Tot-coli	/ 100 ml	6	1250.83	90	3700	100	18.3	10	1234.6	43	4600	90.0	62.8	20	498.25	16	3650	60.9	62.8
Fecal-coli	/ 100 ml	2	70	20	120	0	50.9	4	637	220	1420	100	20.5	3	784	12	1910	66.7	88.9
Cu	ug/l	N/A						N/A						1	23.0	23.0	23.0	100	
Fe	ug/l	N/A						1	0.21	0.21	0.21	0		21	15.34	0.012	319	4.8	
Pb	ug/l	N/A						N/A						20	2.2	1.0	5.0	0	
Zn	ug/l	N/A						N/A						20	0.32	0.013	6.0	0	
Chlor a	ug/l	N/A						3	34.43	6.3	84	33.3		2	6.85	3.7	10	0	
WQI	%						39.1						58.4						50.8

Fahka Union Canal
No current data was available for Fahka Union Canal. Historical water-quality data from two stations from 1980 to 1989 indicate exceptional physical water quality. Turbidity measured less than 1 NTU/NTU, better than 90% of state waters, and color was low, between 10 and 30 PCUs. The DO was high (6.4 mg/L) and at one station it was above saturation (9.9). Conductivity was between 600 and 700, which is above average, but far from exceeding state standards.

Nutrient levels, bacterial contaminants, and BOD were all well within state standards and screening levels. Total nitrogen ranged from 0.51-0.73 mg/L and total phosphorus measured 0.01 mg/L. The WQI rated Fahka Union Canal a 17, an indication of "good" water quality. **Table 16** provides a summary of the water quality in the Fahka Union Canal Basin by decade for several water-quality parameters. The data from which **Table 16** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a "good", "fair" or "poor" basis; as typically included in the Florida's 305b water quality report (FDEP, 1996a).

The literature provided very little historical or current water-quality data for the Collier-Seminole Basin. **Table 17**, however, provides a summary of the water quality from the STORET database by decade for various water-quality parameters of the Collier-Seminole Basin. Sediment quality information was not available.

Estuarine Systems

Naples Bay
Current water-quality information is not available for Naples Bay. STORET data from 1989 are used to describe water quality. Water clarity is characterized by near average turbidity (3.6-4.5 NTU/NTUs), and slightly better than average color (40-80). No information on TSS was available from STORET for Naples Bay. Low DO was observed at two sample locations in the Bay. Average DO ranged from 4.5 to 6.0 mg/L.

Chlorophyll a was low, measuring 6-7 µg/L, while total nitrogen levels the screening level (1.31 mg/L), as did total phosphorus (0.10 mg/L).

Sediment quality information was not available.

Listed or otherwise protected species include the West Indian manatee (*Trichechus manatus*), protected under the Endangered Species Act; the Atlantic bottlenose dolphin (*Tursiops truncatus*), protected under the Marine Mammal Protection Act; and several species of wading birds.

Historically, the major sources of freshwater to Naples Bay were the Gordon River, Haldeman Creek, Rock Creek and direct run-off from the city of Naples providing a combined discharge of approximately 100 cubic feet per second (cfs). The construction of Golden Gate Canal has considerably increased the flow of freshwater into the Bay in the wet season to as much as 1,500 cfs. In contrast, during the dry season in April discharge to the Bay drops to near zero (Simpson et al., 1979). **Tables 18 and 19**, provide summaries of the water-quality data by decade for various water-quality parameters of the Corkscrew/Cocohatchee Coastal Area (Wiggins Pass) and the District VI Coastal Area (Naples Bay and Rookery Bay) estuaries, respectively. The data from which these tables were developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a "good", "fair" or "poor" basis; as typically included in the Florida's 305b water quality report (FDEP, 1996a).

Rookery Bay:

Current water-quality data is not available through STORET. Under the National Oceanic Atmospheric Association (NOAA) National Estuarine Reserve Research (NERR) National Monitoring Program, automated data collectors deployed throughout Rookery Bay will soon make continuously collected water-quality data available on the Internet. In addition to being part of the NERR program, Rookery Bay is designated by the state of Florida as an aquatic preserve, and as a National Audubon Society Wildlife Sanctuary.

Rookery Bay has been described as a "transitional" estuary in terms of its location between the high-energy (erosional forces) coastline to the north and the lower energy. Physical water quality is characterized by large fluctuations in salinity and low flushing due to the small size of the adjacent upstream watershed. Freshwater arrives into Rookery Bay via Henderson Creek to the west and Stopper Creek to the northwest. Tidal exchange is low due to the presence of oyster bars and low flushing of the shallow creeks that feed into the Bay. Hypersaline conditions can result during periods of drought (Drew and Schomer, 1984).

TABLE 16. SUMMARY OF WATER-QUALITY DATA FOR THE FAHKA UNION CANAL BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	83	9.51	0.3	68	15.7	88.3	102	1.3	0.1	10.2	0	15	3	0.767	0.4	1	0	5.7
pH	pH	95	7.2	4.1	8.45	0		75	7.7	6.8	9.8	0		3	7.7	7.6	8	0	
Salinity	ppt	1	6	6	6	0		N/A						91	1.119	0	34.3	0	
Temperature	deg. C	104	23.83	15.1	50.5	0		3	28	24	30	0		132	24.818	15.55	32.1	0	
Chlorides	mg/L	77	364.83	4	19999.96	5.2		94	52.3	18.7	199	0		109	668.042	1.4	20,300	11.9	
Fluorides	mg/L	N/A						3	0.17	0.17	0.17	0		91	0.141	0.025	0.42	0	
Conductivity	micromho	114	1933.99	70	52499	7.9		101	594.9	235	1490	0.99		3	770	700	810	0	
DO	mg/L	91	5.68	0.24	15.1	53.8	58.2	78	6.9	1.4	18.8	26.9	36	131	4.685	0.06	12.0	53.4	68.1
BOD	mg/L	3	1.63	1.5	1.7	0	45.3	3	1.3	0.9	2	0	31	94	4.595	0.40	64.8	45.7	91.0
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	61	1.41	0.1	11.02	34.4	51	100	0.796	0.1	2.99	12	19.1	91	1.048	0.02	10.5	25.3	38
Tot-P	mg/L	92	0.05	0	0.48	20.7	32	102	0.02	0	0.6	2	12	132	0.095	0.002	1.15	31.8	54
Tot-C	mg/L	53	177.25	1	9000	3.8		27	10.367	5.4	23.1	3.7	N/A	119	14.587	0.250	33.0	20.2	
Tot-coli	/ 100 ml	39	18497.18	40	91000	97.4	97.3	N/A						86	238.401	0.5	1314	68.5	52.8
Fecal-coli	/ 100 ml	39	36.72	2	180	0	42.5	1	4	4	4	0	12	3	28	4	68	0	38.9
Cu	ug/l	3	2.93	1	5.8	33.3		2	0.815	0.63	1	0		2	5	5	5	100	
Fe	ug/l	48	1243.78	0.03	7200	75		90	0.127	0.02	0.5	0		93	1.102	0.05	65	0	
Pb	ug/l	3	3.43	1	7.3	33.3		2	1.7	0.4	3	0		93	2.388	1	10	2.2	
Zn	ug/l	3	211.3	40	297	66.7		2	27.55	21	34.1	0		93	0.255	0.013	17	0	
Chlor a	ug/l	N/A						3	2	1	3	0	12	3	1.49	1.03	2.14	0	8.5
WQI	%						60.6						21.9						51.3

TABLE 17. SUMMARY OF WATER-QUALITY DATA FOR THE COLLIER/SEMINOLE BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	NO DATA						NO DATA						3	1.63	0.8	28	0	21.3
pH	pH													32	7.36	5.98	8.79		
Salinity	ppt													15	6.7	0.1	33.0		
Temperature	deg. C													32	25.76	18.05	34.3		
Chlorides	mg/L													18	2183.5	0.50	20625	33.3	
Fluorides	mg/L													18	20.19	0.05	0.70	0	
Conductivity	micromho													3	21666.7	2000	48000	100	
DO	mg/L													30	4.62	0.18	11.90	56.7	68.8
BOD	mg/L													11	3.07	0.8	6.6	45.5	81.2
COD	mg/L													N/A					
Tot-N	mg/L													8	1.24	0.10	1.87	50.0	48
Tot-P	mg/L													31	0.36	0.01	1.1	80.6	80.5
Tot-C	mg/L													13	13.32	0.05	27.0	23.4	
Tot-coli	/ 100 ml													12	1276.33	25	8750	78.6	76.2
Fecal-coli	/ 100 ml													3	94.67	28	136	0	53.8
Cu	ug/l													2	25.5	25	26	100	
Fe	ug/l													10	32.59	0.15	204	0	
Pb	ug/l													10	2.95	1.66	10	10	
Zn	ug/l													10	3.12	0.01	25	0	
Chlor a	ug/l													3	7.6	3.74	14.7	0	43
WQI	%																		60.1

TABLE 18. SUMMARY OF WATER-QUALITY DATA FOR THE CORKSCREW/COCOCHATCHEE COASTAL AREA (WIGGINS PASS)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI
Turbidity	NTU	33	7.67	2	55	12.1		1	1.10	1.10	1.10	0.0		38	4.2	1.8	12.7	2.6	
pH	pH	53	8.06	6.75	8.7			1	7.25	7.25	7.25			120	7.72	6.4	9.38		
Salinity	ppt	11	31.68	26				N/A						49	22.35	0.2	34.25		
Temperature	deg. C	68	27.22	16.6	32.1			102	25.59	11.8	35.7			97	28.18	19.0	35.6		
Chlorides	mg/L	26	20907	12800	24500	100		8	232.75	116.0	457.0	37.5		2	166.25	129.5	203.0	0	
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	16	46287	5100	53000	100		N/A						38	32215	11721	48700	100	
DO	mg/L	54	6.5	3.7	10.8	3.7		80	5.721	0.900	11.9	35.0		98	4.95	0.1	11.75	57.1	
BOD	mg/L	43	2.9	0.4	8.0	62.8		1	0.80	0.80	0.80	0		15	2.56	1	5.7	53.3	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	20	0.10	0.01	0.98			N/A						20	.66	0.41	.89	0.0	
Tot-P	mg/L	N/A				20		100	0.095	0.01	0.86	37.0		94	0.19	0.01	1.9	41.5	
Tot-C	mg/L	N/A						N/A						39	14.42	3.35	40.0	15.4	
Tot-coli	/ 100 ml	37	25.68	2	180	10.8		14	0.078	0.025	0.13	78.6		N/A					
Fecal-coli	/ 100 ml	39	8.54	0	40.0			N/A						38	57.08	4	610	2.6	
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	N/A						2	0.078	0.025	0.13	0.0		5	0.15	0.10	0.24	0	
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						N/A						N/A					
Chlor a	ug/l	N/A						N/A						22	4.78	1.6	11.8	0.0	
TSI		TSI NOT CALCULATED						TSI NOT CALCULATED											45

TABLE 19. SUMMARY OF WATER-QUALITY DATA FOR THE DISTRICT IV COASTAL AREA (NAPLES BAY & ROOKERY BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI
Turbidity	NTU	48	7.18	1.0	40.0	14.6		475	7.70	1.0	44.0	8.0		332	4.47	0.5	21.0	2.4	
pH	pH	58	7.54	6.3	8.5			754	7.57	6.6	8.2			919	7.74	5.43	8.41		
Salinity	ppt	22	14.05	1.0	36.00			287	33.34	13.5	43.8			910	29.07	0.00	41.80		
Temperature	deg. C	72	27.44	21	31.0			754	25.61	15.6	32.81			944	26.27	15.8	33.9		
Chlorides	mg/L	45	9530.4	36.7	22500	88.9		N/A						20	11582.4	433	19,600	100	
Fluorides	mg/L	0	N/A					N/A						20	0.37	0.09	0.60	0	
Conductivity	micromho	27	32807	1070	53100	96.3		754	1105.7	4.98	53700	2.9		864	167.1	0.32	41000	0.6	
DO	mg/L	55	4.77	1.5	8	50.9		741	5.81	2.04	9.7	30.2		935	5.74	1.45	14.13	28.7	
BOD	mg/L	52	1.78	0.0	5.8	21.2		20	1.79	0.2	4.4	25.0		32	2.44	0.77	6.2	34.4	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						20	2.97	0.10	43.17	15.0	
Tot-P	mg/L	26	0.11	0.02	0.78	46.1		23	0.08	0.04	0.28	39.1		86	0.13	0.005	0.93	46.5	
Tot-C	mg/L	4	8.50	1.00	16.00	0.0		N/A						56	7.95	0.50	21.33	1.8	
Tot-coli	/ 100 ml	55	524.4	2.0	5000	76.4		N/A						18	286.06	17	1150	75.0	
Fecal-coli	/ 100 ml	18	169.9	2.0	1980	11.1		19	89.84	2	515	15.8		6	528.2	4.0	1220.0	66.7	
Cu	ug/l	N/A						N/A						2	16.5	8.0	25.0	100	
Fe	ug/l	N/A						N/A						28	21.05	0.008	484	3.6	
Pb	ug/l	N/A						N/A						22	3.13	1.0	12.0	13.6	
Zn	ug/l	N/A						N/A						22	1.47	0.013	25.0	0	
Chlor a	ug/l	N/A						22	12.59	3	40.5	18.2		4	15.4	2.4	31.4	25.0	
TSI			TSI NOT CALCULATED						TSI NOT CALCULATED										52.2

Table 20 provides a summary of the water quality for the Rookery Bay Estuary by decade for several water-quality parameters. The data from which **Table 20** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a).

Mangrove and seagrass are important habitats within and around Rookery Bay that are subject to changes in water quality, particularly altered freshwater flow. Based on recent nonpoint source assessments Rookery Bay fully meets its designated use as a Class 2 water body for support of shellfish harvesting (FDEP, 1996a).

Important habitat types listed in the Rookery Bay and Cape Romano-Ten Thousand Islands Aquatic Preserve Management Plan (Gardner, 1988) include seagrasses, saltmarsh, mangrove forests, and coastal strand. Seaturtles, manatees, several species of wading birds, the Florida panther, and the Florida black bear are some of the protected species that occur in or near Rookery Bay.

Marco Bay

Neither current nor historic water-quality data was available through STORET. However, Drew and Schomer (1984) presented some general information on the freshwater and tidal exchange, nutrients, and habitats of the estuary.

Freshwater flow into Marco Bay is through coastal wetlands, and from groundwater, between the freshwater aquifer and the saline coastal aquifer. Inputs from the wetlands are approximately 100 to 200 times that of the groundwater input, with some of this large surface volume attributed to man-made drainage operations (Drew and Schomer, 1984).

DO levels were frequently found to be lower in natural areas than in disturbed areas (i.e. canals). Accumulations of mangrove detritus and restricted backwater circulation were cited as the cause for the low DOs (Drew and Schomer, 1984).

Nutrients are low in natural and artificial waterways of the Marco Bay/Estuary system. Locally, high nutrient conditions are theorized to result from certain wind conditions mixing the water column and causing releases from sediments (Drew and Schomer, 1984). Chlorophyll a was highest in the canals. No data accompanied the descriptions.

TABLE 20. SUMMARY OF WATER-QUALITY DATA FOR THE HENDERSON CREEK COASTAL AREA (ROOKERY BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	**Units**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**
Turbidity	NTU	4	11.25	3.0	19.0	50.0		186	155	0.60	28.5	14.5		141	4.19	0.50	13.0	0.71	
pH	pH	4	8.13	7.80	8.5			284	7.47	6.1	8.5			355	7.59	6.4	8.5		
Salinity	ppt	2	10.5	7.0	14.0			100	26.09	0.0	43.4			370	21.48	0.0	40.5		
Temperature	deg. C	4	38	3	30.5			284	25.85	15.6	32.4			377	26.61	16.98	34.17		
Chlorides	mg/L	2	1120	4500	18000	100		N/A						N/A					
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	2	42000	33000	51000	100		284	4601	0.40	64.4	0.0		373	33.62	0.28	60.30	0.0	
DO	mg/L	2	5.9	4.9	6.4	25.0		278	5.88	2.04	16.3	31.3		373	5.67	1.78	13.12	37.53	
BOD	mg/L	4	1.93	1.10	2.60	25.0		N/A						N/A					
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						N/A					
Tot-P	mg/L	2	0.04	0.04	0.04	0.0		N/A						4	0.2929	0.0015	0.975	50	
Tot-C	mg/L	N/A						N/A						1	2.7	2.7	2.7	0	
Tot-coli	/ 100 ml	2	19	6	32	0.0		N/A						N/A					
Fecal-coli	/ 100 ml	2	5.0	2.0	8.0	0.0		N/A						N/A					
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	N/A						N/A						N/A					
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						N/A						N/A					
Chlor a	ug/l	N/A						N/A						N/A					
TSI		TSI NOT CALCULATED						TSI NOT CALCULATED						TSI NOT CALCULATED					

Fahkahatchee Bay
Current water-quality information on Fahkahatchee Bay was not available from the STORET database. Relative comparisons between Fahkahatchee Bay and adjacent Fahka Union Bay were given in Drew and Schomer (1984) for freshwater input, salinity regimes, and nutrient loading. Salinity ranges from 0 to 40 ppt throughout the wet and dry seasons. Specific data on other water-quality parameters are lacking. Heavy metal analysis from data collected in the 1970s did not indicate contamination of the waters, but some sediments did contain detectable amounts of lead particularly those near areas receiving roadway runoff (Drew and Schomer, 1984). Pesticides were also detected in some of the sediment samples; waters were described as uncontaminated. No specific concentrations were given.

Habitat types include various benthic communities, seagrass meadows, mangrove forests, and saltmarsh.

Abbott and Nath (1996) cited increased freshwater from Fahka Canal and abnormal salinity levels to blame for disappearance of seagrass meadows, displaced benthic habitats and fish communities, and declines in shellfish harvests.

2.4. Southern Big Cypress Swamp: West Collier County

The Southern Big Cypress Swamp is located in the southern half of the Big Cypress National Preserve and is part of the Big Cypress Swamp Watershed, USGS unit 03090204. The study area is situated in the western part of the Southern Big Cypress Swamp. Interest will focus on the Collier-Seminole Basin, the Fahkahatchee Strand, Okaloacoochee Slough, and the Barron and Turner Rivers, two canals which hydrologically affect the western portion of the preserve. The Turner and Barron River canals were not originally designed for the specific purpose of draining land, but as a supply source for road construction materials (Drew and Schomer, 1984).

Physical Description
Perhaps the most important drainage feature of the Big Cypress Swamp is the Fahkahatchee Strand. A strand is an elongate area of large trees growing within drainage depression with no well-defined channel. The Fahkahatchee Strand is a natural community of mixed hardwood swamp about five miles wide and twenty miles long. Along with Okaloacoochee Slough, it is a principal drainage slough of the western Big Cypress Swamp (McElroy and Alvarez, 1975). It is notable for being the world's only royal palm-bald cypress forest, having the largest stand of native Florida royal palms and the largest concentration of native orchids in North America. Numerous threatened and endangered plant and animal species are found within the Fahkahatchee Strand (McElroy and Alvarez, 1975).

Land use within the Southern Big Cypress Swamp is primarily wetlands, with an estimated less than 5% of land under agricultural use and less than 5% in small towns. Census data record that in 1990, Everglades City, at which Barron Canal discharges, had a population of 317, and Chokoloskee, a small fishing town at which Turner River discharges, had a population of 240 (U.S. Department of Commerce, 1992).

It is estimated that greater than 80% of the area consists of wetland habitat types. Mangrove swamp and saltmarsh are found along the coast, while freshwater swamp and freshwater marsh begin about 5 miles inland from Chokoloskee. Some dry prairie exists along the Barron River canal (SFWMD, 1995).

General soil types within the Southern Big Cypress Swamp are mangrove peat in coastal areas, and marl interspersed with peat in inland areas. Mangrove peat is found in "very low, wet areas of organic, marly to mucky soils thinly overlying bedrock" (Drew and Schomer, 1984).

The Turner and Barron River canals drain freshwater from the strands and sloughs of the Big Cypress Swamp, and also receive additional freshwater input from the shallow water aquifer. Okaloacoochee Slough and Deep Lake Strand are two such features that contribute freshwater to the canals. The Barron River canal flow rate varies from 0 to 8.27 m^3/s (0 to 292 cfs) over the course of a year. During dry season, flows are low, from 1.42 to 2.84 m^3/s (50 to 100 cfs) but increase during the wet season to between 2.84 and 4.96 m^3/s (100 to 175 cfs). Over the long term (decades), flows average 2.89 m^3/s (102 cfs). Given the age of the canals, constructed over 50 years ago, water levels in the Barron and Turner River canal watersheds are assumed to have stabilized. A series of removable stop-log gates control flow along the Barron River canal, inserted during the dry season to conserve the aquifer, and removed during the wet season to accommodate increased drainage (Drew and Schomer, 1984).

The Collier-Seminole Basin drains primarily cypress wetlands ultimately into Gullivan Bay. The basin exists within the boundaries of the Collier-Seminole State Park. No water-quality data was available.

Historical Description

Historical data from STORET indicate that water quality within much of the Big Cypress has been "fair" to "good" with respect to physical and biological parameters, and nutrient condition. However, metals were detected in previous sample data from Chokoloskee Bay at levels higher than in other local estuaries. Monitoring data from 1980-89 indicate that Barron River canal had good water conditions with a pH of 7.6, good water clarity as indicated by low turbidity (2.0 NTUs), low TSS (1 mg/L), and low color (55 PCUs). However, DO levels failed to meet state criteria with an average of 4.2 mg/L. Conductivity was normal at 536 micromhos. The Turner River canal exhibits freshwater conditions inland and estuarine conditions nearer the coast. Samples of the Turner River collected near the Tamiami indicate that physical water quality is good with an average DO of 7.3, low turbidity of 1.0 NTUs, and pH of 8.4. Conductivityhad an average measurement of 1300 micromhos. Where Turner River flows into Oyster Bay, turbidity was higher at 4 NTUs, color was higher at 40, and conductivity was higher at 41250 micromhos due to higher concentration of salts. DO was high at 8.5.

Biological parameters, BOD, chlorophyll a, and fecal coliform bacteria, were 1.3 mg/L, 7 µg/L, and 14 MPN/100 ml, respectively. None of these values exceeded (i.e. failed to meet) state standards or screening levels. Nitrogen and phosphorus levels of Barron

River canal runoff into the Gulf has been historically low. The annual average for total nitrogen was 0.98 mg/L, and for total phosphorus, concentrations were low at 0.02 mg/L. The TSI for Barron River canal runoff into the Gulf was 46 and for Turner Canal, 47.

Freshwater Systems

Turner and Barron Canals

Current water-quality information for the Barron and Turner River canals is available from the Estuarine Receiving Water Quality Monitoring Program Data Summary (**Table 21**), Collier County for FY90-95 (Gibson, 1997). The STORET database does not contain data from this particular sampling phase of this program.

TABLE 21. WATER QUALITY MONITORING DATA OF BARRON AND TURNER CANALS (1990-95)

Location	PH	DO	Sal	Turb	TSS	TP	Chl A	Cond
April 1991								
Turner	7.9	6.6	33	.65	136	.15	BDL	N/A
Barron	7.8	5.4	31	.4	130	.12	BDL	50,000
August 1991								
Turner	7.7	3.7	15	2.3	25.5	.2	2.5	20,750
Barron	7.9	4.8	14	2	31	.13	11.5	25,000
April 1994								
Barron	7.8-8.1	4.9-6.0	27-28	4.3-14.4	22.0-40.0	N/A	N/A	43.6K-46K
Barron	7.3	3.6	1.2	1.0-2.0	1.0-1.5	N/A	N/A	2840-2850

No color, no Total nitrogen, no Fecal or Total coliform

The literature provided very little historical or current water-quality data for the Fahkahatchee Strand Basin. **Table 22**, however, provides a summary of the water quality in the Fahkahatchee Strand Basin by decade for several water-quality parameters. The data from which **Table 22** was developed are specific to the South Florida study area. The WQIs reflect changing water quality conditions over time only and are not intended to evaluate water quality on a “good”, “fair” or “poor” basis; as typically included in the Florida’s 305b water quality report (FDEP, 1996a).

TABLE 22. SUMMARY OF WATER-QUALITY DATA FOR THE FAHKAHATCHEE STRAND BASIN

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI	Obs	Mean	Min.	Max.	% Exc	WQI
Turbidity	NTU	73	4.41	0.35	63	5.5	52.1	N/A						3	2.5	1.8	3.5	0	38
pH	pH	84	7.38	6.7	8.2	0		74	7.492	2.5	9.05			92	7.34	6.28	8.43	0	
Salinity	ppt	1	0.0	0.0	0.0	0		N/A						51	4.97	0.0	33.2		
Temperature	deg. C	88	21.22	15	30	0		101	24.756	16.0	36.0			92	24.53	15.3	33.1	N/A	
Chlorides	mg/L	29	58.1	10	916	3.4		8	28.375	21.0	36.0	0		52	2644.27	70	19,700	26.9	
Fluorides	mg/L	N/A						N/A						9	0.17	0.03	0.53	0	
Conductivity	micromho	73	367.92	190	670	0		N/A						3	21333.33	9000	42000	100	
DO	mg/L	79	4.12	0.73	13	74.7	74.8	78	4.514	1.5	10.0	75.6	69.9	92	3.5	0.23	9.6	76.1	81
BOD	mg/L	3	2.83	2	4.2	33.3	76.3	N/A						3	2.2	1	4.5	33.3	64
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						49	1.17	0.01	4.31	32.7	44.5
Tot-P	mg/L	14	0.02	0.009	0.04	0	16	101	0.32	0.006	0.22	8.9	27.2	90	0.10	0	3.05	29.7	54.0
Tot-C	mg/L	72	11.9	1	45	13.9	N/A	N/A						84	14.92	0.05	43.85	10.7	
Tot-coli	/ 100 ml	60	17777.58	50	59000	98.3	97.3	14	771.929	4.0	2400	85.7	68.8	48	309.23	12	2250	83.7	56.5
Fecal-coli	/ 100 ml	61	146.13	2	1320	24.6	71.6	N/A						2	22	4	40	0	37
Cu	ug/l	N/A						N/A						2	17.5	10	25	100	
Fe	ug/l	60	201.67	100	1400	10		N/A						53	4.08	0.02	107	0	
Pb	ug/l	N/A						N/A						51	2.41	1.0	10	3.9	
Zn	ug/l	N/A						N/A						51	0.63	0.01	25	0	
Chlor a	ug/l	N/A						N/A						3	7.18	2.6	14.1	0	41.6
WQI	%						60.7						55.3						55.8

Estuarine Systems

Chokoloskee Bay

Recent water-quality information was obtained from Gibson (1997) for 1990-1995. Historical data were obtained from the STORET database and from Drew and Schomer (1984).

The hydrology or rates of flushing and mixing of Chokoloskee Bay are not well known (Drew and Schomer, 1984). Historically salinity has varied from 2.5 ppt to 20.2 ppt at the mouth of the bay. The water has been relatively clear as indicated by the average turbidity (3 NTUs), and color (30 PCUs). DO was high at 8.5 and the pH was normal for saline waters at 8.5. High conductivity (41250 micromhos) is normal for waters with high salt content. No historical bacterial analyses or chlorophyll a measurements were available.

Historically nutrients increase with the rainy season from apparent increased flow from the Barron River Canal. Other sources of nutrients are possibly the oxidation of drained soils and runoff from agricultural and roadways (Drew and Schomer, 1984). Total nitrogen has historically been lower than average at 0.64 mg/L compared to other Florida streams. Total phosphorus likewise has been lower than average at 0.03 mg/L. The TSI indicated that the overall nutrient status of Chokoloskee Bay was good, with a 46. Contaminants have been sampled in the Bay, but seasonal increases were theorized to result from “desorption by dissolved ions in seawater” as salinity varied (Drew and Schomer, 1984). Manganese, copper, lead, and zinc were metals that increased with an increase in salinity. Concentrations of these metals were reported to be 1.5 to 3 times higher than metal concentrations from estuaries that received natural drainage (Drew and Schomer, 1984).

Current water quality from Gibson (1997) are available for Chokoloskee Bay and presented in **Table 23**. Average salinity is higher, while average DO is lower than historical data measurements. Nutrient data were not available.

TABLE 23. AVERAGE WATER-QUALITY DATA FROM CHOKOLOSKEE BAY (1990-95)

pH	DO	Sal	Turb	TSS	TP	Chl A	Cond
8.0	5.2-5.3	29.9	10.3-13.0	33.0-34.0	N/A	N/A	48050 avg

The literature provided very little historical or current water-quality data for many of the bays and estuaries of southwest Florida. Limited data are available for the Ten Thousand Isles region, and the associated bays of Chokoloskee and Fahka Union. **Tables 24, 25, and 26** provide limited summaries of the water-quality data by decade for various water-quality parameters of the Seminole/Collier Coastal Area(10,000 Isles), Fahka Union Canal Coastal Area (Fahka Union Bay), and Fahkahatchee Strand Coastal Area (Chocoluskee Bay) regions.

TABLE 24. SUMMARY OF WATER-QUALITY DATA FOR THE COLLIER/SEMINOLE COASTAL AREA (TEN THOUSAND ISLES)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI
Turbidity	NTU	71	4.61	0.42	46.0	9.9		18	8.74	2.40	30.0	22.2		87	7.04	0.60	40.50	9.2	
pH	pH	70	7.5	6.1	8.6			65	7.67	6.99	8.00			808	7.9	5.73	8.80		
Salinity	ppt	108	35.3	32.0	37.1			33	34.58	16.80	43.40			448	23.18	0.7	41.0		
Temperature	deg. C	205	28.75	10.0	35			65	26.039	17.76	32.76			995	25.87	15.36	34.56		
Chlorides	mg/L	66	18.4	3.0	153.0	0.0		N/A						N/A					
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	60	294.95	160	1190	0.0		62	50.82	6.34	64.30	0.0		157	48.44	23.50	60.60	0.0	
DO	mg/L	204	4.66	0.0	9.6	44.1		64	5.5678	2.49	8.08	34.4		876	5.68	0.10	11.97	27.7	
BOD	mg/L	N/A						3	1.7	1.35	2.05	0		9	1.51	0.5	2.65	22.2	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						N/A					
Tot-P	mg/L	193	0.112	0.00	2.90	62.2		3	0.1133	0.04	0.24	33.3		91	0.13	0.0015	0.8	36.3	
Tot-C	mg/L	193	10.64	2.40	120.0	5.7		N/A						67	7.69	0.05	20.5	0	
Tot-coli	/ 100 ml	N/A						N/A						115	9567.02	4.0	1,000,000	87.8	
Fecal-coli	/ 100 ml	N/A						NA						N/A					
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	64	202.5	10.0	2680.	10.9		N/A						6	0.05	0.0025	0.08	0	
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						N/A						N/A					
Chlor a	ug/l	N/A												42	4.49	0.20	11.20	0.0	
TSI		TSI NOT CALCULATED						TSI NOT CALCULATED						TSI NOT CALCULATED					

TABLE 25. SUMMARY OF WATER-QUALITY DATA FOR THE FAHKA UNION CANAL COASTAL AREA (FAHKA UNION BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	**Units**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**	**Obs**	**Mean**	**Min.**	**Max.**	**% Exc**	**TSI**
Turbidity	NTU	14	15.79	1.2	42.0	50.0		8	4.65	3.30	7.00	0.0		120	6.84	1.5	26.6	7.5	
PH	pH	12	7.34	6.8	8.1			9	7.789	7.4	7.81			724	8.11	6.84	8.8		
Salinity	ppt	N/A						9	32.95	27.50	37.0			339	26.37	0.1	40.20		
Temperature	deg. C	14	22.64	19.0	28.0			9	25.61	25.01	27.25			1086	25.47	14.76	34.2		
Chlorides	mg/L	6	855	42	3300	50.0		N/A						10	9280	76.0	21993	60	
Fluorides	mg/L	N/A						N/A						10	0.32	0.10	0.60	0	
Conductivity	micromho	12	1887.9	580	10400	25.0		8	49.59	42.7	52.2	0.0		N/A					
DO	mg/L	12	4.64	2.88	8.0	58.3		9	6.6656	5.05	7.58	0.0		929	6.27	0.6	12.16	16	
BOD	mg/L	N/A						1	0.8	0.8	0.8			13	2.10	0.75	7.2	23.1	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						N/A						10	0.45	0.01	1.22	0	
Tot-P	mg/L	N/A						1	0.21	0.21	0.21	100		151	0.06	0.0015	0.99	8.6	
Tot-C	mg/L	11	5.00	1.00	14.0	0.0		N/A						145	7.27	0.05	18.0	0.0	
Tot-coli	/ 100 ml	9	16456.7	2800	51000	100.0		N/A						10	83.4	10.0	210.0	50	
Fecal-coli	/ 100 ml	9	269.7	10	1600	33.0		N/A						N/A					
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	9	466.7	200.0	600.0	77.8		N/A						13	0.13	0.05	0.23	0	
Pb	ug/l	N/A						N/A						10	2.0	1.0	4.0	0	
Zn	ug/l	N/A						N/A						10	0.03	0.0125	0.06	0	
Chlor a	ug/l	N/A						N/A						126	3.23	0.10	9.30	0.0	
TSI		TSI NOT CALCULATED						TSI NOT CALCULATED											38.04

TABLE 26. SUMMARY OF WATER-QUALITY DATA FOR THE FAHKAHATCHEE STRAND COASTAL AREA (CHOKOLOSKEE BAY)

		1970-1980						1980-1990						1990-1998					
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI	Obs	Mean	Min.	Max.	% Exc	TSI
Turbidity	NTU	5	16.1	2.2	48	40		5	3.20	2.40	4.00	0.0		60	6.70	1.70	25.00	10.0	
pH	pH	3	7.53	6.8	8			9	7.72	7.50	7.90			227	8.0754	6.94	8.70		
Salinity	ppt	N/A						3	35.6	31.8	37.75			113	25.412	3.00	38.40		
Temperature	deg. C	6	26.0	23.0	28.0			12	25.5	15.0	30.0			324	25.7	15.52	34.5		
Chlorides	mg/L	11	3158.2	1160	15000	100.0		20	5110.5	600	20000	100.0		N/A					
Fluorides	mg/L	N/A						N/A						N/A					
Conductivity	micromho	11	9709	3500	41000	100.0		17	14531.7	48.6	48500	94		N/A					
DO	mg/L	3	4.4	1.8	6.1	33.3		10	6.07	3.10	9.90	50		282	6.13	1.3	11.67	22	
BOD	mg/L	N/A						2	1.15	0.90	1.40	0		5	2.23	1.45	4.10	20	
COD	mg/L	N/A						N/A						N/A					
Tot-N	mg/L	N/A						8	0.84	0.45	1.1	0.0		N/A					
Tot-P	mg/L	N/A						10	0.06	0.02	0.14	20		86	0.1129	0.01	1.60	19.8	
Tot-C	mg/L	1	19	19	19	0		8	12.24	8.20	17.0	0.0		76	9.1296	4.9	23.0	1.3	
Tot-coli	/ 100 ml	N/A						N/A						N/A					
Fecal-coli	/ 100 ml	N/A						N/A						N/A					
Cu	ug/l	N/A						N/A						N/A					
Fe	ug/l	N/A						2	0.03	0.025	0.04	0		4	0.172	0.025	0.45	0	
Pb	ug/l	N/A						N/A						N/A					
Zn	ug/l	N/A						N/A						N/A					
Chlor a	ug/l	N/A						N/A						63	3.17	.020	7.70	0.0	
TSI		TSI NOT CALCULATED											55.2	TSI NOT CALCULATED					

3.0 GROUNDWATER (AQUIFERS)

The Surficial, Intermediate, and Floridan Aquifer systems are the principal aquifers within the study area (**Figure 5**). The Floridan Aquifer system is widely used for ground water supply in other areas of the state, but within the study area, it is of naturally poor quality, having a high degree of mineralization. Thus, only the Surficial and Intermediate Aquifer Systems are used for ground water supply (SFWMD, 1995). The Floridan Aquifer is separated from the Surficial and Intermediate Aquifers by several layers of confining beds. Recharge areas for the Floridan Aquifer are outside the study area.

Within the study area, the Surficial Aquifer system contains the undifferentiated water table aquifer and the confined lower Tamiami Aquifer. The Biscayne Aquifer is another principal aquifer system within the Surficial Aquifer that occurs outside the study area (SFWMD, 1995).

Florida Geological Survey: Water quality

The primary data and discussion material for aquifer water quality was provided from Florida's Ground Water Quality Monitoring Program. This program derives aquifer water-quality data from three sources; Background Network wells, Very Intensive Study Area (VISA) Network wells, and Private Well Surveys. Only preliminary data from the Background Network were available from 1984 through 1988. A summary of these water-quality data for the Surficial, Intermediate, and Floridan Aquifers is presented in **Table 27**. With the data available, it is not possible to determine the impact of septic tanks on groundwater quality.

Study Area: Water quality

To evaluate more recent and geographically specific water-quality data available within the study area, supplemental data (USGS) were gathered (including STORET) through June 1998 and water-quality trends were revisited. To assess historical and current water-quality trends for the study area aquifers, summary data statistics for various water-quality parameters were recalculated for the following time periods: 1970-1980, 1980-1990, and 1990-1998.

3.1. Surficial Aquifer System

The Surficial Aquifer System is located beneath and adjacent to the land surface and is composed of Pliocene to Holocene quartz sands, shell beds, and carbonates. It consists of porous unconsolidated quartz sand deposits mixed with hardened carbonated rocks belonging to the Upper Miocene to Holocene Series (Florida Department of Natural Resources). The carbonate rocks are the water-producing zones (SFWMD, 1995).

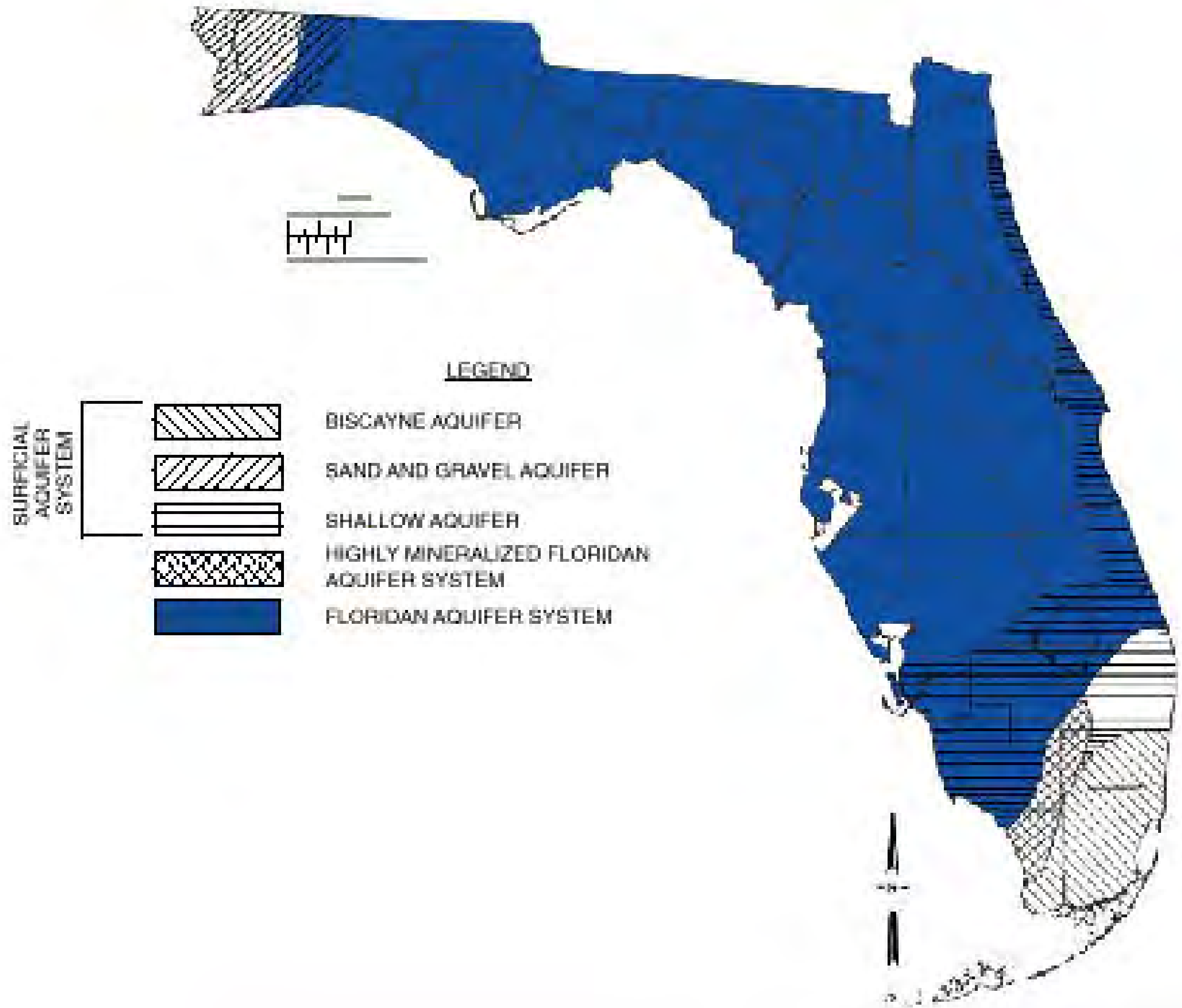


Figure 5. Surficial, Intermediate, and Floridan Aquifers (Source: Florida Department of Natural Resources, 1992).

TABLE 27. SUMMARY OF AQUIFER WATER-QUALITY DATA FOR THE SFWMD

Parameter	Surficial			Intermediate			Floridan		
	Median	Min	Max	Median	Min	Max	Median	Min	Max
Temperature	24.8	18.5	30.0	25.1	22.3	27.5	26.3	22.2	30.5
PH	6.9	**3.9**	**13.2**	7.3	**6.1**	8.5	7.4	**5.6**	8.9
Calcium	98.0	<0.1	756.0	70.5	2.5	478	67.2	5.9	227.0
Magnesium	3.9	<0.1	51.9	26.6	2.2	465.6	46.4	<0.1	264.2
Sodium	21.1	1.6	620.0	108.6	11.4	1264.0	220.5	2.7	2500.0
Potassium	1.3	<0.1	159.2	9.6	0.4	46.9	9.5	0.5	99.0
Iron	**0.88**	<0.01	**41.50**	<0.05	0.03	**26.6**	<0.05	<0.02	0.29
Mercury	<0.2	<0.1	**0.6**	<0.1	<0.1	<0.3	<0.1	<0.1	**0.2**
Lead	<2	<1	**173**	**1**	<1	**71**	<1	<1	**9**
Alkalinity	251	3	2260	234	111	445	130	10	287
Sulfate	11.8	<1.0	431	52.3	2.0	1754.0	176.4	3.3	713.1
Chloride	48.3	<0.4	**1100.0**	172.0	15.2	**2092.5**	**419.6**	3.5	**3785.0**
Phosphate	0.01	<0.01	4.0	<0.01	<0.01	2.28	<0.01	<0.01	0.15
Fluoride	0.20	0.02	3.73	0.82	<0.10	4.78	0.81	<0.10	3.70
Nitrate	<0.01	<0.01	**44.8**0	<0.01	<0.01	0.19	<0.01	<0.01	1.97
Total Dissolved Solids	388	26	**2537**	**508**	47	**4188**	**1138**	58	**7425**
Conductivity	619	41	8281	947	245	6920	1787	120	12204
Total Organic Carbon	17.0	<0.1	380.0	6.3	<0.1	71.0	1.9	<0.1	80.6
Total Synthetic Organics	0.00	0.00	995.00	<1.00	0.00	2.10	0.00	0.00	3.9
Total Pesticides	0.00	0.00	1100.00	<1.20	<0.01	<30.00	<1.30	<0.70	4.20

* - Bold values indicate an exceedence of maximum contaminant levels (MCL)

Within the Surficial Aquifer system, the water table is mostly unconfined, but in deeper regions some partially confined or locally confined conditions may predominate from beds of low permeability. Underneath the Surficial Aquifer are broad thick beds that are more confining. In south Florida, sediment beds of the Surficial Aquifer are the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formation, the Key Largo, and Miami Limestones, and the undifferentiated sediments (Florida Department of Natural Resources, 1992). In general, Surficial Aquifer water levels slope downwards in a southwesterly direction towards the coast. Little seasonal fluctuation of the Surficial Aquifer water levels occurs (Dames and Moore).

Median values for water-quality measurements for the Surficial Aquifer are within state drinking water standards, with the exception of iron and lead. The MCL secondary standard for iron is 0.3 mg/L and the average for the Surficial Aquifer within the SFWMD was 0.88 mg/L. The high maximum values (>5mg/L) are likely the result of using unfiltered samples during analysis (Florida Department of Natural Resources, 1992). Iron is high in the Surficial Aquifer system due to its proximity to iron minerals, organic rich soil horizons, and dissolved humic substances (Florida Department of Natural Resources, 1992). Lead occurs in the surficial at "high" levels (Florida Department of Natural Resources, 1992). Given the lack of natural sources of lead in Florida, the presence of lead is attributed to human sources, most often lead weights used in water level recorders (Florida Department of Natural Resources, 1992).

Saltwater intrusion, incomplete flushing of seawater from the Everglades, and leftover irrigation water from the Floridan Aquifer system have created areas of increasing mineralization and high dissolved solids along the coast (SFWMD, 1995). The Surficial Aquifer System is susceptible to anthropogenic contamination due to its closeness to the land surface. Lack of confinement, high recharge, and relatively high permeability and high water table all increase contamination potential. The increasing demands heighten the constant threat of saltwater intrusion, often resulting in water usage restrictions to users of the Surficial Aquifer (SFWMD, 1995).

Physical and Geological Description

Water-quality data in this section is derived from the FY95/96 Trend Ground Water Quality Monitoring Program for Collier County (Gibson, 1997). Ground water samples from sixteen monitoring wells sampled quarterly were analyzed for "specific chemical analytes that are indicative of natural ground water geochemistry and potability" and compared to public water supply standards. In 1995-96, total dissolved solids, iron, chloride, and sulfate levels in the monitoring wells exceeded MCL standards (**Table 9**) established in F.A.C. 17-550 for treated community water supplies, but still compared favorably with historical data. The report concluded that these conditions "appear to represent the norm" for Surficial Aquifer waters in Collier County (Gibson, 1997). The lower Tamiami Aquifer supplies Collier County with most of its potable water supplies (Dames and Moore, 1997). **Table 28** provides a summary of the water-quality data by decade for various water-quality parameters of the Surficial Aquifer. The data from which **Table 28** was developed are specific to the South Florida study and reflect changing water quality conditions over time.

Recharge of the Collier County area of the Surficial Aquifer occurs primarily by rainfall over virtually the entire land surface. Less than 20% results from lateral and upward vertical recharge from other aquifers and surface waters (Gibson and Preston, 1993). North of Immokalee is an area of high recharge known as Immokalee Rise (Dames and Moore, 1997). Discharges primarily occur at surface water bodies and along the coast (Dames and Moore, 1997). The degree of movement of water through an aquifer is defined in terms of conductivity and transmissivity values. Figure 6 shows these values for the aquifers within the Collier County portion of the study area (Gibson and Preston, 1993). In the Tamiami Aquifer, the hydraulic conductivity can vary from 0.124 ft/day to 0.008860 ft/day with steep hydraulic gradients occurring near the local wellfields. An unconfined area of the Tamiami Aquifer occurs near Immokalee (Dames and Moore, 1997).

TABLE 28. SUMMARY OF WATER-QUALITY DATA FOR THE SURFICIAL AQUIFER

		1970-1980					1980-1990					1990-1998				
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	Obs	Mean	Min.	Max.	% Exc	Obs	Mean	Min.	Max.	% Exc
Temperature	deg. C	NO DATA					134	24.6	20.5	28.2		546	25.3	17	31	
PH	std pH						133	6.9	5.4	7.6		4	7.05	6.8	7.3	
Calcium	mg/L						120	100.4	10	171		19	94.8	54.3	126.5	
Magnesium	mg/L						NA									
Sodium	mg/L						121	49.6	3.9	498.8	0	19	92.2	5	504.5	0
Potassium	mg/L						120	2.43	0.06	20.6	0	19	4.3	0.2	259.5	0
Iron	mg/L						120	2117.08	20	25520	70	74	2747	15	18600	85.1
Mercury	mg/L						3	0.1	0.1	0.1	100	55	0.12	0.1	0.4	100
Lead	mg/L						83	12.76	0.1	99.1	37.3	55	16.3	0.2	140	36.4
Alkalinity	mg/L						121	258.5	66.2	358.4	0	19	248.1	143.7	298.2	0
Sulfate	mg/L						114	30.5	2	261	0	19	47.4	2	259.5	0
Chloride	mg/L						121	74.13	4.4	875.2	7.4	19	110.1	6.1	774.8	10.5
Phosphate	mg/L						21	0.04	0.004	0.21	14.3	19	0.05	0.005	0.2	21.1
Fluoride	mg/L						121	0.29	0.027	2.8	0.83	19	0.87	0.048	3.05	21.1
Nitrate	mg/L						108	0.02	0.004	0.41	1.9	18	0.01	0.004	0.04	0
TDS	ug/l						122	424.2	66.9	2032.9		66	510.9	56.4	1967	
Conductivity	Micromho						133	748.6	259	3320	12	545	991.1	62	3560	21.7
Total Carbon	mg/L						80	38.1	2.5	678	43.8	28	16.6	2	55	28.6
Synthetic Organics	g/l						900	65	65	65	0.11	500	6.49	5	37.3	0.2
Arsenic	ug/l						76	1.59	0.1	13.5	0	55	12.5	1	540	1.8
Pesticides	g/l						60	1.63	1.63	1.63	41.7	162	33.71	0.292	65.5	40.1

Withdrawals/Public Use

The principal source of urban water in Lee County is the Shallow Water Table Aquifer. The Shallow Water Table Aquifer is also used for agricultural irrigation. Transmissivities for the water table within Lee County range from 10,000 to 1,000,000 gpd/ft. Typical yields from public water supply wells are around 300 gpm (SFWMD, 1995) (**Table 29**).

TABLE 29. PERCENT EXCEEDENCES OF MCL STANDARDS FOR COLLIER CO.

Analyte	**MCL Value in mg/L**	**Percent Exceedences in FY 95/96**
	Physical	
Ph	6.5 – 8.5 pH units	0
	Metals	
Cadmium	0.005	0
Chromium	0.01	0
Copper	1.0	0
Iron	0.3	53
Lead	0.015	0
Manganese	0.05	0
Mercury	0.002	Detection limits not low enough
Sodium	160.0	0
Strontium	4.2	0
Zinc	5.0	0
	Inorganic	
Chloride	250	12.5
Fluoride	4.0*, 2.0**	0
Nitrate	10.0	0
Nitrite	1.0	Not analyzed
Sulfate	250	12.5
	Other	
Total Dissolved Solids	500	38

*Primary **Secondary N/A – Not applicable

The Tamiami is a major potable resource for Collier County serving as the primary source of municipal, industrial, and agricultural water supply (SFWMD, 1995). The water quality is similar to that of the water table aquifer, but often with lower iron concentrations, making it more suitable for potable supplies. Chloride concentrations may still be high in some coastal areas, with levels up to 10,000 mg/L. Aquifer thickness ranges from 150 ft to over 250 ft. Transmissivities range from 100,000 to 500,000 gpd/ft (Dames and Moore, 1997). Water use of the Surficial and Intermediate Aquifers by Collier and Lee Counties in 1995 is presented in **Table 30**. More water is used in agricultural irrigation than any other category for both counties. In Collier County, agricultural irrigation accounted for approximately 68% of all water use in 1995.

TABLE 30. 1995 WATER USE FOR COLLIER AND LEE COUNTY*

County	Public Supply	Domestic Self-Supply (private well)	Industry/ Commercial Self-Supply	Agricultural Irrigation Self-Supply	Recreation Self-Supply	TOTAL
Collier	14,250	1,785	2,181	51,985	16,641	**86,842**
Lee	14,673	2,081	1,974	22,063	12,011	**52,802**
TOTAL	**28,923**	**3,866**	**4,155**	**74,048**	**28,652**	**139,644**
% of Total	***20.7%***	***2.8%***	***3.0%***	***53.0%***	***20.5%***	***1%***

Source: SFWMD, 1998b * Note: Millions of Gallons per Year

3.2. Intermediate

The Intermediate Aquifer System is located in the Hawthorn group sediments and is comprised of two confined or in place semi-confined aquifers (Figure 6). The Sandstone Aquifer present in Lee County and Collier County north of Alligator Alley and the mid-Hawthorn aquifer underlie Collier County (Dames and Moore, 1997).

Physical and Geological Description

The Sandstone Aquifer is composed of sandy limestone, dolomites, and sandstone up to 100 feet thick and is possibly part of the Peace River Formation. The aquifer slopes southeastward, gradually thinning out. The transmissivity is generally below 100,000 gpd/ft with hydraulic gradients ranging from 0.5 feet per mile to 5 feet per mile. A recharge zone exists northeast of Immokalee. The iron content is relatively low and the chloride concentrations are usually less than 600 mg/L. Increases in hardness and alkalinity occur as one moves toward the coast. Water quality is described overall as good. Within Collier County, the direction of water flow in most confined layers is southwestward (Dames and Moore, 1997).

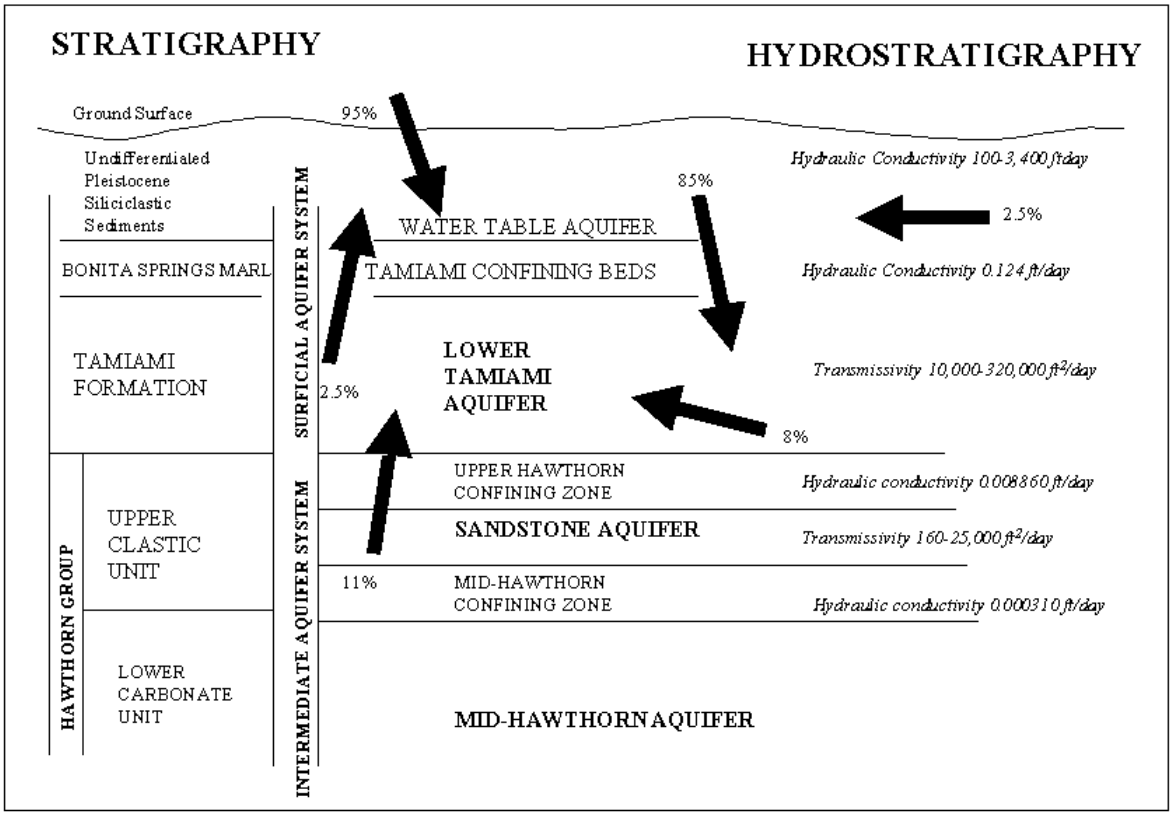
Limestone and dolomites from the Acadian Formation comprise the mid-Hawthorn Aquifer. Transmissivities are less than 50,000 gpd/ft. The mid-Hawthorn averages 100 feet in thickness with highly mineralized water. High levels of chlorides, calcium, magnesium, and sulfate are present within this aquifer. The mid-Hawthorn slopes toward the east-southeast and is under sufficient hydrostatic pressure to produce artesian conditions for wells drilling into this aquifer (Dames and Moore, 1997).

Mean water-quality parameters meet state drinking water standards with the exception of lead and total dissolved solids. Total dissolved solids in the Intermediate Aquifer range from 47 mg/L to 4188 mg/L within the SFWMD. Contact of water with carbonates and chemically unstable silicates (e.g. clays, opal), as well as saline intrusion are probable sources of high total dissolved solids (Florida Department of Natural Resources, 1992). **Table 31** provides a summary of the water-quality data by decade for various water-quality parameters of the Intermediate Aquifer. The data from which **Table 31** was developed are specific to the South Florida study area and reflect changing water quality conditions over time. **Figure 6** illustrates the Surficial and Intermediate Aquifer formations and confining layers.

3.3. Floridan Aquifer

The Floridan Aquifer within the study area is characterized by low hydraulic potential, low flushing, and saline intrusion from long contact/high dissolution of base strata of aquifer and coast (Florida Geological Survey, 1992). It is composed of Tampa Formation sediments and is connected to the underlying Suwannee and Ocala Limestone, and Avon Park, Oldsmar, and Cedar Keys Formations. It is separated from the Intermediate Aquifer through confining sediments of the Hawthorn Group. The transmissivity ranges from 75,000 to 450,000 gpd/ft in the upper areas of the Floridan. Water quality has been described as brackish, degrading with depth and towards the coast (Dames and Moore, 1997).

Mean chloride levels for Floridan Aquifer wells within the SFWMD exceed the states MCLs for drinking water. Median levels are 419.6 mg/L and the state standard is 250 mg/L. Median levels of total dissolved solids also exceed state standards (Florida Department of Natural Resources, 1992). **Table 32** provides a summary of the water-quality data by decade for various water-quality parameters of the Floridian Aquifer. The data from which **Table 32** was developed are specific to the South Florida study area and reflect changing water quality conditions over time. **Figure 7** illustrates the potential recharge areas of the Floridian Aquifer (Florida Geological Survey, 1992).



Source: Gibson et al., 1993

Figure 6. Surficial and Intermediate Aquifer Formations and Confining Layers.

TABLE 31. SUMMARY OF WATER-QUALITY DATA FOR THE INTERMEDIATE AQUIFER

		1970-1980					1980-1990					1990-1998				
WQ Parameters	Units	Obs	Mean	Min.	Max.	% Exc	Obs	Mean	Min.	Max.	% Exc	Obs	Mean	Min.	Max.	% Exc
Temperature	deg. C	No Data					91	25.4	23.2	27.6		227	25.43	19.5	29.3	
PH	std pH						91	7.3	6.6	8.3		2	7.2	7.1	7.3	
Calcium	mg/L						83	68.8	15	478	0	10	53	44.3	62.5	0
Magnesium	mg/L						N/A									
Sodium	mg/L						83	179.6	31.4	538	0	10	101.9	69.5	344	0
Potassium	mg/L						83	13.3	2.4	46.9	0	10	8.71	7	15.7	0
Iron	mg/L						81	453.2	30	9720	33.3	47	555.5	3	7600	19.1
Mercury	mg/L						5	0.1	0.1		100	37	0.1	0.1	79	100
Lead	mg/L						55	8.8	0.3	152	25.5	37	8.65	0.1	79	29.7
Alkalinity	mg/L						83	246.2	134	445	0	10	254.1	237	277	0
Sulfate	mg/L						78	106.8	4.7	1754	0	10	38.53	14	113	0
Chloride	mg/L						83	245.8	24.8	846	31.3	10	115.4	46.2	535	10
Phosphate	mg/L						11	0.06	0	0.25	18.2	10	0.05	0	0.18	30
Fluoride	mg/L						83	0.86	0.1	3.6	9.6	10	1.08	0.24	4.95	10
Nitrate	mg/L						77	0.01	0	0.07	0	9	0.01	0	0.03	0
TDS	ug/l						81	805.3	46.6	3329		36	715.6	258	2520	0
Conductivity	micromho						90	1315	431	3801	35.6	228	1191	257	3345	25.4
Total Carbon	mg/L						58	20	0.1	71	31	15	6.95	1.8	19	0
Synthetic Organics	g/l						650	65	65	65	0.15	260	5.74	5	19	0.4
Arsenic	ug/l						50	1.15	0.1	4.6	0	37	1.41	1	4	0
Pesticides	g/l						44	1.63	1.63	1.63	45.5	12	60.23	60.2	60.2	41.7

TABLE 32. SUMMARY OF WATER-QUALITY DATA FOR THE FLORIDIAN AQUIFER

WQ Parameters	Units	1970-1980 Obs	Mean	Min.	Max.	% Exc	1980-1990 Obs	Mean	Min.	Max.	% Exc	1990-1998 Obs	Mean	Min.	Max.	% Exc
Temperature	deg. C	No Data					41	27.1	24.9	28.8		79	26.79	21	31	
pH	std pH						40	7.25	6.6	7.8	0	2	7.45	7.4	7.5	0
Calcium	mg/L						36	92.66	28	170	0	9	98.9	47.7	164	0
Magnesium	mg/L						N/A					N/A				
Sodium	mg/L						36	534.9	60.3	931	0	9	576.6	347	716	0
Potassium	mg/L						36	25.84	4.53	33.9	0	9	27.96	23.3	34.7	0
Iron	mg/L						35	81.14	20	350	2.9	14	83.71	10	310	7.1
Mercury	mg/L						3	0.1	0.1	0.1	100	5	0.1	0.1	0.11	100
Lead	mg/L						21	1.02	0.3	3.1	0	5	1.4	1	3	0
Alkalinity	mg/L						36	170.7	116	287	0	9	173.4	114	213	0
Sulfate	mg/L						34	389.4	5.2	611	0	9	391.6	272	583	0
Chloride	mg/L						36	878.5	380	1335	100	9	818.1	167	1318	77.8
Phosphate	mg/L						9	0.01	0	0.01	0	9	0.01	0	0.02	0
Fluoride	mg/L						36	1.98	1.12	4.03	58.3	9	3.13	0.6	6.18	44.4
Nitrate	mg/L						32	0.01	0	0.06	0	9	0.06	0	0.46	11.1
TDS	ug/l						36	2190	1	3039	0	13	2036	197	2988	0
Conductivity	micromho						41	3071	1769	4920	100	79	4006	460	5100	98.7
Total Carbon	mg/L						23	6.93	0.9	48	8.7	3	1.53	1	1.9	0
Synthetic Organics	g/l						219	65	65	65	0.46	30	6.32	5	7	0
Arsenic							19	0.94	0.1	1.7	0	5	3.4	1	10	0
Pesticides	g/l						11	1.7	1.7	1.7	45	N/A				

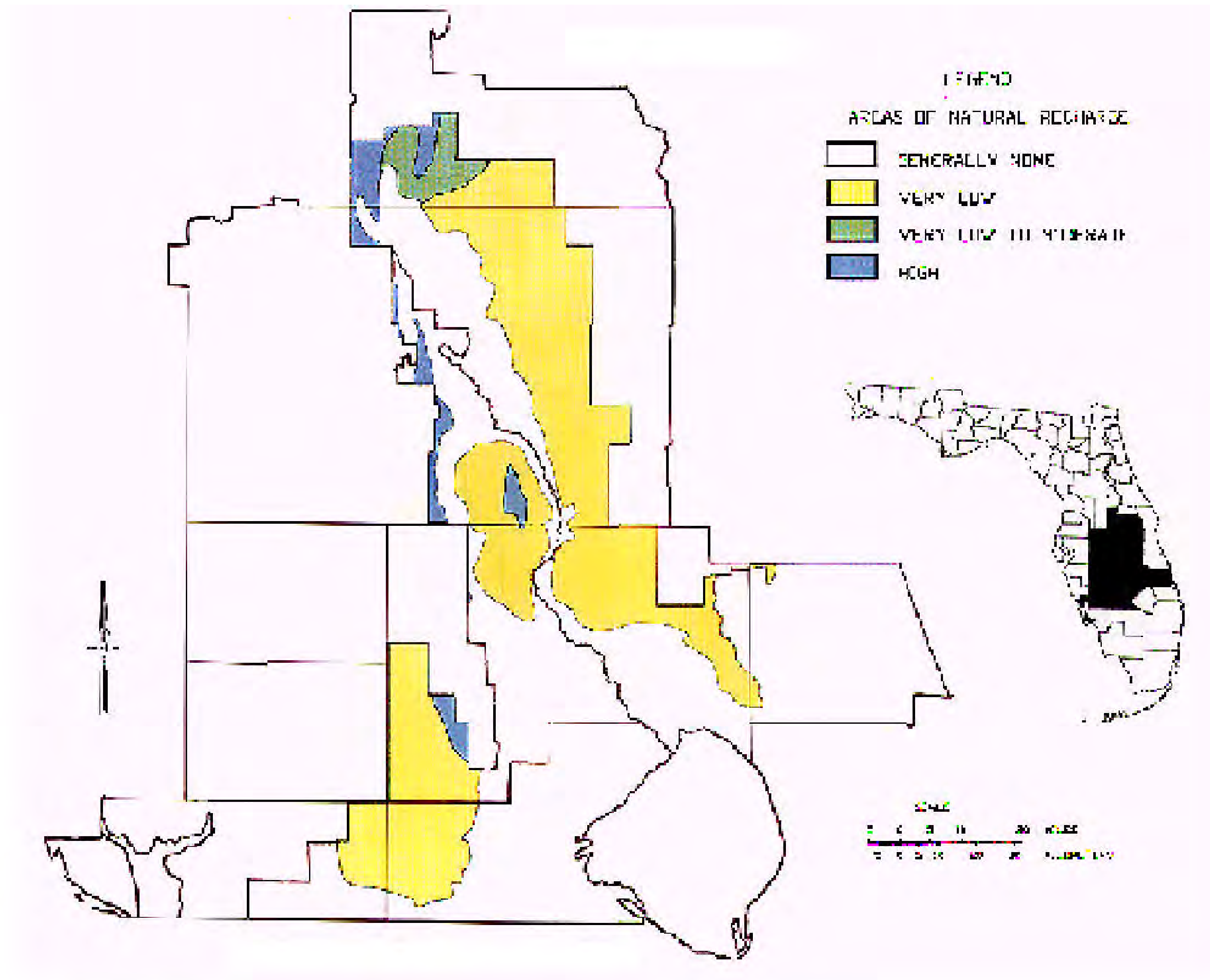


Figure 7. Recharge Potential of the Floridan Aquifer (Source: Florida Department of Natural Resources, 1992).

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APPENDIX F - CRITERIA ASSOCIATED WITH EACH ENSEMBLE LEGEND AS DEVELOPED DURING THE ADG PROCESS

Appendix F

This Appendix includes several documents that are referenced by the narrative in Section 2.3 describing the Ensembles and other locations.

1. 404(b)(1) Guidelines. Excerpt from 40 CFR 230, U.S. Environmental Protection Agency, Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

2. Criteria associated with Ensemble U. Alternative Plan Standards and Criteria. Submitted by Kris Thoempke, National Wildlife Federation, during the meeting of the Alternatives Development Group, August 27, 1998.

3. Principles of the Estero Bay Agency on Bay Management. Adopted December 8, 1997.

4. Estero Bay Watershed Land Conservation/Preservation Strategy Map. Adopted July 13, 1998 by the Estero Agency on Bay Managemeent.

5. Regional or Comprehensive Stormwater Management. Proposal submitted to the Alternatives Development Group.

6. Southwest Florida Region Regionally Significant Natural Resources. Map.

Environmental Protection Agency

40 CFR Part 230

Guidelines for Specification of Disposal Sites for Dredged or Fill Material

Authority: This regulation is issued under authority of Sections 404(b) and 501(a) of the Clean Water Act of 1977, 33 U.S.C. § 1344(b) and § 1361(a).

§ 230.10 Restrictions on discharge.

Note.—Because other laws may apply to particular discharges and because the Corps of Engineers or State 404 agency may have additional procedural and substantive requirements, a discharge complying with the requirement of these Guidelines will not automatically receive a permit.

Although all requirements in § 230.10 must be met, the compliance evaluation procedures will vary to reflect the seriousness of the potential for adverse impacts on the aquatic ecosystems posed by specific dredged or fill material discharge activities.

(a) Except as provided under § 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

(1) For the purpose of this requirement, practicable alternatives include, but are not limited to:

(i) Activities which do not involve a discharge of dredged or fill material into the waters of the United States or ocean waters;

(ii) Discharges of dredged or fill material at other locations in waters of the United States or ocean waters;

(2) An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered.

(3) Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in Subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demostrated otherwise.

(4) For actions subject to NEPA, where the Corps of Engineers is the permitting agency, the analysis of alternatives required for NEPA environmental documents, including supplemental Corps NEPA documents, will in most cases provide the information for the evaluation of alternatives under these Guidelines. On occasion, these NEPA documents may address a broader range of alternatives than required to be considered under this paragraph or may not have considered the alternatives in sufficient detail to respond to the requirements of these Guidelines. In the latter case, it may be necessary to supplement these NEPA documents with this additional information.

(5) To the extent that practicable alternatives have been identified and evaluated under a Coastal Zone Management program, a § 208 program, or other planning process, such evaluation shall be considered by the permitting authority as part of the consideration of alternatives under the Guidelines. Where such evaluation is less complete than that contemplated under this subsection, it must be supplemented accordingly.

(b) No discharge of dredged or fill material shall be permitted if it:

(1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard;

(2) Violates any applicable toxic effluent standard or prohibition under section 307 of the Act;

(3) Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification of a habitat which is determined by the Secretary of Interior or Commerce, as appropriate, to be a critical habitat under the Endangered Species Act of 1973, as amended. If an exemption has been granted by the Endangered Species Committee, the terms of such exemption shall apply in lieu of this subparagraph;

(4) Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.

(c) Except as provided under § 404(b)(2), no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States. Findings of significant degradation related to the proposed discharge shall be based upon appropriate factual determinations, evaluations, and tests required by Subparts B and G, after consideration of Subparts C–F, with special emphasis on the persistence and permanence of the effects outlined in those subparts. Under these Guidelines, effects contributing to significant degradation considered individually or collectively, include:

(1) Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.

(2) Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes;

(3) Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or

(4) Significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.

(d) Except as provided under § 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem. Subpart H identifies such possible steps.

§ 230.75 Actions affecting plant and animal populations.

Minimization of adverse effects on populations of plants and animals can be achieved by:

(a) Avoiding changes in water current and circulation patterns which would interfere with the movement of animals;

(b) Selecting sites or managing discharges to prevent or avoid creating habitat conducive to the development of undesirable predators or species which have a competitive edge ecologically over indigenous plants or animals;

(c) Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species;

(d) Using planning and construction practices to institute habitat development and restoration to produce a new or modified environmental state of higher ecological value by displacement of some or all of the existing environmental characteristics. Habitat development and restoration techniques can be used to minimize adverse impacts and to compensate for destroyed habitat. Use techniques that have been demonstrated to be effective in circumstances similar to those under consideration wherever possible. Where proposed development and restoration techniques have not yet advanced to the pilot demonstration stage, initiate their use on a small scale to allow corrective action if unanticipated adverse impacts occur.

(e) Timing discharge to avoid spawning or migration seasons and other biologically critical time periods;

(f) Avoiding the destruction of remnant natural sites within areas already affected by development.

As submitted to the ADG at meeting 10 8/27/98

Alternative Plan Standards and Criteria
(Submitted by Kris Thoemke/NWF)

The permitting standards and criteria below focus on the Corps' §404 permitting program in SW. Florida, in recognition that the alternatives have been developed for the Corps' EIS on its 404 Program in SW. Florida. It is understood, however, that achieving the vision outlined in the alternatives will require consistent and complementary efforts by EPA, FWS, NMFS, USDA, the SFWMD, DEP, FWGFC, other state agencies, regional and local governments, and the private sector. These efforts will include regulatory decisions, land use planning, water resource planning, and land acquisition (including conservation easement acquisition). These critical complementary efforts are also reflected in these standards and criteria.

****

PRESERVATION ZONE

<u>Area Includes</u>: SEE ALTERNATIVE MAPS. The basic intent is to include, at a minimum, all areas within the Study Area that are presently owned or under easement for conservation/preservation purposes (by government or private owners/easement holders). The Preservation Zone may also include areas within the Study Area that are targeted for such ownership or easement acquisition in the immediate future, including, but not limited to, such areas that are Florida Panther Habitat Areas 1&2, Strategic Habitat Critical Areas, and areas included on the Agency for Bay Management Land Conservation/Preservation Map.

<u>Standards and Criteria</u>

The Preservation Zone consists of lands that are, or soon will be, set aside strictly for conservation purposes. Many of these lands have been, or soon will be, purchased outright, in fee title, by government or private entities to protect critical wildlife and water resources. In other cases, such entities have purchased conservation easements on preservation zone lands, ensuring that such lands will not be used in ways that defeat their conservation purposes. <u>Because of the protected status of its lands, the Preservation Zone is off limits to future development activity</u>.**

This vision requires that owners of conservation lands and easements protect and manage Preservation Zone lands to protect the critical resources located on these lands, and that all governmental actions within the Preservation Zone are consistent with and complement these conservation goals.

**** The terms "development" and "development activity" refer to all human activities that physically alter lands and waters for human use, including agricultural and mining activities as well as urban, suburban, and industrial development activities.**

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Corps §404 permitting decisions must be made consistent with this vision as follows:

A. Denial of dredge and fill permits in the Preservation Zone because:

(1) dredge and fill activities in the Preservation Zone are contrary to the conservation purposes of these lands and waters;

(2) dredge and fill activities in the Preservation Zone are against the public interest;

(3) dredge and fill activities in the Preservation Zone will cause unacceptable adverse effects on critical wildlife and water resources, and significant degradation to Preservation Zone and "downstream" wetlands and waterways;

(4) dredge and fill activities in the Preservation Zone are adversely affecting, and likely jeopardizing the continued existence of, federally-listed threatened and endangered species;

(5) practicable alternatives exist elsewhere to dredge and fill activities within the Preservation Zone.

B. EPA should consider a §404(c) veto action prohibiting discharges of dredged and fill material in the Preservation Zone.

AGRICULTURAL ZONE

Area Includes: SEE ALTERNATIVE MAPS. The basic intent is to include all agricultural areas within the Study Area that are not included in the Preservation Zone, including agricultural areas identified as: Florida Panther Habitat Areas 1&2, Strategic Habitat Critical Areas, and/or areas included on the Agency for Bay Management Land Conservation/Preservation Map.

Standards and Criteria

The Agricultural Zone includes lands and waters that support critically important wildlife and water resources, and that warrant protection for conservation purposes, but have not yet been put in preservation status. These lands and waters are unsuitable for future non-agricultural development activity, and must be protected for conservation purposes. On-going agricultural use of these lands and waters can, under certain circumstances, be compatible with conservation of the critical wildlife and water resources in this zone. Agricultural areas within the zone should remain in agricultural use, compatible with conservation purposes, or be placed in preservation status, subject to the standards and criteria for the Preservation Zone.

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This vision requires that agricultural lands not be converted to non-agricultural development uses. This vision also requires that government and private entities move aggressively to acquire and manage lands and easements within the Agricultural Zone, where necessary to protect critical resources while avoiding unfair regulatory takings of private property. All governmental actions within the Agricultural Zone must be consistent with and complement conservation goals within this zone.

Most on-going agricultural activities are exempt from Corps §404 permitting requirements under §404(f). Some drained wetlands no longer meet the Corps' definition of wetlands and are exempt from permitting requirements as "prior converted cropland." However, to the extent that these agricultural exemptions have not been CLEARLY DEMONSTRATED TO APPLY, Corps §404 permitting decisions must be made consistent with the vision described above as follows:

A. Corps strictly applies the §404(b)(1) guidelines, including:

(1) a strong presumption that practicable alternatives exist outside the Agricultural Zone to dredge and fill activities in jurisdictional waters within the zone;

(2) a strong presumption that significant degradation to wetlands and waterways results within the Agricultural Zone and "downstream" from dredge and fill activities within the Agricultural Zone;

(3) significantly heightened levels of compensatory mitigation for any unavoidable impacts that are permitted within the Agricultural Zone. Such mitigation must fully replace wetland losses on an acreage and function basis.

B. Within the Agricultural Zone, Corps regulatory actions shall also:

(1) consider only "single and complete" projects, including all phases of residential, commercial, recreational, and mixed use development projects;

(2) reflect a strong presumption that dredge and fill activities will adversely affect, and likely jeopardize the continued existence of, federally-listed threatened and endangered species;

(3) fully consider and explicitly address all U.S. Fish and Wildlife Service, National Marine Fisheries Service, and state resource agency recommendations;

(4) eliminate the use of nationwide and other general permits that could authorize more than minimal cumulative adverse impacts (e.g., dock gp, NWPs 12, 14, 18, 26 and 26 replacements, and 29);

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(5) increase scrutiny of drainage, excavation, and fill activities on agricultural lands (e.g., careful review of prior converted cropland and 404(f)(1) exemptions);

(6) strictly enforce these standards and criteria for the Agricultural Zone in jurisdictional waters on agricultural lands, within the limits of §404(f), to prevent additional degradation of wetlands and waterways;

(7) reduce the potential for additional, secondary development surrounding any permitted activities;

(8) reflect a strong presumption against new road construction;

(9) implement the principles adopted by the Estero Bay Agency on Bay Management throughout the Agricultural Zone, as appropriate;

(10) ensure maintenance of water tables and recharge areas;

(11) promote restoration of flow ways;

(12) for any permitted activity, require establishment of buffer zones around wetlands and along flow ways, streams, and rivers;

(13) for any permitted activity, require buffer zones around eagles' nests and colonial bird rookeries;

(14) ensure no adverse impacts on water quality;

(15) ensure that any permitted activities do not contribute to hurricane shelter deficit or increase evacuation times.

C. In those instances where the Corps issues a permit within the Agricultural Zone, including a permit for agricultural activity on agricultural lands, the Corps shall require, in addition to full compliance with the 404(b)(1) guidelines and the standards and criteria above, compliance with the development criteria and standards set forth in the Big Cypress Area of Critical State Concern regulations (28-25.006 et seq.) throughout the Agricultural Zone.

D. The Corps shall work with other federal, state, local, and private entities to target aggressive acquisition/compensation and restoration initiatives in the Agricultural Zone (including Corps restoration and federal, state, local, and private acquisition initiatives).

E. The Corps shall work with other federal, state, local, and private entities to encourage agricultural preservation and best management practices that reduce impacts to water quality, listed species, and reduce conversion to residential, commercial, and industrial

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uses.

BUFFER ZONE

Area Includes: SEE ALTERNATIVES MAPS. The basic intent is to include in this zone areas that are adjacent to the Urban Zone, or already include some limited residential use. The buffer zone may include areas identified as: Florida Panther Habitat Areas 1&2, Strategic Habitat Critical Areas, and/or areas included on the Agency for Bay Management Land Conservation/Preservation Map. Some alternatives may not include a buffer zone.

Standards and Criteria:

The Buffer Zone is recognized to be a critical resource protection area to be conserved and protected, yet bordering urban areas. The vision is to protect the critical resources of this area, and to discourage urban expansion in and through this area, while recognizing that some development activity has already been approved here.

This vision requires that government and private entities move aggressively to acquire and manage top priority lands and easements within the Buffer Zone, where necessary to protect critical resources while avoiding unfair regulatory takings of private property. Government agencies must commit to actions that are consistent with and complement conservation goals within the Buffer Zone. New roads, utilities, and other infrastructure in the Buffer Zone must be strongly discouraged and, where essential to existing uses, must be designed to discourage growth in Preservation and Agricultural Zones.

Corps §404 permitting decisions must be made consistent with this vision as follows:

A. Corps strictly applies the §404(b)(1) guidelines, including:

(1) a strong presumption that practicable alternatives exist outside the Buffer Zone to dredge and fill activities in jurisdictional waters within the zone;

(2) a strong presumption that significant degradation to wetlands and waterways results within the Buffer Zone and "downstream" from dredge and fill activities within the Buffer Zone;

(3) significantly heightened levels of compensatory mitigation for any unavoidable impacts that are permitted within the Buffer Zone. Such mitigation must fully replace wetland losses on an acreage and function basis.

B. Corps regulatory actions shall also:

(1) consider only "single and complete" projects, including all phases of residential, commercial, recreational, and mixed use development projects;

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(2) reflect a strong presumption that dredge and fill activities will adversely affect, and likely jeopardize the continued existence of, federally-listed threatened and endangered species;

(3) fully consider and explicitly address all U.S. Fish and Wildlife Service, National Marine Fisheries Service, and state resource agency recommendations;

(4) eliminate the use of existing nationwide and other general permits that could authorize more than minimal cumulative adverse impacts within the Buffer Zone (e.g., dock gp, NWPs 12, 14, 18, 26 and 26 replacements, and 29);

(5) increase scrutiny of drainage, excavation, and fill activities on any areas within the Buffer Zone claimed to be exempt as prior converted cropland;

(6) reduce the potential for additional, secondary development surrounding any activities that are permitted within the Buffer Zone;

(7) reflect a strong presumption against new road and utilities construction in the Buffer Zone.

C. In those instances where the Corps issues a permit within the Buffer Zone, the Corps shall require, in addition to full compliance with the 404(b)(1) guidelines and the standards and criteria above, compliance with the development criteria and standards in the Big Cypress Area of Critical State Concern regulations (28-25.006 et seq.) throughout the Buffer Zone, as appropriate.

D. The Corps shall work with other federal, state, local, and private entities to target aggressive acquisition/compensation and restoration initiatives in the Buffer Zone (including Corps restoration and federal, state, local, and private acquisition initiatives).

E. The Corps shall work with other federal, state, local, and private entities to encourage best management practices within the Buffer Zone that reduce impacts to water quality, listed species, and reduce conversion to residential, commercial, and industrial uses.

F. <u>In implementing these standards and criteria within the Buffer Zone, the Corps shall</u>:

(1) implement the adopted principles of the Estero Bay Agency on Bay Management throughout the Buffer Zone, as appropriate;

(2) ensure maintenance (no net reduction) in water tables and recharge areas within the Buffer Zone;

(3) ensure, at a minimum, actual no net loss in area and function of wetlands beyond existing (1998) conditions;

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(4) promote restoration of flow ways;

(5) promote establishment of buffer zones around wetlands and along flow ways, streams, and rivers;

(6) promote buffer zones around eagles' nests and colonial bird rookeries;

(7) ensure no adverse impacts on water quality;

(8) ensure that regulatory actions do not contribute to hurricane shelter deficit or increase evacuation times.

ACQUIRE/RESTORE/FIX ZONE

Area Included: SEE ALTERNATIVES MAPS. The basic intent is to include in this zone specific areas where residential development has been attempted, but is unsuccessful and not considered suitable, and where there si potential to restore and preserve critical wildlife and water resources. This zone includes at least parts of Lehigh Acres and Golden Gates Estates. The acquire/restore/fix zone may include areas identified as: Florida Panther Habitat Areas 1&2, Strategic Habitat Critical Areas, and/or areas included on the Agency for Bay Management Land Conservation/Preservation Map. Some alternatives may not include an acquire/restore/fix zone.

Standards and Criteria:

The Acquire/Restore/Fix (ARF) Zone includes areas recognized to be in need of restoration and retrofit to protect and restore the critical wildlife and water resources of the area. Such restoration and retrofitting must also recognize that much land has been purchased for residential development in this area, and some residential development has been attempted in and around these areas.

This vision requires that government and private entities move aggressively to acquire top priority lands and easements within the ARF Zone, where necessary to protect and restore critical resources while avoiding unfair regulatory takings of private property. Government agencies must commit to actions that are consistent with and complement the conservation goals within the ARF Zone. Where lands are acquired and restored, they should generally be placed in preservation status, subject to the standards and criteria for the Preservation Zone. In very limited cases, some ARF Zone lands might be returned to a development use if: (1) located adjacent to existing successful development; (2) retrofitted and regulated to allow only development compatible with conservation purposes; and (3) the public is fully reimbursed for retrofitting and infrastructure costs. New roads, utilities, and other infrastructure in the ARF Zone must be strongly discouraged and, where essential, must be designed to discourage growth in Preservation and Agricultural Zones.

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Unless and until ARF Zone areas are placed in preservation status, Corps §404 permitting decisions must be made consistent with this vision as follows:

A. Corps strictly applies the §404(b)(1) guidelines, including:

(1) a strong presumption that practicable alternatives exist outside the ARF Zone to dredge and fill activities (except restoration/retrofit activities) in jurisdictional waters within the zone;

(2) a strong presumption that significant degradation to wetlands and waterways results within the ARF Zone and "downstream" from dredge and fill activities (except restoration/retrofit activities) within the ARF Zone;

(3) significantly heightened levels of compensatory mitigation for any unavoidable adverse impacts that are permitted within the ARF Zone. Such mitigation must fully replace wetland losses on an acreage and function basis.

B. Corps regulatory actions shall also:

(1) consider only "single and complete" projects, including all phases of residential, commercial, recreational, and mixed use development projects;

(2) reflect a strong presumption that dredge and fill activities (except restoration/retrofit activities) in the ARF Zone will adversely affect, and likely jeopardize the continued existence of, federally-listed threatened and endangered species;

(3) fully consider, and explicitly address, all U.S. Fish and Wildlife Service, National Marine Fisheries Service, and state resource agency recommendations;

(4) eliminate the use of existing nationwide and other general permits that could authorize more than minimal cumulative adverse impacts within the ARF Zone (e.g., dock gp, NWPs 12, 14, 18, 26 and 26 replacements, and 29);

(5) increase scrutiny of drainage, excavation, and fill activities on any areas within the ARF Zone claimed to be exempt as prior converted cropland;

(6) reduce the potential for additional, secondary development surrounding any activities that are permitted within the ARF Zone;

(7) reflect a strong presumption against new road and utilities construction in the ARF Zone.

C. In those instances where the Corps issues a permit within the ARF Zone, the Corps shall require, in addition to full compliance with the 404(b)(1) guidelines and the standards and criteria above, compliance with the development criteria and standards in the Big Cypress

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Area of Critical State Concern regulations (28-25.006 et seq.) throughout the ARF Zone, as appropriate.

D. The Corps shall work with other federal, state, local, and private entities to target aggressive acquisition/compensation and restoration initiatives in the ARF Zone (including Corps restoration and federal, state, local, and private acquisition initiatives).

E. The Corps shall work with other federal, state, local, and private entities to encourage best management practices within the ARF Zone that reduce impacts to water quality, listed species, and reduce conversion to residential, commercial, and industrial uses.

F. <u>In implementing these standards and criteria within the ARF Zone, the Corps shall</u>:

(1) implement the adopted principles of the Estero Bay Agency on Bay Management throughout the ARF Zone, as appropriate;

(2) ensure, at a minimum, maintenance (no net reduction) in water tables and recharge areas within the ARF Zone;

(3) ensure, at a minimum, actual no net loss in area and function of wetlands beyond existing (1998) conditions;

(4) promote restoration of flow ways;

(5) promote establishment of buffer zones around wetlands and along flow ways, streams, and rivers;

(6) promote buffer zones around eagles' nests and colonial bird rookeries;

(7) ensure no adverse impacts on water quality;

(8) ensure that regulatory actions do not contribute to hurricane shelter deficit or increase evacuation times.

URBAN ZONE

Area Includes: SEE ALTERNATIVES MAPS. The basic intent is to include areas within the Study Area that are: (1) presently in urban and suburban use, and (2) adjacent areas that are considered most suitable for urban and suburban development in the future.

<u>**Standards and Criteria**</u>:

The Urban Zone is recognized to be the focal point for present and future urban development. The vision is to direct development into this zone, in lieu of urban expansion

east, west, north, or south of the zone, while maintaining watershed integrity within the zone.

This vision requires that government and private entities plan carefully for future growth in the Urban Zone, while protecting watershed integrity (and overall quality of life). Land and water use decisions must support the goals of protecting watershed integrity and focusing growth in the Urban Zone. New roads, utilities, and other infrastructure in the Urban Zone must be designed to support these goals as well.

Corps §404 permitting decisions must be made consistent with this vision as follows:

A. Corps applies the §404(b)(1) guidelines within the Urban Zone, including:

(1) a presumption that practicable alternatives exist to locating dredge and fill activities in creeks, rivers, other historic flow ways and adjacent wetlands; and to locating dredge and fill activities in isolated wetlands identified as important to wading birds, other species of concern, water quality, groundwater recharge, or flood control. In other words, a presumption that dredge and fill activities in these wetlands and waterways can be avoided. Otherwise, a recognition that practicable, off-site alternative locations for proposed dredge and fill activities are less likely to be available within the Urban Zone, and may be considered unavoidable.

(2) a presumption that significant degradation to wetlands and waterways results from dredge and fill activities in Urban Zone creeks, rivers, other historic flow ways and adjacent wetlands; and in Urban Zone isolated wetlands identified as important to wading birds, other species of concern, water quality, groundwater recharge, or flood control.

(3) mitigation for unavoidable wetland/water way losses within the Urban Zone that focuses on maintaining and improving watershed integrity (i.e., groundwater and surface water supply, surface water levels, flood retention, water quality, fresh/salt water balance, wading bird and fisheries production).

B. Corps regulatory actions shall also:

(1) consider only "single and complete" projects, including all phases of residential, commercial, recreational, and mixed use development projects;

(2) fully consider, and explicitly address, all U.S. Fish and Wildlife Service, National Marine Fisheries Service, and state resource agency recommendations;

(3) limit the use of nationwide and other general permits that could authorize more than minimal cumulative adverse impacts to the watershed or encourage secondary development beyond the Urban Zone (e.g., dock gp, NWPs 12, 14, 18, 26 and 26 replacements, 29, programmatic gp).

220, 270, 750, 760, 770 pg 11

(4) reduce the potential for additional, secondary development beyond the Urban Zone.

(5) require compliance with the Endangered Species Act, water quality standards, and promote compliance with the state Growth Management Act, other WMD and DEP environmental requirements, and local comprehensive plans (to the extent as strict or stricter than the above) to protect watershed integrity in the Urban Zone.

C. In implementing these standards and criteria within the urban zone, the Corps shall:

(1) implement the adopted principles of the Estero Bay Agency on Bay Management throughout the Urban Zone, as appropriate;

(2) promote restoration of flow ways;

(3) promote restoration or retrofitting of buffer zones around wetlands and along flow ways, streams, and rivers;

(4) work with other agencies to promote retrofitting of septic systems and package treatment plants as appropriate;

(5) work with other agencies to set and meet water pollution reduction goals through Urban Zone permit conditions and limitations and other appropriate regulatory actions;

(6) ensure that regulatory actions do not contribute to hurricane shelter deficit or increase evacuation times.

(7) encourage "smart growth" land use practices (e.g., clustering, TDRs, residential/commercial mixing, mass transit) to accommodate growth and watershed integrity within the Urban Zone.

220, 270, 750, 760, 770 pg 12

Principles of the Estero Bay Agency on Bay Management

The Estero Bay Agency on Bay Management (ABM) is a non-regulatory body whose directive is to make comments and recommendations for the management of Estero Bay and its watershed. The waters of Estero Bay provide a tremendous resource for local residents and tourists who enjoy fishing and appreciate the local vegetation and wildlife. It is also important to note that Estero Bay is Florida's first aquatic preserve. Due to the forthcoming increase in population density on and near the shores of Estero Bay and its watershed and the attendant increase in boat traffic, the Estero Bay Agency on Bay Management has adopted the following guiding principles. These principles are an attempt by the ABM to make strong and clear recommendations for the preservation and restoration of this rare and unique ecosystem. The ABM realizes that some situations within the Estero Bay Watershed may not allow the strict adherence to these principles, however, the ABM recommends that they be utilized wherever and whenever possible.

Water Courses

General

- Non-structural approaches versus structural approaches will be used for water resource management solutions.
- No further channelization of remaining natural watercourses will occur.
- A better balance of ecological needs versus water flow will be used for water resource management decisions.
- Establish and restore the historic basin flood plains to the maximum extent possible.
- Compliance and enforcement of existing environmental regulations will be a top priority for regulatory agencies.

Vegetation

- Natural, native vegetation versus non-native invasive vegetation within flowways and natural systems will be retained to the greatest extent possible.
- Physical removal of invasive vegetation versus widespread chemical treatment will be utilized for control.
- Limited application of herbicides that rapidly degrade may be used on a case-by-case basis, under the supervision of certified personnel, for control of nuisance and invasive non-native vegetation and to maintain native plant communities.
- Promote, whenever possible, the active and aggressive removal of invasive non-native plants from all common areas, conservation easements, preserves and natural areas within the Estero Bay watershed.

Physiographic

The ancient relief of the upper tributary reaches will be maintained by:

- Preserving vegetation that provide the characteristic riparian habitat and canopy.
- Retaining the relic natural features of the tributary bank contours.
- Reconnecting historic natural flowways that have been diverted or severed.
- No further channelization.
- No further dredging.

New Construction

- New setback criteria will be developed and implemented along watercourses to provide construction setbacks to the maximum extent possible. These setback criteria will be based on the best available scientific data.
- Construction within tributary flood plains shall be avoided wherever possible.
- For construction that must occur within flood plains, utilize techniques that do not adversely impact the capacity of the floodplain (e.g. pilings to raise living floor elevations versus fill).
- Utilize non-polluting construction materials (e.g. concrete pilings versus treated wood) within flood plains.

Hazardous Materials

- Specifically placed larvicides and biological controls are the preferred methods for mosquito control. Adulticides should only be used in compliance with Section 388.011(1) Florida Statutes.

Agriculture and Urban

- Old surface water management (SWM) systems built before current regulations will be retrofitted, using best available management practices, to meet current SWM standards.
- Permitting must address cumulative impacts to the water storage capacity of the watershed.
- Grants or incentives should be provided for retrofitting old surface water management systems that are not effectively managing water volume or flow, or removing nutrients and other pollutants.

Roadways

- All future roadways to be located in the floodplain within the Estero Bay watershed will be designed and constructed to not impede flows from a 25-year, 3 day, storm event.

Boating

- No special accommodations will be made for boats (e.g. no cutting of overstory vegetation, no removal of oxbows, no dredging or filling except for permitted maintenance of navigation channels).

Public Notice

- Activities in the watershed by any regulatory agency shall provide the opportunity for public participation.

Uplands, Headwaters and Isolated Wetlands

General

- Lands identified as critical for listed species shall be targeted for public purchase and managed to maintain their environmental value.
- The Lee County Conservation Land Acquisition and Stewardship Advisory Committee will

consider priorities for land purchases adopted by the "Arnold Committee" and the ABM.

- The Lee County Conservation Land Acquisition and Stewardship Advisory Committee will use proactive approaches to investigate the willingness of landowners to be voluntary sellers, as specified in the requirements of the ordinance that established the land acquisition program.
- Tax incentives should be created so that landowners may continue land use practices that maintain ecologically important habitat.
- Adequate staff at Property Appraisers' Offices within the watershed will be provided to review the high number of applications and strictly enforce the rules for bona fide agricultural tax exemptions.
- The minimum time period for re-zoning of agricultural land should be increased from three years to ten years to reduce the speculative clearing of agricultural land for "higher use" which results in the loss of natural habitat and the loss of tax revenue.
- Regulations within the existing "Notice of Clearing" process by Lee County will be developed that require wildlife surveys, habitat assessments, and a development plan for the agricultural operations so that critical habitats for state and federal listed species can be preserved.
- Conservation easements will be used as an option to protect critical habitats.
- Legislation should be implemented that provides inheritance tax, real estate tax and estate tax relief for agriculture landowners and their heirs, who will maintain their land in agriculture.
- Legislation should be implemented that provides inheritance tax, real estate tax and estate tax relief for landowners and their heirs, who provide permanent conservation easements on their property.
- All re-zoning requests within the Estero Bay watershed will be critically evaluated to ensure protection of water quality, rare and unique habitats, listed wildlife, and ecosystem functions.
- Variances from environmental regulations and deviations from development standards will be the exception, not the rule.
- Environmental protection and long-term quality of life will not suffer based on short-term economic impacts or political pressures.
- Zoning resolutions that are required as a part of the approval for re-zoning must be tracked for future compliance and enforcement.
- Additional staff will be hired to assist in the compliance and enforcement of zoning resolutions related to environmental issues.
- The ABM will be cognizant of the "big picture" and to the concept of "ecosystem management" and sustainable development.
- Agency staffing will keep pace with increased demand on services, especially environmental protection issues. Trained and experienced wildlife biologists and environmental scientists will be hired to ensure adequate development review.
- Programs such as the "Keep It Clean" and "Florida Yards and Neighborhoods" programs should be promoted, to minimize inputs of stormwater pollutants into the bay.
- Compliance and enforcement of existing environmental regulations will be a top priority for regulatory agencies.
- The Inheritance Tax will be repealed, so as to encourage the retention of agricultural lands.

Vegetation

- Natural, native vegetation within natural systems will be retained to the greatest extent possible.
- Physical removal of invasive vegetation will be utilized for control rather than widespread chemical treatment.
- Limited application of herbicides that rapidly degrade may be used, according to the product label, on a case by case basis for the control of nuisance and invasive non-native vegetation

and to maintain native plant communities.
- Promote, whenever possible, the active and aggressive removal of invasive non-native plants from all common areas, conservation easements, preserves and natural areas within the Estero Bay watershed.

Physiographic

Consideration will be given to the ancient relief of the watershed by:

- Preserving vegetation that provide the characteristic habitat and canopy.
- Retaining the relic natural features.
- Reconnecting historic natural flowways that have been diverted or severed.

New Construction

- Construction within flood plains shall be avoided wherever possible.
- For construction that must occur within flood plains, utilize techniques that do not adversely impact the capacity of the floodplain (e.g. use of pilings to raise living floor elevations versus use of fill).
- Utilize non-polluting construction materials (e.g. concrete pilings versus treated wood) within flood plains.

Hazardous Materials

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Roadways

- All future roadways to be located in the floodplain within the Estero Bay watershed will be designed and constructed to not impede flows from a 25-year, 3 day, storm event.

Public Notice

- Activities in the watershed by any regulatory agency shall provide the opportunity for public participation.

Bay Waters

Water Quality

- Regulatory agencies will continue to support "Best Management Practices."
- Operation of overloaded and outdated package wastewater treatment plants will be discontinued.
- All urbanization will be served by centralized sewage systems.
- There should be uniform application of water quality protection measures by regulatory agencies. A holistic management scheme should be implemented that takes into consideration ecological impacts of regulated activities.
- Compliance and enforcement of existing regulations are needed to protect water quality and biological integrity.
- There shall be no discharge of hazardous materials into Estero Bay.
- Surface water management systems in new developments will be required to utilize state-of-the-art best management practices.
- Grants or incentives should be provided for retrofitting old systems that are not effectively removing nutrients and other pollutants from urban and agricultural stormwater systems.
- The State of Florida will actively investigate and prosecute water quality violators.
- Retrofitting existing shorelines hardened with vertical seawalls to sloping limerock revetments or native, salt tolerant vegetation, should be encouraged wherever possible.
- Compliance and enforcement of existing environmental regulations will be a top priority for regulatory agencies.

Habitat Alteration

- Construction within Estero Bay waters shall be avoided wherever possible.
- For construction that must occur within Estero Bay waters as proven necessary for the health, safety and welfare of the natural resources of Estero Bay and of the people in the watershed, utilize techniques that do not adversely impact Estero Bay waters

New Construction

- New construction projects should utilize best management practices to minimize negative impacts to the bay to the greatest extent possible; and in addition, the project as a whole, including mitigation, should be necessary to protect the public health, safety, or welfare, or the property of others, and should improve the current condition and relative value of functions being performed by the areas affected by the project.
- Utilize non-polluting construction materials (e.g. concrete pilings versus treated wood).

Wildlife

- A manatee protection plan will be adopted to reduce the number of boat-related manatee mortalities and that respects the rights of other users of the bay; to achieve a sustainable manatee population (the goal of the Marine Mammal Protection Act, the Endangered Species Act and other pertinent legislation); to protect manatee habitat; to promote boating safety; and to increase public awareness of the need to protect manatees and their environment.
- Efforts by wildlife protection agencies will be accelerated to reduce other non-boat related manatee mortalities.
- Maintain and improve the overall ecology of the bay and its watershed.

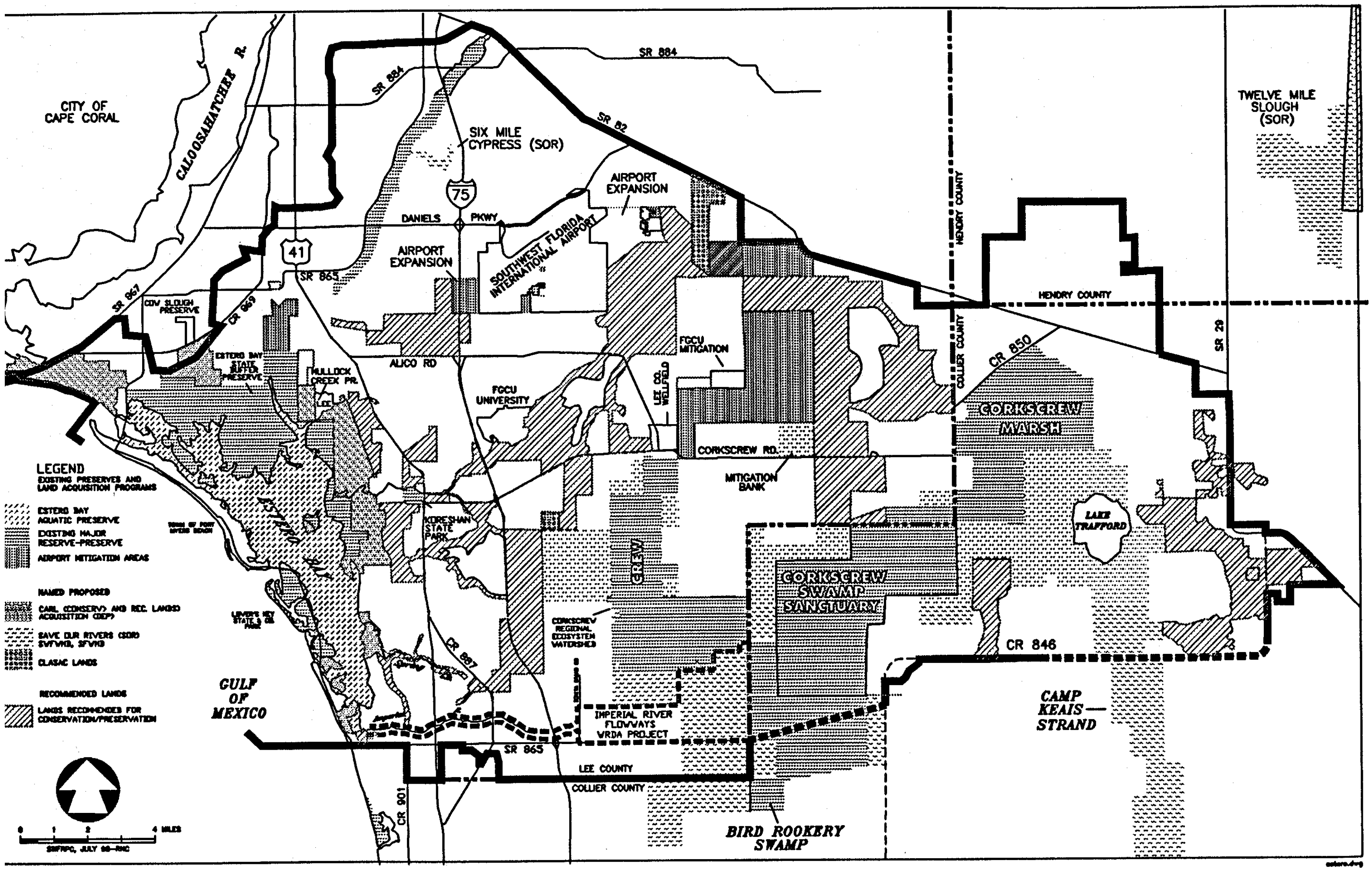
- Wildlife resources such as rookeries, sea grass beds and fisheries are under increasing threat from human activity. Greater efforts are required by regulatory and other agencies and groups to insure the sustained productivity of these resources.

Recreation

- Regulatory agencies will make special effort to maintain the bay as a major natural resource for fishing and appreciation of vegetation and wildlife.

Public Notice

- Activities in Estero Bay by any regulatory agency shall provide the opportunity for public participation.



ADOPTED JULY 13, 1998 BY THE ESTERO BAY AGENCY ON BAY MANAGEMENT

ESTERO BAY WATERSHED

LAND CONSERVATION/PRESERVATION STRATEGY MAP

PROPOSAL FOR AN ADG ALTERNATIVE

Criteria Identifier: REGIONAL OR COMPREHENSIVE STORMWATER MANAGEMENT

Potential Application: As an alternative for future urban areas (e.g. as a requirement of a general permit). Emphasis areas are those with receiving water bodies that are subject to the most significant impact. Examples might include the OFW tributaries of Estero Bay in the "Hub". In some cases, retrofitting existing systems may be possible.

Problem Description: In Florida, stormwater is the largest source of pollutants to lakes, rivers, and estuaries. In many lakes, it is the only major source of pollutants. On a statewide basis, stormwater as compared to regulated discharges (sewage and industrial treatment facilities) is the source of: 1) 80 to 95 percent of heavy metals; 2) 99 percent of all sediment; 3) 90 percent of oxygen demanding substances; and 4) 50 percent of nutrients. Thus severe environmental and economic impacts result when stormwaters are not managed. The usual approach to watershed management delegates stormwater management responsibilities to local land developers and each would be responsible for constructing stormwater management facilities on the development site to maintain post-development peak runoff and pollution loads from the site at predevelopment levels. With the usual approach there is little or no consideration of the cumulative effects of the developments with their individual stormwater systems on either the local government stormwater infrastructure or downstream lands and waters.

Proposed Criteria: Develop a comprehensive watershed plan for specific watersheds to identify the most appropriate control measures and the optimum locations to control watershed wide activities. A regional stormwater management approach would involve combinations of the following:

1) Overall review of the watershed and its characteristics to assess problems and potential solutions.

2) Strategically locating a single stormwater detention facility (a regional system) to control post-development runoff from several land development projects.

3) Provide stream channel improvements (e.g. removal of obstructions to flow, properly vegetating) where necessary upstream from the stormwater detention facility.

4) The use of nonstructural measures throughout the watershed, such as acquisition of parkland and floodproofing to supplement structural control measures.

5) Coordinate infrastructure improvements with point and nonpoint source management programs to provide a vital link between land use and water resources management.

Advantages of a regional stormwater management plan

— reduces capital and operation/maintenance costs
— reduces the risk of downstream flooding and erosion particularly in multi-jurisdictional waters
— Offers better opportunities to comprehensively manage stormwater problems
— Increases land development opportunities
— Increased opportunities for recreational uses

Advantages cont.

— Potential contributions to local land use planning
— Enhanced reuse of stormwater
— Popularity among land developers
— Better compliance with EPA stormwater discharge regulations

Possible disadvantages of regional stormwater management

— Local governments must conduct, in advance, studies to locate, and develop preliminary designs for regional stormwater management facilities.

— Local governments must finance, design, and construct the regional stormwater management facilities before most development occurs and provide for reimburesement by developers over a build-out period that can be many years long. However, there are a number of state and federal funding sources for this type of management.

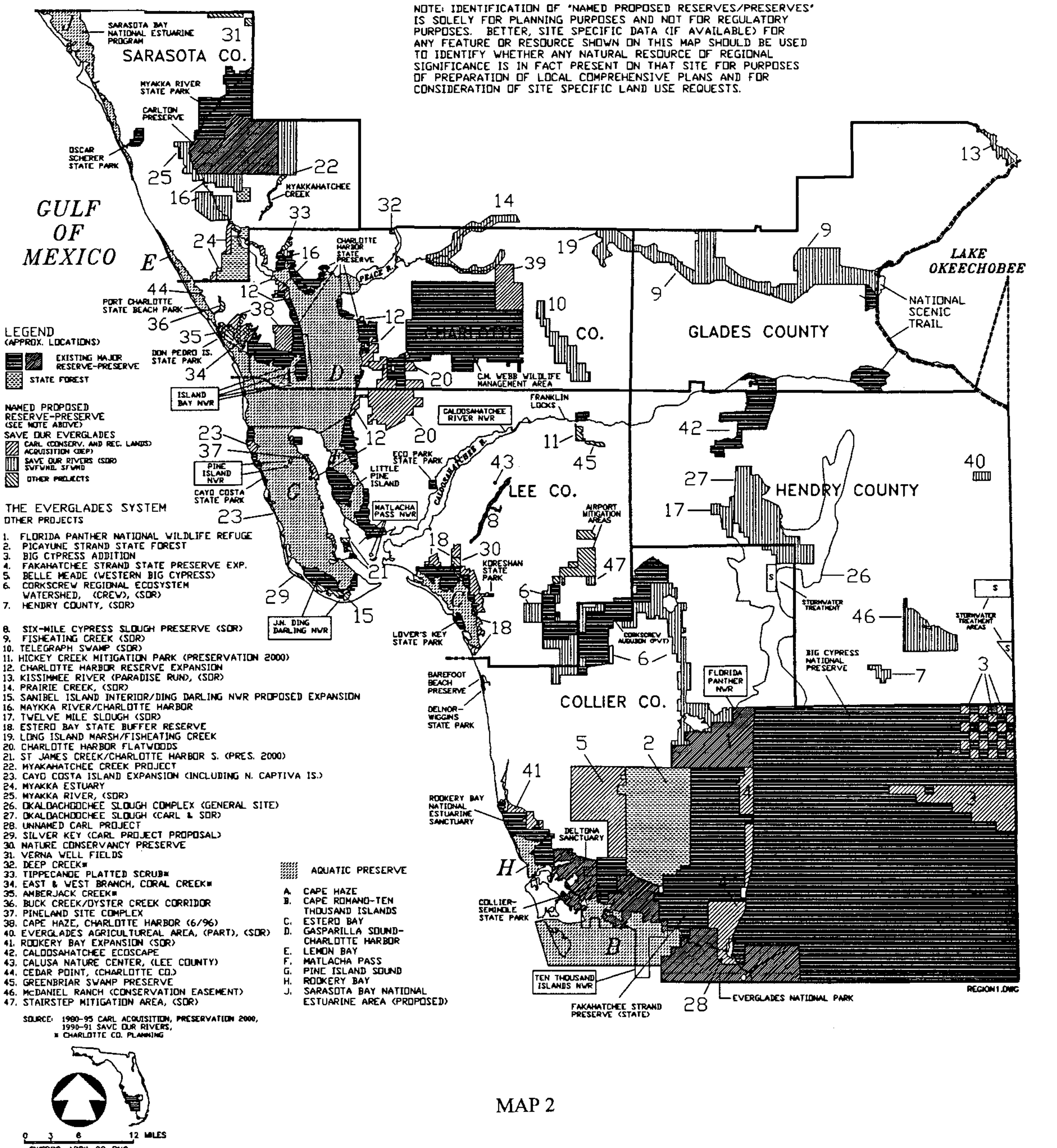
— In some cases, local governments may have to conduct extraordinary maintenance activities for regional stormwater management facilities the public feels are primarily recreational facilities that merit protection for water quality. An example might be canal dredging in Cape Coral canals. Howver the public accepts this and in some cases demands it.

Possible Funding Sources

— Florida Stormwater State Revolving Fund Loan Program (SWSRF). The SWSRF Program provides subsidized financing for stormwater management projects sponsored by local governmental agencies. The SWSRF is capitalized by federal appropriations, matching state funds and repayments form ongoing loans. The major program requirements are linked to federal appropriations and the federal Clean Water Act.

— EPA Clean Water State Revolving Fund (SRF) and the Clean Water Action Plan (CWAP). The SRF provides a powerful funding resource for implementing the CWAP. Since the end of FY 97, the SRF had funded a total of more than $650 million in nonpoint source and estuary projects around the country.

— Lee County Stormwater Utility if passed in November 1998.



MAP 2

SOUTHWEST FLORIDA REGION
REGIONALLY SIGNIFICANT NATURAL RESOURCES

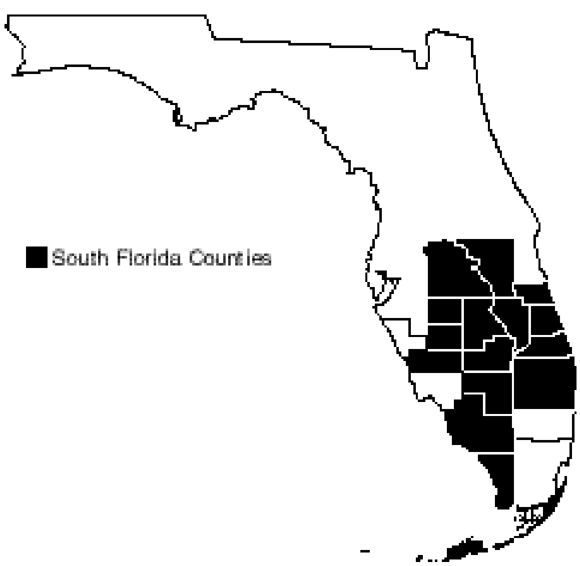
APPENDIX G - EXTRACTS FROM MULTI SPECIES RECOVERY PLAN

Audubon's Crested Caracara

Polyborus plancus audubonii

Federal Status:	**Threatened (July 6, 1987)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Revision (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. County distribution of Audubon's crested caracara.



Audubon's crested caracara is a large, boldly patterned raptor, with a crest and unusually long legs. It is a resident, diurnal, and non-migratory species that occurs in Florida as well as the southwestern U.S. and Central America. In Florida, this species is found in the prairie area of the south-central region of the state. The subspecies is no longer present at its type locality, which is near St. Augustine, St. Johns County, Florida.

Only the Florida population, which is isolated from the remainder of the subspecies in the southwestern U.S. and Central America, is listed under the Endangered Species Act. Although no management activities have been undertaken for the U.S. population of this species, draft habitat management guidelines are being developed that should aid in the caracara's recovery.

This account represents a revision of the existing recovery plan for the Audubon's crested caracara (FWS 1989).

Description

Audubon's crested caracara is a large raptor with a crest, naked face, heavy bill, elongate neck, and unusually long legs. It is about 50 to 64 cm long and has a wingspan of 120 cm. The adult is dark brownish black on the crown, wings, back, and lower abdomen. The lower part of the head, throat, upper abdomen, and under tail coverts are white, sometimes tinged with yellow; the breast and upper back are whitish, heavily barred with black. The tail is white with narrow, dark crossbars and a broad, dark terminal band. Prominent white patches are visible near the tips of the wings in flight. The large, white patches in the primaries and the white tail, broadly tipped with black, are both very conspicuous in flight and can be recognized at a long distance (Bent 1961). Juveniles have a similar color pattern but are brownish and buffy with the breast and upper back streaked instead of barred. Subadults resemble adults but are more brownish in color. Adults have yellow-orange facial skin and yellow legs. Facial skin of juveniles is pinkish in color, and the legs are gray (Layne 1978). Full adult plumage is obtained sometime after 2 years of age (J. Morrison, University of Florida, personal communication 1997).

There is no evidence of sexual dimorphism, the sexes being similar in color and size (J. Morrison, University of Florida, personal communication 1996a); however, gender can be determined surgically or through blood analysis (Humphrey and Morrison 1996).

The bare skin on the face of this bird is an interesting and distinctive feature. When the bird is at rest, preening or being preened, or engaged in other non-aggressive behaviors, the facial skin is bright orange-red. When threatened, the color of the facial skin changes to a pumpkin color and finally to pale yellow (Lyons 1984). Apparently, threat or fear causes blood to bypass the subepidermal blood vessels, resulting in a change in facial skin color. The caracara's crest provides another method for communication. When a caracara is comfortable and not threatened, the crest lies flat. The crest is raised when they feel threatened, frightened, or are on alert (Lyons 1984).

A caracara's feet and flight behavior are also notable. Their feet are clearly those of a raptor; however, their talons are flatter, enabling caracaras to run and walk more easily than other raptors. Bent (1938) and Layne (1985) noted that the caracara's flight pattern resembles that of a northern harrier (*Circus cyaneus*), but caracaras fly faster and more gracefully. Caracaras are strong fliers and may reach speeds of 40 mph. They have also been observed soaring in large circles at great heights (Howell 1932).

Little information is available on vocalizations of this species; however, in the morning or evening, the caracara may throw its head back until it almost touches its shoulders and emit a high, cackling cry that resembles its Brazilian name (Bent 1961). Observations of caracaras in Costa Rica and Mexico indicate that this call may be a part of pair formation or courtship. The only other vocalizations heard in Costa Rica were a one-syllable greeting and an alarm call (Palmer 1988).

Taxonomy

Audubon's crested caracara is a member of the Class Aves, Order Falconiformes, Family Falconidae. It was originally described by John James Audubon (1834), who discovered the caracara on November 21, 1831, and published an account under the name *Polyborus vulgaris*. It was renamed in 1865 by John Cassin to *Polyborus audubonii* and has had several other scientific names since that time. Most recently it was renamed *Caracara plancus* (Banks and Dove 1992). Banks (1985) provided a historical review of the taxonomy of the caracara prior to its listing.

The only other species of *Polyborus* known from recent times is the Guadalupe caracara (*Polyborus lutosus*). This species was extirpated from Guadalupe Island, Mexico in the early part of the 20th century (Abbott 1933).

Audubon's crested caracara. *Original photograph by Joan Morrison.*

Distribution

The overall range of the crested caracara is from Florida, southern Texas, southwestern Arizona, and northern Baja California, through Mexico and Central America to Panama, including Cuba and the Isle of Pines. It is accidental in Jamaica. Other subspecies range into South America as far as Tierra del Fuego and the Falkland Islands (Stevenson 1976, Layne 1978).

Historically, this subspecies was a common resident in Florida from northern Brevard County, south to Fort Pierce, Lake Okeechobee, and Hendry County. It has been reported as far north as Nassau County, and as far south as Collier County and the lower Florida Keys in Monroe County. Some of the birds sighted in the Florida Keys most likely escaped or were released from captivity. Available evidence indicates that the range of this subspecies in Florida has experienced a long-term continuing contraction, with birds now rarely found as far north as Orlando in Orange County or on the east side of the St. Johns River. Presently, Audubon's crested caracara may be found in Charlotte, Collier, DeSoto, Glades, Hardee, Hendry, Highlands, Martin, Monroe, Okeechobee, Osceola, Palm Beach, Polk, and St. Lucie counties (Figure 1). However, there is little evidence of breeding in Palm Beach, Indian River, Martin and Monroe counties (Layne 1978, Stevenson 1976, Sprunt 1954, FWS 1989, J. Morrison, University of Florida, personal communication 1996a). The region of greatest abundance for this subspecies is a five-county area north and west of Lake Okeechobee, including Glades, Desoto, Highlands, Okeechobee, and Osceola counties.

Habitat

The Florida population commonly occurs in dry or wet prairie areas with scattered cabbage palms (*Sabal palmetto*). It may also be found in lightly wooded areas. Scattered saw palmetto (*Serenoa repens*), scrub oaks (*Quercus geminata*, *Q. minima*, *Q. pumila*), and cypress (*Taxodium* spp.) may also be present. Widespread changes in land use may have forced a change in the type of habitat this subspecies will use. The caracara now uses improved or semi-improved pasture (Layne 1996b, J. Morrison, University of Florida, personal communication 1996a). The presence of seasonal wetlands may be an important factor in the attractiveness of these pastures to caracaras (K. Dryden, GFC, personal communication 1996).

Humphrey and Morrison (1997) characterized habitat features and land use patterns at active caracara nest sites in south-central Florida. They found that caracaras prefer to nest in cabbage palms (*Sabal palmetto*) surrounded by open habitats with low ground cover and low density of tall or shrubby vegetation. The study also indicated that there was a strong association of caracara home ranges with improved pasture. In addition, occupancy rate, breeding rates, and nesting success were consistently higher on private lands during the 3-year study. One of the variables that may contribute to the difference in success is vegetation height. This may be related to lower predation rates in areas with less cover, or it may simply be easier for caracaras to walk around and forage in shorter vegetation. Other factors contributing to nest success may be nest tree height, and distance to major roads or human activity.

Routine observation and radiotelemetry monitoring suggest that there are three congregation areas in south-central Florida which may be important to caracaras during the first year after leaving their natal territory (Humphrey and Morrison 1996). One is along the Kissimmee River, north of State Route 98, one is north of U.S. Highway 27 in Glades County, and one is in the vicinity of Eagle Island Road in northern Okeechobee County. These congregation areas consist of large expanses of improved pasture; however, the particular habitat values of these areas have not yet been evaluated.

Behavior

Reproduction

Caracaras are relatively long-lived. A caracara was kept in captivity for at least 30 years, suggesting that this falconid may have a high reproductive potential (Brown and Amadon 1968). Layne (1996b) describes a 20 year-old female brought into captivity as a nestling as still being in good health. The age at first breeding is unknown (Palmer 1988).

Breeding behavior in Audubon's crested caracara is relatively unknown. Based on the limited amount of information available, courtship behavior may involve the pair perching next to each other, almost touching, uttering the cackling call with their heads thrown back (Batten 1969). Brown and Amadon (1968) stated that males may occasionally fight in the air. Caracaras in Costa Rica have been observed in a ritual involving the rattle call where one of the birds had a lizard that was later broken apart so that both individuals could eat.

It is not known if this is a true courtship ritual or pair bond maintenance (Palmer 1988). The pair bond is relatively strong, lasting until one mate dies (FWS 1989).

Caracaras are one of the first of Florida's raptors to begin nesting. Egg laying has been estimated to begin as early as late September based upon evidence of chicks fledging in December (Humphrey and Morrison 1997). The height of the nesting season is in January and February. Nests with eggs have also been found as late as April (Nicholson 1929). In their study, Humphrey and Morrison (1997) suggest that most reproductive activity occurs during the winter dry season, although nesting attempts may occur throughout the year.

Caracaras construct new nests each nesting season, often in the same tree as the previous year. Nests are well-concealed and most often found in the tops of cabbage palms (J. Morrison, University of Florida, personal communication 1996a) although nests have been found in live oaks (*Q. virginiana*), cypress (first record, 1996), Australian pine (*Casuarina* spp.), saw palmetto, and black gum (*Nyssa sylvatica*). Caracaras usually construct their nests 4 to 18 m above the ground; their nests primarily consist of haphazardly woven vines trampled to form a depression (Bent 1938, Sprunt 1954, Humphrey and Morrison 1996, Layne, Archbold Biological Station, personal communication 1996a). Both adults participate in nest construction. Caracaras do not vigorously defend their nest site although they are aggressive toward other adult caracaras intruding near the nest itself (J. Morrison, University of Florida, personal communication 1996a). Sprunt (1954) wrote, "One female remained on the nest until approached to within four feet, when she flew to a stub about 12 feet away and watched. The male soon joined her and they together uttered rasping, cackling noises with their heads bent back upon their backs." A.C. Bent (1961) wrote, "Almost any small bird would probably drive one away from the vicinity of its nest, or at least attempt to do so."

Clutch size is two or three eggs, but most often two. Incubation lasts for about 28 days and is shared by both sexes. Ordinarily only one brood is raised in a season. If the eggs are taken, a second or even third set may be laid (Bent 1961). The young fledge at about 8 weeks of age (Layne 1978). Double brooding (two clutches successfully reared in one breeding season) has been documented in the Florida population, particularly for pairs that initiate nesting early in December or January (Humphrey and Morrison 1996; J. Morrison, University of Florida, personal communication 1996a).

Foraging

Caracaras are highly opportunistic in their feeding habits, eating carrion and capturing live prey. Their diets include insects and other invertebrates, fish, snakes, turtles, birds, and mammals (Layne 1978). Live prey also include rabbits, skunks, prairie dogs, opossums (*Didelphis marsupialis*), rats (*Rattus* spp.), mice, squirrels, frogs, lizards, young alligators (*Alligator mississippiensis*), crabs, crayfish, fish, young birds, cattle egrets (*Bubulcus ibis*), beetles, grasshoppers, maggots, and worms (Bent 1961, Layne *et al*. 1977). Several authors have noted that caracaras may consume unusual items, including turtle and other eggs (Terres 1980, Grossman and Hamlet 1964) as well as coconut meat (Haverschmidt 1947). This last food item may have been taken while foraging for insects on the coconut.

These raptors hunt on the wing, from perches, and on the ground (FWS 1989). They will also regularly patrol sections of highway in search of carrion (Palmer 1988). They may be seen feeding on road kills with vultures. However, caracaras are dominant over vultures and may occasionally chase the larger raptor from the road kill (Howell 1932).

Caracaras may also attack or harass other avian species in order to steal their food. Bent (1938) observed a caracara attacking a bald eagle (*Haliaeetus leucocephalus*) to steal its food. Caracaras may also attack other caracaras, pelicans (*Pelecanus* spp.), gulls (*Larus* spp.), and other large birds. They jump on the victim's back or strike from above with the talons; the victim usually drops its prey or regurgitates its food. The caracara then dives and snatches the prey before it hits the ground (Lyons 1985).

Localized Movements

Caracaras are resident, diurnal, and nonmigratory. Adult caracaras may be found in their home range year-round. Home ranges may encompass an area of up to 2,389 ha with an average of 1,552 ha. There is no significant difference between male and female home ranges; Humphrey and Morrison (1996) found female home ranges from 3.8 to 24.9 km^2 and male home ranges ranging from 3.9 km^2 to 22.5 km^2.

Occasionally large groups of individuals are encountered (Layne 1978). Oberholser (1974) attributes this to the birds' carrion feeding habit although Morrison (University of Florida, personal communication 1996a) has noted that juvenile caracaras are nomadic. This may account for the number of sightings far outside the core area in Glades, Hendry, Okeechobee, Osceola, and Highlands counties. Occasional sightings have been reported in Polk, Orange, Indian River, St. Lucie, Martin, Palm Beach, Monroe, and Charlotte counties. When subadult birds are associated with one of the aggregation areas, the aggregation areas are comprised of similar habitat to that found in the natal territory.

Relationship to Other Species

There appears to be no migration or genetic exchange between the Florida population and other populations of the subspecies. The only other member of the genus *Polyborus* was the Guadalupe caracara that was extirpated in the early 1900s. Detailed studies on natural predators are lacking; however, fish crows (*Corvus ossifragus*) and raccoons (*Procyon lotor*) have been documented as nest predators (J. Layne, Archbold Biological Station, personal communication 1996a, J. Morrison, University of Florida, personal communication 1996b).

Status and Trends

The caracara has declined throughout its range, from the early 1900s until the 1980s. It was once plentiful in Texas, and was more numerous in Arizona than it is at this time. It was considered uncommon in New Mexico and extremely rare in Oklahoma (Ellis *et al*.1988). It would appear that the distribution of the bird presently is similar to the historic distribution, however, numbers of individuals are lower. The status in most areas where the caracara is found is largely unknown, however, it is thought to be severely declining in Mexico. It is relatively unprotected except in Florida and is actively shot in Argentina (J. Morrison, University of Florida, personal communication 1996b).

The size of the Florida caracara population remains in question. Accurate counts become difficult because of limited access to areas of suitable habitat and because of the bird's behavior and detectability (Humphrey and Morrison 1997). In 1970, Heinzmann published the results of a 4-year survey (1967 - 1970) which indicated that fewer than 100 individual caracaras at 58 localities remained in Florida. Stevenson (1976) concurred with this estimate in 1974. Layne (1995), however monitored caracara distribution and population status in Florida from 1972 to 1991. He estimated that the population was stable with a minimum of about 300 adults in 150 territories. The immature population was estimated to be between 100 and 200 individuals, bringing the total statewide population to between 400 and 500 birds.

The caracara's decline, as described in historic literature, is primarily due to habitat loss (Layne 1985); the documentation of this decline eventually resulted in the caracara's listing as threatened in 1987 (52 FR 25232). In particular, the caracara was listed as threatened because its dry prairie habitat had been destroyed or modified for agriculture and residential development. It was also listed because existing regulatory mechanisms did not adequately prevent the destruction or modification of the caracara's habitat, which is mainly located on private land. (The only federal property that supports caracaras is Avon Park AFR in Polk and Highlands counties. In recent years, nesting on the AFR has been limited to only one nesting pair (J. Morrison, University of Florida, personal communication 1996a).

The presence of disease in caracara remains largely unknown. However, Lyons (1985) reported that some cases of avian pox had been diagnosed in the past.

In addition to population declines related to habitat loss, direct human-caused mortality may also be a factor in the slow recovery of the species. Caracaras may still be killed in the false belief that they prey on newborn calves. In the past, large numbers of caracaras were killed in vulture traps (FWS 1989). Individuals may also be caught in leghold traps used to control mammalian predators (Morrison 1996c). Road mortalities may be a significant cause of caracara decline; Morrison (University of Florida, personal communication 1996a) identifies highway mortalities as a major cause of juvenile mortalities with young birds especially vulnerable within the first 6 months of fledging.

The Florida population of caracaras is isolated and habitat-specific. Therefore, it may be susceptible to environmental catastrophes and potentially reduced reproductive rates because of demographic accidents such as skewed sex ratios or disproportionate age-related mortality. Because of its scavenging habits, the caracara may be susceptible to mass poisonings. Low numbers may also reduce the genetic viability through loss of heterozygosity, thereby increasing vulnerability to environmental stresses. The location of many of the occupied territories on private land, and the inaccessibility of these territories to surveyors, makes it difficult to census the caracara and detect changes in its population size and distribution. This difficulty increases the possibility of not detecting a population decline that could result in extinction.

Large areas of native prairie have been lost in south-central Florida to citrus operations, tree farms, improved pasture, other forms of agriculture, and real estate development (Layne 1978, Layne 1985). The threat of habitat loss persists as these changes in land use continue. Florida's burgeoning population has also increased the number of motor vehicles and the need for roads. The increase in traffic as well as the caracara's predisposition for feeding on road-killed animals has probably increased this type of mortality.

Cattle ranching on large tracts of land seems to be compatible with caracara survival. The number of territories occurring in improved or unimproved pasture is expected to increase as juvenile caracaras establish their territories in similar, adjacent settings (J. Morrison, University of Florida, personal communication 1996a). The conversion of pasture to citrus (Cox *et al*. 1994), sugarcane and residential development is reason for concern. Humphrey and Morrison (1996) found that pasture constitutes the highest percentage of habitat cover type found within the home ranges of breeding caracaras.

Management

To date, no active conservation measures have been undertaken for this species in Florida. Management activities are also lacking throughout its range. Avon Park AFR has conducted caracara surveys in the past. This contract allowed a biologist to perform research activities both on the AFR and in the surrounding region. In recent biological opinions and informal consultations, the FWS has endeavored to better address effects to the caracara through recommendations to: set aside home ranges, allow research and monitoring, perform surveys, avoid work during the nesting season, and formulate a management plan for protection of the resident pair. Proposed development projects evaluated by the FWS for their effect on the caracara have included the conversion of pasture to citrus, a DOT road improvement project, and the construction of a juvenile detention center.

Caracaras appear to benefit from prescribed burning, plowing, and mowing (Morrison 1996c). These activities reduce available cover and may facilitate the observation and capture of prey. In addition, regular mowing, burning, and high-density grazing maintain low vegetative structure, an important habitat characteristic of the caracara's nest stand area (Humphrey and Morrison 1996).

Draft habitat management guidelines similar to those in place for the bald eagle (*Haliaeetus leucocephalus*) are being developed (J. Morrison, University of Florida, personal communication 1996a). The bald eagle guidelines (FWS 1987) have been useful in preserving bald eagle nest sites in areas subject to development pressure.

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Recovery for the Audubon's Crested Caracara

Polyborus plancus audubonii

Recovery Objective: DELIST the species once recovery criteria are met.

Recovery Criteria

This objective will be achieved when any further loss, fragmentation, and degradation of habitat in south-central Florida has been prevented; when the number of Audubon's crested caracara territories in the historic range increases from 200 to 300; when Audubon's crested caracara have maintained or exceeded this number of territories for at least 10 years; when these territories are well-distributed throughout the core counties of Glades, DeSoto, Highlands, Okeechobee, and Osceola; when additional breeding pairs have established territories on unoccupied or restored habitat; when those lands have been protected through land acquisition, conservation easements, or cooperative agreements; and when the Audubon's crested caracara population in Florida exhibits an intrinsic rate of increase (*r*) equal to or greater than 0.0, sustained as a 3-year running average over at least 10 years.

Species-level Recovery Actions

S1. **Determine the distribution, status, and abundance of Audubon's crested caracaras**. Dry prairie habitats throughout the Kissimmee River valley should be targeted for surveys. Other areas that might support populations of the Audubon's crested caracara should be determined through the use of satellite imagery to locate search areas and other aggregation areas important to juvenile caracaras.

S1.1. **Locate active caracara territories in Glades, DeSoto, Highlands, Okeechobee, and Osceola counties.** Active territories in these counties should be mapped using digital, spatial information; this information should be maintained as part of a database to facilitate land protection and monitoring efforts for the caracara.

S1.2. **Locate and map potential habitat within the former range of the caracara that might be rehabilitated for reintroduction purposes**. Caracaras once occurred in prairie habitat from northern Brevard County south to Collier County. Caracara were once reported from as far north as Nassau County and as far south as the lower Keys in Monroe County but have been extirpated over much of their former range. Efforts should be made to locate and map these formerly inhabited areas, to determine if it is feasible to restore habitat and expand the range of the caracara.

S1.3. **Develop standardized, systematic censusing procedure**s. The census should use active territories as a variable.

S2. **Protect and enhance existing populations of Audubon's crested caracara.**

S2.1. **Protect and enhance existing populations of Audubon's crested caracara on public and private land.** Caracaras currently occur on several properties managed by the SFWMD in the Kissimmee River valley as well as other publicly owned land in south central Florida; however most pairs occur on private lands. Territories on private lands are critical to the survival and recovery of the caracara.

2.1.1. **Inform landowners of the presence of caracaras on their property**. Appropriate State and Federal authorities should inform landowners that their property contains resident caracaras.

2.1.2. **Encourage landowners to protect caracara nesting sites by providing incentives (awards, credits for mitigation, special recognition, etc.)**. Inform landowners of the amount of habitat needed around each nest and the level of human activity tolerated by each pair during nesting. Encourage landowners to adhere to guidelines derived from item S3.1.4. Investigate options for monetary or tax incentives to encourage lower intensity farming operations or preservation of native habitats in occupied and restorable areas. Encourage the media to focus on these land protectors. Also, provide public recognition for proper land management.

S2.2. Develop and implement a plan to reintroduce Audubon's crested caracaras into suitable habitats within their historic range. Caracaras once occurred in prairie habitat from northern Brevard County south to Collier County. Caracara sightings were once reported from as far north as Nassau County and as far south as the lower Keys in Monroe County. Efforts should be made to locate and map these formerly inhabited areas, to determine if it is feasible to restore habitat and expand the range of the caracara. This plan must identify the specific areas that are suitable for such reintroductions, protocols for determining when habitat is suitable for a reintroduction, the size of a reintroduced population, monitoring protocols for reintroduced populations, and land management prescriptions for reintroduction areas.

S2.3. Encourage natural colonization of restored habitats by Audubon's crested caracaras. Many areas within the historic range of the caracara are being restored as part of the COE and SFWMD's restoration projects in the South Florida Ecosystem. Other areas are being restored because of a change in land use in the Kissimmee River valley (such as the expansion of Three Lakes WMA). Dispersal of the caracara into restored areas from occupied sites should be encouraged by enhancing areas adjacent to active territories.

S2.4. Introduce rehabilitated birds into expanded or restored areas whenever and wherever possible. When caracaras are taken into captivity for rehabilitation purposes, those without permanent disabilities should be considered for release into expanded or restored areas when they have recovered. Myakka River SP has been recommended as a possible location for reintroducing caracaras that have been rehabilitated.

S2.5. Establish rehabilitation centers for injured or sick caracaras found in the wild. Lyons (1984, 1985) had considerable success in rehabilitating sick and injured caracaras in Texas. Traumatic injuries in Texas usually involve leg or foot injuries (from leg-hold traps) and gunshot wounds. Lyons found that caracaras quickly adapt to captive conditions, and respond well to medical treatment. By establishing a center in Florida, sick or injured caracaras could be rehabilitated and returned to the wild. This could also be accomplished by developing agreements with a local veterinarian, bird rehabilitation center, or university.

S2.5.1. Develop an emergency program for removing injured or sick caracaras from the wild including a hotline number for notification of responsible individuals. When a sick or injured caracara is located, it may be necessary to place the bird into a rehabilitation center where it can receive proper medical treatment. A rehabilitation center should consider such factors as housing, equipment, veterinary expertise, proximity to the present core distribution of caracaras, etc. Key individuals should be appointed to pick up sick or injured birds and transport them to the rehabilitation center. The phone numbers of these individuals should be provided to all wildlife officers within the core range of the caracara.

S2.5.2. Establish a caracara rehabilitation team, made up of rehabilitation experts, raptor biologists, veterinarians, etc.

S2.5.3. Maintain accurate and detailed records on individuals brought in for rehabilitation.

S2.5.4. Determine where recovered birds should be released into the wild. When sick or injured birds have recovered to the point that they can return to the wild, they should be released in expanded or restored habitat areas.

S2.5.5. Monitor the health and status of Audubon's crested caracara that have returned to the wild. Monitor rehabilitated birds through radiotelemetry to determine whether they survive. If the introduction of rehabilitated caracaras is successful, more widespread reintroductions could be accomplished with juvenile birds.

S2.5.6 Conduct section 7 consultations on all Federal activities that may affect caracaras and their habitat. Federal agencies shall consult with the FWS on any activities (authorized, funded, or carried out) that may affect caracaras. Such activities include: pesticide use, road building, construction of new facilities, training exercises, wetland fill, clearing for new runways, etc.

S3. Conduct research to determine the basic biological needs of the caracara. Although considerable research has been done on the biology and ecology of the Audubon's crested caracara, more information is necessary before this species can be properly managed and effects of habitat management actions assessed. Biological studies should be continued to complete our knowledge of the demographics of caracara populations (survivorship, fecundity, mortality, dispersal) and the relationship of these demographic variables to habitat availability and quality, particularly water regimes and fire management.

S3.1. Determine habitat requirements of the caracara in Florida. Habitat loss is believed to be the primary cause of caracara decline in Florida. Research to determine precise details are ongoing, but more information is needed on nesting and feeding habitat requirements, the percentage of forest or agricultural encroachment caracaras will tolerate, and their need for water. Precise details are also needed on the extent of caracara movement into other habitats for feeding and drinking purposes.

S3.1.1. Determine essential habitat components. Identify all the components that make up prime habitat. Prime habitat is the sum of all essential components, where their absence would make the habitat suboptimal or result in abandonment of the area for nesting and/or feeding. Determine the habitat components necessary for successful nesting and roosting. Determine the need for water in proximity to nests, and the level of tolerance to human disturbance during early and late reproductive stages. This action should involve the use of Geographic Information Systems and remote mapping since much of the occupied caracara territories are present on private lands.

S3.1.2. **Determine the minimum amount of nesting and feeding habitat needed to support a population of caracaras**. Determine the amount of nesting and feeding habitat needed to support a single pair of caracaras. Nesting habitat is relatively restricted, but territories extend over large areas. Therefore, maintaining nesting habitat might be the crucial factor in protecting the birds. Protection of nest sites from predators may be necessary at some nesting sites.

S3.1.3. **Formulate estimates of habitat carrying capacity under optimum conditions**. Determine the carrying capacity of nesting and feeding habitats of the Florida population of Audubon's crested caracara. This will allow scientists to evaluate which habitats are underutilized or overutilized. This knowledge is essential for management of the birds.

S3.1.4. **Establish habitat management guidelines to protect the nests and nesting pairs of Audubon's crested caracaras**. These guidelines should be modeled after the "Habitat Management Guidelines for the Bald Eagle in the Southeast Region" (FWS 1987). Their purpose will be to assist land owners, land managers, and regulatory biologists in avoiding impacts to caracaras.

S3.1.5. **Utilize current information and conduct additional research to develop a Population Viability Analysis for the caracara.** This analysis would be used to evaluate management and regulatory actions as well as other conservation strategies, including the development of reintroduced populations. It would also aid in determining which ecological factors are most critical for the survival and recovery of the species.

S3.2. **Compile caracara data into a central database at one location.** Gather historic data from all researchers. This data would be an important element in determining recovery of the population.

S4. **Develop and implement a program to monitor the status and trends of wild Audubon's crested caracara populations**. It will be necessary to continually monitor the stability and health of existing wild populations to assess recovery efforts.

S4.1. **Develop monitoring protocols and techniques for the Audubon's crested caracara**. Develop a set of monitoring protocols that are able to identify small changes in the size and distribution of Audubon's crested caracara populations over time.

S4.2. **Monitor Audubon's crested caracara populations on public lands to evaluate management actions**. Establish monitoring programs for the Audubon's crested caracara on public lands in south-central Florida to determine if fire management, water management, and other management actions are consistent with the recovery needs of the caracara.

S4.3. Monitor the success of reintroduced Audubon crested caracara populations. To determine whether recovery efforts are successful, it will be necessary to conduct periodic censuses and surveys of all introduced populations.

S5. Increase public awareness of the biology, ecology, status and trends of the Audubon's crested caracara. The public must be made more aware of the status and trends of the Audubon's crested caracara, its recovery needs, and opportunities to participate in the caracara's recovery. This public awareness program must include an effort to contact owners of lands that support populations of Audubon's crested caracaras; it must also include development and distribution of materials developed specifically to inform the public about the Audubon's crested caracara.

S6. Assess reclassification criteria based on the results of research projects; revise as necessary. One condition required to reach the recovery objective for the caracara is to ensure that the amount of nesting and feeding habitat needed to maintain stable or expanding populations remains stable or increases over a 10-year period.

Habitat-level Recovery Actions

H1. Protect and enhance currently occupied habitat. Alteration and habitat loss are primary threats to prairie species. As much of the remaining prairie habitat as possible must be secured. State and COE efforts to restore the Kissimmee River floodplain may provide habitat for prairie dependent species.

H1.1. Protect privately owned, occupied lands wherever possible. Particular effort should be made to acquire or protect lands on which prairie species reside.

H1.1.1. Encourage the purchase of unprotected lands that support caracaras. State, county, and local governments and private organizations can purchase lands. The FWS can consider purchase of land to protect endangered or threatened species through its Land Acquisition Planning System.

H1.1.2. Use conservation easements and other non fee-title ownership options to maintain habitat. Conservation easements, recognized under both Federal and State law, may protect habitat while allowing it to remain in private ownership. Non-binding conservation agreements with landowners may also prove useful. Investigating tax and monetary assistance or incentives should be a high priority for willing landowners.

H1.1.3. Where private lands cannot be acquired, or protected through conservation easements, encourage landowners to maintain suitable habitat for the benefit of prairie species. The private landowner must be informed of the needs and value of caracaras in order to obtain their cooperation in providing protection.

H1.1.4. Maintain and enhance habitat on acquired lands or lands under conservation easements or agreements. Conduct prescribed burns, selective thinning, or mechanical manipulation at periodic intervals to maintain dry prairie and pasture habitat and prevent forest encroachment. Plant scattered cabbage palms, where needed, to serve as nesting sites for caracaras. Intensive rangeland improvements should be discouraged in prairie areas to maintain as many native vegetative species as possible.

H1.2 **Protect and enhance habitat on public lands**. Occupied caracara territories present on public land should be protected and enhanced for this species. Public lands that are occupied by caracara include Avon Park AFR in Polk and Highlands counties, and the Latt Maxcy property (Kissimmee Prairie State Preserve) in Okeechobee County. Federal land management agencies should try to protect, maintain, and enhance occupied habitat on all lands they manage. Habitat must be maintained in an early stage of succession through selective thinning and prescribed burning. Since caracara nesting is minimal on Avon Park AFR and this site is essential for the survival of the Florida grasshopper sparrow (Ammodramus savannarum floridanus), grazing should not be increased in this area, and prairie management should focus on the grasshopper sparrow. Other public lands should utilize the recommendations obtained from habitat component research on the caracara to determine which management actions are compatible with the survival of this species and the Florida grasshopper sparrow.

H1.2.1. **Conduct prescribed burns at periodic intervals.** Occupied areas should be burned in a mosaic fashion on a periodic rotational basis to maintain early stages of succession.

H1.2.2. **Maintain pastures in native vegetation to the extent possible.** Prairie species may be adversely affected if pasture lands are improved to the point where native vegetation is totally removed.

H1.2.3. **Do not allow reforestation of prairies.** Prairie species prefer unforested areas. Small patches of cabbage palm areas should be maintained to afford nesting sites for caracaras.

H1.2.4. **Establish appropriate burn seasonality.** Fire management should be conducted in all seasons although the majority of natural fire occurs in summer.

H2. **Create, restore, or expand occupied habitat wherever possible.** Habitat loss has occurred throughout the range of the caracara, and has been the primary factor threatening the survival of these animals. Conversion to higher intensity agricultural uses (e.g. sugar cane) may reduce the amount of useable habitat within a territory to the point that caracaras are unable to survive and reproduce. These areas can be enhanced to become suitable again. Mosaics of agriculture and native prairie may afford the landowner best use of their land while maintaining enough suitable habitat for caracaras.

H2.1. **Expand habitat in currently occupied areas.** Wherever possible, enhance prairie habitat in the vicinity of occupied habitat. Use prescribed burning and mechanical treatment or planting of cabbage palms to enhance areas to attract caracaras.

H2.2. **Restore habitat in currently unoccupied areas.** Delineate areas which once supported the caracara but are no longer suitable and restore them to a suitable condition. This may involve cabbage palm plantings and fire management.

H3. **Conduct research on caracara response to habitat modifications.** Little is known concerning the level of tolerance or the extent to which habitat within caracara home ranges may be modified before the birds abandon the site. The response to habitat modification from rangeland to a higher intensity agricultural use should be investigated. A study employing radiotelemetry should be designed and implemented.

H3.1. Determine why certain habitat areas are not used. Certain areas are apparently unsuitable for caracaras since they are not used. The cause(s) for the lack of use should be investigated.

H3.2. Determine which elements need to be modified to make unused areas suitable for the caracara. The unoccupied habitat may lack suitable nest trees or be too wooded. Pesticide contamination, especially in agricultural areas, may be a factor. Water quality analysis should be conducted to determine whether agricultural chemicals are making water unsuitable for caracaras. Blood sampling of individual caracaras should be used to determine levels of various chemicals present in the population. Adverse conditions present on potentially suitable habitat must be recognized and corrected before caracaras can expand their range, or be reintroduced.

H4. Use satellite imagery and updated aerial photographs to monitor changes in land use in the core of the caracara population. This information may be essential in determining the probability of recovery of caracaras, especially in response to agricultural development pressure.

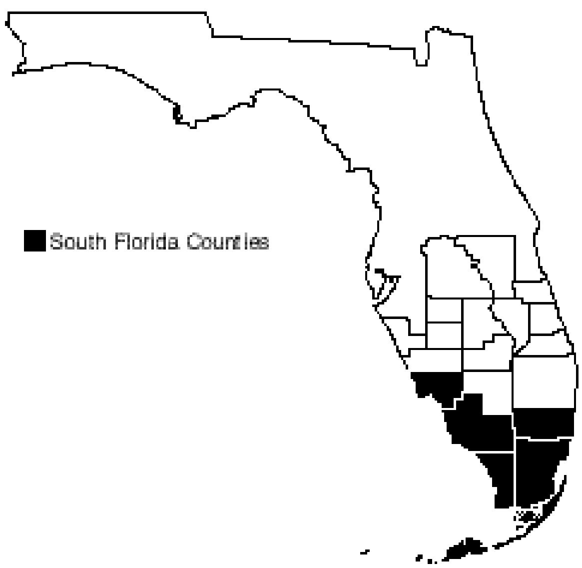
H5. Inform the public. Prairie communities are unique to central Florida and both the caracara and Florida grasshopper sparrow are only found in this community. The general public needs to be informed of the value of prairie, and its management needs.

American Crocodile

Crocodylus acutus

Federal Status:	**Endangered (Sept. 25, 1975)**
Critical Habitat:	**Designated (Dec. 1979)**
Florida Status:	**Endangered**
Recovery Plan Status:	**Revision (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. Florida distribution of the American crocodile; this species is only found in mangrove habitats within the shaded counties.



The American crocodile is one of two species of crocodilians endemic to the United States. The American crocodile inhabits coastal habitats of extreme South Florida, the Caribbean, Mexico, Central America and northern South America. At the northern limit of its range in Florida, American crocodiles coexist with American alligators. As with most other species of crocodilians, the American crocodile has been hunted for its hide and meat. Habitat loss and fragmentation due to increased urbanization and agricultural land uses are also threats to this species. In Florida, changes in the distribution, timing, and quantity of water flows also have affected the American crocodile, although the specifics of these effects are not clear. The crocodile population in Florida, although small, appears to be stable. The status throughout the remainder of its range is less certain. Future threats in Florida include stochastic natural disasters such as hurricanes and cold weather, road mortality, and continued habitat degradation. The American crocodile is a valuable indicator species of the health of South Florida's estuarine environments.

This account represents a revision of the existing recovery plan for the American crocodile (FWS 1984).

Description

The American crocodile is a large, greenish-gray crocodilian with black mottling. In Florida, adults reach lengths of about 3.8 m, although a specimen measuring 4.7 m was reported in the late 1800s (Moler 1992). In other portions of their range, individual crocodiles may reach 6.0 m (Ross and Magnusson 1989). Like all other crocodilians, males are larger than females. All adults have a hump above the eyes which may or may not be distinct, and irregular, asymmetrical dorsal armoring. Hatchlings measure approximately 27 cm and are normally yellowish tan to gray with dark crossmarkings on the body and tail. These markings fade as the animal grows. A lateral indentation of the upper jaw leaves the fourth tooth of the lower jaw exposed when the mouth is closed. Compared to the alligator, the American crocodile may be distinguished by its longer, narrower, more tapered snout and the exposed fourth tooth of the lower jaw.

Taxonomy

The American crocodile is one of 22 species of crocodilians (*Crocodylidae*) found throughout the world, and one of 13 species of crocodiles (*Crocodylinae*). Four species of crocodilians are found in North America; only the American crocodile and American alligator (*Alligator mississippiensis*) occur in the United States. In addition to the present treatment as American crocodile (*Crocodylus acutus*, Cuvier), Florida populations have also been reported as *Crocodylus floridanus* (Hornaday) and *Crocodylus americanus* (Boulenger).

Distribution

The historic distribution of American crocodiles in southern Florida has been debated for many years. Kushlan and Mazzotti (1989) provided the most comprehensive review of information regarding crocodile distribution, and suggested that the overall range of American crocodiles has not changed substantially over the past 200 years. Historically, American crocodiles occurred at least as far north on the Florida east coast as Lake Worth, Palm Beach County (DeSola 1935, Hornaday 1914, FWS 1984), to Tampa Bay on the west coast (Kushlan and Mazzotti 1989), and as far south as Key West (Allen and Neill 1952, Neill 1971).

The current distribution of the American crocodile is limited to extreme South Florida, including coastal areas of Miami-Dade, Monroe, Collier, and Lee counties (Figure 1). In Biscayne Bay, crocodiles have been observed as far north as Crandon Park, Bill Baggs Cape Florida SRA, and Snapper Creek (J. Maguire, Miami-Dade County Park and Recreation Department, personal communication 1998). Occasional sightings are still reported farther north on the east coast, and there are also records from Broward County, along the entire length of Biscayne Bay (Barbour 1923, 1944, DeSola 1935, Dimock 1915, FWS 1984); a few isolated crocodiles still survive in remnant mangrove habitats there. Along Florida's southwest coast, several small groups and individual crocodiles have been documented from Sanibel Island, Lee County, south to Collier Seminole SP, Collier County. Very few reliable reports are available for the Ten Thousand Islands area. Crocodiles are regularly seen in Everglades NP along the mainland shoreline of Florida Bay from the Cape Sable peninsula east to U.S. Highway 1, in mangrove habitats on North Key Largo from Blackwater Sound north to Ocean Reef Club, and at Florida Power and Light's Turkey Point Nuclear Electrical Generating Facility. These areas include Federal or State owned/managed lands in Everglades NP and Biscayne NP; Crocodile Lake NWR and J. N. "Ding" Darling NWR; Collier Seminole SP; and Key Largo Hammocks State Botanical Preserve. Crocodiles possibly occur on Homestead AFB and John Pennekamp Coral Reef SP. There are also records further south in the Florida Keys to the Matecumbe Keys, Stock Island, and Bahia Honda (Carr 1940, FWS 1984, P. Moler, GFC,

American crocodile. *Original photograph by Paul Moler.*

personal communication 1998).

The distribution of crocodiles during the non-nesting season may vary considerably among years since adult crocodiles can disperse great distances (Kushlan and Mazzotti 1989). However, the majority of crocodiles are present in the vicinity of core nesting areas, located near Biscayne and Florida bays (Kushlan and Mazzotti 1989).

The American crocodile also occurs in Cuba, Hispaniola, Jamaica, Trinidad, Margarita; the Atlantic Coast of Mexico from the Bay of Campeche south through the offshore islands of Belize to Venezuela and Colombia. On the Pacific Coast it is found from Sinaloa, Mexico, and the Tres Marias Islands south to coastal Ecuador and the Rio Chira in Peru (King *et al*. 1982, Ross and Magnusson 1989). Throughout their range, American crocodiles are sympatric with other crocodilians, although they tend to inhabit more saline waters than most other species. In Cuba they overlap with the Cuban crocodile (*Crocodylus rhombifer*) and in Central America and southern Mexico with the common caiman (*Caiman crocodylus*) and Morelet's crocodile (*Crocodylus moreletti*). The American crocodile and alligator are sympatric in brackish-water portions of their range in South Florida, but, due to evolutionary divergence, no hybridization would be expected.

Habitat

The American crocodile is found primarily in mangrove swamps and along low-energy mangrove-lined bays, creeks, and inland swamps (Kushlan and Mazzotti 1989). In Florida, patterns of crocodile habitat use shift seasonally. During the breeding and nesting seasons, adults outside of Key Largo and Turkey Point use the exposed shoreline of Florida Bay. Males tend to stay more inland than the females at this time (L. Brandt and F. Mazzotti, University of Florida, personal communication 1998; P. Moler, GFC, personal communication 1998). During the non-nesting season, they are found primarily in the fresh and brackish-water inland swamps, creeks, and bays, retreating further into the back country in fall and winter (Kushlan and Mazzotti 1989). In a study by Kushlan and Mazzotti (1989) along northeastern Florida Bay, crocodiles were found in inland ponds and creeks (50 percent of observations), protected coves (25 percent of observations), exposed shorelines (6 percent of observations) and a small number were observed on mud flats. The high use of inland waters suggests crocodiles prefer less saline waters, using sheltered areas such as undercut banks and mangrove snags and roots that are protected from wind and wave action. Access to deep water (>1.0 m) is also an important component of preferred habitats (Mazzoti 1983).

Natural nesting habitat includes sites with sandy shorelines or raised marl creek banks adjacent to deep water. Crocodiles also nest on elevated man-made structures such as canal berms and other places where fill has been introduced. In natural nesting situations, creek bank nests are generally considered optimal since these sites provide a good incubation medium and are generally protected from wind and wave action. These nest sites also provide deep water refuge for adult females. Nests adjacent to open water provide little protection from wave action for the nest, hatchlings, or adults. Shore nests are typically not located near good nursery habitat, and mortality of hatchlings is generally higher than in inland nests (Kushlan and Mazzotti 1989). Both nesting sites are desirable as there are tradeoffs associated with each, and hatching success at each type of location will vary among years depending on climatic conditions (L. Brandt and F. Mazzotti, University of Florida, personal communication 1998).

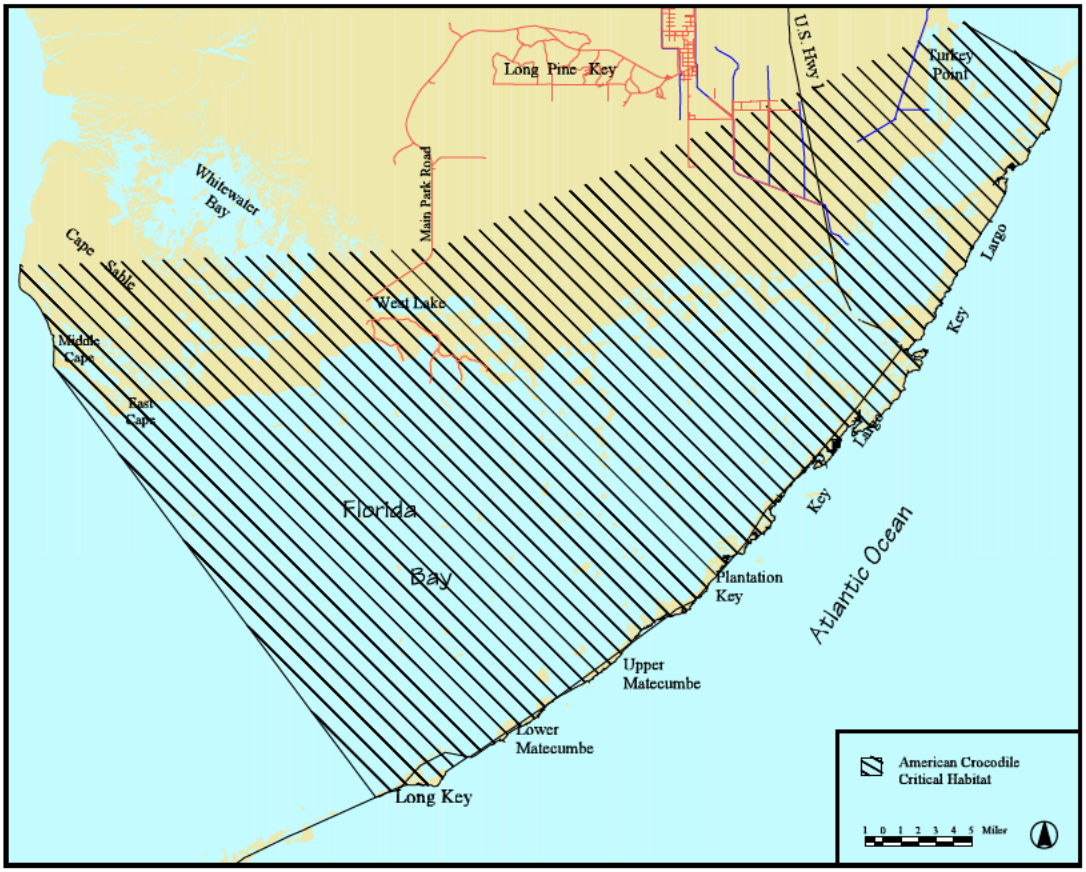
Critical Habitat

Critical habitat for the American crocodile (Figure 2) includes all land and water within an area encompassed by a line beginning at the easternmost tip of Turkey Point, Miami-Dade County, on the coast of Biscayne Bay; southeast along a straight line to Christmas Point at the southernmost tip of Elliott Key; southwest along a line following the shores of the Atlantic Ocean side of Old Rhodes Key, Palo Alto Key, Angelfish Key, Key Largo, Plantation Key, Lower Matecumbe Key, and Long Key, to the westernmost tip of Long Key; northwest along a straight line to the westernmost tip of Middle Cape; north along the shore of the Gulf of Mexico to the north side of the mouth of Little Sable Creek; east along a straight line to the northernmost point of Nine-Mile Pond; northeast along a straight line to the point of beginning (50 CFR 17.95).

Behavior

Reproduction

Females reach sexual maturity at about 2.25 m (Mazzotti 1983), a size reached at an age of about 10 to 13 years (LeBuff 1957). It is not known at what age and size females mature (Ogden 1978a). Similarly, the maximum



reproductive age for either sex is not known, although it is known that captively reared crocodilians eventually fail to reproduce.

As with most crocodilians, courtship and mating are stimulated by increasing ambient water and air temperatures. Reproductive behaviors peak when body temperatures reach levels necessary to sustain hormonal activity and gametogenesis. In South Florida, temperatures sufficient to allow initiation of courtship behavior are reached by late February through March. Like all other crocodilians, the mating system of the American crocodile is polygynous; each breeding male may mate with a number of females (Magnusson *et al.* 1989). Males typically establish and defend a breeding territory from late February through March (Moore 1953a, Garrick and Lang 1977). Vocalizations, body posturing, and outright aggression are used to maintain and defend territories and to secure mating privileges with females that roam freely between territories. Male and female American crocodiles go through a ritualistic mating sequence prior to copulation. Courtship in this species is considered to be one of the most structured of all crocodilians, with copulation predictably following precopulatory behaviors (Lang 1989, Thorbjarnarson 1991).

Following courtship and mating, females search for and eventually select a nest site in which they deposit an average of about 38 elongated oval eggs. Reported clutch size ranges from 8 to 56 eggs (Kushlan and Mazzotti 1989; P. Moler, GFC, personal communication 1998). Although American crocodile nesting is generally considered a non-social event, communal nesting is the norm in parts of the Caribbean, southeast Cuba, and Haiti. In the U.S., several incidents of 2-clutch nests have been reported (Kushlan and Mazzotti 1989; P. Moler, GFC, personal communication 1998). Nest sites are typically selected where a sandy substrate exists above the normal high water level. Nesting sites include areas of well drained sands, marl, peat, and rocky spoil and may include areas such as sand/shell beaches, stream banks, and canal spoil banks that are adjacent to relatively deep water (Ogden 1978a, Kushlan and Mazzotti 1989). In some instances, where sand or river banks are not available for nesting sites, a hole will be dug in a pile of vegetation or marl the female has gathered. The use of mounds or holes for nesting is independent of the substrate type and may vary among years by the same female (Kushlan and Mazzotti 1989).

The success of American crocodile nesting in South Florida is dependent primarily on the maintenance of suitable egg cavity moisture throughout incubation. Predation and flooding also affect nest success. On Key Largo and other islands, failure of crocodile nests is typically attributed to desiccation due to low rainfall (Moler 1991a). On Key Largo, about 52 percent of nests were successful in hatching at least one young (Moler 1991a). Nest failures on the mainland may be associated with flooding, desiccation, or predation (Mazzotti *et al.* 1988, Mazzotti 1989). On the mainland, about 13 percent of nests monitored were affected by flooding or desiccation, whereas 13 percent of nests were partially or entirely depredated (Mazzotti *et al.* 1988, Mazzotti 1989). More recently, Mazzotti (1994) found that predation rates on the mainland increased to 27 percent, and only 9 percent of nests failed because of infertility or embryonic mortality. Most examined eggs have been fertile (90 percent, range 84 to 100 percent) (Kushlan and Mazzotti 1989, Mazzotti 1989).

Incubation of the clutch takes about 86 days (Lang 1975), during which time the female periodically visits the nest (Moore 1953a, Neill 1971, Ogden 1978a). Some females may also attend and defend their nest during incubation (Alvarez del Toro 1974, Ross and Magnusson 1989), but this behavior is highly variable among individuals and nest defense has not been observed in the U.S or Cuba (P. Moler, GFC, personal communication 1998). In Florida, American crocodiles are not known to regularly defend their nest against humans (Kushlan and Mazzotti 1989). However, all females must return to the nest to excavate hatchlings since the young are unable to liberate themselves from the nest cavity (Moore 1953b, Neill 1971, Ogden and Singletary 1973, FWS 1984). Parental care after hatching has not been reported for this species in Florida, even though this behavior has been documented in other American crocodile populations (Kushlan and Mazzotti 1989).

The young may remain together loosely for several days to several weeks following hatching, but they are rarely seen with adults (Lang 1975, Moler 1991b, Mazzotti 1983, Kushlan and Mazzotti 1989). Hatchling survival appears to be low in Everglades NP (< 5 percent) (Mazzotti 1983, Kushlan and Mazzotti 1989), higher at Turkey Point (8.5 percent) (L. Brandt and F. Mazzotti, University of Florida, personal communication 1998), and even higher in the more sheltered habitats of North Key Largo (20.4 percent) (Moler 1991b). Higher survival on Key Largo has been attributed to the close proximity of nest sites to suitable nursery habitat. On the mainland, nest sites on exposed beaches are often far from nursery habitat, requiring recently hatched young to disperse long distances in unsheltered water. Hatchlings seek shelter during the day in beach wrack or among mangrove roots when available (Mazzotti 1983). Predation during these dispersals is probably high, although little information is available to support this conclusion (Kushlan and Mazzotti 1989).

Foraging

The American crocodile is typically active from shortly before sunset to shortly after sunrise (Lang 1975, Mazzotti 1983). During these times, crocodiles forage opportunistically, eating whatever animals they can catch. Juveniles typically eat fish, crabs, snakes, and other small invertebrates, whereas adults are known to eat fish, crabs, snakes, turtles, birds, and small mammals (Ogden 1978b, Ross and Magnusson 1989). American crocodiles probably feed only rarely during periods of low ambient air temperatures, since metabolic and digestive systems are slowed at lower body temperatures.

Relationship to Other Species

As mentioned above, American crocodiles live sympatrically with American alligators where salinities are low. Most crocodilians tolerate others of the same species and of different ages provided food and other essential habitat requirements are not limiting. Where two or more species coexist, tolerance among species is also common and is usually ensured by species-specific differences in habitat utilization. In Florida, the American crocodile and alligator have probably coexisted for thousands of years and relied on changing salinity gradients of surface waters to dictate which species predominated in certain areas. Though these species probably intermingle frequently throughout the year, we are aware of only one location where both species may nest side-by-side. If substantiated, the nesting sites along a canal berm in the vicinity of Marco Island, Collier County, would indicate use of a common nesting area by these species. However, the species' breeding seasons may be sufficiently asynchronous in this area to allow crocodiles to breed and nest before alligators become reproductively active.

The depredation rate of American crocodile nests by raccoons (*Procyon lotor*) in South Florida is low compared to depredation rates other crocodilians suffer from terrestrial nest predators. Therefore, although the raccoon may locally be an important predator, their overall effect on the crocodile population is not considered limiting in areas where their populations are not unnaturally high. Once hatched, crocodilians may be eaten by several species of wading birds and gulls, blue crabs, sharks, and other crocodiles. Though limited, survival information from Key Largo suggests that predation does not limit recruitment of juveniles in that area.

Status and Trends

Crocodiles were listed as endangered throughout their range in 1975, (40 CFR 44151) and critical habitat was established for this species in 1979 (44 CFR 75076). The listing of the species and protection of habitat were required because of documented population declines most likely associated with habitat alterations and direct human disturbances to crocodiles and their nests (FWS 1984).

Historic estimates of the American crocodile population in South Florida are difficult to substantiate because many records are anecdotal and early observations may have been confused with sympatric alligators. In addition, estuarine habitats, preferred by crocodiles, were remote and inaccessible to early settlers, thereby precluding reliable and consistent observations. Ogden (1978a) estimated that between 1,000 to 2,000 American crocodiles existed in South Florida in the early 20th century, but he thought this probably underestimated the population because extensive settlement and associated hunting had already occurred by this time. During the late 19th century and the first half of the 20th century, many Florida crocodiles were collected for museums and live exhibits (Cory 1896, Hornaday 1914, Dimock 1915, DeSola 1935, Dickinson 1953, Behler 1978). The species was also legally hunted in Florida until about 1962. By the mid-1970s, crocodile numbers had been reduced to between 100 to 400 non-hatchling individuals (Ogden 1978a).

In addition to the taking of individual crocodiles, habitat modification and destruction has been occurring since the human settlement of South Florida. Formerly occupied habitats from Lake Worth, Palm Beach County, south to central Biscayne Bay, Miami-Dade County, have been largely destroyed by urbanization. In some of these areas, crocodiles have been essentially extirpated. (DeSola 1935, FWS 1984). Recent trends, however, indicate that they may be expanding back into central Biscayne Bay, and that they have successfully nested at Chapman Field Park (J. Maguire, Miami-Dade County Parks and Recreation Department, personal communication 1998). In the Middle and Lower Florida Keys urbanization has led to habitat degradation and loss. Though crocodiles were never abundant in these areas, further habitat loss limits opportunities for dispersing crocodiles to persist there. Crocodiles were also probably never common along Florida's west coast. Urbanization there has also substantially altered much of the habitat once occupied.

Human encroachment into estuarine habitats can disturb crocodiles to such an extent that normal behavior patterns are altered. As recreational demands increase on public lands, indirect disturbance by apparently innocuous human activities such as camping, fishing, and boating are expected to increasingly affect crocodiles. Observations suggest that repeated close human presence may cause female crocodiles to abandon nests or relocate nest sites (Kushlan and Mazzotti 1989). Recreational boating, including use of jet skis, has been limited in portions of the American crocodile's habitat within Everglades NP, but public demands for additional recreational opportunities will likely threaten these sanctuaries in the future.

Crocodiles are frequently killed on U.S. Highway 1 and Card Sound Road. On average, 3 to 4 crocodiles are killed annually while crossing these roads (Mazzotti 1983, Moler 1991b). Unfortunately, subadults and adults make up the majority of road mortalities. Efforts to preclude crocodile movement across portions of Card Sound Road by fencing sections of the road have been largely unsuccessful, due primarily to improper installation of the fence.

Natural, catastrophic, stochastic events such as hurricanes also are known to adversely affect American crocodiles and may be one of the most important factors limiting the number and distribution of this species in South Florida. Crocodiles are long-lived and suffer high juvenile mortality and must, therefore, produce many young over their lifetime to ensure sufficient recruitment and population persistence. Natural events that add substantial adult mortality can result in long periods of little or no recruitment. Failure to successfully recruit age classes in consecutive years can, if repeated periodically, depress small populations.

Crocodiles undoubtedly perish during tropical storms and hurricanes that make landfall in extreme South Florida. The tidal surges, rough seas, and high winds probably result in direct mortality, but may also erode important nesting beaches, destroy nests, and alter other important habitat features. The adverse effects of tropical weather have not been quantified or reported extensively in the literature. Ogden (1978a) suggested that the occurrence of major hurricanes at regular intervals may be a factor that serves to hold the Florida crocodile population at some depressed level.

Even though extreme South Florida is considered sub-tropical, it is occasionally exposed to sub-freezing temperatures. The effect of freezing temperatures on American crocodile populations is not well known, principally because crocodiles which may be killed during freezes are rarely found (Dimock 1915, Barbour 1923, Mazzotti 1983). Critical minimum water temperatures are not known, but water temperatures of 13 to 14° C in sheltered canals did not result in crocodile mortality during an extremely hard freeze in southern Florida during 1989. Unconfirmed reports identified four dead crocodiles in exposed areas after this freeze; mortality was likely much higher since dead crocodiles were difficult to find (Moler 1991b). Moler (1991b) documented a substantial decline in nesting effort during the following spring, and suggested that adult mortality during the freeze may have been responsible for the observed decline in nesting.

Water salinity affects habitat use and may be locally important, especially during periods of low rainfall. Although American crocodiles have salt glands that excrete excess salt and physiological mechanisms to reduce water loss (Dunson 1970, 1980, 1982; Evans and Ellis 1977; Dunson and Mazzotti 1989; Mazzotti 1989), maintenance of an osmotic balance requires access to low salinity water for juveniles. Hatchling crocodiles are particularly susceptible to osmoregulatory stress and may need to have brackish to fresh water (4 ppt) available at least once per week to increase growth (Mazotti *et al.* 1986). Crocodiles larger than 200 g have sufficient mass to withstand osmoregulatory stress and are not typically believed to be affected by drought (Mazzotti and Dunson 1984). Freshwater needs of the crocodile are usually met with frequent rainfall, which results in a “lens” of fresh water on the surface that may persist for several days after rainfall (Mazzotti and Dunson 1984). Hatchling crocodiles are probably stressed and occasionally die during periods of low rainfall. Anthropogenic changes in the amount and timing of freshwater flow to South Florida may have resulted in shifts in the distribution of American crocodiles. Unfortunately, detailed data on crocodile distribution is only available since the early 1970s, and any changes that may have occurred due to hydrological perturbations over the past century cannot be identified with available information.

Combined, many of the natural and anthropogenic factors described above have resulted in adverse effects to the American crocodile. Compared to the historical estimates of 1,000 to 2,000 animals (Ogden 1978a), populations have declined, and shifts in the nesting distribution have likely occurred. The lowest estimated population levels apparently occurred sometime during the 1960s or 70s, when Ogden (1978b) estimated the Florida population of the American crocodile to be between 100 and 400 non-hatchlings.

The American crocodile population in South Florida has increased substantially over the last 20 years. P. Moler (GFC, personal communication 1996) believes between 500 and 1,000 individuals (including hatchlings) persist there currently. The recent increase is best represented by changes in nesting effort. Survey data gathered with consistent effort indicate that nesting has increased from about 20 nests in the late 1970s to about 50 nests in 1997. Since female crocodiles produce only one clutch per year, it follows that the population of reproductively active females has more than doubled in the last 20 years. In addition, since at least a portion of the population's sex ratio approaches 1:1 (Moler 1991b), it is likely that the male portion of the population has also increased substantially.

Throughout the remainder of its range, the American crocodile has suffered from threats similar to those that have adversely affected the species in South Florida. Unfortunately, only Costa Rica and Venezuela have adequately protected the American crocodile and its habitat, although Cuba protects a number of areas with large crocodile populations (King 1989, P. Moler, GFC, personal communication 1998). Other countries have no or few laws to protect them or are unable to enforce conservation laws that do exist. Current threats to the continued survival of the American crocodile outside of the United States include changes in agricultural, ranching, and forestry practices that affect coastal habitats; developing tourism industries that seek to benefit from tropical, beachfront properties (Alcala and Dy-Lyiacco 1989); and legal and illegal hunting. As natural habitats are destroyed and replaced with landscapes that benefit humans, American crocodiles will become increasingly susceptible to the public's intolerance of human/crocodile conflicts.

Management

Protection of the American crocodile outside of the United States was enhanced when most countries throughout the range of the species became signatories to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES signatories agreed that, as an Appendix I species, the American crocodile would be afforded protection from international commerce. This protective measure has greatly reduced, and in some cases eliminated illegal harvests of the crocodile for its hide. Other protective measures include prohibitions against hunting all crocodilians in Mexico, and establishment of no-hunting areas in certain portions of Cuba (National Resolution No. 21-79).

In 1984 the FWS prepared a recovery plan for the American crocodile. Numerous conservation measures were identified in the recovery plan that were needed to ensure persistence and recovery of the crocodile in South Florida, including securing habitat for all life stages and establishment of self-sustaining populations at natural carrying capacity in appropriate habitats. In addition, the recovery plan for the American crocodile called for research to determine habitat needs, habitat distribution, ownership, and habitat availability to crocodiles. Management options include controlling of human-related mortality, informing the public, reducing natural mortality, and protecting nest sites.

Recovery efforts for the American crocodile are underway and are likely responsible for increases in the number of crocodiles in South Florida. About 2,640 ha have been acquired for protection of crocodiles and other imperiled species at Crocodile Lake NWR. This area consists of 262 ha of wetlands and open water habitats that directly support crocodile conservation. Crocodile habitat is also protected in Everglades NP Biscayne NP, J. N. "Ding" Darling NWR, Ten Thousand Islands NWR, Collier Seminole SP, Key Largo Hammocks State Botanical Preserve, and several Miami-Dade County parks: Matheson, Snapper Creek, Black Point, Chapman Field and Crandon. The Biscayne Wetlands and Cutler Wetlands acquisition projects in Miami-Dade County seek to place over 810 additional ha of coastal habitat into public ownership; these areas border Biscayne National Park (J. Maguire, Miami-Dade County Park and Recreation Department, 1998). The only area extensively used by crocodiles that is not under public ownership is the habitat created by construction of Florida Power and Light's Turkey Point electrical generating facility.

Crocodile nesting continues to be monitored by the GFC and FWS on Key Largo, Florida Power and Light at Turkey Point, NPS on the mainland, and by Miami-Dade County at Chapman Field. In 1984, crocodile crossing signs were erected along U.S. Highway 1 to provide public awareness and reduce automobile/crocodile collisions. During future road widening of U.S. Highway 1, box culverts will replace existing small diameter culverts to allow crocodiles to pass under the highway. Fencing also may be erected along portions of U.S. Highway 1 to discourage crocodile movement over the road (P. Moler, GFC, personal communication 1996).

The timing and frequency of the freshwater hydroperiod substantially influences the health of the estuarine environment in South Florida and may be one of the most important large scale factors influencing crocodile populations on the mainland. It is well known that historic alterations to the natural flow have directly affected plant and animal communities. Although there is no direct causal relationship between freshwater flow alterations and American crocodile numbers, some of the population decline witnessed through the 1970s probably was attributable to changes in the amount and timing of surface water flow to South Florida. Future changes in hydrology that mimic natural flow conditions are likely to benefit crocodiles in the long-term, but care should be taken to ensure that changes in the delivery of water do not result in catastrophic, short-term, adverse effects. When added to all other natural and anthropogenic sources of mortality, such habitat changes could have substantial impacts on crocodile nesting and hatchling survival. As advances in water management are made in South Florida, research is expected to continue to assess the effects on the American crocodile of changes in the amount and timing of water delivery (Mazzotti 1996).

As discussed above, availability of fresh water is essential to hatchling crocodile survival. Instream freshwater flow and rainfall provide this water to hatchlings emerging from mainland nests, but hatchlings from islands (including Key Largo) depend solely on rainfall. During periods of low rainfall, island hatchlings do not gain mass and are less likely to survive during winter months (Moler 1991b). To increase hatchling survival and recruitment, Moler (1991b) suggested that supplemental sources of fresh water be provided during the 3 to 4 month period following hatching. Supplemental sources of fresh water may be particularly important since recent efforts to restore functioning mangrove wetlands in Crocodile Lake NWR have increased salinities in an important crocodile nursery area. Restoration of suitable salinities in this area should be considered if future monitoring indicates low hatchling growth and survival.

The numerous hydrologic projects associated with the restoration of the South Florida Ecosystem are in various stages of planning and implementation. The FWS has determined that the Central and South Florida Restudy should provide a benefit to the American crocodile. These efforts propose to improve habitat conditions through decreased salinities in Florida Bay and Shark River Slough estuarine areas by increasing volume and improved timing of freshwater flows to those areas.

Encroachment of exotic vegetation has degraded thousands of hectares of wildlife habitat in South Florida. In coastal areas, and on Key Largo, Australian pine (*Casuarina equisetifolia*), cajeput (*Melaleuca quinquenervia*), and Brazilian pepper (*Schinus terebinthifolius*) aggressively invade levees and berms. Moler (1991a) found widespread invasion of *C. equisetifolia* and to a lesser extent *M. quinquenervia* and *S. terebinthifolius* at crocodile nesting sites on Key Largo. Many of the exotics were removed during habitat restoration efforts in 1994, but vigorous regrowth and reinvasion is inevitable, and periodic efforts to control exotic vegetation will likely be required to maintain suitability of crocodile nesting sites. F. Mazzotti (University of Florida, personal communication 1996) indicated that invasive exotics were also encroaching on crocodile nest sites at Turkey Point. However, he noted that if measures outlined in Florida Power and Light's crocodile management plan were followed, exotic vegetation would be controlled before it threatened crocodile nesting sites. Renewed efforts may be needed to control exotic plants at Turkey Point. Exotic plant control in Everglades NP should continue. Australian pine has been found, and destroyed by Park staff, on nesting beaches and keys (Brandt *et al.* 1995; L. Brandt and F. Mazzotti, University of Florida, personal communication 1998).

Management programs or land-use restrictions are used on some public lands to protect and conserve natural resources. In Everglades NP, closure of water bodies has reduced boat traffic and minimized human-crocodile encounters. Unfortunately, restrictions on land and water use are now being challenged, and increasing demands for recreational opportunities may threaten crocodiles in some areas. Although human exclusion may be the best management technique for protecting crocodiles and their habitat, it is clear that an increasing number of the general public do not support this management alternative.

Though management of the physical components of crocodile habitat is essential to the continued survival of this species, emphasis must be placed on mimimizing the potential for human-crocodile encounters. Human tolerance for and acceptance of increasing crocodile numbers is one of the primary reasons for the increase in population numbers over the last 20 years. However, as the crocodile population continues to increase, we anticipate an increasing number of human-crocodile conflicts. Unfortunately, dredging of shallow waters and creation of exposed shorelines have resulted in artificial habitats that attract crocodiles to areas adjacent to human habitation. Although American crocodiles are generally considered to be non-aggressive, the public's perception of them is that of a large, dangerous, carnivore. If crocodile numbers continue to increase, we believe that more encounters will result in an increasing intolerance of crocodiles and more demands for action to reduce human-crocodile conflicts.

The GFC, through a cooperative agreement with the FWS, currently addresses human-crocodile conflicts on a case-by-case basis (GFC 1988). We believe that the GFC's guidelines for managing human-crocodile conflicts are a reasonable and flexible management alternative that can be used well into the future. These guidelines, however, are reactionary and do not attempt to address the factors leading to human-crocodile conflicts. As mentioned above, part of the reason for increasing conflicts is that humans have altered the landscape for residential, commercial, or recreational purposes without rendering this formerly potential crocodile habitat completely unsuitable. The expanding crocodile population will continue to move into these habitats and will occasionally come into conflict with humans. The guidelines should be updated to include guidance to land managers who are dealing with an increased presence of crocodilians near populated areas. The guidelines should then be incorporated into management plans.

It is unlikely that the expanding crocodile population can be prevented from using artificial habitats. These areas provide important components of crocodile habitat including basking, nesting, nursery, and deep water refugia. It is less likely that human use of already altered land can be substantially modified. For example, homeowners are not likely to abandon their houses because crocodiles bask or nest in their yards. Similarly, filling of deep water channels is improbable since these provide watercraft access to waterfront homesites. Seasonal restrictions for disruptive recreational uses such as powerboating, jet skis, camping, etc. may be appropriate near crocodile nesting locations. In other areas, new or increased recreational access may not be appropriate, since recreational use could result in greater human-crocodile conflict. Implementing recreational restrictions will be difficult, as demands for access continue to increase. Public education must provide the foundation for developing positive, proactive, attitudes about crocodile conservation. Aggressive public education is probably the most effective tool available to ensure the continued growth and recovery of South Florida's American crocodile population.

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Recovery for the American Crocodile

Crocodylus acutus

Recovery Objective: **RECLASSIFY** to threatened.

Recovery Criteria

The initial recovery plan for this species identified habitat alteration and human disturbances as the primary threats to this species and those that warranted its listing. Although efforts have been undertaken to ameliorate these threats, it is generally believed that these factors continue to act against the American crocodile to some extent. However, despite the ongoing influences of these threats, the crocodile has increased in numbers and is approaching population levels targeted by the initial recovery plan. It is apparent, therefore, that the effects of these threats are not as deleterious as previous assessments may have suggested, and that the reclassification of this species is possible.

Previous recovery efforts identified the need for a minimum of 60 breeding females within the population before reclassification could be considered. Since these criteria were developed, new information, based on consistent surveys, has indicated that the total number of nesting females has increased substantially over the last 20 years, from about 20 animals to about 50, and that nesting has remained stable at the major nesting areas. Based on the fact that the population appears stable, and that all of the threats as described in the original listing have been eliminated or reduced, reclassification of the crocodile will be possible, provided existing levels of protection continue to be afforded to crocodiles and their habitat, and that management efforts continue to maintain or enhance the amount and quality of available habitats necessary for all life stages

Species-level Recovery Actions

S1. **Conduct surveys to determine the current distribution and abundance of American crocodiles**. Survey all remaining suitable habitats in South Florida for American crocodiles. Most knowledge about the current distribution of crocodiles comes from surveys conducted within Everglades NP, the upper Florida Keys, and areas surrounding Turkey Point in Miami-Dade County. These areas correspond to locations with the highest known crocodile densities, but do not represent the entire range of the American crocodile. Surveys for crocodiles have not been conducted in large portions of South Florida; for example, American crocodiles have been observed in increasing numbers on the southwest coast of Florida, north to the J.N. Ding Darling NWR. These areas should be surveyed in order to determine the size and distribution of the American crocodile population and should include occurrence of individuals and nesting effort.

S1.1. **Evaluate coastal wetlands to determine their suitability for crocodiles**. Inventory potential habitat for American crocodiles with an emphasis on the southwest coast of Florida from Whitewater Bay north to Marco Island. Most known nesting and nursery sites are now publicly owned, but large areas of mangrove-lined coastline have not been surveyed for crocodiles. Before beginning time-consuming population surveys, coastal habitat in southwestern Florida should be assessed to identify areas that could support

American crocodiles. Continue to survey coastal wetlands of Biscayne Bay because of the increased potential for human/crocodile interactions.

S1.2. **Survey crocodile colonies in suitable habitats in South Florida**. In combination with **S1.1,** survey suitable habitats for all age classes of crocodile, especially in Biscayne Bay where nesting has been documented, and those areas of southwest Florida where information on the distribution and status of crocodiles is lacking. If substantial aggregations are located, they should be included in annual population monitoring programs.

S2. **Protect and enhance existing colonies of American crocodile**s. Although numbers of crocodiles are increasing in South Florida, habitat loss and degradation may limit the extent to which this expansion continues. In order to sustain the growth of the crocodile population, habitat that is suitable to meet the needs of all age classes must be protected. In some cases this habitat must be restored. Even though information is not available on the habitat requirements for each age class of American crocodile, the recovery team has basic information about the biotic and abiotic factors required for survival of this species. Although juvenile and adult crocodiles are less susceptible to fluctuations in their environment than hatchlings, the availability of refugia adjacent to deep water may be the single most important habitat characteristic that ensures the survival of these age classes.

S2.1. **Reduce or eliminate sources of American crocodile mortality**. All activities that affect crocodile habitat should be evaluated and appropriate steps taken to minimize or eliminate adverse affects to crocodiles and their habitat.

S2.1.1. **Control human-induced crocodile mortality and disturbance**. Reduce or eliminate anthropogenic sources of mortality. Human causes of mortality may be additive to an otherwise unknown level of natural mortality. However, many depressed populations can be pushed beyond their capability to recover when sources of additive mortality also affect population levels.

S2.1.2. **Alert motorists on roads where repeated collisions between automobiles and American crocodiles have occurred**. State Road 905, U.S. 1, and Card Sound Road have been posted with crocodile crossing warning signs for some time, but collisions with automobiles still occur periodically. An assessment of the effectiveness of signing should be conducted to determine if additional information would be useful in reducing American crocodile mortalities.

S2.1.3. **Reduce the incidence of American crocodile road mortalities by installing box culverts**. Construct culverts on portions of U.S. 1 to reduce automobile-crocodile collisions. Automobile-crocodile collisions have occurred periodically on portions of U.S. 1 and may be minimized through installation of pass-through culverts. Although there remains uncertainty about the effectiveness of installing culverts for the safe passage of crocodiles under highways, it is likely they will be used to some extent. When U.S. Highway 1 is widened, culverts should be installed at locations where crocodile mortalities have occurred.

S2.1.4. **Control terrestrial predators of crocodile eggs and hatchlings in areas where they may be artifically high**. Human visitation of some areas (such as Cape Sable in Everglades NP) create unnatural conditions for predators such as raccoons. These animals could be adversely affecting survival and recruitment of the crocodile on public lands **.**

S2.2. **Continue long-term assessment of pesticide and heavy metal contamination levels in crocodile eggs**. Assessments of environmental contaminants in eggs should be conducted every 5 years.

S2.3. **Assure coordinated management actions by interagency agreements or other means**. Responsibility for the management of the American crocodile is currently divided between the State of Florida (GFC), the NPS, and the FWS. Currently the GFC, in consultation with the FWS, is managing human-crocodile conflicts outside of Everglades NP The NPS retains management authority for crocodiles within Everglades NP. The FWS protects the American crocodile throughout its range through its regulatory programs. Steps should be taken to insure that the actions of these agencies are coordinated and non-conflicting.

S3. **Conduct research on the biology and life history of crocodiles**. Although basic information on the biology of the American crocodile has been collected, more detailed information is needed to determine the status of the crocodile population in South Florida.

S3.1. **Determine the carrying capacity of remaining crocodile habitat in South Florida**. The expansion of the American crocodile population in South Florida will be limited by the amount of habitat suitable for one or more life-history stages (*e.g.*, nesting, feeding, dispersal, refuge, *etc.*). To estimate the potential for the American crocodile population to continue to grow, it will be necessary to identify limiting habitats. Historical information on the South Florida crocodile population and information on other American crocodile populations may be essential in determining the carrying capacity for South Florida.

S3.2. **Conduct research to determine basic biological needs of the American crocodile**. Conduct or continue mark-recapture efforts, population and nest surveys, and habitat monitoring in the vicinity of previous research and monitoring work done on Key Largo, Turkey Point, and Everglades NP Where other congregations of crocodiles are found in the future, conduct similar efforts. We know little about the species in southwest Florida or within the recently discovered breeding aggregation on Marco Island. Additional information is needed to determine the demographics of the American crocodile. Information on survival, recruitment, fecundity, and mortality are important in assessing the relative health of this population.

S3.3. **Evaluate the effects of human disturbances on crocodile behavior**. Conduct research to determine behavioral reactions to human disturbances.

S3.4. **Develop identification techniques for American crocodiles**. Distinguishing genetic differences between American crocodiles found in South Florida from American crocodiles throughout the remainder of their range will be essential in assessing the extent to which foreign crocodiles have contributed to the present genetic profile of crocodiles in South Florida.

S4. **Monitor the South Florida crocodile population**. Long-term monitoring is essential to the assessment of the status of the crocodile population.

S4.1. **Coordinate monitoring programs and protocols.** Data collected, marking system, and database management methods should be standardized among researchers.

S4.2. **Conduct surveys for American crocodiles**. Ongoing population surveys at Key Largo, Everglades NP, Turkey Point, and Biscayne Bay are important in the long-term assessment of the crocodile population in South Florida. Survey data should provide information on the number, distribution, and size class trends in these areas. As the population expands, survey efforts should be initiated in other areas where congregations of crocodiles occur.

S4.3. **Conduct a mark-recapture program for the American crocodile**. Mark-recapture data provide important information on growth, survival, and dispersal. These data will be essential in assessing the status of the crocodile in South Florida.

S5. **Inform the public about the recovery needs of crocodiles.** The public is generally unaware of the biology and status of the American crocodile, and misunderstandings still result in adverse sentiment towards this species. Public education is required to provide accurate biological information and to stimulate interest in the conservation of the American crocodile. Public information should include the general public, public officials, land managers, and policy makers.

S5.1. **Continue relocation of problem crocodiles**. GFC policy currently provides for the relocation of crocodiles that threaten human safety. Although this program results in the non-lethal removal of problem animals, it reduces the likelihood that habituated or bold crocodiles will be killed by members of the public. This program reduces mortality and provides opportunities for public education.

S5.2. **Assess the effectiveness of road signage for reducing the numbers of American crocodiles killed by automobiles**. U.S. 1 in the Florida Keys has been posted with crocodile crossing warning signs for some time, but collisions with automobiles still occur periodically. An assessment of the effectiveness of signing should be conducted to determine if different approaches to these signs should be used to reduce crocodile mortalities along these two roads. The signs that have been used for the West Indian manatee should be examined as alternative models.

S5.3. **Develop and distribute informational brochures regarding the biology and conservation of American crocodiles**. Distribution locations should include facilities that rent boats and personal watercraft, fishing charters, county and State parks, bait and tackle shops, restaurants along Florida Bay, and neighborhoods with resident crocodiles.

Habitat-level Recovery Actions

H1. **Protect nesting, basking, and nursery habitat of American crocodiles in South Florida**.

H1.1 **Acquire or otherwise protect habitat for crocodiles**. Large amounts of suitable habitat for American crocodiles have been protected inside Everglades NP, Biscayne NP, and Crocodile Lake NWR. However, extensive areas of suitable, occupied habitat and potentially restorable habitat for American crocodiles are not protected, particularly in southwestern Florida (Collier and Lee counties). Once lands that support suitable, occupied, or potentially restorable habitat for American crocodiles have been identified (see Task **S1**.), those lands should be protected either through additional land acquisition or cooperative management agreements with the land owner or land manager

H1.2. Protect essential crocodile habitat on private lands. If suitable habitat for American crocodiles is found on private lands, determine owner and appropriate conservation measures such as acquisition, easements, transfer of development rights, establishment of protective management plans, *etc*. Less than simple fee title acquisition may be required for crocodile habitat on private lands. Conservation agreements or easements or transfer of development rights may protect crocodile habitat on some private lands.

H2. Manage and restore suitable habitat of American crocodiles.

H2.1. Continue to maintain nesting sites adequate to maintain viability of the American crocodile. Crocodile Lake NWR on Key Largo, Everglades National Park, and Florida Power and Light's Turkey Point nuclear electrical generating facility currently provide the majority of nesting habitat for the American crocodile in South Florida. These areas must be adequately managed to sustain or increase the current level of nesting. Continue efforts to control exotic plants that have invaded portions of crocodile nesting habitat in these areas.

H2.2. Restore areas to suitable habitat. Much of the suitable habitat outside of Everglades and Biscayne national parks has been degraded or destroyed due to residential, commercial, or agricultural uses. Some of these areas may be suitable for restoration efforts. This will require: removal of exotic plants that degrade the quality of dispersal habitat for juvenile crocodiles, nesting sites, and basking areas; restoration of native vegetation in areas where the control of exotic vegetation or other human disturbances created large gaps in vegetated shoreline; and restoration of hydroperiods and hydropatterns in the Everglades and Big Cypress drainages so that hydrologic patterns mimic timing, flows, and depths that would have occurred under a rainfall-driven system. Natural hydroperiods will likely provide sufficient fresh water to periodically flush creek beds to maintain deepwater refugia for breeding adults. Restored hydroperiods also will decrease average salinities during late summer, when hatchlings require low-salinity water.

H2.1. Complete the Project to Modify Water Deliveries to Everglades NP and the Canal 111 Project. Both of these U.S. Army COE projects are designed to restore more natural patterns of water deliveries to eastern Florida Bay through Taylor Slough and Shark River Slough. Both projects should substantially improve habitat quality for American crocodiles in eastern Florida Bay. Although these projects have been authorized and construction on these projects initiated, they have not been completed. Both projects must be completed to increase the likelihood of the crocodiles' survival and recovery in the wild.

H2.2. Continue to monitor the effects of the Program of Experimental Water Deliveries to Everglades NP on the American crocodile to determine optimal operational schedules. As outlined in item **H2.1**. the COE is currently authorized to construct the Project to Modify Water Deliveries to Everglades National Park and the Canal 111 Project. Both of these projects are designed to restore more natural patterns of water deliveries to eastern Florida Bay through Taylor Slough and Shark River Slough and should substantially improve habitat quality for American crocodiles in eastern Florida Bay. However, the benefits of these projects to the American crocodile will depend on how the structures associated with the projects will be operated. The Program of Experimental Water Deliveries to Everglades NP iteratively assesses how the operations of water control structures affect the health of Everglades NP and associated biota. American crocodiles are currently being monitored as part of the Experimental Program; this monitoring should continue with a specific emphasis on determining the response of American crocodiles and their habitat to different operational schedules.

H2.3. Continue habitat and population modeling to determine operational schedules for structures associated with the Program to Modify Water Deliveries to Everglades NP, Canal 111, and the Central and Southern Florida Flood Control Project that provide optimal habitat for the American crocodile. The operations of structures associated with these three projects will determine the actual benefits of these projects to the American crocodile. For example, these projects could be operated in ways that either restore or create nursery habitat for juvenile American crocodiles (see item **H2.4.**). Some of the information necessary to determine how to operate structures associated with these projects to optimize habitat for American crocodiles will be generated by the monitoring program associated with the Experimental Program of Water Deliveries to Everglades National Park, but additional evaluations will be necessary. Additional models that will help determine optimal operational schedules are being developed as part of the USGS's (BRD) Across Tropic Level System Simulation. This modeling effort should continue and new efforts should be initiated to determine optimal operational schedules for COE structures in South Florida.

H.2.4. Create additional nesting habitat for crocodiles in South Florida. Recovery of the American crocodile is dependent on the availability of adequate nesting sites, and an increase in the amount of suitable nesting habitat could increase recruitment into the population.

H2.5. Restore or create nursery habitat for American crocodiles in South Florida. This will generally require restoration of suitable, lower-salinity regimes to nursery areas for juvenile American crocodiles. Restoration of mangrove wetlands within Crocodile Lake NWR has resulted in increased salinity in one important nursery area, rendering the area less suitable for hatchlings. On Florida's southeastern coast, three COE projects (Project to Modify Water Deliveries to Everglades NP, Canal 111 Project, and the Central and Southern Florida Flood Control Project) will have significant effects on salinity regimes in nursery habitat for American crocodiles. On Florida's southwestern coast, efforts to restore Rookery Bay, the Big Cypress drainage, and the Ten Thousand Islands Region could have similar benefits to the American crocodile. As these projects undergo further development, benefits to nursery habitat for American crocodiles should be included as performance criteria to determine project benefits.

H2.6. Continue to enforce land-use restrictions in essential crocodile habitat. The NPS and FWS preclude human use in important crocodile habitat in the areas these two agencies manage in Florida Bay and on Key Largo. These restrictions, as well as others that may be required if new crocodile congregations are located, will help protect crocodiles during their recovery. Periodic assessments should be conducted to determine the need for land-use restrictions.

H3. Conduct research on the habitat relationships of the American crocodile. Much of the habitat-based research needed for the recovery of the American crocodile is currently addressed in one or more research projects dealing with the maintenance and recovery of the Florida Bay ecosystem. However, specific research information on the relationship of

American crocodiles to salinity regimes, exotic species, and adjacent land uses will be critical to the design of future management actions for the American crocodile.

H4. Continue to monitor crocodile habitat.

H4.1. Continue to monitor crocodile nesting habitat to determine environmental factors that affect nesting success.

H4.2. Continue long-term assessments of pesticide and heavy metal contamination levels in South Florida ecosystems. Numerous contaminant assessment projects are ongoing in South Florida. Support of these projects and use of the periodic data they provide will be important in assessing the quality of crocodile habitat.

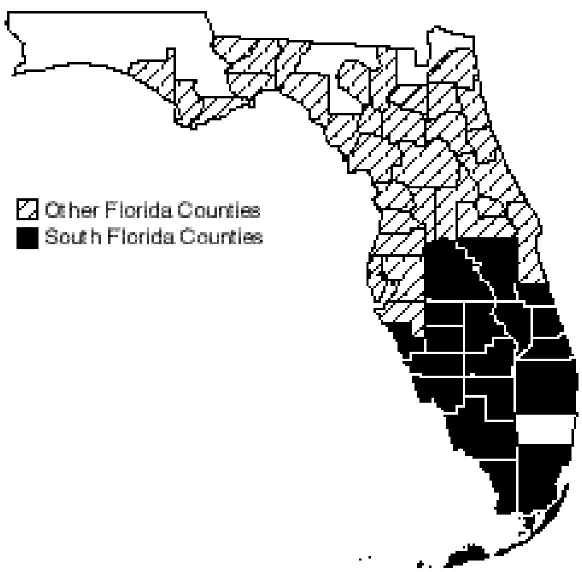
H5. Increase public awareness of the habitat needs of crocodiles. Tidally influenced areas provide important habitat for crocodiles, but these areas are also attractive to humans for recreational and residential uses. Efforts to protect crocodile habitat will probably not be well received because of the public's general misperceptions about crocodiles. Effective protection and restoration of habitat can only be achieved if these efforts demonstrate that such protection will also benefit other commercially and recreationally important species. Habitat protection should be approached from an ecosystem perspective, emphasizing conservation benefits to Florida Bay. The efforts that have been used to increase public awareness of the habitat needs of the West Indian manatee should serve as the model for these efforts.

Bald Eagle

Haliaeetus leucocephalus

Federal Status:	**Threatened (July 12, 1995)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. Florida distribution of the bald eagle.



The bald eagle is the only member of the sea eagle genus commonly found in the western hemisphere. In the eastern U.S., the bald eagle is the largest raptor and is commonly associated with large bodies of water. Bald eagles are considered common in South Florida and are known to breed throughout the state. Nest sites are usually located near large rivers, lakes, or estuaries where the eagle feeds primarily on fish and water-dependant birds. This large raptor was adversely affected by the bioaccumulation of pesticides, principally DDT. These organochlorines interfered with calcium metabolism, which resulted in eggshell thinning. Reduced productivity resulted in population declines and jeopardized the existence of this species. Banning of DDT and other organochlorines during the early 1970s reversed the decline in bald eagle numbers throughout its range. In Florida, overall bald eagle nesting has increased from a few hundred nesting territories in 1973 to 831 in 1995. Similar increases in nesting activity have been documented throughout the remainder of its range. Current threats to the bald eagle include: habitat fragmentation and loss, collisions with cars and powerlines, and shooting. In recognition of increases in the eagle population, efforts are currently underway to reevaluate the management of bald eagles in the southeastern U.S. and to refine conservation recommendations to reduce eagle-human conflict.

This account represents South Florida's contribution to the range-wide recovery plan for the bald eagle (FWS 1989).

Description

The bald eagle is a large raptor with a wingspan of about 2.1m and total body length of 0.9 m. Females are typically larger than males, although distinguishing them can be difficult unless both are side-by-side. Adult plumage is mainly dark brown with a pure white head and tail, while the eyes, feet, and bill are yellow (Palmer 1988). First year juveniles are often chocolate brown to blackish, sometimes with white mottling on the tail, belly, and underwings

(Palmer 1988). They may be confused with turkey vultures (*Cathartes aura*) in flight. The head and tail become increasingly white with age until full adult plumage is reached in the fourth or fifth year of age. During this same period, the legs, bill, and eyes change gradually from black to yellow.

Taxonomy

The bald eagle is in the order Falconiformes, family Accipitridae. Of the 289 species of hawk-like birds, there are 59 species of eagles (Grossman and Hamlet 1964, FWS 1989). The sea and fish eagles account for 11 species comprising 3 genera, of which eight species are in the genus *Haliaeetus*. The bald eagle is the only member of the genus *Haliaeetus* which regularly occurs in North America.

Also our nation's symbol, the bald eagle was first described in 1766 as *Falco leucocephalus* (Linnaeus), and was later renamed the southern bald eagle (*Haliaeetus leucocephalus leucocephalus*, Linnaeus). In 1897, a new northern subspecies was identified as *H. l. alascanus* (Townsend). Although the two subspecies of *leucocephalus* were described based on size and weight, few ornithologists acknowledge these subspecies because there is a continuous gradient in size from north to south throughout the range.

Distribution

The bald eagle was historically found throughout the North American continent from the Aleutian Islands and western Alaska to the Maritime Provinces of Canada and south to the Florida Keys, the Gulf Coast, and Baja California (Curnutt 1996). Apart from Alaska, most nesting bald eagles were found in Florida, the Chesapeake Bay area, the Great Lakes region, Maine, and the Pacific Northwest. In Florida, eagles were historically found throughout the state, although they were probably most abundant along large rivers and lakes. Eagles were probably never numerous in the panhandle of Florida. Currently in South Florida, bald eagle nesting is prevalent along the southwest Gulf Coast and the Kissimmee River valley including Polk and Osceola counties (Curnutt 1996) (Figure 1).

Habitat

Bald eagles are considered a water-dependant species typically found near estuaries, large lakes, reservoirs, major rivers and some seacoast habitats (Robards and King 1966, King *et al*. 1972, Weekes 1974, Whitfield *et al*. 1974, Gerrard *et al*. 1975, Grier 1977, Anthony and Isaacs 1989, Wood *et al*. 1989). Their distribution is influenced by the availability of suitable nest and perch sites near large, open waterbodies, typically with high amounts of water-to-land edge. Throughout their range, bald eagles demonstrate a remarkable ability to tolerate perturbations to their habitat. Their adaptability to a variety of habitat conditions makes generalizations about habitat requirements and nesting behavior difficult. Though variable, eagles have basic habitat requirements that must be met in order to successfully reproduce and survive during the winter or non-nesting season.

Bald eagle.
Photograph is clipart from Corel Ccorporation (1996).

Nesting Habitat

Nesting habitat includes a nest tree, perch, and roost sites, and adjacent high-use areas but usually does not include foraging areas. The active nest, perch, roost sites, and use areas around the nest, comprise the nesting territory. The size and shape of a defended nesting territory varies greatly depending on the terrain, vegetation, food availability, and eagle density in the area. Generally, bald eagle nesting habitat is adjacent to, or near large bodies of water that are used for foraging (Herrick 1924, Stevenson and Anderson 1994). Nest sites must also provide good visibility, and a clear flight path to the nest (Robards and King 1966, Anthony *et al*. 1982, Anthony and Isaacs 1989, Montana Bald Eagle Working Group 1991).

Most breeding eagles construct nests within several hundred meters of open water (Robards and King 1966, Robards and Hodges 1977, Henney *et al*. 1978), though these distances may increase in areas occupied by humans. Shorelines provide fishing and loafing perches, nest trees, and open flight paths (Whitfield *et al*. 1974). In most studies of nesting bald eagles, at least 90 percent of the nests were less than 200 m from open water. In Florida, most nests were located within 3 km of open water, substantially further than other reported distances (McEwan and Hirth 1979, Wood *et al.* 1989). In extreme southern Florida, nest sites are located principally near the coast, within 50 m of open water (W.B. Robertson, Jr., former NPS and USGS/BRD biologist, personal communication 1998).

Most eagles select nest trees that are larger and taller than surrounding trees (Grubb 1980, Anthony *et al*. 1982, Anthony and Isaacs 1989), except in extreme southern Florida where nests are typically located in mangrove snags (W.B. Robertson, Jr., former NPS and USGS/BRD biologist, personal communication 1998). Forest stands containing the nest site are usually multi-layered, mature, or old-growth stands. Most nest trees are alive, even though mangrove snags are used extensively in extreme southern Florida. (W.B. Robertson, Jr., former NPS and USGS/BRD biologist, personal communication 1998). Nests are usually positioned below the treetop in live conifers, although many tree species have been used for nesting. The structure of the tree appears to be more important to nesting eagles than the species of the tree. Clear flight paths and a good line of sight are essential and nests are often found at or above the surrounding forest canopy in very large trees with open crowns and sturdy horizontal limbs.

Perch sites serve many functions. They may be used to hunt from, consume food, display, or act as sentry posts to advertise and defend the nesting territory (Montana Bald Eagle Working Group 1991). Perches may also be used for loafing, warming, drying, and refuge from the wind or rain. Unlike perches, roost sites are used at night for resting. Some perch sites may serve as roosts, but roost sites need not be near water and foraging sites. Roost trees are usually the tallest, dominant tree in the surrounding forest and are selected to provide protection from the wind and cold (Keister and Anthony 1983, Stalmaster 1987).

In Florida, nests are often in the ecotone between forest and marsh or water, and are constructed in dominant or co-dominant living pines (*Pinus* spp.) or bald cypress (*Taxodium distichum*) (McEwan and Hirth 1979). About 10 percent of eagle nests are located in dead pine trees, while 2 to 3 percent occur in other species such as Australian pine (*Casuarina equisetifolia*) and live oak (*Quercus virginiana*). The stature of nest trees decreases from north to south (Wood 1987, Wood *et al*. 1989) and in extreme southwest Florida eagles nest in black (*Avicennia germinans*) and red mangroves (*Rhizophora mangle*), half of which are snags (Curnutt and Robertson 1994). Nest trees in South Florida are smaller and shorter than reported elsewhere; however, comparatively they are the largest trees available (Wood *et al.* 1989, Hardesty 1991). The small size of nest trees in South Florida relative to other nest sites throughout the eagle's range is due to the naturally smaller stature of *Pinus elliottii*, *P. taeda*, *P. palustris* and *P. clausa* in South Florida, and the lack of pines (*Pinus* spp.) in extreme southern Florida.

Winter Habitat

In southern peninsular Florida, bald eagles breed and nest during the temperate winter. Contrary to changes in habitat use exhibited by northern bald eagle populations, eagles in the south do not substantially alter habitat use throughout the year. Some adults may remain in and defend their nesting territory outside of the breeding season (Palmer 1988), use or defend portions of their territory, or disperse and congregate at predictable food sources such as landfills. Of those adults that do not maintain territories throughout the year, most are not thought to leave the state. Conversely, following fledging, many juvenile eagles disperse north and summer from along the Atlantic Coast west to the Appalachian Mountains and north as far as Canada (Broley 1947, Wood and Collopy 1995).

Behavior

Reproduction

Bald eagles are monogamous and annual courtship behavior reinforces pair bonds (Palmer 1988). Pair bond formation includes dramatic pursuit flights, high soaring, talon locking and cartwheeling (Johnsgard 1990). In establishing territories, eagles may also fly around the perimeter of their nesting areas visually communicating their presence. Pair bond behavior, as well as territory establishment and defense, probably occur concurrently throughout much of the eagle's range. Successful pair bond formation ultimately leads to nest site selection and nest construction for newly formed pairs or established pairs without nests. For pairs which have previously nested, nest repair or construction of an alternate nest may occur concurrent with copulation.

In South Florida, nesting activities generally begin in early September, with egg laying occurring as early as late October, and peaking in the latter part of December. Depending on latitude, incubation may be initiated from as early as October to as late as March. Clutches usually consist of one or two eggs, but occasionally three or four are laid. Incubation takes approximately 35 days and fledging occurs within 10 to 12 weeks of hatching. Parental care may extend 4 to 6 weeks after fledging even though young eagles are fully developed and may not remain at the nest after fledging (FWS 1989).

Foraging

The bald eagle is an opportunistic feeder, but in South Florida the bulk of the diet is fish. Broley (1947) found catfish (*Ictalurus* spp.), mullet, and turtles to be the most common food items found at nests in Florida. He also found that the variety of prey items differs among individual pairs. McEwan (1977) reported 79 percent fish and 17 percent bird prey, by occurrence, based on 788 animal remains recovered from nests. Of these, the dominant items were catfish and the American coot (*Fulica americana*). Eagles in Florida Bay may take birds as large as great white herons (*Ardea herodias*) (J. Ogden, SFWMD, personal communication 1998).

Bald eagles typically hunt from perch sites or by soaring over foraging areas. Most foraging occurs early in the morning with another, less intense feeding period usually occurring late in the afternoon.

Movements

Juvenile birds fledged in Florida are highly migratory, with more than one-third of the recoveries made 1,620 km or more north of Florida, all during the non-nesting season (Broley 1947). Wood and Collopy (1995) found that juvenile Florida eagles tend to move rapidly to northern summering grounds ranging from South Carolina to Prince Edward Island, Canada. Most radio-collared juveniles return each year but a small proportion remain away for 2 to 3 years. The southward migration of juveniles is more dispersed and leisurely.

Little information is available on the dispersal of bald eagles as they approach early adulthood. If paired, it is assumed these birds remain in South Florida as do most other paired adults. If not paired, it is not clear whether these birds continue to migrate north during summer or remain in South Florida with the breeding adults. Similarly, it is not known whether all birds fledged in South Florida ultimately breed in South Florida.

Relationship to Other Species

Throughout their extensive range, bald eagles live sympatrically with many other species, but rarely interact except during the breeding season. Interspecific competition for nests may occur with great horned owls (*Bubo virginianus*), red-tailed hawks (*Buteo jamaicensis*), and several species of crows (*Corvus* spp.). Throughout the year, other bird species may occasionally mob or attack eagles, but these short-term interactions are not considered significant. Raccoons may also depredate eagle nests. Eagles may impact nesting ospreys (*Pandion haliaetus*) by disrupting nesting patterns, and they may also "steal" prey from ospreys (J. Ogden, SFWMD, personal communication 1998).

Interaction between eagles and humans is the single most important factor affecting bald eagles. As discussed in more detail below, anthropogenic affects have been responsible for degradation of nesting, foraging, and wintering habitat throughout the species' range. However, efforts to conserve and manage eagle habitat are resulting in the improvement of the bald eagle population throughout much of its range.

Status and Trends

Bald eagle nesting in Florida, which has traditionally been used to assess population status, has been widely studied, and published accounts are available from a variety of sources. Broley (1947) was the first to document a decline in eagle nesting in the late 1940s. A further decline from 73 to 43 active nesting areas was reported for west central Florida between 1936 and 1956 (Broley 1958). Howell (1937, 1941, 1949, 1954, 1958, 1962, 1968, 1973) reported a decline in nesting around Merritt Island from 24 nests in 1935 to four nests in 1971. McEwan and Hirth (1979) provided additional information on productivity and nest site selection. An excellent summary was provided by Peterson and Robertson (1978), in which they characterized the bald eagle population of the 1970s as less than 50 percent of historic numbers and still slowly decreasing. In contrast, Everglades NP has conducted eagle nest surveys since the early 1960s. These surveys indicate that nesting in Everglades NP remained stable between the 1960s and 1990s at about 45 to 50 nesting pairs (J. Ogden, SFWMD, personal communication, 1998).

Prompted by the work of Broley, State natural resource agencies and conservation organizations initiated surveys for nesting bald eagles in the early 1950s, which have continued in some form to the present day. Unfortunately, many of these studies were short term and covered only portions of the nesting range of the species. These studies did reveal, however, that in many locations, bald eagle numbers had declined from historic numbers. A nationwide survey by the FWS, State wildlife agencies, and conservation groups in 1974 indicated that eagle numbers and their reproductive success in certain areas were low enough to warrant protective actions. As more and more states began systematic surveys for bald eagles, better information became available to assess the status of the bald eagle throughout much of its range.

Since being listed as endangered, bald eagle populations have continuously improved. Improvement in population numbers resulted primarily from the

Table 1. Florida bald eagle nesting trends, 1973-95 (from Nesbitt 1995).

Year	# Active Territories	# Successful Nests	# Young Produced	Young/Active Territory	Young per Successful Nest
1973	88	55	74	0.84	1.35
1974	157	82	117	0.75	1.43
1975	246	145	213	0.87	1.47
1976	241	162	260	1.08	1.61
1977	270	170	265	0.98	1.56
1978	319	182	262	0.82	1.44
1979	353	223	324	0.92	1.45
1980	363	212	345	0.95	1.63
1981	359	234	368	1.03	1.57
1982	340	240	356	1.04	1.48
1983	374	231	351	0.94	1.52
1984	378	247	351	0.93	1.42
1985	387	280	435	1.12	1.55
1986	329	247	429	1.30	1.74
1987	391	251	400	1.02	1.59
1988	399	276	448	1.12	1.62
1989	439	310	474	1.08	1.53
1990	535	366	585	1.09	1.60
1991	601	285	591	0.98	1.54
1992	652	468	729	1.12	1.56
1993	667	447	679	1.02	1.52
1994	779	591	951	1.22	1.61
1995	831	621	982	1.18	1.58
Total	9,498	6,425	9,989	1.05	1.56
10-year Average	**518**	**362**	**572**	**1.11**	**1.59**

banning of DDT and other persistent organochlorines, and has been accelerated by other recovery efforts. In 1963, a National Audubon Society survey reported only 417 active nests in the lower 48 states with an average of 0.59 young produced per active nest. In 1995, about 4,450 occupied breeding areas were reported by the lower 48 states with an estimated average young produced per occupied territory of 1.17 (J. Millar, FWS, personal communication 1996). Compared to 1974, for example, the number of occupied breeding areas in the lower 48 states has increased 4.6 times. Since the late 1970s, the species has doubled its breeding population every 6 to 7 years (FWS 1995).

In Florida, bald eagle nesting and productivity has increased dramatically since the early 1970s (Table 1). Florida currently supports the highest number of breeding bald eagles of any southeastern state, supporting approximately 70 percent of the occupied territories in this region (Nesbitt 1995).

Habitat Alteration

The human population in Florida has grown dramatically over the past several decades. Between 1980 and 1995, the human population grew from an estimated 9.7 million to 14.2 million, making Florida the third most populous state (Florida Commission on Government Accountability to the People 1996). Human population growth in Florida has resulted in extensive alterations in land use. Kautz (1993) estimated that as of 1987, Florida's landscape was composed of 30 percent agricultural land and 13 percent urban development, leaving 57 percent in natural to semi-natural land cover. Intensive conversion of natural plant communities to agricultural, residential, and commercial uses has encroached, and continues to encroach, on bald eagle nesting and foraging habitats (Heinzman 1961, 1962; Wood *et al.* 1989). Adverse effects are particularly evident near water bodies since humans and eagles both prefer waterfront locations (Harris *et al.* 1987, Wood *et al.* 1989).

Habitat alterations affect the quantity, quality, and distribution of essential environmental factors needed to support bald eagles. Changes in the landscape reduce or fragment natural vegetative communities, thereby decreasing the suitability of nest sites. Human population growth and associated land alterations are also responsible for degradation of many of Florida's surface waters, indirectly affecting bald eagle foraging areas. In addition to the direct effects of altering the physical habitat, human growth, and the infrastructure necessary to support that growth, often indirectly result in an increased exposure of nesting bald eagles to human disturbance. New roads, houses, commercial complexes, agriculture, and recreational facilities which result from land conversions may have adverse effects on nesting eagles.

Nesting bald eagles are more sensitive to disturbance than non-nesting or wintering birds, and the early stages of the breeding cycle (nest construction or repair, egg laying, and incubation) are the most critical time (Mathisen 1968, Weekes 1974). Bald eagles are more likely to abandon a nest early in the season before a bond is established or young hatch. The vulnerability of eggs or young to adverse weather is also most critical early in the season. Disturbances later in the nesting cycle may be a problem if eaglets fledge prematurely (Grier 1969).

Human disturbance has been shown to reduce productivity, nest success, and territory use (Newman *et al*. 1977, Grubb 1980, Stalmaster 1987, Anthony and Isaacs 1989, Buehler *et al*. 1991, Montana Bald Eagle Working Group 1991, Steidl 1994, Anthony *et al.* 1995). In Oregon, Anthony and Isaacs (1989) found that nests were constructed further from human disturbances (recreational activities and roads) than were old nests in the same territory. Similarly, Fraser *et al*. (1985) found that nests on developed shorelines tended to be moved further from the water than nests on undeveloped shorelines. Segments of the Chesapeake Bay shoreline historically used for nesting have now become so saturated with human activity that bald eagles no longer use these sites (Buehler *et al.* 1991). Similarly, as shoreline development and human activity increases, eagles often rebuild nests further inland to avoid disturbance (Whitfield *et al*. 1974, Newman *et al.* 1977, Fraser *et al.* 1985). Bald eagles have altered nesting activity to avoid human disturbances in Saskatchewan and Manitoba (Gerrard *et al*. 1975) and forestry operations in western Florida (Broley 1947) and Oregon (Anthony and Isaacs 1989). Grubb (1980) showed that nests closer to human activity were less productive than secluded nests.

The effects of recreational disturbances on wintering and breeding eagles has been extensively researched. Most of this work has focused on eagle habitat along large rivers, lakes, and reservoirs in the Pacific Northwest. In general, it was found that recreational activities usually disrupt eagles temporarily over short time periods. In Florida, Wood and Collopy (1995) indicated that boating use throughout the year limited bald eagle use of foraging areas. Short term disturbance may have a cumulative impact and affect individual fitness through reduced reproductive success (Stalmaster and Newman 1978, Knight and Knight 1984, Harmata and Oakleaf 1992, Anthony *et. al.*1995).

The response of bald eagles to habitat change has not been comprehensively evaluated in Florida. However, as discussed above, research in other portions of the eagle's range indicates that in some situations, nesting bald eagles respond negatively to human disturbance. Florida's bald eagle population has not shown any overt signs of stress (reduced territory occupancy, decreased productivity, increased nest failures, etc.). Recent analyses conducted by the GFC indicate that productivity of nests in urban areas did not differ significantly from nests in more rural areas (S. Nesbitt, GFC, personal communication 1998). However, it is generally believed that the threshold at which the stressors will first be recognized is rapidly approaching, particularly in the urban areas of southwestern and central portions of the State. In these areas, little unoccupied habitat remains and it is expected that eagles will begin nesting in areas more susceptible to disturbance.

Mortality

Within the lower 48 states, shooting has historically been a major source of mortality for bald eagles (Stalmaster 1987). Mortality from shooting is often expressed as a percentage of the total deaths. Published estimates of mortality from shootings are as follows: 62 percent from 1961 to 1965 (Coon *et al.* 1970), 41 percent from 1966 to 1968 (Mulhern *et al.* 1970), 46 percent from 1969 to 1970 (Belisle *et al.* 1972), 35 percent from 1971 to 1972 (Cromartie *et al.* 1975), 25 percent from 1973 to 1974 (Prouty *et al.* 1977), and 20 percent from 1975 to 1977 (Kaiser *et al.* 1980). Since the early 1980s, no systematic analyses of bald eagle mortality have been conducted; however, recent evidence suggests that mortality resulting from shooting is now exceeded by collisions with powerlines and automobiles (S. Nesbitt, GFC, personal communication 1998).

Perhaps the most dramatic declines in bald eagle populations nationwide were caused by environmental contaminants. Organochlorine compounds (DDT and its metabolites) are known to inhibit calcium deposition, which caused eggshell thinning, ultimately reducing reproductive success (Radcliffe 1967, Hickey and Anderson 1968). Mulhern *et al.* (1970) found widespread occurrence of DDT, DDE, and DDD in eagle carcasses; and at least one female had lethal levels of DDT and DDD. Similarly, cyclodiene dieldrin had been documented at lethal levels in eagles (Mulhern *et al.* 1970). Results of measurements from 87 eggshells collected from 1984 to 1987 from Florida nests showed that the shells were only slightly thinner, on average, than pre-1947 eggs. However, there were a few eggs with shells as much as 29 percent thinner indicating that there may still be localized problems with residual contaminants (Wood *et al.* 1989). Since a 1972 ban on the use of DDT in the U.S., increases in eagle productivity has been rapid.

Lead poisoning has been documented as a significant source of mortality in eagles (Pattee *et al.* 1981). The National Wildlife Health Research Center has diagnosed lead poisoning in more than 225 eagles during the last 15 years. Lead poisoning occurs when eagles eat prey that contains lead shot or has assimilated lead into its own tissues. Winter killed waterfowl that have ingested lead shot or were crippled during hunting season are typical sources of lead contamination (Stevenson and Anderson 1994). Chronic low levels of lead increase susceptibility to a variety of mortality factors including: neurological dysfunction, behavioral and learning aberrations, anemia, and increased susceptibility to disease. Restrictions on the use of lead shot for waterfowl hunting has reduced the incidence of lead contamination in bald eagles in the U.S.; however, lead shot is still used in other portions of the eagles' range *(e.g.* Canada and Mexico).

Mercury, in the form of methylmercury, is one of the most toxic naturally occurring substances. Mercury is metabolized at very slow rates and may accumulate in tissues over time resulting in a variety of sublethal effects including: reduced fitness, reproductive impairment, brain lesions, paralysis, and reduced survival of offspring (Fimreite and Darstad 1971, Heinz 1975, Pass 1975, Finley and Stendell 1978, Heinz 1979, Eisler 1987, Wren *et al.* 1995). Elevated mercury levels have been reported in bald eagles in the Northeast and Great Lakes region (Evans 1993); Ontario, Canada (Evans 1993); Oregon (Frenzel and Anthony 1989); and Alaska (Evans 1993). In South Florida, elevated mercury has been found in fish, alligators (*Alligator mississippiensis*), raccoons (*Procyon lotor*), Florida panthers (Puma (=Felis) concolor coryi) and some wading birds (Hord *et al*. 1990, Facemire and Chlebowski 1991, Roelke *et al*. 1991, Spalding and Forrester 1991, Brim *et. al*. 1994, Sundlof *et. al.* 1994).

Limited information is available on the bioaccumulation of mercury in bald eagles in South Florida. Preliminary analysis of blood from eagles in Florida Bay, Everglades NP, showed a mean level of 0.28 parts per million (ppm) in 1993 and a mean level of 0.31 ppm in 1995 (B. Mealy, Miami Museum of Science, personal communication 1996). These data, however, are derived from few samples and over a limited geographical range and may not adequately represent the threat of mercury contamination. Wood *et al*. (1993) collected blood, tissues, and feathers from bald eagles in central and northern Florida and found mercury levels in bald eagles to be above background levels that were considered high enough to elicit sublethal effects. Unfortunately, without extensive monitoring, sublethal effects such as changes in growth, development, reproduction, and behavior are difficult to identify and quantify. However, available information for South Florida indicates that mercury contamination and bioaccumulation in the environment and in other species may already be a problem (Royals and Lange 1990, Facemire and Chlebowski 1991, Spalding *et al*. 1994, Sundlof *et al*. 1994). Since many of the species studied are prey or are representatives of other species that may be prey, it is likely that the transfer of mercury to eagles will remain a conservation problem.

Management

A nationwide recovery program for the bald eagle was established in the mid-1970s. The lower 48 states were divided into five recovery regions: Chesapeake Bay, Pacific, Southeastern, Northern States, and Southwestern. A recovery plan was prepared for each region by separate recovery teams composed of species experts in each geographic area. Each team established recovery goals and identified specific tasks needed to achieve these goals. In the southeastern U.S., the recovery plan established the reclassification criteria from endangered to threatened as 600 or more occupied territories throughout at least 75 percent of the eagle's historical range. In addition, reclassification of the southeastern population required that more than 0.9 young be produced per occupied nest, greater than 1.5 young be produced per successful nest, and at least one young be produced in 50 percent of the nests for each nesting season (FWS 1989). These criteria were based on a 3 year average. Delisting criteria have not been established for the bald eagle in the southeastern U.S.

To help achieve recovery goals for the bald eagle, the FWS, with the assistance of State wildlife resource agencies, produced bald eagle habitat management guidelines that provide recommendations to avoid or minimize detrimental human-related impacts on nesting bald eagles (FWS 1987). These habitat management guidelines provide much of the direction for the management of bald eagles in the U.S. and include measures designed to maintain or improve environmental conditions (FWS 1987). Though the guidelines vary slightly from region to region, they generally provide for the spatial and temporal protection of nesting and foraging sites and flight paths. These guidelines have been widely adopted by Federal and State agencies and are applied to both public and private lands.

A principal component of the guidelines for the southeastern U.S. includes a recommendation that two protective zones be established around bald eagle nests. A primary zone is recommended to encompass an area extending outward from the nest tree between 230 m and 460 m. The exact distance encompassed by this zone is dependent on the location of feeding areas, roosts, and perch sites within a particular nesting territory (FWS 1987). Within the primary zone it is recommended that certain activities be avoided at all times. Activities to be avoided include: residential, commercial, or industrial development, tree cutting, logging, construction, mining, or use of chemicals toxic to wildlife. Activities such as human entry and low-level aircraft flights over the primary zone are not recommended during the nesting season, but may be allowed in some situations during the non-nesting season.

The guidelines recommend a secondary zone extending from the outer boundary of the primary zone outward up to 1.6 km. Restrictions within the secondary zone are recommended to minimize disturbance that might compromise the integrity of the primary zone and to protect areas used by the nesting eagles outside of the primary zone (FWS 1987). Restrictions are recommended on new commercial and industrial development, construction of multi-story buildings or high-density housing developments, construction of roads that increase access to nest sites, and use of chemicals toxic to wildlife. Most other sources of disturbance are allowed within the secondary zone during the non-nesting season.

The guidelines have been used many times in Florida to avoid or minimize adverse effects to nesting bald eagles. Nesbitt *et al.* (1993) evaluated the effectiveness of the guidelines in protecting bald eagle habitat and found that eagle use and productivity was not significantly affected by human encroachment when the guidelines were implemented and adhered to. These results indicate that limited human encroachment was not yet affecting nesting eagles and that no modifications to the guidelines were needed in Florida.

Evaluation of long-term trends in nest success and productivity should provide the information necessary to evaluate continued effectiveness of the guidelines. Data analyses are anticipated to reveal regional differences, principally due to variations in duration, type, and magnitude of threats to bald eagles. If the results indicate decreasing trends either regionally or statewide, guideline modifications will identify more stringent protection of breeding and foraging habitat. Conversely, where trends are increasing, it is expected that the modified guidelines will relax some or all of the protective restrictions.

The effects of disturbance on bald eagles have become apparent over time in portions of the eagles' range. It is clear that bald eagle habitat is slowly being altered or destroyed throughout much of the species' range. The impacts, as described by Stalmaster (1987) are "cumulative and may have few effects on a local and short-term basis, but because it [habitat alteration] is so widespread and long-term in nature, the effects to eagles are tremendous." Stalmaster (1987) was referring to the effects of forest management on bald eagle nesting when he stated that "once altered, forest habitat is rarely allowed to return to the old-growth state that the eagle prefers ...the last vestiges of old growth are now being removed and replaced with fast-growing, economically efficient forest stands." Throughout much of the bald eagles' range, we believe that nesting and wintering habitats are threatened by many other types of anthropogenic factors that will slowly make these areas unsuitable for eagles.

However, by all accounts, the bald eagle population in South Florida has increased dramatically over the last 20 years. The success of eagles in Florida may ultimately be the primary reason for the recovery and delisting of eagles in the southeastern U.S. Even in this time of optimism, there remain concerns about the future of bald eagles in South Florida. Nesbitt *et al*. (1993) indicated that even though the number of nesting eagles in Florida has recovered to one-half to two-thirds of historic numbers, the amount of feeding and nesting habitat remaining in Florida may not be sufficient to support the eagle population that existed in the early 1900s. Wood *et al*. (1989) indicated that Florida eagles are faced with significant disturbances from human land-use patterns, especially land alterations associated with urban development. In combination, these and other factors may be working synergistically to reduce the value of bald eagle habitat in Florida. Currently, however, the threshold of human disturbance which triggers large-scale observable adverse effects has not yet been reached or is not detectable under current monitoring programs.

In Florida, only the total number of nesting eagles and statewide reproductive success have been used as the benchmarks for assessing the health of the bald eagle population. Undoubtedly, many of the same cumulative effects noted elsewhere are affecting eagles in South Florida. Whether bald eagles in South Florida respond adversely to these cumulative effects is a question that must be answered before we proclaim South Florida's eagle population to be recovered.

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Recovery for the Bald Eagle

Haliaeetus leucocephalus

Recovery Objective: DELIST the species once recovery criteria are met.

South Florida Contribution: South Florida's contribution to meeting this recovery objective will be achieved by maintaining or increasing the number of successful nests and the average annual productivity.

Recovery Criteria

Delisting criteria for the bald eagle in the southeast region are currently being developed. Until this species is delisted, South Florida's contribution to recovery of the bald eagle in the southeast is in accordance with the recovery criteria as indicated in the current approved Southeastern States Bald Eagle Recovery Plan. Specifically, South Florida can contribute to the recovery of the bald eagle in the southeast by furthering the goals of: nesting productivity of at least 0.9 chicks per occupied nest, greater than 1.5 young per successful nest, and at least 50 percent success in raising at least one young. These criteria must be accompanied by three years of data.

Species-level Recovery Actions

S1. **Determine distribution of the bald eagle in South Florida**. This task is covered by the bald eagle monitoring program performed by GFC described below in task 3.

S2. **Protect and manage bald eagle populations in South Florida**.

S2.1. **Prevent or mitigate the effects of behavioral degradation**. Behavioral degradation is the modification of normal eagle activity by any disturbance which reduces an area's ability to support eagles. These disturbances may result in increased energy expenditures, decreased feeding efficiencies, reduced reproductive potential, or decreased habituation by eagles.

S2.1.1. **Identify and quantify effects of disturbance on nesting eagles and incorporate into management plans**. Quantifying disturbance effects must focus on increases or decreases in annual productivity.

S2.1.2. **Identify and quantify the effect of disturbance on bald eagle feeding sites and incorporate into management plans as indicated in task H1.2.5**. The impact of disturbance to foraging eagles is not clear, but reduced feeding efficiency and increased energy expenditures are likely. The effect of these factors on productivity must be examined.

S2.1.3. **Continue to require permits for all research activities which have the potential to negatively impact eagles**. The effects of disturbance from research projects should be evaluated against the information to be gained and the project's enhancement of the recovery potential of eagles.

S2.1.4. **Help the Department of Defense develop and implement bald eagle guidelines for use on Military Areas of Operation in South Florida.**

S2.2. **Reduce bald eagle mortalities in South Florida**. Minimizing mortality will involve documenting the type, amount, source, and location of mortality and providing effective enforcement of existing laws.

S2.2.1. **Enforce laws protecting bald eagles**. Maintain and/or augment active enforcement of existing laws and preventive actions designed to reduce the number of violations. Law enforcement personnel at the State and Federal levels should be made aware of the potential sources of harm to bald eagles.

S2.2.2. **Establish and maintain adequate rehabilitation facilities**. Mortality may be reduced through the use of rehabilitation facilities. Existing emergency care protocols should continue at established, permitted rehabilitation facilities.

S2.2.3. **Reduce mortality from aerial collisions**. Structural modifications and project planning modifications in documented problem areas can reduce potential sources of mortality for bald eagles. The frequency of collisions between eagles and towers or powerlines may be reduced by locating structures away from eagle habitat and increasing structure visibility *(i.e.* installing marker balls or other marker models).

S2.2.4. **Reduce eagle mortality due to collisions with automobiles**. Increasing roadway clear zones and minimizing access to carrion may reduce collision mortality. Cooperation with DOT is essential to completing this task.

S2.2.5. **Work with utility companies and municipal governments to reduce mortality from electrocution**. Appropriate design and location of power lines can reduce mortality due to electrocution. Poles and lines should be designed to prevent electrocutions in areas of high eagle use.

S2.2.6. **Prevent mortality due to poisoning**. Prohibit the use of poisons for predator control in areas used by feeding eagles. This would alleviate the problem of secondary or unintentional ingestion of poisons which are being used for the control of other species.

S2.2.7. **Prevent poisoning mortality due to secondary ingestion of euthanized domestic animals**. Educate veterinarians and municipalities of the dangers of depositing euthanized domestic animals in landfills. Develop landfill management recommendations to reduce likelihood of secondary ingestion of barbiturates.

S3. **Continue to monitor bald eagle nesting activities in South Florida**. Population monitoring is necessary in order to determine the status and distribution of the species. The GFC currently monitors eagle nests twice per nesting season. This activity should be continued and expanded, as necessary, to provide important information on nesting success and the success of the habitat management guidelines, in addition to providing essential information on the population status throughout the state. If the bald eagle is to be delisted in the future, this information is essential to ensuring delisting criteria, once developed, are met.

S4. Develop public information and education materials to inform the public of the recovery needs of the bald eagle in South Florida. Public information programs should provide updated, accurate information on the status and needs of eagles and the relationship between eagle recovery and the well-being of man. While support must be evoked from the general public, specific problems such as indiscriminate shooting of eagles must be resolved by focusing efforts at specific user groups.

S4.1. Continue to use permanently incapacitated eagles for educational presentations. Exhibiting disabled eagles during lectures is an effective method of teaching. Such activities should, however, be carefully limited to qualified, permitted, individuals and employ only eagles which may not be returned to the wild.

S4.2. Prepare general informational brochures for distribution in South Florida. This should include life history information relative to the southeast since many general accounts depict only characteristics of northern populations. This brochure should present accurate status information as well as recovery needs. It should also give sources for additional informational materials.

S4.3. Develop and distribute information to pilots concerning the potential for disturbance of nesting eagles by aircraft. A poster should be developed and distributed to all public, private, and military airports. Information on eagle and eagle nest protection should also be included in the Airman's Information Manual in the section on bird strike hazard.

S5. Develop delisting criteria for the bald eagle in South Florida. Delisting criteria for the bald eagle will be developed on a regional basis by the Southeastern Bald Eagle Recovery Team.

Habitat-level Recovery Actions

H1. Prevent further loss and degradation of bald eagle habitat in South Florida. Despite the amount of habitat loss and degradation throughout South Florida, the number of bald eagles with breeding territories in South Florida has increased. Nevertheless, the continued loss and degradation of bald eagle habitat in South Florida is expected to cause population declines in the long-term if it continues unabated or unmitigated. In the long-term the persistence of bald eagles in South Florida will require protection of their nests, foraging areas, migratory corridors, and juvenile dispersal areas.

H1.1. Continue to gather information on the effects of habitat loss and degradation of habitat on bald eagles in South Florida. One of the challenges to protecting habitat for bald eagles in South Florida is the different responses of individual pairs to habitat loss and degradation within their territories. Some pairs will abandon their territories when minimal amounts of disturbance occur, while other bald eagle pairs will ignore seemingly significant disturbance. Future efforts to conserve bald eagles in South Florida will require better information on how different types of habitat loss affect bald eagle pairs and identification of biological effects (such as reduced productivity) that occur regardless of the behavioral responses of nesting adults.

H1.1.1. Identify alterations to terrestrial and aquatic habitats that adversely affect bald eagles in South Florida. Alterations of aquatic habitat have affected eagles in a variety of ways. Altered hydrology due to channelization for flood protection and water storage and agricultural, commercial, and residential uses of surface and groundwater affect the amount of surface water available to support forage fish and other terrestrial prey. Agricultural, commercial, and residential development also affect water quality and the ability of aquatic resources to provide suitable foraging sites for bald eagles.

H1.1.2. **Quantify essential characteristics of occupied bald eagle habitat**. Quantification of the characteristics of habitats, undertaken in a systematic and uniform format, is needed. Such characteristics should be determined by comparing differences between historic and currently occupied territories. In addition, areas of high productivity should be compared and contrasted to areas of low productivity. This should provide for the accurate prediction of impacts during early planning stages and allow for the protection of potential as well as occupied habitat.

H1.1.3. **Quantify responses of bald eagles in South Florida to habitat alteration**. Individual eagles, pairs, or groups of eagles vary widely in their response to alteration of habitat. Information is needed to address the effects of disturbance, including the duration, frequency, and intensity as they relate to each stage of reproduction.

H1.2. **Protect bald eagle habitats in South Florida through site management**. Management of occupied territories in South Florida is the first priority of recovery. Nowhere else in its range is the eagle under greater threat from habitat changes than in the South Florida Ecosystem.

H1.2.1. **Continue to implement and adhere to "Habitat Management Guidelines for the Bald Eagle in the Southeast Region"**(op cit). The current level of knowledge for bald eagle habitat management is reflected in these guidelines and they should be used in resource planning. They should also be reviewed and revised as new information becomes available.

H1.2.2. **Develop specific management plans for each breeding territory**. Individual management plans should be developed for each breeding area whenever possible. This should include occupied, recently occupied, and historic nesting areas. The plans should be designed to accommodate local factors of habitat use, use-area configuration, nesting success, and level of tolerance to disturbance.

H1.2.3. **Protect eagle habitat through cooperative agreements, easements, acquisition or other appropriate means**. Funding for habitat management should be sought from a multitude of sources including Federal, State, local, and private sources.

H1.2.4. **Identify and incorporate important bald eagle habitat in land use plans and planning**. Identify important habitat in order to ensure that accurate information is available for the development of land use plans.

H1.2.5. **Use section 7 of the ESA to protect bald eagles and their habitats**. Interagency consultations on permits issued by the U.S. COE pursuant to section 10 of the Rivers and Harbors Act and section 404 of the Clean Water Act are important for the conservation of bald eagles in South

Florida. With the human population in South Florida expected to almost double over the next 15 years, these interagency consultations will become increasingly important to prevent bald eagles in South Florida from declining.

H1.3. **Prevent or mitigate the degradation of eagle habitat from environmental contaminants**. Mercury occurs throughout South Florida and may reduce recovery opportunities for eagles in South Florida. The numbers, nesting effort, and fecundity of bald eagles that nest in areas where high levels of mercury are known or suspected should be monitored to detect possible mercury contamination. Similarly, addled bald eagle eggs, carcasses and prey from areas where high levels of mercury are known or suspected should be tested for mercury contamination.

H2. **Develop methods to restore previously occupied habitat or to establish new territories**. In South Florida, an increasing number of bald eagles, territories occur in areas that are being cleared for residential housing or for industrial sites. In some instances, individuals have applied for permits to take bald eagles incidental to land clearing for residential housing. At the same time, several managers of wetland mitigation banks have included bald eagles as beneficiaries of their mitigation banks without demonstrating opportunities to restore or enhance the value of bald eagle territories. In the past, the FWS and GFC have had no information on opportunities to restore previously occupied bald eagle territories or to establish new territories. This information, which would require some experimentation, would help establish measures to minimize or mitigate the effects of habitat loss or degradation on bald eagles associated with land clearing for residential housing construction in South Florida.

H3. **Increase public awareness of habitat-related issues that affect the recovery of the bald eagle in South Florida**.

H3.1. **Produce an information brochure for landowners**. Land management information and guidelines should be prepared for landowners including information on where to obtain additional professional assistance. State foresters should be included in this effort since they provide silvicultural expertise to private landowners.

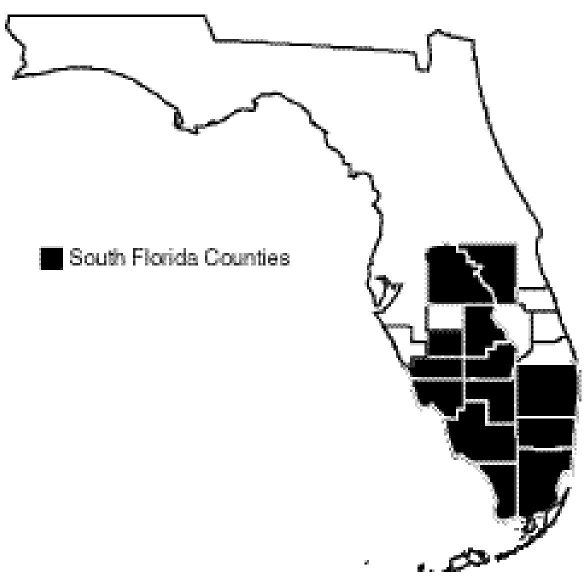
H3.2. **Establish displays at public boat landings to provide information on laws, penalties, rewards, and identification of eagles**. Many boaters utilize public landings for access to aquatic habitat used by eagles. This includes use by hunters and fishermen as well as by recreational and commercial boaters. These user groups should be provided with information on identification and legal protection of eagles. Local phone numbers where violations may be reported should also be included.

Florida Panther

Puma concolor coryi

Federal Status:	**Endangered (March 11, 1967)**
Critical Habitat:	**None Designated**
Florida Status:	**Endangered**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. County distribution of the Florida panther since 1981, based on radiotelemetry data.



The Florida panther, a subspecies of mountain lion, is one of the most endangered large mammals in the world. It is also Florida's state animal. A small population in South Florida,estimated to number between 30 and 50 adults (30 to 80 total individuals), represents the only known remaining wild population of an animal that once ranged throughout most of the southeastern United States from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida and parts of South Carolina and Tennessee. The panther presently occupies one of the least developed areas in the eastern United States; a contiguous system of large private ranches and public conservation lands in Broward, Collier, Glades, Hendry, Lee, Miami-Dade, Monroe, and Palm Beach counties totaling more than 809,400 ha.

Geographic isolation, habitat loss, population decline, and associated inbreeding have resulted in a significant loss of genetic variability and overall health of the Florida panther population. Natural gene exchange ceased when the panther became geographically isolated from other subspecies of *Puma concolor* about a century ago. Population viability projections have concluded that, under current demographic and genetic conditions, the panther would probably become extinct within two to four decades.

A genetic management program was implemented with the release of eight female Texas cougars (*Puma concolor stanleyana*) into South Florida in 1995 (refer to the Management section for a discussion of this program).

The survival and recovery of the Florida panther is dependent upon: (1) protection and enhancement of the extant population, associated habitats, and prey resources; (2) improving genetic health and population viability; and (3) re-establishing at least two additional populations within the historic range.

This account represents South Florida's contribution to the range-wide recovery plan for the Florida panther (FWS 1995); the range-wide recovery plan is currently under revision.

Description

The Florida panther is a medium-sized puma or mountain lion that is described as being relatively dark tawny in color, with short, stiff hair (Bangs 1899), and having longer legs and smaller feet (Cory 1896) than other subspecies. Adult male panthers reach a length of 2.15 m from their nose to the tip of their tail and may reach or exceed 68 kg in weight, but typically average around 54.5 kg. They stand approximately 60 to 70 cm at the shoulder. Female panthers are considerably smaller with an average weight of 34 kg and length of 1.85 m. The skull of the Florida panther has been described as having a broad, flat, frontal region, and broad, high-arched or upward-expanded nasals (Young and Goldman 1946).

The coat of an adult Florida panther is unspotted and typically rusty reddish-brown on the back, tawny on the sides, and pale gray underneath. The long cylindrical tail is relatively slender compared to some of the other subspecies of *Puma concolor* (Belden 1988).

Florida panther kittens are gray with dark brown or blackish spots and five bands around the tail. The spots gradually fade as the kittens grow older and are almost unnoticeable by the time they are six months old. At this age, their bright blue eyes slowly turn to the light-brown straw color of the adult (Belden 1988).

Three external characters are often observed in Florida panthers which are not found in combination in other subspecies of *Puma concolor*. These characters are: a right angle crook at the terminal end of the tail; a whorl of hair or “cowlick” in the middle of the back; and irregular, light flecking on the head, nape, and shoulders (Belden 1986). The light flecking may be a result of scarring from tick bites (Maehr 1992a, Wilkins 1994). The kinked tail and cowlicks are considered manifestations of inbreeding (Seal *et al.* 1994).

Taxonomy

The Florida panther was first described by Charles B. Cory in 1896 as *Felis concolor floridana*. The type specimen was collected by Cory in Sebastian, then considered a part of Brevard County (Hall and Kelson 1959). Bangs (1899), however, noted that *Felis floridana* had previously been used for a bobcat and, believing that the panther was restricted to peninsular Florida and could not intergrade with any other form, assigned it full specific status as *Felis coryi*. The taxonomic classification of the *Felis concolor* group was revised by Nelson and Goldman (1929), wherein the panther was reassigned subspecific status as *Felis concolor coryi*. This designation also incorporated *Felis arundivaga*, which had been classified by Hollister (1911) from specimens collected in Louisiana. Detailed descriptions of each of the subspecies are provided in Young and Goldman (1946) [30 subspecies], and Hall (1981) [27 subspecies]. The genus *Felis* was recently revised so all mountain lions, including the Florida panther, were placed in the genus *Puma* (Nowell and Jackson 1996).

Distribution

The only known, reproducing panther population is located in the Big Cypress Swamp/Everglades physiographic region of South Florida. The core of the breeding population is centered in Collier, Hendry and Miami-Dade counties.

Florida panther.
Original photograph by David Maehr.

Radio-collared panthers have also been documented in Broward, DeSoto, Glades, Highlands, Lee, Monroe, Osceola, Palm Beach, and Polk counties (Figure 1). There are still large areas of privately owned land in Charlotte, Collier, Hendry, Lee, and Glades counties where uncollared individuals may reside (Maehr 1992b). Private lands account for approximately half the occupied panther range in South Florida (Maehr 1990b, Logan *et al*. 1993). This region is extremely reduced from the species' former range. The Florida panther once ranged from eastern Texas or western Louisiana and the lower Mississippi River valley east

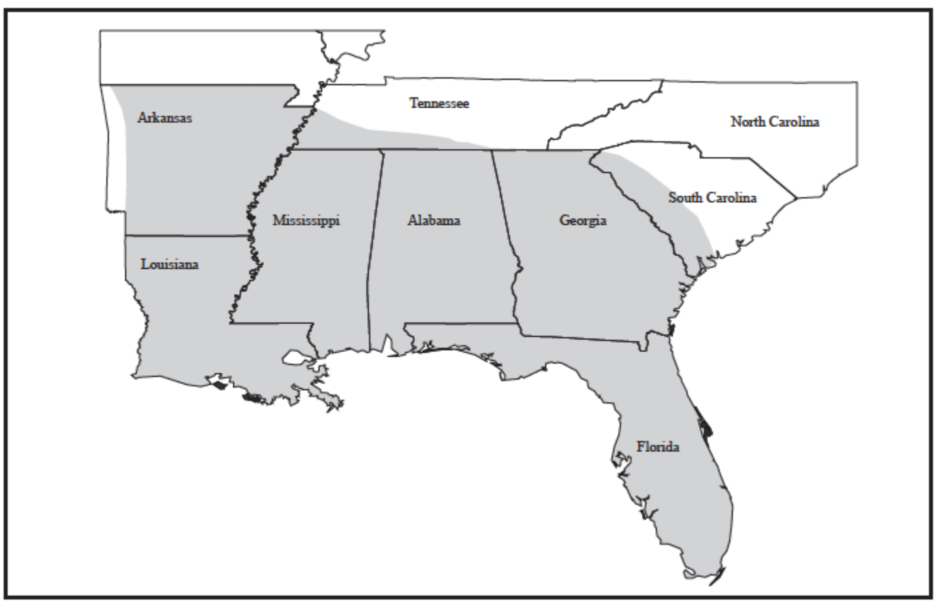


Figure 2. Historic distribution of the Florida panther (Young and Goldman 1946).

through the southeastern states (Figure 2), intergrading to the north with *F. c. couguar*, to the west with *F. c. stanleyana*, and to the northwest with *F. c. hippolestes* (Young and Goldman 1946).

Habitat

Early radiotelemetry investigations indicated that panther (n=6) use of mixed swamp forests and hammock forests was greater than expected in relation to the availability of these vegetative communities within the panthers' home range area (Belden *et al.* 1988). As investigations expanded onto private lands between 1985 and 1990, it was determined that panthers (n=26) preferred native, upland forests, especially hardwood hammocks and pine flatwoods, over wetlands and disturbed habitats (Maehr *et al.* 1991a). For pine flatwoods, which comprised about 12 percent of the habitat available to male Florida panthers (n=5) and female Florida panthers (n=5), mean habitat use between 1986 and 1994 averaged 33 and 32 percent respectively. For hardwood hammocks, which comprised about 13 percent of the habitat available, mean habitat use averaged 38 and 31 percent respectively (Maehr 1996). Hardwood hammocks provide important habitat for white-tailed deer (*Odocoileus virginianus*), an important panther prey species (Harlow 1959, Belden *et al.* 1988, Maehr 1990a, 1992a, Maehr *et al.* 1991a). Understory thickets of tall, almost impenetrable, saw palmetto (*Serenoa repens*) have been identified as the most important resting and denning cover for panthers (Maehr 1990a).

Agricultural and other disturbed habitats, freshwater marsh, thicket swamp, and mixed swamp are not preferred, and are either used in proportion to their availability or are avoided (Maehr 1990a). Panthers have not been found in pastures during daytime radiotelemetry flights but may travel through them at night (Maehr *et al.* 1991a, Maehr 1992a).

Male and female panther home range size is inversely related to habitat quality; the greater the extent of agricultural land and wetland habitats the larger the home range, and the greater the extent of mixed hardwood forests and dry pine forests the smaller the home range. High-quality habitat produces abundant prey and influences female panther reproductive success (Maehr 1992b, Maehr *et al.* 1989b).

The largest contiguous tract of panther habitat is in the Big Cypress Swamp/Everglades physiographic regions. Big Cypress National Preserve, Everglades NP, and Florida Panther NWR together comprise about 927,793 ha of native habitats--46 percent of which is forested. However upland forests, *e.g.* pine forests and hardwood hammocks, comprise only 8 percent of the total land area (Duever *et al*. 1986, FWS 1996, NPS 1998).

Behavior

Interactions between Florida panthers are infrequent. Most interactions occur between adult females and their kittens. Interactions between adult male and female panthers, lasting from 1 to 7 days, were second in frequency and usually resulted in pregnancy. Interactions between males were rare but often resulted in serious injury or death. Aggressive encounters between females have not been documented. "In the absence of unnatural mortality (*i.e.* road kills, illegal shooting, research accidents), aggression between males may be the most common form of male mortality and an important determinant of male spatial and recruitment patterns" (Maehr *et al.* 1991a).

Reproduction and Demography

The pattern of Florida panther distribution involves several males maintaining large, mutually exclusive home ranges containing several adult females and their dependent offspring. This spatial arrangement seems to be a prerequisite for successful reproduction (Maehr 1993).

Male Florida panthers are polygynous. Breeding activity peaks in fall and winter (Maehr 1992a). Parturition is distributed throughout the year with 81 percent of births occurring between March and July (July having the greatest number of births). Litter sizes range from one to four kittens, with a mean of 2.2 kittens surviving to at least 6 months. Intervals between litters range from 16 to 37 months (Land 1994).

Den sites are usually located in dense, understory vegetation, typically saw palmetto (Maehr 1990a) at distances greater than 1 km away from roads (Maehr 1996). Den sites are used for up to 2 months by female panthers and their litters from parturition to weaning. Female panthers losing their litters generally produce replacement litters. Five of seven females whose kittens were brought into the captive breeding program successfully reproduced an average of 10.4 months after the removal of the litter (Land 1994).

Female Florida panthers have bred as young as 18 months of age (Maehr *et al.* 1989a) and as late as 11 years of age. The mean age of denning females was 5.8 years (Land and Taylor 1998). The first sexual encounters for males occur at about 3 years of age (Maehr *et al.* 1991a) although a male in Everglades NP bred at 18 months (O. Bass, NPS, personal communication 1997). Dispersal of young typically occurs around 1.5 to 2 years of age, but may occur as early as one year of age (Maehr 1992a).

Infant mortality is thought to be relatively high with fewer than half of all pregnancies resulting in offspring that survive beyond 6 months of age (Roelke *et al.* 1993). The kitten survival rate between age 6 months and 1 year has been estimated at 0.895 (Land 1994). This is based on a sample of 15 radio-collared kittens monitored from 6 months to 1 year of age. Young panthers are considered recruited into the population when they have successfully reproduced (D. Jordan, FWS, personal communication 1997). Of 21 dependent kittens radio-collared and followed beyond independence, 71 percent of females (5 of 7) and 29 percent of males (4 of 14) have been recruited into the population. Females are readily recruited into the population as soon as they are capable of breeding (Maehr *et al.* 1991a). Males appear to have more difficulty being recruited. Without large areas of suitable habitat to accommodate dispersal, young males have few opportunities for recruitment as residents. As a result, the panthers' ability to increase and outbreed has been severely restricted. Successful male recruitment appears to depend on the death, or home range shift, of a resident adult male (Maehr *et al.* 1991a). Turnover in the breeding population is low; with documented mortality in radio-collared Florida panthers being greatest in subadult and non-resident males (Maehr *et al.* 1991b).

Florida panther mortality (n=67) averaged 3.5 deaths per year from 1978 through June 30, 1998. Male panthers accounted for 57.6 percent of mortality. Sub-adult panthers (0 to 3 years) of both sexes accounted for 45.5 percent of mortality. Specific causes of panther mortality include road kill (37.9 percent), intraspecific aggression (21.2 percent), disease and old age (18.2 percent), causes unknown (12.1 percent), shootings (9.1 percent), and research related (1.5 percent) (Land and Taylor 1998).These mortality figures only include panthers endemic to South Florida, and not the introduced Texas cougars.

Foraging

Food habit studies of Florida panthers indicate that feral hog (*Sus scrofa*) was the most commonly taken prey followed by white-tailed deer, raccoon (*Procyon lotor*), and nine-banded armadillo (*Dasypus novemcinctus*). Deer and hogs accounted for 85.7 percent of consumed biomass north of Interstate 75, and 66.1 percent south of Interstate 75 (Maehr *et al.* 1990a). No seasonal variation in diet was detected; however, panthers inhabiting an area of better soils north of Interstate 75 consumed more large prey. In addition, deer abundance was up to eight-fold greater north of Interstate 75 (McCown 1991). The estimated number of deer consumed per panther did not differ between the areas north and south of Interstate 75. Hog numbers were lower south of Interstate 75. Fewer large prey may, in part, explain the poorer physical condition, larger home ranges, and lower reproductive output of panthers residing south of Interstate 75. Hogs dominated the diet of panthers in the north in terms of both estimated biomass and numbers. In the south, deer accounted for the greatest estimated biomass consumed, whereas raccoons were the highest estimated number of consumed prey. Domestic livestock were found infrequently in scats or kills, although cattle were readily available (Maehr *et al.* 1990a).

Movements and Dispersal

Adult Florida panthers space themselves throughout available habitat in southwest Florida in a pattern similar to that of western cougars (Land 1994). The home range size of 26 radio-collared panthers monitored between 1985 and 1990 varied from 53 to 1,183 km^2, averaging 519 km^2 for resident males and 193 km^2 for resident females. Home ranges of resident adults were stable unless influenced by the death of other residents. Home-range overlap was extensive among resident females and limited among resident males (Maehr *et al.* 1991a).

There are no known differences in seasonal movements, wet and dry season habitat use, or effects of season on road crossing. There may be a response to fluctuations in water levels; however, the response is believed to be undetectable (Maehr 1989; Maehr *et al.* 1990b, 1991a).

A female panther was killed by automobile on S.R. 84 in 1986. Prior to, and during the early phases of, conversion from two-lane S.R. 84 to four-lane Interstate 75 only male panthers were detected crossing this roadway. The highway may have been a deterrent to female movements (Maehr *et al.*

1991a). Since the completion of Interstate 75 and associated wildlife crossings, numerous male panthers and a female panther have regularly crossed underneath the roadway (Lotz *et al.* 1996).

Western subspecies of *puma* have been documented crossing wide, swift-flowing rivers up to a mile in width (Seidensticker *et al*. 1973, Anderson 1983). The Caloosahatchee River, a narrow, channelized, blackwater river, should not be a significant barrier to panther movements, but the combination of the river, S.R. 80, and land uses along the river seems to have restricted panther dispersal northward (Maehr 1996). In 18 years of research only one radio-collared panther crossed the Caloosahatchee River. This dispersing subadult male crossed the river in April of 1998 enroute to Osceola County setting a dispersal record of 220 km in the process (Land and Taylor 1998). Dispersal distances average 58.7 km for subadult males and 16 km for a single subadult female. Mean dispersal age was 17.9 months (Maehr 1992a).

Activity levels for Florida panthers peak around sunrise and sunset (Maehr *et al.* 1990b). The lowest activity levels occur during the middle of the day. Female panthers at natal dens follow a similar pattern with less difference between high and low activity periods.

Relationship to Other Species

The Florida panther requires extensive, biotically diverse landscapes to survive. Large carnivores are considered critical in maintaining ecological integrity in many large forest systems (Terborgh 1988). Landscapes through which the panther ranges support a vast array of South Florida's rich faunal and floral diversity including the Florida black bear (*Ursus americanus*), Big Cypress fox squirrel (*Sciurus niger avicennia*), American swallow-tailed kite (*Elanoides forficatus*), hawks and owls, neotropical migratory birds, and endemic orchids and epiphytes (K. Dryden, GFC, personal communication 1996).

Deer, hog, and raccoon have already been mentioned as the most important prey species taken in terms of biomass and numbers (Maehr *et al*. 1990a). As a result of human-induced changes in habitat quantity and quality, it is possible that competition between key members of a faunal community may develop. However, comparisons of food habits, habitat use, and movements among bobcat (*Lynx rufus*), panther, and black bear revealed a low probability for competitive interactions (Maehr 1996).

Status and Trends

The State of Florida declared the panther a game species in 1950 and an endangered species in 1958. The FWS listed the panther as endangered in 1967 (32 FR 4001). Activities in the 1800s and early 1900s contributed to its need for listing.

The first bounty on Florida panthers was passed in 1832. Another Florida law passed in 1887 authorized a payment of $5.00 for panther scalps (Tinsley 1970). Agricultural land clearing in the southeast between 1850 and 1909 totaled 12.8 million ha. Lumbering reduced the original southern forest nearly 40 percent from 121.4 million ha to 72.0 million ha by 1919. A staggering 36.4 million ha of pine forests were considered cut-over by 1920 with one-third classified as restocked with sawable timber, one-third restocked with scrubby cordwood only, while one-third remained barren (Williams 1990). Meanwhile the white-tailed deer, primary prey of the panther, was reduced from a range-wide population of about 13 million in 1850, to under 1 million by 1900 (Halls 1984). Over a 100-year period, bounty hunting, land clearing, lumbering, and market hunting of deer contributed to the range-wide decline of the panther.

Of the 27 *Puma concolor* subspecies described in Hall (1981), the Florida panther is the only one remaining in the eastern U.S. The panther population in Florida numbered about 500 at the turn of the century (Seal *et al.* 1989). Kautz (1994) estimated that a loss of 1.74 million ha of forests in Florida between 1936 and 1987 was the equivalent of 35 to 70 male panther home ranges and 100 to 200 female panther home ranges. The Big Cypress population was estimated at 125 in 1969 (DOI 1969) and a South Florida population at 92 in 1972 (Schemnitz 1972). The Florida Panther Act, a State law enacted in 1978, made killing the panther a felony.

The uncertain status of the panther led to the establishment of a GFC Florida Panther Record Clearinghouse in the 1970s. Records were compiled prior to extensive field surveys and radiotelemetry research of remaining animals (Belden 1977). The first field surveys began in 1972. Radiotelemetry research began in 1981 and through 1983 was limited to Fakahatchee Strand State Preserve and Big Cypress National Preserve (Belden *et al.* 1988). The research program gradually expanded to include Everglades NP, Florida Panther NWR, Picayune Strand State Forest, Okaloacoochee Slough State Forest, the Corkscrew Regional Ecosystem Watershed, and private lands in Collier, Hendry, and Lee counties. A total of 72 panthers (41 male, 31 female) have been radio-collared since telemetry research began in 1981. As of June 30, 1998 there were 30 panthers (14 male, 16 female) being monitored.

Ten Florida panther kittens, five male and five female, were removed from the wild between February 1991 and August 1992 for captive breeding purposes. The kittens ranged in age from 10 days to 8 months and represented progeny of 11 different adult panthers. Two females died in captivity in 1992. One died after heart surgery in an attempt to correct an atrial septal heart defect and one died of unknown causes. Two males died of severe respiratory distress after being released to the wild in southern Big Cypress National Preserve in 1997. Six panthers remain in permanent captivity, one male and one female each, at White Oak Conservation Center in Yulee, FL, Lowry Park Zoo in Tampa, and at the Jacksonville Zoo (Land and Taylor 1998).

Threats

The Florida panther's existence is threatened by extinction processes. Population viability analysis projections indicate that under existing demographic and genetic conditions the panther will likely be extinct in 24 to 63 years (Seal *et al.* 1992). Environmental factors affecting the panther include: habitat loss and fragmentation, contaminants, prey availability, human-related disturbance and mortality, disease, and genetic erosion (Dunbar 1993). Any reference to mortalities associated with these threats refers only to the endemic South Florida population and not to the introduced western cougars.

Genetic and Physiological: Natural gene exchange between the Florida panther and three other subspecies ceased when the panther became geographically isolated, probably over a century ago (Seal *et al*. 1994). Isolation from *F. c. cougar*, *F. c. hippolestes*, and *F. c. stanleyana*, habitat loss, reduced population size, and inbreeding have resulted in loss of genetic variability and diminished health. Data on polymorphism and heterozygosity, when combined with multiple physiological abnormalities, suggest that the panther is experiencing inbreeding depression (Roelke *et al*. 1993, Barone *et al*. 1994). Inbreeding depression has been related to decreased semen quality, lowered fertility and neonatal survival, and congenital heart defects in a variety of domesticated and wild species (Lasley 1978, Ralls and Ballou 1982, Wildt *et al*. 1982, O'Brien *et al*. 1985, Roelke 1991). The panther exhibits many of these traits.

Congenital heart defects were documented in 11 Florida panthers in 1990 and 1991 (Roelke 1991). Some of these heart defects were severe enough to result in death. All eight panther kittens examined that year had heart murmurs, as well as 30 percent of the adults examined. Congenital heart defects are believed to result from inbreeding, and may interfere with survival and reproduction (Roelke 1991, Dunbar 1993, Barone *et al*. 1994).

The Florida panther exhibits poorer male reproductive characteristics than other populations of mountain lions in North America or Latin America (Barone *et al*. 1994). Of 16 panthers, more were unilaterally cryptorchid (43.8 percent vs. 3.9 percent), had lower testicular and semen volumes, poorer sperm progressive motility, and more morphologically abnormal sperm than did 51 individuals from other *Puma concolor* populations in Texas, Colorado, Latin America, and North American zoos (Wildt 1994).

Research indicates the extant Florida panther population is comprised of two genetic stocks. Panthers in Big Cypress Swamp descended from *F. c. coryi*. Panthers in the Everglades also descended from *F. c. coryi* but contain additional Latin American genetic markers (O'Brien *et al*. 1990) that probably originated from captive "Piper" stock released into the Everglades between 1956 and 1966 (Vanas 1976, Mounger 1991). The presence of Latin American genes may explain the lack of congenital heart defects in Everglades panthers. None of the Everglades panthers tested in one study were cryptorchid, whereas 64 percent of the Big Cypress panthers tested were cryptorchid (Barone *et al*. 1994).

Low heterozygosity levels indicate that the Florida panther has lost approximately half of its genetic diversity (Roelke 1990). The level of mDNA variation in the panther is the lowest reported in any similarly studied feline population, including leopards, cheetahs, and other *puma* subspecies. Electrophoretic analyses also indicate the panther has less variation than any other *puma* subspecies and is nearly as low as the level of allozyme variation reported in the two cheetah subspecies. Panther DNA fingerprint variation is nearly as low as the genetic variation in Asiatic lions from the Gir Forest Sanctuary in India (Roelke *et al.* 1993).

Disease: Disease is a threat to small, inbred populations (Roelke 1991, Barone *et al.* 1994, Seal *et al.* 1989). All Florida panthers undergo an examination to assess general health and physical condition at the time of capture. Panthers greater than 8 weeks of age are dewormed and vaccinated for feline viral rhinotracheitis (FVR), feline calicivirus (FCV), feline panleukopenia (FPV), and rabies. Biomedical samples collected include whole blood, skin biopsy, hair, and feces. Bacterial cultures are taken as needed. Panther kittens less than 6 weeks of age are also given injections of iron, vitamin B, and penicillin (Taylor 1997).

Six of 20 free-ranging Florida panthers (30 percent) captured from Everglades NP, Big Cypress National Preserve, and adjacent lands between 1986 and 1988 tested positive for feline immunodeficiency virus (FIV) (Barr *et al.* 1989). Five out of 19 panthers (26.3 percent) examined in 1992 (Roelke and Glass 1992) and one of 23 examined between July 1, 1996 and June 30, 1997 (Taylor 1997) tested postive for FIV. FIV has a long incubation period but leads to non-specific immunosuppression and death in domestic cats (Roelke 1991). Its significance to the panther is not known.

Other diseases, such as feline infectious peritonitis (FIP), feline leukemia virus (FeLV), *Cytauxzoon felis*, and *Bartonella henselae*, are present in varying degrees (Roelke 1991, Roelke and Glass 1992, Dunbar 1993).

Parasites found on 12 panthers examined between 1978 and 1983 included one protozoan, two trematodes, three cestodes, seven nematodes, six ticks, and one flea. The trematode *Alaria marcianae* and a hookworm *Ancylostoma pluridentatum* were the most prevalent and abundant (Forrester *et al.* 1985).

Mortality from shooting: Six Florida panther shootings, five fatal and one non-fatal, occurred between 1978 and 1986--an average of one every 2 years. These data do not include the more recent shootings of introduced Texas cougars; however, it should be noted that all subspecies of *Puma concolor* that occur in Florida are protected by a “similarity of appearance” provision in the Endangered Species Act.

Highways: Construction of highways in wildlife habitat may result in habitat fragmentation, direct mortality, direct habitat loss, displacement and avoidance, and associated human development (Ruediger 1998).

Rare carnivores are generally present only in locations with the lowest highway densities. Highways, and other human developments, tend to create boundaries for individuals and populations. Habitat fragmentation isolates small populations, subjecting them to demographic and stochastic factors (Ruediger 1998) that reduce their chances for survival and recovery.

Panthers consistently use large areas with few major highways (Maehr and Cox 1995). Belden and Hagedorn (1993) observed that Texas cougars, used in a population reintroduction study, established home ranges in an area with one-half the road density of the region in which the study was conducted. In particular, the study animals tended to avoid crossing more heavily traveled roads (*e.g.* primary and secondary hard-surface highways, and light-duty roads) in favor of more lightly traveled roads. Of 26 *puma* home ranges examined by Van Dyke *et al.* (1986), 22 (85 percent) included unimproved dirt roads, 15 (58 percent), included improved dirt roads, but only 6 (23 percent) included hard-surfaced roads. Female panthers rarely establish home ranges bisected by highways and maternal dens are located at distances one kilometer or greater away from highways (Maehr 1996).

Florida panther road mortality (n=24) between 1978 and June 30, 1998 averaged 1.2 panthers per year and was almost evenly divided between males (n=13) and females (n=11). Vehicle collisions resulting in the death of subadult panthers (0 to 3 years) of both sexes exceeds subadult mortality due to intraspecific aggression (23.4 versus 10.9 percent) and equals all other forms of subadult mortality combined (Land and Taylor 1998). Although the relative significance of highway deaths to other sources of mortality is not entirely known, it has been the most often documented source of mortality (Maehr 1989, Maehr *et al*. 1991b).

Florida panther road mortality and injury (n=30) between 1978 and June 30, 1998 was greatest in Collier County (76.7 percent), followed by Hendry County (10.0 percent), and Lee County (10.0 percent). During the same period panther mortality and injury was greatest on S.R. 29 (33.3 percent) and Alligator Alley (16.7 percent) in Collier County (Land and Taylor 1998). Nighttime speed limits were reduced on S.R. 29 and Alligator Alley in 1984 in an effort to minimize panther/vehicle collisions. Wildlife underpasses, first used by panthers in 1989 (Maehr 1992a), have greatly reduced risks in these problem areas (Foster and Humphrey 1995).

A 33 m (2 lane) and 100 m (4 lane) cleared right-of-way would consume, respectively, 1.9 and 5.7 percent of each section of land through which it passes (Ruediger 1998). Highways stimulate more land development than is generally recognized. Change occurs as far away as 3.2 km on either side of the highway. Thus for each kilometer a highway is extended, 644 ha are opened to new development (Wolf 1981).

Urbanization: The rapid and extensive loss of panther habitat is a result of Florida's flourishing human population, which has doubled nearly every 20 years since 1830. Only five percent of the state's residents lived in South Florida in 1900. Today 50 percent live there. Florida's population, fourth largest in the U.S., is expected to reach 17.8 million (127 persons per km^2) by 2010 (Floyd 1996).

The population of South Florida passed one million (130 persons per km^2) in 1950, three million (391 persons per km^2) in 1970, and six million (780 persons per km^2) in 1990. The population density of South Florida has exceeded the statewide average since 1960. South Florida's population is projected to reach 8.2 million (1,070 persons per km^2) by 2010 (Floyd 1996).

South Florida accounted for 49 percent of Florida's residential construction starts in 1995. Ft. Lauderdale, Miami, West Palm Beach-Boca Raton, Sarasota-Bradenton, Ft. Myers-Cape Coral, Ft. Pierce-Port St. Lucie, Lakeland-Winter Haven, Punta Gorda, and Naples, in descending order, accounted for 39 percent of Florida home sales in 1996. Ft. Lauderdale ranked third and Miami fourth statewide in total numbers of houses sold. Naples ranked second statewide in the percentage increase of houses sold (Floyd 1996).

Population growth and agricultural expansion in South Florida are compromising the ability of natural habitats to support a self-sustaining panther population. Continued expansion of the urbanized east coast, increasing growth on the west coast, and the spread of agricultural development in the interior have placed increasing pressures on forested tracts in Collier, Glades, Hendry, and Highlands counties (Maehr 1990b, Maehr 1992a, Maehr *et al*. 1991a).

Agriculture: Statewide between 1936 and 1987, cropland and rangeland increased 1.72 million ha or 30 percent, urban areas increased by 1.60 million ha or 538 percent, while herbaceous wetlands declined by 1.57 million ha or 56 percent and forests declined by 1.74 million ha or 21 percent.

Agricultural and urban development continues to replace and fragment panther habitat. Over 83 percent of the 648,000 ha of agricultural land in southwest Florida; *i.e.* Charlotte, Collier, Glades, Hendry, Lee and Sarasota counties, is categorized as rangeland. Between 1986 and 1990, row crop acreage increased by 3,640 ha or 21 percent, sugarcane increased by 6,475 ha or 21 percent, citrus increased by ha or 75 percent, and rangeland--much of it suitable for panther occupation - decreased by 64,750 ha or 10 percent. Rangeland losses were about evenly divided between agricultural development (citrus, row crops, sugarcane) and urban development (Townsend 1991).

Occupied panther habitat is about evenly divided between public and private lands. If private land habitats are lost the existing public lands in South Florida are judged capable of supporting only 9 to 22 (Maehr 1990b) of the minimum 50 adult panthers needed to sustain a genetically viable population. Where current uses on private lands are compatible with panthers, owners should be economically encouraged to continue those practices (Maehr 1992a, 1992b).

Management

Early conservation efforts benefitting the Florida panther involved land protection and natural areas management. After nearly a decade of planning, Everglades NP was established in 1947. Corkscrew Swamp Sanctuary was established in 1954, when the National Audubon Society and The Nature Conservancy purchased remnant stands of old growth cypress from the Lee Tidewater Cypress Company and Collier Enterprises.

The Florida Legislature passed the Big Cypress Conservation Act of 1973, thus designating 347,228 ha of the 634,561 ha Big Cypress Watershed as an "Area of Critical State Concern (ACSC)." The Fakahatchee Strand State Preserve, established in 1974; the Big Cypress National Preserve, established in 1974 (P.L. 93-440); and the Florida Panther NWR, established in 1989 (the only public land established specifically to protect the panther), all lie within the Big Cypress ACSC. Today 24,282 ha remain in private ownership. Site alteration within the Big Cypress ACSC is limited to 10 percent of the land parcel. Impervious surfaces are limited to one-half of the site altered. Agricultural activities are exempt from these restrictions (Chapter 28-25, F.A.C.).

The Florida Panther Research and Management Trust Fund and the Florida Panther Technical Advisory Council were established by the Florida Legislature in 1983. Money from the trust fund is used to manage and protect the extant panther population and panther prey; to inform the public of panther recovery activities, and to reintroduce panthers into areas where habitat is suitable. These funds are obtained through donations and a portion of the severance tax on oil extracted in Collier County.

The Technical Advisory Council is comprised of two members that represent State or Federal agencies responsible for endangered species management, two members with academic expertise in the research and management of felines or large mammals, and one member from the public at large. Membership was expanded in 1997 to include two members representing landowners from that part of South Florida where panthers inhabit private lands. The purpose of the Technical Advisory Council is to advise the GFC on technical matters relevant to panther recovery, review and comment on research and management activities, and provide a public forum for technical review and the status of recovery efforts.

The Florida Panther Interagency Committee (FPIC), comprised of the FWS, NPS, GFC, and DEP, was established in 1986 to coordinate recovery of the Florida panther. A Habitat Preservation Plan (HPP), prepared in 1993 for the FPIC, identified 374,868 ha of occupied and potential habitat considered essential to maintaining a minimum viable population of 50 breeding adult panthers in South Florida. The HPP also identified habitat threats, and the means by which the habitat could be protected; *e.g.,* land acquisition, conservation easements, exchanges, donations, voluntary management agreements, landowner incentives, and landowner disincentives. Figure 3 shows the relationship of existing and proposed state land acquisition and conservation easement projects to nine of the ecological units identified in the HPP (Logan *et al.* 1993).

Present-day conservation efforts include accelerating state acquisition of Picayune Strand SF with matching Federal funds. Okaloacoochee Slough SF, the first publicly owned conservation land in Hendry County, was purchased by the SFWMD in 1996. Lands were added to the Big Cypress National

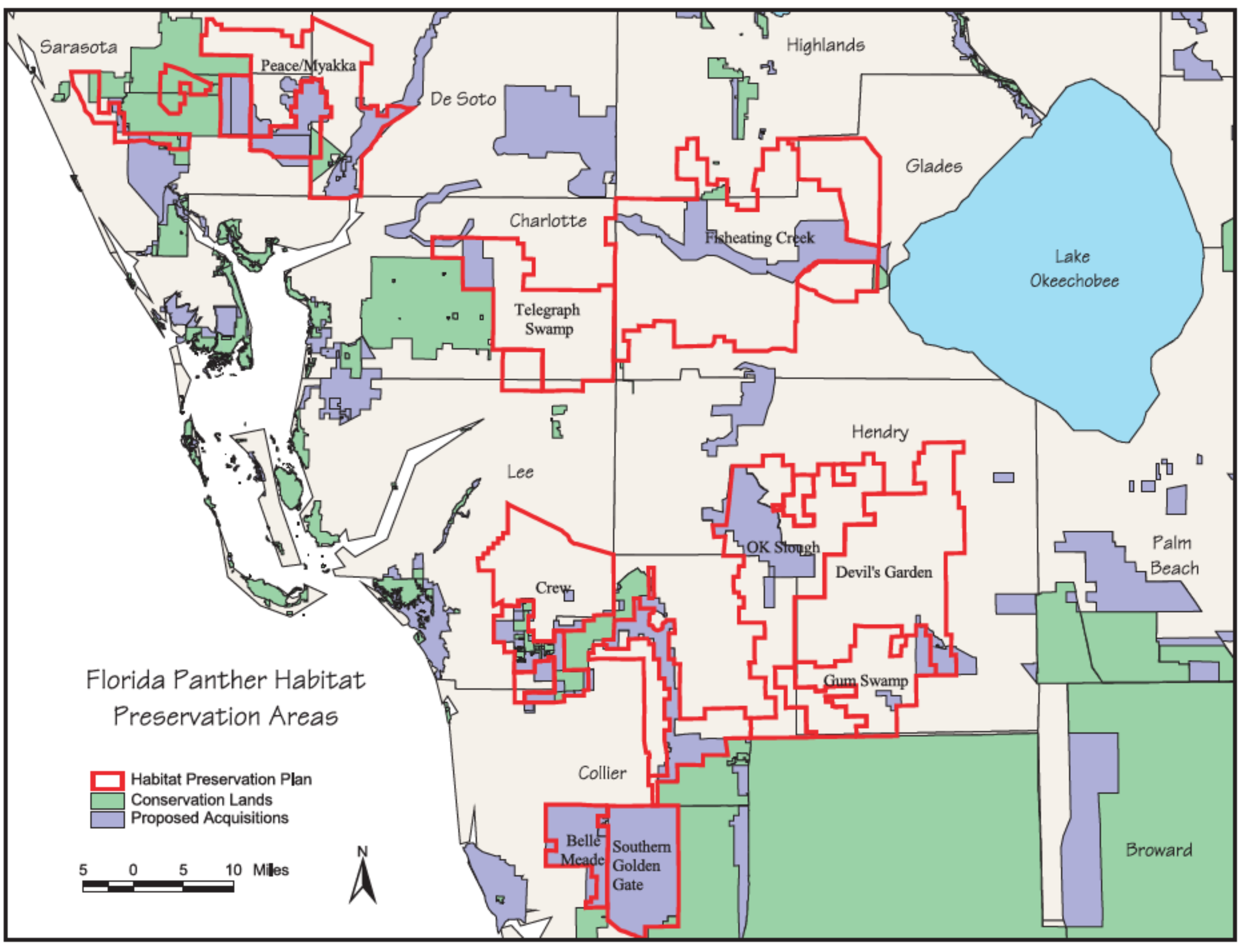


Figure 3. Florida panther habitat preservation areas.

Preserve and Florida Panther NWR when the Arizona-Florida land exchange (P.L. 100-696) was finalized late in 1996. Caloosahatchee Ecoscape, a landscape corridor connecting panther habitat in Glades and Hendry counties, was added to the Conservation and Recreation Lands acquisition list in 1998. USDA/NRCS and FWS landowner incentive programs are suited to panther habitat protection and their full potential has yet to be realized. The State of Florida is promoting the use of conservation easements to protect panther habitat and easements are expected to play a larger role in Florida's land conservation efforts after 2000. Private landowners in South Florida have initiated a grassroots effort to link Federal estate tax reform with protection of endangered species habitat.

* * * * *

The survival and recovery of the Florida panther is dependent on: (1) protection and enhancement of the extant population, associated habitats, and prey resources; (2) improving genetic health and population viability; and (3) reestablishing at least two additional populations within the panther's historic range.

The first area of emphasis in Florida panther recovery is protection and enhancement of the extant population, its associated habitat, and its prey resources. Several State and Federal agencies manage within existing financial, legal, philosophical, and ecological constraints, public lands inhabited by the panther and its prey.

Panther habitat management on public lands consists primarily of prescribed fire and wildfire suppression in fire-adapted vegetation communities. Chemical, biological, and mechanical control of invasive exotic plants helps maintain and perpetuate preferred panther habitat types. In addition to prescribed fire and exotic plant control, management for panther prey, *e.g.* white-tailed deer and feral hog, consists of hunting restrictions and vehicle access restrictions.

Two-to-five year fire rotations and burn compartments less than 2,500 ha are recommended to increase habitat heterogeneity (Schortemeyer *et al.* 1991). However, fire prescriptions will vary based on fuel conditions, weather conditions, and historic fire frequency. Compartment size will vary based on site conditions, including the use of existing fire breaks or reluctance to establish new fire breaks that would reduce native habitats, fragment native habitats, and serve as vectors for the spread of exotic plants. For example, Florida Panther NWR uses existing swamp buggy trails and highways as burn compartment boundaries. The refuge is divided into 54 burn compartments that range in size from 121 to 445 ha. A range of 2,023 to 3,238 ha is burned annually depending on weather conditions. Best results have been obtained by burning 3 to 5 days following a light rain shower (<12.7 cm) and when dead fuel moistures (1 and 10 hour fuels) are 8 to 12 percent and live fuel moistures (1 and 10 hour fuels) are 134 to 168 percent (FWS 1996).

Food plots, clearings and feeders can be effective in local situations. Disturbed sites, particularly those invaded by willows, can produce good forage for deer. Establishment of oaks and palms on disturbed sites can significantly increase mast production in select areas (Schortemeyer *et al.* 1991).

Prey management has also been accomplished by regulating harvest. A variety of strategies have been used. Everglades NP, Fakahatchee Strand State Preserve, and Florida Panther NWR are closed to hunting. Portions of Big Cypress National Preserve are closed to hunting, open only for archery hunting, or open for a limited general gun season. Use of hunting quotas and off road vehicle (ORV) access permits have reduced or redistributed hunting pressures. Use of dogs for hunting is prohibited. A five-inch antler rule reduced the harvest of does and fawns. Big Cypress National Preserve and all private lands south of Interstate 75 are excluded from the doe season (Schortemeyer *et al.* 1991).

Overall, management activities directly benefitting the panther and panther prey are limited to upland habitats which comprise only 8 percent of the total land area in Big Cypress National Preserve, Everglades NP, and Florida Panther NWR.

Private landowners should be encouraged to continue or initiate land management practices beneficial to the Florida panther. Landowner incentive programs can be used to provide technical and financial assistance for prescribed fire, exotic vegetation control, rotational grazing, fencing, tree planting, *etc*. Given that 60 to 80 percent of panther radio-locations occur in pine flatwoods and hardwood hammocks (Maehr 1996) landowners should be encouraged to restore pine flatwoods and protect hardwood hammocks from over-grazing.

The Immokalee Rise physiographic region includes all of Hendry County and parts of Collier, Glades, and Lee counties, *i.e.* the core of occupied panther habitat. Pine flatwoods in this area declined 88 percent from 153,928 ha in 1900 to 17,970 ha in 1989. Pine flatwoods have also been severely fragmented and today are comprised of thousands of patches less than 50 ha in size (Mazzotti *et al.* 1992). Pine flatwoods have been replaced by pasture, row crops, and citrus.

Restoration of pine flatwoods will not be easy. Few landowners in South Florida are located within the critical radius of a railhead in Palmdale, Florida--the only route by which timber from South Florida can be hauled to North Florida mills for processing and distribution. Consequently there is little incentive to replant timber in South Florida once it matures and is harvested. One possible long-term solution is development of local outlets for “value-added” pine timber products. An alternative, short-term solution is to pay landowners to replant and maintain sufficient stands of pine flatwoods to increase panther distribution and densities.

Hardwood hammocks have increased (probably due to land drainage) from 6,703 ha in 1900 to 9,516 ha in 1989 but have never comprised more than 2 percent of the vegetative cover in the Immokalee Rise physiographic region (Mazzotti *et al.* 1992). Given the high level of panther use and scarcity as a cover type it is important that hardwood hammocks be maintained in conditions attractive to panthers and panther prey. Hardwood hammocks are sometimes manipulated by landowners to increase understory browse for cattle. In extreme cases over-grazing has reduced the hammock understory to bare dirt. Landowner incentive programs should be used to establish rotational grazing programs to reduce grazing pressure on the hammocks and to fence cattle from the hammocks where appropriate.

The second area of emphasis in Florida panther recovery is genetic health and population viability.

A program to address these concerns through the restoration of gene flow was initiated in 1995. The rationale and details for the program, as well as morphological and genetic criteria used to monitor and measure success, are found in the FWS document entitled "Final Environmental Assessment - Genetic Restoration of the Florida Panther" and the associated genetic restoration and management plan (FWS 1994).

The level of introgression required to reverse the deleterious effects of inbreeding is estimated at 20 percent, or 6 to 10 Texas cougars (*F. c. stanleyana*), based on the current population estimate of 30 to 50 breeding adult panthers. Each of the Texas cougars released needs to produce at least two offspring that survive and are recruited as breeders. One additional Texas cougar will be translocated into South Florida every 6 years thereafter. This should restore genetic variability in the panther without significant alteration to its basic genetic makeup which may be adapted to local environmental conditions (Seal *et al.* 1994).

Unrelated animals were selected from various locations throughout Texas, screened in the field for cowlicks and kinked tails, and screened in quarantine for atrial septal heart defects and disease. Females 2 to 4 years of age were selected because they were considered more likely to remain near release sites, less likely to be adversely affected, and could be more easily assimilated into the extant panther population (Seal *et al.* 1992).

The extent of introgression will be assessed by several factors: pedigree analysis based on Florida and Texas founder contributions, analysis of molecular genetic markers, and analysis of morphological characters that differentiate the two subspecies (Seal *et al.* 1992).

Genetic management began with the release of eight female Texas cougars in 1995. Two each were released in Fakahatchee Strand State Preserve, northern Big Cypress National Preserve, southern Big Cypress National Preserve (Figure 4), and Everglades NP.

As of July 1, 1998 six of the eight female Texas cougars remained alive. One was killed in a vehicle collision in Hendry County September 1, 1995. The second was found shot in a Collier County citrus grove April 18, 1998. Five of the six female Texas cougars remaining alive have produced eight litters of first generation (F_1) intercross kittens--eight female and four male (Land and Taylor 1998). An F_1 female produced the first litter of F_2 kittens (one female, two male) in September 1998. A population viability analysis workshop will assess the progress of the genetic management program.

The third area of emphasis in Florida panther recovery is to establish two additional populations within the historic range of the panther (FWS 1987, FWS 1995). Population establishment involves site selection and use of surrogate animals for site evaluation (Jordan 1994, Belden and Hagedorn 1993, Belden and McCown 1994). Between 1988 and 1995, 26 Texas cougars were released near Okefenokee NWR and Osceola NF. Six animals were born and raised in captivity. Twenty were captured in western Texas and translocated to Florida, 17 of which were released into the wild shortly after arrival. The remaining three were part of a study to develop captive breeding techniques and were held in captivity for 2 to 8 years prior to release (Belden *et al*. 1989, Belden and McCown 1996).

The study animals, monitored by radiotelemetry at least 3 days per week, established overlapping home ranges, made kills of large prey at predicted frequencies, and generally adapted well to their new environment (Belden *et al*. 1989). Captive-raised animals tended to establish home ranges more quickly, and were more likely to associate with other study animals than were wild-caught animals. Captive-raised animals, particularly males, were more likely to be seen by humans and were the primary cause of negative attitudes toward the study. The mean distance from the release site to the home range center and the mean home range size were significantly greater for the wild-caught males than captive-held males, and captive or wild-caught females (Belden and McCown 1996).

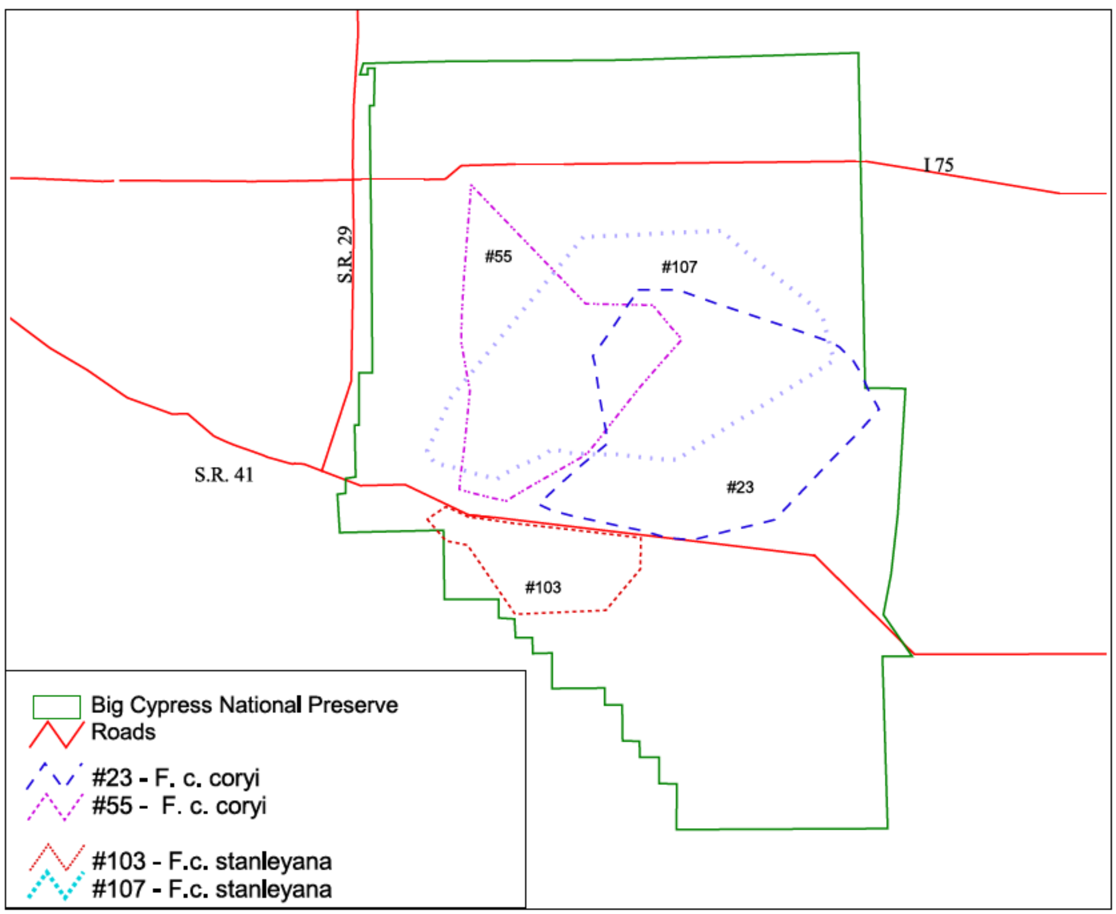


Figure 4. Home ranges of collared *F. concolor* in portions of Big Cypress National Preserve.

One of two plans for population re-establishment discussed by Belden and McCown (1996) involves the release of four to five wild-caught female Florida panthers into a select area. Once they established home ranges a captive-raised male would be introduced only long enough to breed the females. This plan has the advantages of requiring fewer panthers from the South Florida population and of allowing more control over where re-establishment occurs. Wild-caught females with kittens could also be used.

Studies have concluded that Florida panther reintroduction is biologically feasible (Belden and Hagedorn 1993, Belden and McCown 1996). Habitat and prey available in north Florida and south Georgia are sufficient to support a viable panther population. However, complex social issues must be addressed prior to population reestablishment (Belden and McCown 1996). A study is currently underway to identify these issues and ways to manage them.

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Recovery for the Florida Panther

Felis concolor coryi

Recovery Objective: Establish three viable populations within the historic range**.**

South Florida Contribution: The narrative in this multi-species recovery plan is being prepared in advance of the range-wide Florida panther recovery plan revision which will be undergoing complete revision beginning in late 1997. Therefore, recovery tasks identified in this plan should be considered tentative and subject to change based on the results of the range-wide recovery plan revision. The multi-species plan will focus on the South Florida population, while recognizing that full recovery of this species is dependent upon the establishment of additional populations within the historic range of the species. The FWS will ensure the two plans complement one another in effecting recovery of the Florida panther.

Recovery Criteria

The present range-wide recovery objective for the Florida panther is to achieve three viable, self-sustaining populations within the historic range of the animal. First priority will be to secure the population in South Florida. A viable population level will be determined when enough data are available to develop a panther population model. An essential criteria for recovery of the panther needs to ensure 95 percent probability of persistence of the South Florida population over a minimum of 100 years. Re-established populations may require separate population goals. Population objectives will generally be based on the size of the respective areas, prey base, and other ecological factors important to panthers.

This narrative will only address the existing population in South Florida. The range-wide recovery plan revision will incorporate the needs in South Florida with population re-establishment and the many other tasks deemed necessary to recover the panther.

Species-level Recovery Actions

S1. Refine the current distribution of the South Florida panther population. Delineate areas inhabited or frequented by panthers. Radio-collared panthers have been documented in 12 of 19 counties in South Florida. The breeding population is centered in Collier, Hendry, and Miami-Dade counties. Uncollared panthers may still reside on private lands in Charlotte, Collier, Hendry, Lee, and Glades counties.

S1.1. Conduct field surveys on all newly acquired public lands. As State or Federal conservation lands are added to the public trust field surveys should be conducted to determine the presence or absence of Florida panthers. Uncollared panthers encountered should be added to the research population.

S1.2. Conduct field surveys on private lands to document panther presence. Potential sites would include areas identified in the HPP, other areas comprising panther habitat, and areas associated with reliable reports of panther observation/sign. Special emphasis should be placed on developing cooperative partnerships with private landowners for access. Private landowners currently involved in telemetry research studies should be commended for their participation. As in **S1.1**, uncollared panthers encountered should be added to the research population.

S2. Protect and enhance the South Florida panther population.

S2.1. Enhance the panther population through genetic and demographic management. Plans for genetic and demographic management should anticipate the circumstance under which translocation would be appropriate, and should distinguish the advantages and disadvantages of using males, females, pregnant females, animals of various ages, soft- and hard-release techniques, *etc*.

S2.1.1. Translocate animals for genetic management. Eight female western cougars (*F. c. stanleyana*) were translocated from Texas to Florida for genetic introgression in 1995. The approved genetics management plan calls for the translocation of one female western cougar about every 6 years thereafter. Animals selected for translocation must be screened in the field for cowlicks and kinked tails and screened in quarantine for atrial septal heart defects or disease using established protocols.

S2.1.2. Formulate plan for humane disposition of surplus animals. Female western cougars may need to be removed once F1 kitten recruitment goals (two per female) are met. A female western cougar/male F1 kitten pairing (backcross) is undesirable. Contraception, translocation, and removal are techniques by which undesirable pairings can be prevented. Develop a protocol for removal of these surplus animals from the population and attach it to the recovery plan as an appendix.

S2.2. Translocate animals for demographic management. It may be necessary, on occasion, to translocate panthers or intercross progeny to minimize or prevent undesirable pairings, to balance gender representation, and to fill home range vacancies in marginal habitat (*i.e*. southern Big Cypress).

S2.3. Reformulate plan for captive propagation of Florida panthers. Ten kittens, representing 11 adult panthers, were removed from South Florida during 1991 and 1992. Two died in captivity in 1992. Two died after being released to the wild in 1997. The other six panthers remain in permanent captivity. A population re-establishment study showed that there were advantages to using wild-caught versus captive-raised animals. Wild-caught western cougars are being used for genetic management rather than captive-raised animals. Consequently, the role of captive propagation in panther recovery would seem diminished. However, the fate of panthers remaining in captivity, and the role of captive propagation for education, genetic management, demographic management, or population re-establishment has not been determined. These issues need to be addressed.

S2.4. Identify causes of injury and mortality. Florida panther mortality (n=67) averaged 3.5 deaths per year from 1978 through June 30, 1998. Specific causes of panther mortality include: road kill (37.9 percent), intraspecific aggression (21.2 percent), disease and old age (18.2 percent), causes unknown (12.1 percent), shootings (9.1 percent), and capture related (1.5 percent). Other than disease, only those causes of panther injury or mortality attributable to humans can be minimized.

S2.4.1. Continue to minimize injury and mortality from panther/vehicle collisions. Florida panther injury and mortality (n=30) from vehicle collisions averaged 1.5 per year between 1978 and June 30, 1998. Panther/vehicle collisions were greatest in Collier County (76.7 percent), Hendry County (10 percent), and Lee County (10 percent); and on S.R. 29 (33.3 percent) and Alligator Alley (16.7 percent) in Collier County. Reduced nighttime speed limits are in effect, and enforced, on S.R. 29. Underpasses and fencing have eliminated panther mortality on Alligator Alley and certain stretches of S.R. 29. Panther/vehicle collisions continue on other rural roads.

S2.4.1.1. Complete installation of underpasses on S.R. 29. Four of six underpasses have been installed concurrent with the widening and realignment of S.R. 29. Two underpasses remain to be constructed in the Sunniland, Florida vicinity.

S2.4.1.2. Establish an underpass on S.R. 80 east of LaBelle, Florida. The Caloosahatchee Ecoscape was added to the Conservation and Recreation Lands acquisition list in 1998 and serves as the last remaining link between panther habitat in Glades County and Hendry County. S.R. 80, which runs from Ft. Myers to West Palm Beach, bisects the project, is heavily traveled, and likely to be four-laned. An underpass or underpassses will be required to maintain this important landscape link.

S2.4.1.3. Identify and prioritize other underpass needs in South Florida. Panther/vehicle collisions continue on rural two-lane roads in eastern Collier County, Hendry County, and in rapidly developing eastern Lee County. Underpass needs should be identified prior to future road maintenance or improvement projects on appropriate roads in South Florida counties. It is more efficient to construct wildlife underpasses concurrent with road improvements.

S2.4.2. Minimize the risk of disease outbreaks. Disease is a threat to small, inbred populations. All Florida panthers undergo an examination to assess general health and physical condition at the time of capture. Panthers greater than 8 weeks of age are dewormed and vaccinated for feline viral rhinotracheitis (FVR), feline calicivirus (FCV), feline panleukopenia (FPV), and rabies. Biomedical samples collected include whole blood, skin biopsy, hair, and feces. Bacterial cultures are taken as needed. Panther kittens less than 6 weeks of age are also given injections of iron, vitamin B, and penicillin. This protocol should continue--subject to periodic review, and amendment as needed.

S2.4.3. Minimize the risk of shootings. Education, self-policing among hunters, and regulation are the tools by which shootings are minimized. All free-ranging puma in the southeastern U.S. are protected by a “similarity of appearance” provision in the ESA.

S2.4.4. Minimize the risk of capture-related mortality. The only capture-related panther mortality occurred in 1983. Captures are confined to cooler months (November through March) to minimize heat stress. Crash bags and safety nets are used to cushion the impact of panthers that fall from the tree after immobilization. Anesthetic drugs have been changed and doses reduced through experience to minimize adverse reactions to the drugs. Advances in pharmacology have also made anesthesia safer.

S2.5. **Enforce available protective measures.** Implement local, State and Federal regulations and guidelines to protect Florida panthers and their habitat.

S2.5.1. **Initiate section 7 consultation when applicable.** All Federal agencies must consult with the FWS on any of their activities (authorized, funded, or carried out) that might adversely affect Florida panther populations. Such activities include (among others) land clearing, road construction, and military training exercises.

S2.5.2. **Implement on-site minimization, habitat compensation, and mitigation on private lands through section 10 when needed.** Where adverse effects cannot be avoided, measures must be taken to minimize on-site disturbance, and compensate or mitigate for the impacts that remain. The FWS generally recommends that areas used as habitat compensation be located in the vicinity of the affected habitat, where appropriate, and avoid further fragmentation and isolation of existing habitat.

S3. **Continue Florida panther life history and ecology research.**

S3.1. **Conduct research on biology, ecology, and population demographics**. Although considerable work has been done on the biology and ecology of the Florida panther, biological studies should continue to increase information on population viability, and relationship of demographic factors to habitat quality and availability.

S3.2. **Conduct risk assessment and population viability analyses** to determine the probability of persistence of panthers in South Florida, using current demographic data. Conduct periodic workshops to update population viability projections.

S3.3. **Continue research on effects of mortality on the Florida panther.**

S3.3.1. **Assess the current state of knowledge of the effects of environmental contaminants on the Florida panther.** Compile the latest available information from published and unpublished literature, and from scientists, to determine the direction for future research.

S3.3.2. **Continue to research effects of environmental contaminants that could be affecting the Florida panther.** Other environmental contaminants, such as endocrine disruptive chemicals, should be researched to assess any possible effects to the Florida panther.

S3.3.3. **Continue to gather and evaluate data on feline-associated viruses, parasites and other potentially debilitating agents**. Management recommendations should follow guidelines resulting from these data.

S3.3.4. **Develop health indicator matrix** Presence or absence of disease and contaminants (estrogen mimics, mercury) for each animal would be indicated in the matrix. An index of health would be established by noting the number of animals affected by disease or contaminants, the extent to which the animal is affected, the age, sex, and breeding condition of the animal, and comparing that to a desired index.

S3.3.6. Conduct research to determine the effects of road density and development (human density) on white-tailed deer and feral hog distribution and abundance.

S4. Monitor the South Florida panther population.

4.1. Continue and expand the radio-telemetry/monitoring program. The radiotelemetry/monitoring program within the core population area has been underway since 1981. Continue to track locations of collared panthers, and maintain all data on a GIS database. Expand the program by radio-instrumenting individuals in under-studied segments of the population and monitoring outside of the core area (*i.e.* CREW, Okaloacoochee Slough area, areas north of the Caloosahatchee River, *etc.*).

4.2. Continue to monitor translocated animals and offspring. All western cougars used for genetic introgression are radio-collared and monitored. All intercross kittens will be implanted with transponder identification chips, radio-collared prior to dispersal, and monitored. Four F1 kittens implanted with transponder identification chips have dispersed without being radio-collared. These animals, now old enough to breed, will be collared when encountered. DNA analysis will be required to establish the identity of F2 kittens sired or reared by the four uncollared F1 kittens.

S5. Refine statewide education and outreach programs for Florida panther. A 1995 public opinion survey indicates that Floridians are remarkably positive in their opinions and attitudes toward panther conservation (92 percent support, 2 percent oppose). The challenge now is to turn this support into tangible conservation efforts. Educators need to identify specific ways Floridians can become involved in panther protection. The action items should be simple and need to be effectively and constantly communicated to the public.

S5.1. Emphasize basic facts about the Florida panther in outreach materials. Awareness of the panther among respondents of the 1995 survey was high (90 percent) but knowledge levels were limited. Surprisingly, only 44 percent of the people aware of panthers in Florida knew that the panthers were confined to South Florida and only 14 percent knew that there were less than 50 remaining. Public relations efforts and materials must continue to reflect these basic facts.

S5.2. Tailor outreach efforts and materials to non-residents. Tourism, which brings about 40 million people to Florida annually, was not a focus of the 1995 survey. Agencies are only now beginning to understand the relationship between tourism, development, and wildlife conservation. Another way to increase panther awareness levels and support is to tailor outreach efforts and materials to tourists.

S5.3. Publicize Florida panther website. A website has been developed by Florida State University and the Florida Advisory Council on Environmental Education with funding derived from the sale of panther license plates. Education and outreach materials should include the web address (www.panther.state.fl.us).

S5.4. Establish South Florida education and outreach programs for Florida panther. Informing the public about the life history of the panther, land management practices that benefit the panther, and interagency efforts to prevent the extinction of the panther are important components of the panther recovery program. Listed below are tasks specific to South Florida as identified in the Florida Panther National Wildlife Refuge

Comprehensive Conservation Plan.

S5.4.1. Develop multi-agency visitor center. Use high-quality, conventional exhibits and progressive interactive media displays to inform public. The center will serve as an outdoor classroom in the Big Cypress Watershed for students in Collier County, Hendry County, Lee County, and all of South Florida.

S5.4.2. Hire three new personnel at Florida Panther National Wildlife Refuge. A media specialist is needed to coordinate news events, press releases, and information transfer to local, State, and national news outlets. A public use specialist is needed to coordinate visitor center activities, refuge interpretive displays, school outreach, and refuge volunteer activities. An administrative assistant is needed to support the media specialist and public use specialist.

S5.4.3. Increase membership of "Friends of the Panther Refuge" support group. The target is to have 100 members. The group will assist with education programs on and off the refuge. Quarterly evaluations will assess the effectiveness of the group's support efforts.

S5.4.4. Collaborate with partners to support outreach activities. Partners include but are not limited to local, State, and national non-profit organizations, and State and Federal agencies. Participate with partners in at least two events per year (National Wildlife Refuge Week, International Migratory Bird Day, Earth Day, *etc*.).

S5.4.5. Develop lesson plans for local school teachers and community organizations. The lesson plans should focus on the panther, public land management, South Florida ecosystem issues and restoration efforts. An annual workshop will be held for teachers from school districts in Collier County, Hendry County, Lee County, and all of South Florida.

S6. Continue to participate in the Florida Panther Recovery Program. .

S6.1. Reconstitute the Florida Panther Interagency Committee. The Florida Panther Interagency Committee (FPIC), established in 1986 to coordinate panther recovery efforts, is comprised of the FWS, NPS, GFC, and DEP. However, other State and Federal agencies and tribal governments have much to contribute to panther recovery. Consideration should be given to expanding FPIC membership.

S6.2. Convene periodic meetings of the Florida Panther Recovery Team. The Florida Panther Recovery Team should convene periodically to discuss interagency relations, ongoing research, research results, new literature relevant to panther recovery, and to assess panther recovery program accomplishments and needs.

S6.3. Convene periodic meetings of the Florida panther Technical Advisory Council. The Florida Panther Technical Advisory Council should continue to convene biannually.

S6.4. Update and revise the range-wide Florida panther recovery plan. The range-wide recovery plan, first approved in 1981, then revised in 1987 and 1995, is currently undergoing its third revision, which should be complete in 2000. The range-wide plan details the status of the recovery program and the myriad of tasks necessary for panther recovery. The plan should be updated and revised every 5 years. Progress reports on recovery plan implementation should be published annually.

S6.5. Convene periodic conferences for recovery program partners and general public. The Florida Audubon Society sponsored the first Florida Panther Conference in Orlando, Florida in 1978. A second conference sponsored by Florida Defenders of the Environment was held in Gainesville, Florida in 1986. A third conference sponsored by the Florida Panther Interagency Committee was held in Ft. Myers, Florida in 1994. The conferences have all focused on the issues of, and progress towards, panther recovery. Conferences held about once a decade for recovery program partners and the general public seem appropriate.

Habitat-level Recovery Actions

H1. Preserve and protect Florida panther habitat. The Florida Panther Habitat Preservation Plan (HPP) identified 374,868 ha of occupied and potential habitat considered essential to maintaining a minimum viable population of 50 breeding adult panthers in South Florida. Fifty-seven percent of these lands are classified as Priority 1 (highest quality and/or most frequently used) and 43 percent as Priority 2 (lower quality and/or less frequently used). The HPP also identified habitat threats, and the means by which habitat could be protected: land acquisition, conservation easements, exchanges, donations, voluntary management agreements, landowner incentives, and landowner disincentives.

H1.1. Complete acquisition projects comprised of Priority 1 and Priority 2 habitat. Nearly 190,000 ha of priority panther habitat have been proposed for State (75 percent) or Federal (25 percent) acquisition. Thirty-three percent of these lands have been preserved using fee-simple acquisition and conservation easements. The remainder should be preserved in a timely manner.

H1.2. Initiate new acquisition projects comprised of Priority 1 and Priority 2 habitat. The FWS has initiated a proposal to expand the Florida Panther NWR in Collier County and Hendry County by about 150,000 ha. Other proposals are being developed. Appropriate agencies should continue to identify landowners interested in panther recovery from whom land and conservation easements may be purchased.

H1.3. Complete public protection of Big Cypress Area of Critical State Concern. The Big Cypress Conservation Act of 1973 designated 347,228 ha of the 634,561 ha Big Cypress Watershed as an Area of Critical State Concern (ACSC). Today, 93 percent of the ACSC is in public ownership. The 7 percent remaining in private ownership, all Priority 1 habitat, extends from Florida Panther NWR north to Okaloacoochee Slough SF, serves as a large mammal corridor between Collier County and Hendry County, and should be protected.

H1.4. Establish, restore, and maintain important corridors. Corridors are necessary for population expansion and for facilitating gene flow between subpopulations. The Caloosahatchee Ecoscape, added to the CARL acquisition list in 1998, is a 4,047 ha corridor connecting panther habitat in Glades County and Hendry County. Camp Keais strand links Florida Panther NWR with the CREW. A recent 20,695 ha conservation easement acquired by the SWFWMD could link panther habitat in DeSoto County and Glades County. The Florida Greenways Coordinating Council adopted in 1998 a five-year implementation plan for a statewide system of greenways and trails that could benefit the panther long-term.

H2. Use landowner incentive programs to conserve, restore, and manage panther habitat. The USDA-NRCS and FWS administer several landowner incentive programs capable of preserving Priority 1 and Priority 2 panther habitat on farms and ranches in South Florida. Each of the programs is briefly discussed below. Some examples of how the program can be used for panther recovery are given.

H2.1. Environmental Conservation Acreage Reserve Program. The Environmental Conservation Acreage Reserve Program (ECARP) encompasses the Conservation Reserve Program, Wetlands Reserve Program, and the Environmental Quality Incentives Program. The purpose of these programs is to help farmers and ranchers conserve and enhance soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat. Program objectives are achieved primarily through short-term or perpetual retirement of marginal agricultural land and changes in land management practices.

H2.1.1. Conservation Reserve Program. The Conservation Reserve Program (CRP) makes annual rental payments and pays 50 percent of the cost of eligible conservation practices implemented by the landowner. Two types of CRP are recognized.

The **Traditional CRP** allows irregular, periodic enrollment of large acreages and can quickly provide measurable benefits to wildlife species requiring expanses of contiguous habitat. For example, traditional CRP should be used to establish tracts of pine flatwoods 250 ha or greater to reverse a historic pine flatwoods decline of 88 percent in central South Florida. Forest tracts 250 ha or larger are a constituent element of occupied panther range and pine flatwoods can account for about 30 percent of individual panther radio-locations.

The **Continuous CRP** allows year-round enrollment of small acreages with an emphasis on strip-type water quality practices. The continuous CRP should be used to plant pine or hardwood buffers around isolated cypress domes or along cypress strands to provide cover for panthers, cover for panther prey, and to increase average forest patch size in a given area, thus reversing fragmentation. Trees planted in strips of sufficient width along ditches, canals, interior access roads or similar landscape features could serve as cover for panther prey and provide nominal travel corridors for the panther.

H2.1.2. Wetlands Reserve Program. The Wetlands Reserve Program (WRP) pays farmers and ranchers to restore former and degraded wetlands. Restoration of forested wetlands would reverse forest declines and would be somewhat beneficial to the panther given its preference for forested habitats. Wetland restoration would also benefit panther prey, which can be found feeding in, or around the edge of, herbaceous wetlands. The options available include the following: (1) permanent easements, where the easement payment is generally 100 percent of the agricultural value or a predetermined area cap, and NRCS pays 100 percent of the restoration costs; (2) 30-year easements, where the easement payment is generally 75 percent of the agricultural value or a predetermined area cap, and NRCS pays 75 percent of the restoration costs; and (3) restoration cost-share agreements, where there is no easement payment but NRCS pays 75 percent of the restoration costs. The minimum duration for the agreement is 10 years.

H2.1.3. **Environmental Quality Incentives Program.** The Environmental Quality Incentives Program (EQIP) provides educational, technical, and financial assistance to help farmers and ranchers comply with State and Federal environmental laws. Fifty percent of the annual appropriation is allocated to livestock-related natural resource concerns and cattlemen owning land inhabited by the panther are ideal applicants. This program can be used to fence hardwood hammocks that have been degraded by mechanical manipulation or overgrazing. Hardwood hammocks can account for 30 to 40 percent of individual panther radio-locations and are the most productive white-tailed deer habitat.

H2.2. **Wildlife Habitat Incentives Program.** The Wildlife Habitat Incentives Program (WHIP) helps farmers and ranchers to plan and pay for improvements that benefit threatened and endangered upland and wetland species. NRCS will pay up to 75 percent of the cost of implementing the conservation practice. A minimum 10-year contract is required. Annual food plots are not eligible. The program was designed to promote habitat management compatible with active agricultural operations and can be used to develop, restore, or enhance many habitat types. All of the examples given above could be accomplished using this program. Use of prescribed fire to manage pine flatwoods and to stimulate the growth of understory browse for deer is also possible.

H2.3. **FWS Partners for Fish and Wildlife program.** The Partners for Fish and Wildlife (PFW) program provides technical and financial assistance to private landowners to restore and enhance fish and wildlife habitat on their property. The FWS will pay up to 100 percent of the cost of habitat restoration projects and up to 50 percent of habitat improvement projects. The funding is limited to $10,000 per landowner per year and the minimum duration of a PFW contract is 10 years. The PFW program can work in conjunction with any of the USDA-NRCS programs to help implement the conservation practices discussed above.

H3. **Optimize habitat management techniques for panther and prey.** Optimal management of habitat suitable for panther and prey on public and private lands is second only to habitat preservation. Prescribed fire should be used to maintain fire-adapted vegetation communities and provide browse for white-tailed deer. Chemical, biological, and mechanical control methods can eradicate invasive exotic plants. Hunting and access restrictions can be used to manage prey and minimize human activities that might disturb panthers. Research and education are key to optimizing habitat management for panther and prey.

H3.1. **Continue research on panther, panther prey, and habitat relationships.** The USGS-BRD, University of Tennessee is conducting a study on the response of panthers to prescribed fire and a study on panther movements in response to recreational hunting. The University of Florida, Institute of Food and Agricultural Sciences, Southwest Florida Research Center is conducting a deer forage study. Staff at Florida Panther NWR are conducting experiments on food plots for white-tailed deer. Other studies are underway or being planned. Land management programs will be refined as research results dictate.

H3.1.1. Determine properties best suited for habitat restoration using landowner incentive programs. Using most recent low-level aerial photography and land ownership data available, determine which ownerships best fit the ideal for panther habitat.

H3.1.2. Host annual seminar for South Florida land managers. The seminar will provide an interactive forum for farmers, ranchers, and public land managers to discuss management techniques, current research, research needs, public/private partnerships, and other topics pertinent to panther habitat management and panther recovery.

H4. Develop and implement a habitat monitoring program. Data exist for habitat changes in the Immokalee Rise physiographic region from 1900 through 1989. Low-level aerial photography should be acquired every 10 years to ascertain positive and negative changes in habitat quantity. The analysis should focus on upland and wetland forest fragmentation, *i.e.* gaps between forest patches, forest patch size and abundance per patch size, *etc*.

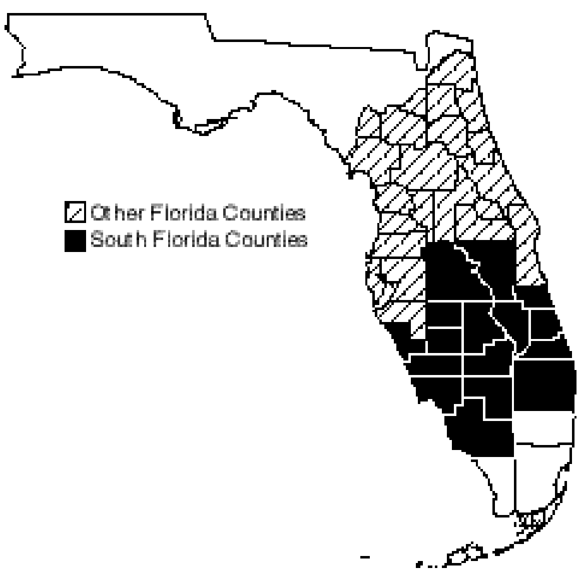
H5. Publicize habitat management techniques and research results to increase public awareness. Publish a periodic newsletter, via print and the internet, on panther habitat management issues and relevant research results. The newsletter should be sent via direct mail to all South Florida land managers (public and private) and distributed through local county extension and USDA-NRCS offices to landowners.

Florida Scrub-jay

Aphelocoma coerulescens

Federal Status:	**Threatened (June 3, 1987)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. County distribution of the Florida scrub-jay.



The Florida scrub-jay is a relict species of fire-dominated oak scrub habitat that occurs on well-drained sandy soils in peninsular Florida. Scrub-jays are extremely habitat-specific, sedentary, and territorial. Florida scrub-jays form family groups; fledglings remain with their parents in their natal territory as helpers. The Florida scrub-jay was listed as a threatened species because of loss, fragmentation, and degradation of scrub habitats throughout Florida, due primarily to urbanization, agriculture, and fire suppression. During the last 10 to 12 years, the population has declined by an estimated 25 to 50 percent, and they have been extirpated from seven counties statewide. The most recent estimate of the scrub-jay population (1993) is 11,000 birds. Conservation measures for Florida scrub-jays will involve protection and long-term management of suitable scrub habitat.

This account represents South Florida's contribution to the range-wide recovery plan for the Florida scrub-jay (FWS 1990).

Description

Florida scrub-jays are about 25 to 30 cm long and weigh about 77 grams. They are similar in size and shape to the blue jay (*Cyanocitta cristata*), but differ significantly in coloration (Woolfenden and Fitzpatrick 1996a). Unlike the blue jay, scrub-jays lack a crest. They also lack the conspicuous white-tipped wing and tail feathers, black barring and bridle of the blue jay. The Florida scrub-jay's head, nape, wings and tail are pale blue, and it is pale grey on its back and belly. Its throat and upper breast are lightly striped and bordered by a pale blue-gray "bib." The sexes of Florida scrub-jays are not distinguishable by plumage, and males average only slightly larger than females (Woolfenden 1978). The sexes may be differentiated by a distinct "hiccup" call vocalized only by females (Woolfenden and Fitzpatrick 1986). Scrub-jays less than about 5 months of age are easily distinguishable from adults; their plumage is smokey gray on the head and back, and they lack the blue crown and nape of adults. Molting occurs between early June and late November, and peaks between mid-July and late September (Bancroft and Woolfenden 1982). During late summer and early fall, when the first basic molt is nearly complete, fledgling scrub-jays may be indistinguishable from adults in the field (Woolfenden and Fitzpatrick 1984). The wide variety of vocalizations of Florida scrub-jays are described in detail by Woolfenden and Fitzpatrick (1996b).

Taxonomy

Scrub-jays (*Aphelocoma coerulescens*) are in the order Passeriformes and the family Corvidae. They have been called a "superspecies complex," and described in four groups that differ in geographic distribution within the United States and Mexico: *A. californicus*, from southwestern Washington through Baja California; *A. insularis*, on Santa Cruz in the Channel Islands, California; *A. woodhousii*, from southeastern Oregon and the Rocky Mountains and Great Plains to Oaxaca, Mexico; and *A. coerulescens* in peninsular Florida (AOU 1983). Other congeners are the Mexican jay or gray-breasted jay (*A. ultramarina*) and the unicolored jay (*A. unicolor*) of southern Mexico and northern Central America (Woolfenden and Fitzpatrick 1996b).

The Florida scrub-jay, which was originally named *Corvus coerulescens* by Bosc in 1795, was transferred to the genus *Aphelocoma* in 1851 by Cabanis. In 1858, Baird made *coerulescens* the type species for the genus, and it has been considered a subspecies (*A. c. coerulescens*) for the past several decades (AOU 1957). It recently regained recognition as a full species (Florida scrub-jay, *Aphelocoma coerulescens*) from the American Ornithologists' Union (AOU 1995) because of genetic, morphological and behavioral differences between the other members of this group: the western scrub-jay (*A. californicus*) and the island scrub-jay (*A. insularis*). The group name is retained for species in this complex; however, it is now hyphenated to "scrub-jay" (AOU 1995).

Distribution

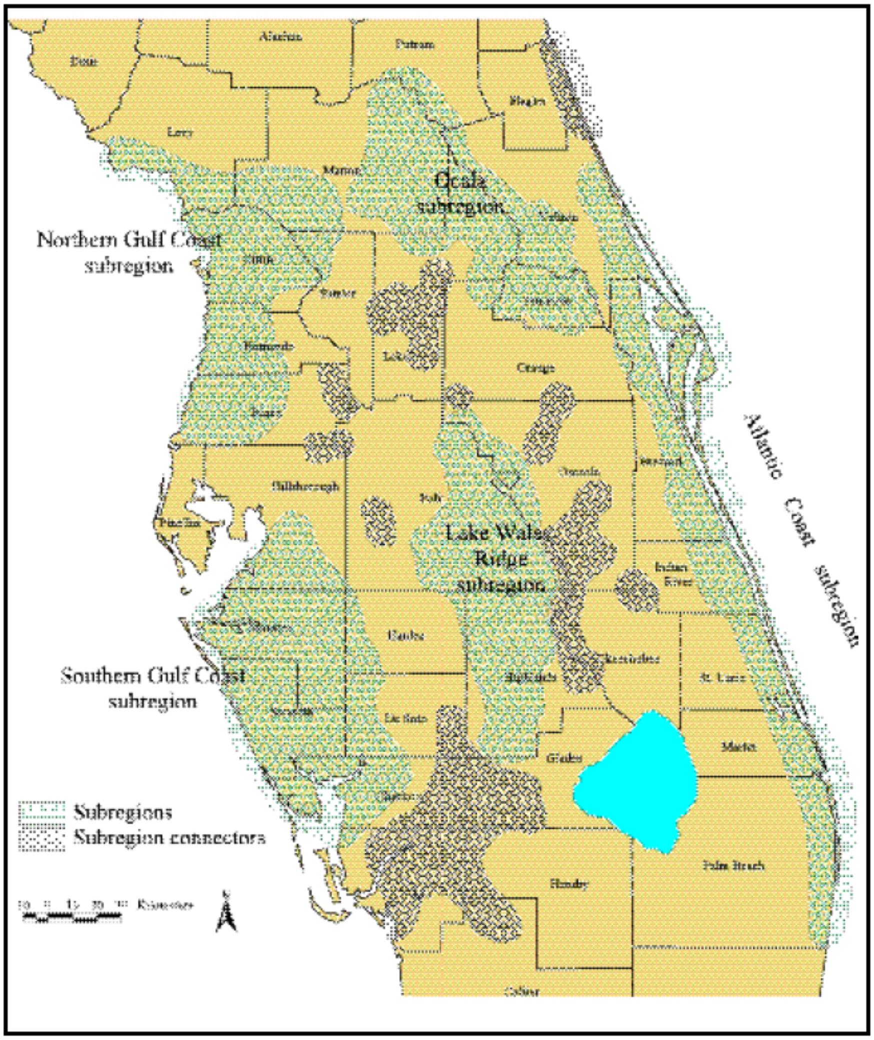
Florida scrub-jays historically were distributed throughout the Florida peninsula in suitable scrub habitat in 39 of the 40 counties south of, and including, Levy, Gilchrist, Alachua, Clay, and Duval counties (Fitzpatrick *et al*. 1991). Historically, the only county on the peninsula that lacked scrub-jays was Monroe, although they were never considered abundant on the Atlantic coast south of Martin County, and occurred only in a narrow coastal band there. The current county distribution of Florida scrub-jays is shown in Figure 1. On the Atlantic coast, scrub-jays extend from Flagler to Palm Beach counties. On the Gulf coast, scrub-jays persist patchily from Levy, Citrus, western Marion, and northwestern Sumter counties south to Sarasota, western DeSoto, Charlotte, Lee, and northwestern Collier counties. In central Florida, scrub-jays range from southwestern Clay through Putnam and Marion counties, south through Polk, Highlands, and Glades counties. Florida scrub-jays have been extirpated from Broward, Dade, Duval, Gilchrist, Pinellas, and St. Johns counties.

Florida scrub-jay.
Original photograph by Brian Toland.

The distribution and status of the Florida scrub-jay across its entire range was updated during 1992 and 1993 (Fitzpatrick *et al*. 1994b). Based upon that survey, the overall Florida population of scrub-jays was divided into five subregions, corresponding to the major sand deposits located on the peninsula (Figure 2). Three of these subregions are considered "core populations" because they contain well over half of the state's remaining scrub-jays. These population cores occur at Merritt Island/Cape Canaveral Complex, Ocala NF, and on the southern Lake Wales Ridge, and are respectively named the Atlantic Coast Subregion, the Ocala Subregion, and the Lake Wales Ridge Subregion (Fitzpatrick *et al*. 1994a).

All extant scrub-jay populations outside of the three core population subregions consist of smaller subpopulations that are isolated to varying degrees (Fitzpatrick *et al*. 1994b). Along the Gulf coast from Levy County south to Lee County, scrub-jays historically occurred in a contiguous fourth major population: the Gulf Coast Subregion. Today, however, this population is divided into two subregions: the Northern Gulf Coast Subregion and the Southern Gulf Coast Subregion, because of the extensive amount of habitat fragmentation and loss that has occurred in Pinellas, Hillsborough, Pasco, and Hernando counties (Fitzpatrick *et al*. 1994b).

Figure 2. Location of Florida scrub-jay subregions and the habitats connecting the sub-regions adapted from Fitzpatrick et al. 1994a).



Habitat

The Florida scrub-jay has extremely specific habitat requirements. It is endemic to peninsular Florida's ancient dune ecosystems or scrubs, which occur on well-drained to excessively well-drained sandy soils (Laessle 1958, 1968, Fitzpatrick *et al*. 1994b). This relict oak-dominated scrub, or xeric oak scrub, is essential habitat to the Florida scrub-jay. This community type is adapted to nutrient-poor soils, periodic drought, high seasonal rainfall and frequent fires (Abrahamson 1984). Xeric oak scrub on the Lake Wales Ridge is predominantly comprised of four species of stunted, low-growing oaks: sand live oak (*Quercus geminata*), Chapman oak, (*Q. chapmanii*), myrtle oak, (*Q. myrtifolia*), and scrub oak, (*Q. inopina*) (Myers 1990). In optimal habitat for scrub-jays, these oaks are 1 to 3 m high, interspersed with 10 to 50 percent unvegetated, sandy openings, and a sand pine (*Pinus clausa*) canopy of less than 20 percent (Woolfenden and Fitzpatrick 1990). Trees and dense herbaceous vegetation are rare. Other vegetation noted along with the oaks includes saw palmettos (*Serenoa repens*) and scrub palmetto (*Sabal etonia*), as well as woody shrubs such as Florida rosemary (*Ceratiola ericoides*) and rusty lyonia (*Lyonia ferruginea*). Although there is more species diversity in the Lake Wales Ridge oak scrub, the Atlantic Coastal Ridge oak scrub is similar in structural composition.

On the Merritt Island/Cape Canaveral Complex and in southwest Florida, scrub-jays occupy areas with less scrub oak cover and fewer openings than xeric oak scrub habitat on the Lake Wales Ridge (Breininger 1981, Thaxton and Hingtgen 1996). The predominant communities here are oak scrub and scrubby flatwoods. Scrubby flatwoods differ from scrub by having a sparse canopy of slash pine (*P. elliottii*); sand pine are rare. Although *Q. inopina* and *S. etonia* are restricted to the Lake Wales Ridge, the other species mentioned above are predominant in these areas as well. In addition, runner oak (*Q. minima*), turkey oak (*Q. laevis*), bluejack oak (*Q. incana*), and longleaf pine (*P. palustris*) have been reported.

Kennedy Space Center, in Brevard County, has one of the largest contiguous populations of the Florida scrub-jay. Studies conducted there provide good descriptions of this habitat type (Schmalzer and Hinkle 1992). Although Kennedy Space Center is geographically located just north of the ecosystem boundaries for South Florida, habitat data for scrub-jays are included for comparative purposes with xeric oak scrub on the Lake Wales Ridge. In a recent study, Breininger *et al*. (1995) reported that scrub-jays occupied all areas at Kennedy Space Center that were more than 136 m from a forest, and that supported more than 29 percent scrub oak cover and more than 4 percent open space. Areas closer to forested habitat, or with greater than 20 percent pine cover, were used infrequently by scrub-jays, even when the percentages of scrub oak cover and open space were suitable. Highest densities of scrub-jays, as an indication of habitat preference, were in areas greater than 136 m from forested habitat, where scrub oak cover exceeded 60 percent, open space exceeded 10 percent, and pine cover was less than 20 percent.

Behavior

Social Structure

Florida scrub-jays have a social structure that involves cooperative breeding, a trait that the western North American populations of scrub-jays do not exhibit (Woolfenden and Fitzpatrick 1984). Florida scrub-jays live in groups ranging from two (a single mated pair) up to large, extended families of eight adults and one to four juveniles. Fledgling scrub-jays remain with the breeding pair in their natal territory as “helpers,” forming a closely-knit, cooperative family group. Pre-breeding numbers are generally reduced to either a pair with no helpers or families of three or four individuals (a pair plus one or two helpers).

Florida scrub-jays have a well-developed intrafamilial dominance hierarchy, with breeder males most dominant, followed by helper males, breeder females, and, finally, female helpers (Woolfenden and Fitzpatrick 1977). Helpers participate in sentinel duties (McGowan and Woolfenden 1989), territorial defense, predator-mobbing, and the feeding of both nestlings (Stallcup and Woolfenden 1978) and fledglings (McGowan and Woolfenden

1990). The well-developed sentinel system involves having one individual occupying an exposed perch watching for predators or territory intruders. When a predator is observed, the sentinel jay gives a distinctive warning call and all group members seek cover in dense shrub vegetation (Fitzpatrick *et al*. 1991).

The only other population of scrub-jays that exhibits cooperative breeding is the southernmost form in Oaxaca, Mexico (Burt and Peterson 1993). Although it is well known that delayed dispersal by juvenile Florida scrub-jays is caused by limitations in the availability of breeding habitats, this does not appear to be the reason for cooperation among the southern Mexico population. It is still unclear why the Mexican population exhibits this social behavior; however, Burt and Peterson (1993) offer several possible explanations for this difference that will require further investigation.

Florida scrub-jay pairs occupy year-round, multi-purpose territories (Woolfenden and Fitzpatrick 1984; Fitzpatrick *et al*. 1991, 1994b). Territory size averages 9 to 10 ha, with a minimum size of about 5 ha. The availability of territories is a limiting factor for scrub-jay populations. Because of this limitation, non-breeding adult males may remain at the natal territory as helpers for up to five years, waiting for either a mate or territory to become available (Fitzpatrick *et al*. 1991). New territories are established several ways: by replacing a lost breeder on a territory (Woolfenden and Fitzpatrick 1984); through “territorial budding,” where a helper male becomes a breeder in a segment of its natal territory (Woolfenden and Fitzpatrick 1978); by inheriting a natal territory following the death of a breeder; by establishing a new territory between existing territories (Woolfenden and Fitzpatrick 1984); or through “adoption” of an unrelated helper by a neighboring family followed by resident mate replacement (B. Toland, FWS, personal communication 1996). Territories can also be obtained by creating suitable habitat in areas that were previously unsuitable through effective habitat management efforts (Thaxton and Hingtgen 1994).

Reproduction and Demography

To become a breeder, a scrub-jay must acquire a territory and a mate. Evidence presented by Woolfenden and Fitzpatrick (1984) suggests that Florida scrub-jays are permanently monogamous. The pair retain ownership and sole breeding-privileges in their particular territory year after year. Courtship to form the pair is lengthy and ritualized, and involves posturing and vocalizations made by the male to the female (Woolfenden and Fitzpatrick 1996b). Copulation between the pair is generally out of sight of other jays (Woolfenden and Fitzpatrick 1984). These authors also reported never observing copulation between unpaired jays, nor courtship behavior between a female and a jay other than her mate. Age at first breeding in the Florida scrub-jay varies from 1 to 7 years, although most individuals become breeders between 2 and 4 years of age (Fitzpatrick and Woolfenden 1988). Persistent breeding populations of Florida scrub-jays exist only where there are scrub oaks in sufficient quantity to provide an ample winter acorn supply, cover from predators, and nest sites during the spring (Woolfenden and Fitzpatrick 1996).

Florida scrub-jay nests are typically placed in shrubby oaks, at a height of 1 to 2 m. *Quercus inopina* and *Q. geminata* are the preferred shrub on the Lake Wales Ridge (Woolfenden and Fitzpatrick 1984) and *Q. myrtifolia* is favored on the Atlantic Coastal Ridge and southern Gulf coast (Toland 1991, J. Thaxton Uplands Inc., personal communication 1998). In suburban areas, scrub-jays nest in the same evergreen oak species as well as in introduced or exotic trees; however they construct their nests in a significantly higher position in these oaks than when in natural scrub habitat (Bowman *et al*. 1996). Florida scrub-jay nests are an open cup, about 18 to 20 cm outside diameter, and 8 to 9 cm inside diameter. The outer basket is bulky and constructed of coarse twigs from oaks and other vegetation, and the inside is lined with tightly wound palmetto or cabbage palm fibers. There is no foreign material as may be present in a blue jay nest (Woolfenden and Fitzpatrick 1996b).

Nesting is synchronous, normally occurring from 1 March through 30 June (Woolfenden and Fitzpatrick 1990, Fitzpatrick *et al*. 1994b). On the Atlantic Coastal Ridge and southern Gulf coast, nesting may be protracted through the end of July (B. Toland, FWS, personal communication 1996; J. Thaxton, Uplands Inc., personal communication 1998). In suburban habitats, nesting is consistently initiated earlier (March) than in natural scrub habitat (Fleischer 1996), although the reason for this difference is unknown. Nesting failures are almost always caused by predation, most frequently by ground-based predators including eastern coachwhip (*Masticophis flagellum*), eastern indigo snake (*Drymarchon corais*), rat snake (*Elaphe obsoleta*), corn snake (*E. guttata*), raccoon *(Procyon lotor*), and domestic cat (*Felis catus*) (Fitzpatrick *et al*. 1991, Schaub *et al*. 1992).

Clutch size ranges from one to five eggs, but is typically three or four eggs. Clutch size is generally larger (up to six eggs) in suburban habitats, and the birds attempt to rear more broods (Fleischer 1996). Double brooding by as much as 20 percent has been documented on the Atlantic Coastal Ridge and in suburban habitat within the southern Gulf coast, compared to about 2 percent on the Lake Wales Ridge (B. Toland, FWS, personal communication 1996, J. Thaxton, Uplands Inc., personal communication 1998). Scrub-jay eggs measure 27.08 mm x 20.18 m (length x breadth) (Woolfenden and Fitzpatrick 1996b), and coloration “varies from a pea green to pale glaucous green, blotched and spotted with irregularly shaped markings of cinnamon rufous and vinaceous cinnamon, these being heaviest about the larger end” (Bendire in Bent 1946). Eggs are incubated for 17 to 18 days, and fledging occurs 16 to 21 days after hatching (Woolfenden 1974, 1978; Fitzpatrick *et al*. 1994b). Only the breeding female incubates and broods eggs and nestlings (Woolfenden and Fitzpatrick 1984). Average production of young is two fledglings per pair, per year (Woolfenden and Fitzpatrick 1990, Fitzpatrick *et al*. 1994a), and the presence of helpers improves fledging success (Mumme 1992). Annual productivity must average at least two young fledged per pair for a population of scrub-jays to maintain long-term stability (Fitzpatrick *et al*. 1991).

Fledglings depend on adults for food for about 10 weeks, during which time they are fed by both breeders and helpers (Woolfenden 1975, McGowan and Woolfenden 1990). In optimal scrub, survival of scrub-jay fledglings to yearling age class averages about 35 percent, while annual survival of adult males and females is equal and averages around 80 percent (Fitzpatrick *et al*. 1994b). Data from Archbold Biological Station, however, suggest that survival and reproductive success of scrub-jays is substantially lower than these values under

Table 1. Mean survivorship and reproduction of Florida scrub-jays in several habitats at Archbold Biological Station, 1969-86 (taken from Woolfenden and Fitzpatrick 1991).

	Optimal Habitat	Suboptimal Habitat		
	Periodically burned, open oak scrub	Unburned, overgrown scrubby flatwoods	Unburned southern ridge sandhill (slash pine-turkey oak)	Mature citrus bordering unburned scrub
N (pair-years)	429	74	8	21
Seasonal nest attempts	1.38 (593/429)	1.49 (110/74)	1.50 (12/8)	1.11 (20/18)
Fledglings/pair	1.97 (843/429)	1.58 (117/74)	1.38 (11/8)	2.00 (38/18)
Independent young/pair	1.17 (500/429)	0.80 (59/74)	1.13 (9/8)	1.56 (28/18)
Yearlings/pair	0.60 (259/429)	0.36 (27/74)	0.50 (4/8)	0.61 (11/18)
First-year survival	0.307 (259/843)	0.231 (27/117)	0.364 (4/11)	0.289 (11/38)
Breeder survival	0.789 (697/883)*	0.723 (107/148)	0.688 (11/16)	0.619 (26/42)
Expected lifetime success/individual				
Breeding seasons	4.4	3.5	3.2	2.6
Fledglings	4.3	2.8	2.2	2.6
Independent young	2.6	1.4	1.8	2.0
Yearlings	1.3	0.6	0.8	0.8

*N=883 breeder years for calculating breeder survival

suboptimal habitat conditions (Woolfenden and Fitzpatrick 1991) (Table 1). The data help explain why local populations inhabiting unburned, late successional habitats become extirpated.

Similarly, data from Indian River County show that mean annual productivity declines significantly in suburban areas. Toland (1991) reported that productivity averaged 2.2 young fledged per pair in contiguous, optimal scrub, 1.8 young fledged per pair in fragmented, moderately developed scrub, 1.2 young per pair fledged in highly fragmented, suboptimal scrub, and only about 0.5 young per pair in residential lawns. Overall nest success (probability of fledging at least one young) is about 50 percent on the Lake Wales Ridge and about 70 percent on the Atlantic Coastal Ridge in Indian River County (B. Toland, FWS, personal communication 1996). The maximum observed lifespan of a Florida scrub-jay is 15.5 years (Woolfenden and Fitzpatrick 1996b).

Dispersal

Scrub-jays are nonmigratory, extremely sedentary, and permanently territorial. Juveniles remain in their natal territory for up to 5 years before dispersing to become breeders (Woolfenden and Fitzpatrick 1984). Once they pair and become breeders, generally within two territories of their natal ground, they remain on their breeding territory until death. In suitable habitat, fewer than 5 percent of scrub-jays disperse more than 8 km (Fitzpatrick *et al*. 1994b). All documented long-distance dispersals have been in unsuitable habitat such as woodland, pasture, or suburban plantations. Scrub-jay dispersal behavior is affected by the intervening landscape matrix. Protected scrub habitats will most effectively sustain scrub-jay subpopulations if they are located within a matrix of surrounding habitats that can be utilized and traversed by scrub-jays. Brushy pastures, scrubby corridors along railway, utility, and country road rights-of-way, and open, burned flatwoods provide links for colonization among scrub-jay subpopulations. Stith *et al*. (1996) believe that a dispersal distance of 8 km is close to the biological maximum for Florida scrub-jays. Table 2 provides estimated distances across which scrub-jays normally disperse in the wild.

In suburban habitats in southwest Florida, however, average dispersal distances for scrub-jays is much greater than in natural habitat (Thaxton and Hingtgen 1996). In their study, these authors also noted that no dispersals were made from preserves to suburban territories, and attributed this to habitat degradation. Scrub-jays are known to disperse up to 94 km in suburban habitats in southeastern Florida and are thought to frequently disperse further than the 8 km average found in more natural conditions (G. Iverson, personal communication 1998).

Table 2. Dispersal distances of Florida scrub-jays in relation to habitat type (from Fitzpatrick *et al.* 1994)

Habitat Type	Normal Dispersal Distance (km)	Maximum Dispersal Distance (km)
Open Water	2	2
Urban areas	2	2
Dense pine forest	2	3
Unbroken, open pasture	3	7
Cropland	3	7
Unbroken citrus groves	5	8
Densely wooded suburbs	5	8
Suburbs with few trees	5	13
Flatwoods	5	17
Broken pasture, fence rows, roadsides	8	24
Overgrown scrub with some clearings	8	24

Foraging

Florida scrub-jays forage mostly on or near the ground, often along the edges of natural or man-made openings. They visually search for food by hopping or running along the ground beneath the scrub, or by jumping from shrub to shrub. Insects, particularly orthopterans and lepidopteran larvae, comprise the majority of the animal diet throughout most of the year (Woolfenden and Fitzpatrick 1984). Acorns are by far the most important plant food (Fitzpatrick *et al*. 1991). From August to November each year scrub-jays harvest and cache thousands of scrub oak acorns throughout their territory. Each scrub-jay may cache 6,000 to 8,000 acorns per year (DeGange *et al*. 1989). Acorns are typically buried 1 to 2 cm beneath the surface of bare sand in openings in the scrub during fall, and retrieved and consumed in winter and early spring. On the Atlantic Coastal Ridge, acorns are frequently cached in pine trees, either in forks of branches, in distal pine boughs, under bark, or on epiphytic plants, between 0.3 to 9 m in height (B. Toland, FWS, personal communication 1996). Other small nuts, fruits, and seeds are also eaten.

Vertebrate prey items comprise the minority of the diet, but may include a wide array of species weighing up to 25 g (B. Toland, FWS, personal communication 1996). Notable vertebrate prey species documented for scrub-jays on both the Lake Wales Ridge and the Atlantic Coastal Ridge include, green treefrog (*Hyla cinerea*), squirrel treefrog (*H. squirella*), green anole (*Anolis carolinensis*), brown anole (*A. sagrei*), Florida scrub lizard (*Sceloporus woodi*), six-lined racerunner (*Cnemidophorus sexlineatus*), black racer (*Coluber constrictor*), peninsula crowned snake (*Tantilla relicta relicta*), rough green snake (*Opheodrys aestivus*), house mouse (*Mus musculus*), cotton mouse (*Peromyscus gossypinus*), oldfield mouse (*P. polionotus*), and Florida mouse (*Podomys floridanus*) (Woolfenden and Fitzpatrick 1984).

In suburban areas, scrub-jays will accept supplemental foods offered by humans, such as peanuts, corn, and sunflower seeds.

Relationship to Other Species

Because Florida scrub-jays are endemic to oak scrub habitat in peninsular Florida, it occurs with many other species also endemic to this community type. As mentioned previously, the scrub-jays are dependent upon the species of evergreen oaks in the scrub. This oak scrub habitat is also essential to at least 21 federally listed plant species on the Lake Wales Ridge and at least two others on the Atlantic Coastal Ridge. The threatened blue-tailed mole skink (*Eumeces egregius lividus*) and sand skink (*Neoseps reynoldsi*) also occur on the Lake Wales Ridge, and the threatened eastern indigo snake (*Drymarchon corais couperi*) and state-listed gopher tortoise (*Gopherus polyphemus*) are also known to occur with scrub-jays. It is critical that management for scrub habitat and for the Florida scrub-jay consider possible effects on these and other scrub-endemic species.

Scrub-jays occasionally interact with blue jays in scrub and scrubby flatwoods habitats. It has been suggested that the presence of blue jays may limit use of woodland habitat by scrub-jays; however, B. Toland (FWS, personal communication 1996) reports successful fledging by both species nesting in close proximity to one another in Indian River, Polk, and Brevard counties. He also reports that in all cases, Florida scrub-jays were dominant over blue jays in agonistic encounters.

There are relatively few predators on adult Florida scrub-jays; however, the most dangerous native predators are the Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*A. striatus*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), and peregrine falcon (*F. peregrinus*) in descending magnitude of threat. House cats and bobcats (*Felis rufus*) have been documented to prey on scrub-jays (Fitzpatrick *et al*. 1994b). Eastern coach whips, eastern indigo snakes, and great horned owls (*Bubo virginianus*) also occasionally prey on adult scrub-jays (Fitzpatrick *et al*. 1994b).

Status and Trends

The Florida scrub-jay was federally listed as threatened in 1987 primarily because of habitat fragmentation, degradation, and loss (52 FR 20719). Scrub habitats associated with Florida's barrier islands, mainland coasts, and Lake

Wales Ridge are some of the most imperiled natural communities in the United States, with estimates of habitat loss since pre-settlement times ranging from 70 to more than 80 percent (Bergen 1994, Fitzpatrick *et al*. 1994b). Historically, this vegetative community type occurred as large, contiguous patches, some of them over hundreds of miles (Cox 1987). Today, only relict patches of xeric oak scrub remain. Throughout the northern part of the range, population declines of scrub-jays are attributed to scrub fragmentation and degradation, due primarily to widespread fire suppression. Citrus conversion and residential development continue to be the most important factors causing the decline of scrub-jay populations in the southern extremes of their range (Fernald 1989, Fitzpatrick *et al*. 1991).

The decreasing trend of the Florida scrub-jay population is closely correlated with loss of scrub habitat. A statewide survey of Florida scrub-jays conducted during 1992 and 1993 documented about 11,000 Florida scrub-jays (~4,000 pairs) as of 1993, extrapolating from the average scrub-jay group size of 2.8 individuals, and estimated that at least two-thirds of the population inhabits federal lands (Fitzpatrick *et al*. 1994a). This population estimate is no more than 15 percent of the pre-settlement population estimate, and corresponds to a similar reduction in the distribution of scrub habitat. As of 1993, half of all remaining Florida scrub-jays occurred in Brevard County (1,232 families) and Highlands County (890 families) (Fitzpatrick *et al*. 1994a). A total of 19 occupied counties contained 30 or fewer groups of scrub-jays. Cox (1987) estimated that 15,600 to 22,800 jays comprised the statewide population as of 1984. Even a conservative assumption that Cox found all of the breeding pairs of scrub-jays illustrates that the Florida scrub-jay has declined by an estimated 25 to 50 percent during the last 10 years (Fitzpatrick *et al*. 1994a).

Stith *et al*. (1996) used a buffering procedure and 3.5 km dispersal buffer to delineate 191 separate Florida scrub-jay subpopulations. Of these, 152 subpopulations (over 80 percent) contained fewer than 10 pairs of scrub-jays, 33 subpopulations contained between 10 and 99 pairs, and only six contained at least 100 pairs. When a 12 km dispersal buffer was applied to these data, 42 separate scrub-jay subpopulations were delineated; half of these subpopulations contained fewer than 10 pairs. Results from their population viability analysis indicate that a population of jays with fewer than 10 breeding pairs has a 50 percent probability of extinction over 100 years. This improves to a 2 to 3 percent chance of extinction for populations with at least 100 pairs. Only the three core subpopulations currently have enough breeding pairs each to provide a 99 percent probability of survival over 100 years (Fitzpatrick *et al*. 1994b).

To prepare this species account, the FWS conducted additional analyses of these data. Instead of the buffers Stith *et al*. (1996) used, we applied an 8.2 km buffer around occupied scrub-jay territories because this is considered the maximum dispersal distance for scrub-jays (Stith *et al*. 1996). Our analyses (Figure 3) revealed 55 distinct subpopulations instead of the 191 and 42 subpopulations Stith *et al*. (1996) identified. Thirty-six of our subpopulations contained fewer than 10 breeding pairs, 13 contained between 10 and 99 breeding pairs, and six contained more than 100 breeding pairs (the latter result was the same Stith *et al*.reached).

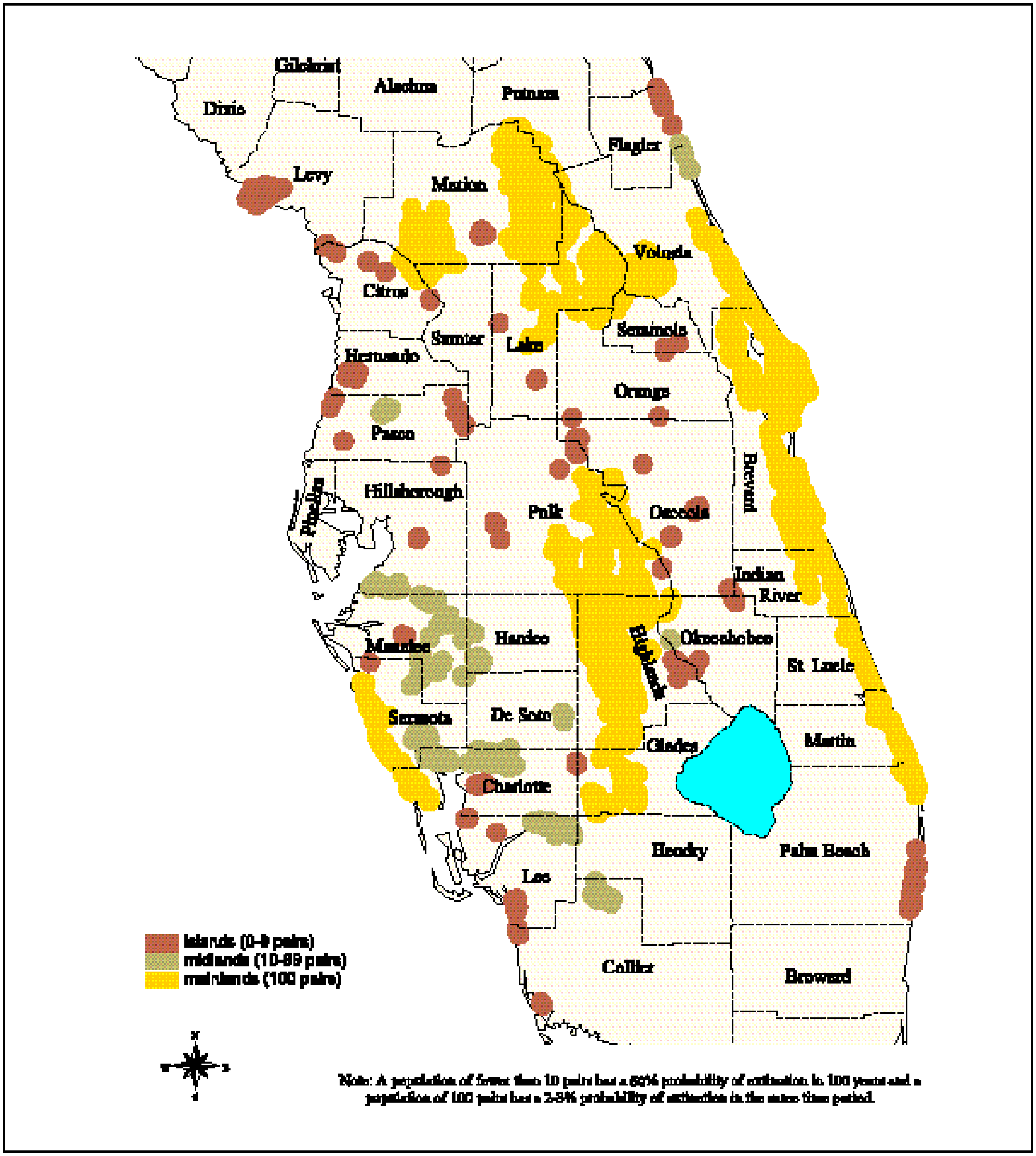


Figure 3. Distribution of Florida scrub-jay subpopulations with an 8.2 km dispersal buffer.

Based on these analyses, about 8.0 percent (324 pairs) of the remaining scrub-jay families have a 50 percent probability of extinction within 100 years. We believe this is a minimum extinction probability because it only addresses extinction risk caused by genetic and demographic phenomena, it does not incorporate the additional extinction risk caused by habitat loss and fragmentation in these territories. These families are important because they occur in the areas that historically connected core populations (see Figure 2); the loss of these birds and their habitat will effectively eliminate any connections between the core populations.

About 16 percent (about 650 pairs, assuming an average of 50 pairs per subpopulation) of the remaining scrub-jay families have an extinction probability ranging between 3 and 50 percent. These subpopulations, which occur primarily in southwestern Florida, particularly in Manatee and Sarasota counties, once comprised the southern part of the Gulf Coast Subregion. Since the 1992-1993 survey that produced these data, this area has experienced extensive habitat loss and fragmentation because of urbanization. Consequently, many (if not most) of these subpopulations have been reduced in area and fragmented, with a commensurate decline in the number of breeding pairs these subpopulations support.

The remaining breeding pairs occur in six subpopulations. Of those, the subpopulations centered in the Ocala NF, Lake Wales Ridge, and Merritt Island/Cape Canaveral Complex represent the “core subpopulations,” which are large enough to have only a 1 percent probability of extinction over 100 years. Of more concern are the two subpopulations along the Atlantic coast from Brevard County to Palm Beach County and along the Gulf coast in Sarasota and Charlotte counties. Since the 1992-1993 survey, these areas have also experienced extensive habitat loss and fragmentation because of urbanization. Consequently, these subpopulations have also been reduced in area with a commensurate decline in the number of breeding pairs they support. We feel these areas, in particular, warrant immediate management actions to preclude the extirpation of the scrub-jay.

In South Florida, the only core population that remains exists on the Lake Wales Ridge. This core population is also experiencing extensive habitat loss and fragmentation because of urbanization; the effects of continued urbanization raises concerns about the current status and trends of this population. We feel the Lake Wales Ridge population is critical to the survival and recovery of the Florida scrub-jay in South Florida; any further declines in the size and distribution of this core population places the Florida scrub-jay at a greater risk of extinction in South Florida.

Florida scrub-jays will also inhabit suburban areas where patches of scrub remain. In central Florida, the highest densities of scrub-jays are in areas where development is 33 percent or less (R. Bowman, Archbold Biological Station, personal communication 1995). Scrub-jay increases in habitats altered by human actions probably result from supplemental food sources (primarily peanuts) and the initial creation of openings in the scrub and visual buffers (buildings) to neighboring jay families. However, as the degree of habitat destruction and fragmentation increases, the survival of fledgling scrub-jays declines and failed nesting attempts increase (Toland 1991). Females from suburban territories may have fewer opportunities to pair with single males, because most males in suburban areas gain territories through breeder replacement (Thaxton and Hingtgen 1996). In addition, the potential for males remaining as helpers to inherit suitable habitat in suburban areas is greatly reduced when compared to protected areas. Resident males may be less likely to maintain any natal territory as a breeder in suburban areas (Thaxton and Hingtgen 1996).

Scrub-jay population numbers are also affected by the frequency and severity of catastrophic mortalities. Epidemic disease is the only known catastrophe that affects Florida scrub-jay populations (Fitzpatrick *et al*. 1991). Archbold Biological Station experienced an epidemic between September 1979 and February 1980 that killed 70 percent of the scrub-jays on that site; the population was not recovered to pre-epidemic numbers as of 1991. The probability of such an epidemic occurring in the future should be considered, along with habitat quality and management, to better predict the future status of scrub-jay populations in Florida. Root (1996) used spatially explicit models to show that an annual epidemic rate of 0.001 (one in a thousand years) produced quasi-extinction probabilities of at least 66 percent for Florida scrub-jays in Brevard County, Florida under optimal habitat conditions and no dispersal, and at least 52 percent when dispersal was allowed among her modeled populations. The addition of connectivity between populations can mitigate the effects of epidemics, and should be an important component of reserve designs for conservation of Florida scrub-jays.

Management

Overall conservation measures for the Florida scrub-jay should include an understanding of the demography and behavior of the species as well as the long-term management needs of oak-dominated scrub habitat. All Florida scrub-jays reside within territories, and each territory must contain sufficient habitat to sustain a family throughout the year. Given that, it is critical to know the total area of suitable habitat needed, the density of territories supported by the habitat, and the long-term management needs for that habitat to maintain its suitability for scrub-jays.

Effective management of the remaining Florida oak scrub habitat, both on public and private lands, will ultimately determine the fate of the Florida scrub-jay. Management to maintain or increase numbers of scrub-jays is directly correlated with maintaining or increasing the amount of habitat available to support territorial pairs of these birds (Fitzpatrick *et al*. 1994b). Maintenance of suitable habitat not only requires management of the patches of scrub occupied by scrub-jays, it also necessitates maintenance of the landscape matrix within which scrub occurs (D. Breininger, DYN-2, personal communication 1998). Periodic fire maintains landscape diversity and reduces likelihood of fragmentation of scrub patches.

Florida scrub-jays will not persist in habitat that is not burned regularly. Natural fires, which typically occur from lightening strikes between May and September, are a frequent influence on scrub habitat succession. These fires probably occurred at intervals of 10 to 100 years in various types of scrub during presettlement times (Myers 1990). Fire does not alter the vegetative species composition of scrub communities; most of the dominant plants either resprout from underground rhizomes, or recruit from seeds in the soil or released above ground after fire (Schmalzer and Hinkle 1987). Oak scrub revegetates to its preburn structure and species composition about 4 to 5 years after a fire (Abrahamson 1984, Schmalzer and Hinkle 1987, Breininger and Schmalzer 1990).

Fire frequencies necessary to maintain scrub and the surrounding landscape matrices vary depending on whether conditions are mesic or xeric. Within the xeric Lake Wales Ridge, fire return intervals averaging about once every 10 to 20 years is optimal for scrub-jays (Fitzpatrick *et al*. 1991). In more mesic conditions such as those found along the Gulf and Atlantic coasts, more frequent fires (every 6 to 12 years) are required to maintain suitable scrub-jay habitat. In mesic scrubs, more frequent fires may be needed initially to restore overgrown scrub and maintain the functions and values of adjacent ecosystems (D. Breininger, DYN-2, personal communication 1998). However, too frequent fires in scrub tend to maintain the principal oak species below acorn-bearing height and may encourage the spread of palmettos at the expense of oaks. Less frequent fires produce tall, dense oak understories and pine forests (also known as “overgrown scrub”) which are unsuitable to scrub-jays.

In the absence of natural fires the oak scrub community requires specific management prescriptions, including controlled burns and/or mechanical renovation, to maintain habitat suitability for scrub-jays (Myers 1990, Woolfenden and Fitzpatrick 1991, Breininger 1992, Fitzpatrick *et al*. 1994b). Prescribed burning is the preferred method of scrub management. Mechanical treatments, such as rollerchopping, are short-term alternatives but may be less effective in the long term. Studies conducted at Archbold Biological Station during the past 25 years conclude that small, isolated populations of Florida scrub-jays are more likely to become extinct due to normal demographic fluctuations if their habitat is not maintained by periodic burning (Fitzpatrick *et al*. 1991). Root (1996) also showed, through the use of various population models, that reserve designs for Florida scrub-jays must incorporate restoration of habitat quality for successful conservation of the species.

According to Fitzpatrick *et al*. (1991), habitat management prescriptions for scrub-jays should include rotations of prescribed burns, each covering relatively small portions of a preserved tract of scrub. Each point in the tract should be burned once every 10 to 20 years, on average; the shorter intervals are applicable to faster-growing coastal scrubs while the longer intervals are correlated to the slow-growing central ridge scrubs (Woolfenden and Fitzpatrick 1991). Small patches left unburned will provide cover and foraging sites as the scrub regenerates. No more than 25 percent of an area occupied by scrub-jays should be burned at any one time (Fitzpatrick *et al.* 1991). Again, it is critical to maintain or make connections between patches of suitable habitat to facilitate dispersal, and to include buffer habitat around scrub patches (Root 1996).

When creating or managing reserves for scrub-jays, consideration must be given to habitat composition, size, shape, and location (Fitzpatrick *et al*. 1991). Effective reserve design to support an adequate protected population of Florida scrub-jays in average habitat should include about 304 ha of periodically burned oak scrub (Fitzpatrick *et al*. 1991). This assumes that an adequate protected population of scrub-jays consists of 15 to 30 territories located within 4 km of at least one other population containing more than 30 territories, and the need for 10 ha per territory. Florida scrub-jay populations containing fewer than 30 territories cannot be considered safe from extinction over the long term. Reserves separated by more than 12 km with no connecting scrub patches or corridors can cause isolation of populations by not allowing for dispersal and colonization (Woolfenden and Fitzpatrick 1996b). Small patches or corridors of scrub between larger tracts will reduce the probability that scrub-jays in any one patch will become extirpated. Fitzpatrick *et al*. (1991), therefore, recommend preservation of large tracts of oak scrub habitat over a number of smaller tracts for reserve design. In suburban areas, it has been shown that Florida scrub-jays may not disperse from natural to suburban territories (Thaxton and Hingtgen 1996). Therefore, it is critical to consider maintaining natural preserves for resident birds within dispersal distance; without these, the resident birds are extremely vulnerable to extirpation.

Although a majority of the population of Florida scrub-jays currently resides on public lands, overall numbers of the species are in decline. Management practices on public lands should focus on enhancing and creating scrub habitat to assist with scrub-jay recovery. Conservation on private lands includes acquisition programs for scrub habitat, through State efforts such as the CARL program, and the implementation of habitat conservation plans to protect large tracts of suitable scrub habitat. The FWS is using the digital data presented by Fitzpatrick *et al*. (1994b) to evaluate the amount of occupied scrub habitat as well as unoccupied but restorable scrub throughout Florida, and to identify areas suitable for creating reserves on both public and private lands, including establishing connections between existing protected habitat. In addition, we will be using spatially explicit models to predict results of various alternative reserve designs and help us implement the most optimal conservation measures for long-term protection of the Florida scrub-jay.

There are cases, however, where long-term management of scrub habitat is not possible, such as in rapidly expanding urbanized areas. Fitzpatrick *et al*. (1991) outline procedures to inventory habitat and protocols to survey for scrub-jays, intended as guidance for determining if proposed development projects will adversely affect Florida scrub-jays or their habitat. These authors also provide instruction on implementing preservation measures for agencies or individuals who believe scrub-jays or their habitat will be negatively affected by land clearing or related activities.

To address potential negative effects of land-use practices on scrub-jays and their habitat, we are adopting the terminology recommended by Fitzpatrick *et al*. (1994b). A subpopulation of scrub-jays consists of a number of territories, where each territory is not separated by more than 3.2 km. Clusters of subpopulations that are separated by more than 8 km are considered satellite systems. Satellite systems are also isolated from the core populations and from each other by this same distance. A subpopulation or satellite system is considered isolated if it is separated from the next nearest one by more than 24 km, the maximum documented dispersal distance for the species.

For projects where adverse effects to Florida scrub-jays and their habitats are likely, on-site minimization measures, as well as off-site habitat compensation may be required. Habitat compensation results in the protection and management of suitable scrub-jay habitat in another area. The FWS generally recommends that areas used as habitat compensation be located in the same subregion of the affected habitat to enhance existing subpopulations and satellite systems, and maintain any subregion-specific characteristics among the birds. It has been shown that genetic, ecological and behavioral differences exist among Florida scrub-jays within the different subregions (Fitzpatrick *et al*. 1994b). It is also important to understand the aforementioned dispersal distances to avoid further fragmentation and isolation of existing scrub-jay subpopulations and satellite systems. For compensation, the FWS also generally recommends conservation and management of two acres of occupied habitat for every one acre of occupied habitat affected. This recommendation is currently under review to determine whether adequate long-term protection to the Florida scrub-jay is afforded. Although the 2:1 ratio may result in scrub-jay persistence in many areas, it does not protect enough habitat to ensure long-term recovery of the species.

In areas where scrub habitat is threatened so that scrub-jays would not be able to survive, translocation of birds to protected areas of suitable habitat may be an alternative to salvage birds that would otherwise be lost. Translocation may also be useful to re-establish populations of scrub-jays from areas where they were extirpated, following habitat restoration. In 1989-90, Mumme and Below (1995) conducted an experimental translocation of 18 scrub-jays (12 helpers and 3 breeding pairs) into unoccupied protected scrub habitat in Collier County. Half of these birds disappeared or emigrated and half remained to eventually establish territories. As of December, 1996, this population consisted of six adults (1 female, 5 males) and three first-year birds (at least 1 female). Because of the apparent shortage of females, supplemental translocation may be needed (Mumme and Below 1996). Further research is still needed to assess translocation as a viable management option for these exceptional circumstances.

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Recovery for the Florida Scrub-jay

Aphelocoma coerulescens

Recovery Objective: To be determined by the recovery team during the ongoing revision of the range-wide recovery plan for the Florida scrub-jay.

South Florida Contribution: Stabilize and increase the South Florida population.

Recovery Criteria

Since its listing as a threatened species in 1987, the Florida scrub-jay population has declined by approximately 50 percent because of the destruction, fragmentation, and degradation of scrub communities throughout peninsular Florida, due to residential housing or commercial development. These areas are not restorable.

The South Florida recovery objective will be achieved when: a reserve design is developed that identifies contiguous patches of suitable-size scrub habitat, within and between all subregions, that is essential for preventing further declines in the population; any further loss, fragmentation, and degradation of habitat within the reserves has been prevented; occupied habitat within the reserves is protected through land acquisition or cooperative agreements with private landowners; scrub-jays and their scrub habitat are appropriately managed to assure population viability and habitat contiguity; unoccupied and overgrown scrub is restored and managed as suitable habitat within dispersal distance (up to 8 km) of occupied habitat to increase numbers of scrub-jays; and subpopulations within the reserves (throughout all subregions) exhibit an intrinsic rate of increase (*r*) equal to or greater than 0.0, sustained as a 3-year running average over at least 10 years.

Species-level Recovery Actions

S1. Determine the distribution of scrub-jays and status of scrub habitat in South Florida.

S1.1. Update the 1992-1993 statewide survey (Fitzpatrick *et al.* 1994) in 2002 by groundtruthing a sample of scrub sites that were considered “occupied” during those surveys to determine the current status of the habitat and to verify if scrub-jays are still present. Priority should be given to areas where habitat fragmentation has been the greatest over the past 5 years, *i.e.*, Polk, Highlands, Sarasota, Charlotte, and Indian River counties. Identify key metapopulations that may require more frequent surveys.

S1.2. Maintain scrub-jay distribution data in a GIS database. Update the existing GIS database by including information obtained in **S1.1** on the distribution of known scrub-jay territories throughout South Florida and the current status of scrub habitat. Ensure terminology is consistent with the 1992-1993 survey: currently occupied, occupied in 1992-1993, formerly occupied (both pre-1980 and current changes from 1992-1993 survey), and unknown.

S2. Protect and enhance Florida scrub-jay populations.

S2.1. Develop a reserve design for scrub-jays in South Florida using landscape maps, GIS and spatially explicit population models. These reserves will consist of areas identified as critical to the survival and recovery of the scrub-jay in South Florida. Large, contiguous patches of scrub habitat with minimum interspersion of forested and urbanized areas are most ideal. Non-contiguous patches, outside of the maximum dispersal distance for scrub-jays, must be large enough to maintain viable populations, or must have corridors to link to additional patches of suitable habitat.

S2.1.1. Identify all public lands, other conservation lands, and private lands where scrub-jays currently exist. Determine the current status and distribution of scrub-jays on protected and private lands from **S1.2**.

S2.1.2. Identify all unoccupied, potentially restorable scrub on public and other conservation lands. Work with Federal, State, and county agencies and non-governmental organizations to identify areas where scrub management is needed, and where such management would benefit scrub-jays.

S2.1.3. Identify additional key privately owned lands that could enhance existing scrub-jay preserves on conservation lands to which suburban scrub-jays could emigrate, or that would provide corridors to facilitate dispersal between occupied conservation lands. Consider willingness of sellers and economic feasibility.

S2.1.4. Use spatially explicit models with the existing information on suitable and restorable scrub remaining in South Florida, and scrub-jay biology, to identify the most suitable and feasible alternative for development of a reserve design to conserve scrub-jays in South Florida.

S2.1.5. Develop criteria under which private lands would be considered for conservation.

S2.2. Protect, manage, and enhance Florida scrub-jay populations on public lands. In South Florida, scrub-jays occur on Avon Park AFR (Highlands and Polk counties), Hobe Sound NWR (Martin County) Lake Wales Ridge NWR (Highlands and Polk counties), and on the BLM and U.S. Coast Guard Jupiter Inlet tract (Palm Beach County). Scrub-jays also occur on many State and county-administered lands with a multitude of land-use designations. The survival of the Florida scrub-jay depends to a large extent on maintaining and improving scrub habitat on these public lands.

S2.2.1. Develop management plans for scrub-jays where they occur on public lands. With assistance from the FWS, each public property manager should develop a long-term management plan designed to protect and enhance scrub-jay populations on their property. The plans should include fire and/or mechanical management to maintain scrub in a suitable condition for scrub-jays.

S2.2.2. Implement management plans for scrub-jays on public lands. Public land managers should coordinate to ensure that implementation and timing of management actions on adjacent properties minimize conflict, and that equipment and personnel are used effectively and efficiently.

S2.2.3. Facilitate communication among entities responsible for carrying out management activities on public lands. Establish a multi-agency team to assist in coordination of management planning.

S2.3. Protect, manage, and enhance Florida scrub-jay populations on privately owned lands. Scattered and disjunct scrub-jay populations occur widely on privately owned lands throughout central and South Florida. The largest of these is on the Archbold Biological Station in Highlands County, where the bird has been extensively studied and is well protected.

S2.3.1. Protect the "core" population on the Lake Wales Ridge. Continue to protect scrub-jays at Archbold Biological Station and initiate protective measures on other private lands. Maintain this core population at or above 400 pairs of birds, and maintain habitat for this population such that dispersal distance between habitat gaps is 3.5 km or less (Stith *et al.* 1996).

S2.3.2. Work with landowners to protect and maintain suitable habitat for scrub-jays. Small, isolated populations of scrub-jays occur on numerous small patches of privately owned scrub in South Florida. Make efforts to contact landowners to encourage them to enhance and maintain scrub habitat to benefit scrub-jays. Where appropriate, use existing local, State or Federal programs to provide funding assistance.

S2.3.3. Recognize or reward protection and management efforts. Management efforts on private lands should be recognized and rewarded in any way possible in light of the limited legal responsibilities involved.

S2.3.4. Explore and implement other conservation programs. The opportunities for a tax incentive program at county, State, and Federal levels should be explored and implemented if feasible.

S2.3.5. Provide information on management and legal requirements to private landowners and managers. Develop articles and guidelines that contain information and visual aids to identifying habitat of the species, detailed information for managing the species by an array of options depending on the total land management objectives of the owner or manager, and specific information on the legal responsibilities of private landowners through section 9 of the ESA.

S2.4. Enforce available protective measures. Identify and implement local, State and Federal regulations and guidelines to protect scrub-jays and their habitat.

S2.4.1. Initiate section 7 consultation when applicable. All Federal agencies must consult with the FWS on any of their activities (authorized, funded, or carried out) that may affect scrub-jays. Such activities include (among others) pesticide use, road construction, military training exercises, clearing of land for new buildings and runways and implementing management plans. Implement on-site minimization through section 7 when needed.

S2.4.2. Implement on-site minimization, habitat compensation, and mitigation on non-Federal lands through section 10 when needed. Where adverse effects cannot be avoided, measures must be taken to minimize on-site disturbance, and compensate or mitigate for the impacts that remain. The FWS generally recommends that areas used as habitat compensation be located in the vicinity of the affected habitat, where appropriate, to enhance existing scrub-jay families, and avoid further fragmentation and isolation of existing habitat.

S2.4.3. Use reserve design in combination with draft management guidelines when scrub-jays and their habitat may be affected by proposed projects. The FWS, in conjunction with the GFC, developed management guidelines in 1991 (Fitzpatrick *et al.* 1991) that discuss ways to minimize adverse effects of proposed projects to scrub-jays. Although these guidelines are not official FWS policy, they are useful when reviewing projects and for making recommendations about scrub-jay conservation.

S3. Identify research needs on the biology and population demography. Although scrub-jays have been well studied at Archbold Biological Station in xeric oak scrub habitat, additional research is needed on the biology of scrub-jays in other xeric communities and in suburban areas.

S3.1. Gather information on the biology of scrub-jays in southwest Florida. Conduct research on habitat use, reproductive success, nesting, role of helpers, juvenile dispersal, adult and juvenile survival and mortality, predation, and food habits of birds in the scrubby flatwoods habitats of southwest Florida to compare with information known from populations at Archbold Biological Station.

S3.2. Conduct risk assessment analysis to determine the probability of persistence of the scrub-jay in South Florida, given the current amount of suitable scrub habitat as well as potentially restorable scrub habitat.

S3.2.1. Identify which subpopulations of scrub-jays are considered "viable" according to recovery criteria, and which subpopulations or groups of birds are most vulnerable to extinction.

S3.2.2. Incorporate results of S3.2.1. into the reserve design for scrub-jays to assist with project review and ESA consultation process.

S3.3. Study the effects of habitat fragmentation due to urbanization. On a landscape level, determine how residential development affects the metapopulation dynamics of scrub-jays. On a population level, identify the conditions that scrub-jays can tolerate and adapt to in a suburban setting, in addition to the conditions that significantly alter their vital rates, such as reproductive success, growth, and survival.

S3.4. Determine the biological and ecological conditions necessary to ensure natural colonization following habitat restoration. Describe the conditions that are conducive to natural immigration of scrub-jays after restoration of unoccupied scrub. Collect life history information on scrub-jays that naturally immigrate to restored habitat, including immigration, habitat use, territoriality, reproduction, adult and juvenile survival, dispersal, and recruitment.

S3.5. **Continue studies on translocation of scrub-jays**. To date, only one study of translocation of scrub-jays has been undertaken. Further research on this technique is needed to assess its utility in recovery. Translocation should only be considered when natural dispersal/immigration to a suitable-sized restored scrub parcel is unlikely, or to "rescue" demographically isolated birds from habitat that will be adversely modified. Translocation could also be used to re-establish birds to historically occupied habitat that is now being appropriately managed.

S3.5.1. **Establish protocols for successful translocation of scrub-jays into unoccupied areas**. Establish criteria for successful re-establishment following translocation, such as the number, age structure, social structure, and gender ratios of birds to be used, geographic boundaries for obtaining source birds, and appropriate techniques for capture and release.

S3.5.2. **Release birds into new sites**. It is recommended to use birds from source populations within the same subregion for translocation efforts.

S4. **Monitor scrub-jay subpopulations**.

S4.1. **Monitor representative groups within each subregion in South Florida** to collect data on habitat use, reproduction, survival, mortality, dispersal, and recruitment to determine the status and trends of the subpopulations and assess recovery efforts.

S4.2. **Monitor birds in urban areas for changes in their vital rates,** such as reproductive success, growth, and survival as urbanization affects territory size.

S4.3. **Monitor natural immigrants and translocated birds**. Collect data as in **S4.1** to determine the success of birds that inhabit newly restored scrub habitat as well as birds that have been translocated to new areas.

S5. **Inform and involve the public**. Inform the public through articles for the news media and popular publications. Particular emphasis should be placed on explaining the status, importance, and biological needs of scrub-jays and the legal responsibilities for the species' protection.

Habitat-level Recovery Actions

H1. **Prevent degradation of existing scrub habitat**. The long-term recovery of the Florida scrub-jay is dependent upon the immediate protection of as much of the remaining occupied and suitable and unoccupied suitable scrub communities as is economically feasible within South Florida.

H1.1. **Prioritize areas identified in reserve design for acquisition and management**. Large, contiguous habitat patches are the most ideal for conserving scrub-jays. High priority should be given to areas contiguous with, or within short dispersal distance of, existing conservation lands where scrub-jays occur. High priority should also be given to areas adjacent to suburban sites where scrub-jays occur, allowing natural dispersal of birds from suburban areas to protected habitat.

H1.2. **Protect scrub-jay habitat on private lands through easements, acquisitions, and donations**. Lands identified for acquisition should be located adjacent to, or be contiguous with, publicly owned conservation lands or other lands proposed for acquisition that contain scrub-jays. Lands containing scrub-jays should receive special consideration where these lands would consolidate Federal ownership or control and contribute to overall resource management objectives of the agencies. Private landowners should be encouraged to avail themselves of these options.

H1.2.1. **Continue Federal acquisition efforts**. Continue acquisition efforts within the Lake Wales Ridge NWR complex. Much of the habitat targeted for acquisition will be acquired by 1998. One or possibly two additional, but currently unidentified parcels may subsequently be targeted for acquisition.

H1.2.2. **Support State acquisition efforts**. The Florida (CARL) program has a number of ongoing projects and proposals for the acquisition of scrub habitat in Florida, totaling approximately 13,900 and 2,400 ha., respectively. About 90 percent of the ongoing projects are in South Florida, however the proposed projects are predominantly in North Florida. Florida's Save Our Rivers (SOR) acquisition program administered by the water management districts targets wetlands for protection but some sites also contain xeric uplands, and potentially scrub-jay habitat, that may also benefit.

H1.2.3. **Encourage acquisition by non-governmental organizations.** Occupied private sector and suitable, unoccupied scrub not targeted in Federal and State acquisition programs may become available for private purchase and management. Scrub habitats already protected such as those at Archbold Biological Station and The Nature Conservancy's Tiger Creek Preserve, Saddle Blanket Lakes, and Lake Apthorpe areas are important for the long-term persistence of scrub-jays.

H1.2.4. **Pursue acquisition of lands identified as necessary for developing scrub-jay reserves that are not covered under H1.2.1-H1.2.3 above**.

H1.3. **Maintain suitable habitat for scrub-jays**. Prescribed burning, where feasible, is the optimal management tool. The fire frequency will vary depending on the type and condition of habitat being managed and the natural fire return interval. Burns should be done in a rotation, with each covering small portions of a preserved tract of scrub. No more than 25 percent of an area occupied by scrub-jays should be burned at any one time (Fitzpatrick *et al.* 1991). In areas where burns are not feasible, mechanical treatments, such as rollerchopping, provide short-term alternatives.

H1.4. **Prevent loss or fragmentation of scrub habitat within scrub-jay reserves identified in S2.1**. Ensure that no habitat gaps > 8 km are created within and between scrub reserves that might preclude dispersal by scrub-jays. Also note any potential physical barriers to dispersal (Stith *et al.* 1996).

H2. **Restore overgrown or unsuitable scrub habitat**. After identification of unoccupied but potentially restorable scrub (see **S2.1.2.**), work with local, State and Federal agencies and non-governmental organizations to determine the most feasible and appropriate management protocols (*i.e.* controlled burns or mechanical techniques at specific rotations) to restore overgrown scrub to suitable habitat for scrub-jays. Implement mechanisms in the protocols or management plans for ensuring continued management of these sites.

H3. **Conduct research to determine the applicability and effectiveness of various mechanical treatments for scrub management**. Mechanical treatments, such as rollerchopping or thinning, are needed as an alternative to burning scrub habitat, particularly on lands in or adjacent to urbanized areas.

H4. **Monitor xeric communities that provide scrub-jay habitat.**

H4.1. **Monitor scrub habitat that is occupied by scrub-jays to ensure public lands are managed to maintain scrub in suitable condition for scrub-jays, and to assess when unmanaged areas become unsuitable for scrub-jays. Also monitor to ensure the site is not becoming a "sink" for the population**.

H4.2. Monitor unoccupied scrub habitat following restoration to collect data on how habitat characteristics afect immigration and establishment of scrub-jays.

H4.3. Maintain scrub-jay habitat data in a GIS database. Update the existing GIS database by including information obtained from surveys in **S1.1** on the current status of scrub habitat in South Florida. Denote the condition of the scrub, and the type and timing of all pertinent management actions.

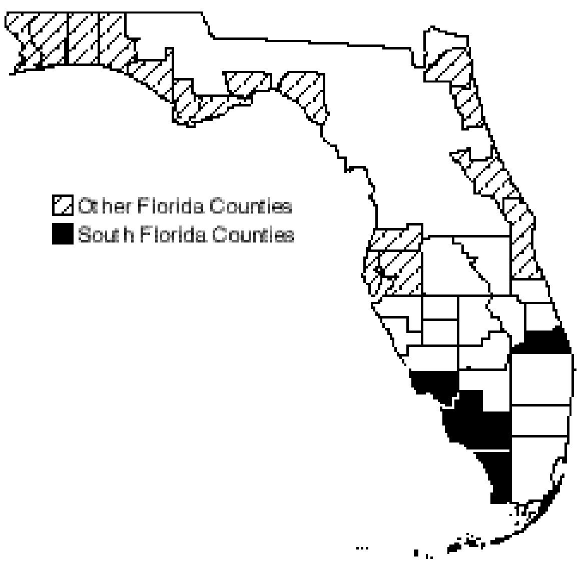
H5. Increase public awareness of the scrub ecosystem. Efforts should highlight habitat acquisition initiatives, importance of biodiversity, and biology of scrub-dependent species. Federal, State, and county governments, as well as private organizations, should support the development and dissemination of educational materials pertaining to the conservation of the scrub ecosystem and endemic scrub species. Materials such as brochures, posters, postcards, slide programs and videotapes can improve public understanding of and increase appreciation for protection of scrub habitat. Environmental education programs across central Florida should be encouraged to distribute materials or develop lesson plans on scrub ecosystems, particular scrub species, and the importance of maintaining biological diversity.

Piping Plover

Charadrius melodus

Federal Status:	**Threatened (Dec. 11, 1985)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. Florida distribution of the piping plover



The piping plover (*Charadrius melodus*) is a small, migratory shorebird that breeds only in three geographic regions of North America: on sandy beaches along the Atlantic Ocean, on sandy shorelines throughout the Great Lakes, and on riverine systems and prairie wetlands of the Northern Great Plains. The Great Lakes population is listed as endangered, whereas the Atlantic Coast and Great Plains populations are listed as threatened.

Though this species does not breed in Florida, individuals from the three breeding populations winter in Florida. The Atlantic Coast birds use Florida's Atlantic and Gulf of Mexico coastlines in the winter. Until recently, the Great Lakes and Great Plains populations were observed along the Gulf Coast shoreline. In 1997, piping plovers from the Great Lakes population were sighted in Georgia. Birds from all three breeding populations have been observed in the Florida Keys.

Early 20th century accounts indicate shorebird harvesting for the millinery trade was the cause of the first known major decline of the species. Since then, many factors contributed to the continued decline of the species. Habitat destruction, human disturbance of nesting and wintering birds, and predation were the main factors affecting the species when it was listed in 1985. At the time of listing, there were less than 2,500 breeding pairs estimated in the U.S. and Canada.

Piping plovers are inconspicuous due to their coloring (sand-colored above and bright white underneath) and behavior. In favored roosting, feeding, and breeding areas, piping plovers tend to spend more time walking or running than flying. Territoriality within breeding sites is well documented and has also been observed at wintering sites.

This account represents South Florida's contribution to the rangewide recovery plan for the piping plover (FWS 1988, 1996).

Description

Piping plovers are one of five commonly occurring North American species of belted plovers. They have an overall body length of 17 to 18 cm (National Geographic Society

1983, Haig 1992) and weigh between 46 g and 64 g (average 55 g) (Wilcox 1959, Haig 1986). Wing lengths range from 11.0 to 12.7 cm, the tarsi range from 2.1 to 2.4 cm, and culmen lengths vary from 1.0 cm to 1.4 cm (Wilcox 1959, Haig 1986). Throughout the year, adults have sand-colored upper body parts, white undersides, and orange legs. During the breeding season, adults acquire a black forehead, a single black breast band, and orange bills with black tips (Bent 1929, Graul 1973, Johnsgard 1981). In general, males have brighter bands than females, and inland birds have more complete bands than East Coast birds (Moser 1942, Wilcox 1959, Haig and Oring 1987). Postbreeding birds lose the black markings and orange on their bill, but are easily distinguished from snowy plovers (*Charadrius alexandrinus*) and collared plovers (*C. collaris*) by their slightly larger size and orange legs (Haig 1987a). Fledglings have flesh-colored legs and black bills (Wilcox 1959) and immature plumage is similar to adult non-breeding plumage. Juveniles acquire adult plumage in spring following the hatching year (Haig 1987b).

The piping plover is similar to other ringed plovers in size and body shape; however, the very pale color of its upper parts, its orange legs, and the complete white band across the upper tail coverts are diagnostic characteristics (Haig 1992).

Taxonomy

Described as a race of *Charadrius hiaticula* (Wilson and Bonaparte [n.d.]), the taxonomy of piping plovers has undergone a number of revisions (Wilson and Bonaparte [n.d.], AOU 1945, 1957). Ord was the first to consider piping plovers a separate species, but it was not until the fourth edition of the AOU Checklist that the binomial, *Aegialitis meloda*, was changed to *Charadrius melodus* (Ridgway 1919, AOU 1931, Moser 1942, Wilcox 1959). In addition to changes in the binomial, ornithologists have argued for over 100 years about acceptance of two subspecies: *C. m. melodus* (Atlantic birds) and *C. m. circumcinctus* (inland birds). The first two editions of the AOU Checklist listed the two forms, the third and fourth listed one form (AOU 1886, 1895, 1910, 1931). Moser's argument that breast bands differed between inland and coastal birds facilitated changing back to two forms in the 1945 supplement of the checklist. Wilcox (1959) reported a variety of breast band forms from birds on Long Island. Subsequent morphological measurements of Atlantic Coast and inland birds did not indicate there was a significant difference between birds from different regions (Moser 1942, Griscom and Snyder 1955, Wilcox 1959). Additionally, electrophoretic samples collected by Haig and Oring (1988a) from piping plovers in Saskatchewan, Manitoba, North Dakota, Minnesota, and New Brunswick, did not indicate genetic differences among local or regional populations. The subspecies designation was only included in the AOU (1957) Checklist (AOU 1983). Recent studies indicated the separation of the species into subspecies is not supported (Haig and Oring 1988a, Haig 1992).

Piping plover.
Original photograph by Phyllis Greenburg.

Distribution

The piping plover has a broad distribution within North America (Bell 1978, Johnsgard 1981, AOU 1983, Dinsmore 1983, Haig 1985, Haig and Oring 1985, FWS 1996). Historically, breeding occurred in three geographic regions: (1) the Northern Great Plains of the U.S. and Canada, from Alberta to Manitoba south to Kansas; (2) beaches along the Great Lakes; and (3) Atlantic coastal beaches from Newfoundland to North Carolina.

Currently, the species' range remains similar to historic range accounts except that breeding sites in the Great Lakes have almost disappeared (Cairns and McLaren 1980, Russell 1983, Haig and Oring 1985). Piping plovers are no longer known to breed in Illinois, Indiana, Ohio, Pennsylvania, and Lake Ontario (Haig 1992).

Historical winter sites were not well described, although piping plovers were generally seen along Gulf of Mexico beaches, southern U.S. Atlantic beaches from North Carolina to Florida, in eastern Mexico, and numerous islands scattered throughout the Caribbean (Ridgway 1919, Bent 1929, Nicholls and Baldassarre 1990a). The complete winter distribution of the piping plover remains to be determined, although specific Gulf and Atlantic coastal sites are becoming better recognized for their importance to wintering birds (Haig and Oring 1985, 1987; Haig 1986; Nicholls and Baldassarre 1990a; Sprandel *et al.* 1997).

Some birds, however, may winter beyond North America. Nicholls (1989) documented small numbers of birds in the Bahamas, Bermuda, Puerto Rico, Virgin Islands, and Yucatan between 1985 and 1988. Haig and Oring (1985) also reported that winter birds have been recorded in the Bahamas, Barbados, Bermuda, Cuba, Dominican Republic, Ecuador, Haiti, Jamaica, Mexico, Netherlands-Antilles, Puerto Rico, U.S. Virgin Islands, and the West Indies by various observers between 1929 and 1984. The broad range of the sightings and the limited number observed indicates that a substantial number of piping plovers may use winter sites outside the U.S.

In 1991, 10 nations participated in an international census of wintering and breeding habitat of the piping plover (Haig and Plissner 1992). The number of birds identified during the winter census (3,451 individuals) comprised 63 percent of those noted during the breeding census (5,482 individuals). In general, birds from the Great Lakes/Northern Great Plains populations tended to winter in the Gulf of Mexico, while those from the Atlantic Coast population wintered along the coastline further to the south. Though some crossover of these populations did occur, the moratorium on banding Atlantic Coast birds affected identifying the actual amount of intermixing (Haig andPlissner 1993). However, piping plovers from the Great Lakes population were sighted in Georgia in 1997.

A second international census was conducted in 1996; the winter census (2,515 birds) comprised 43 percent of the breeding census (5,913 birds). As in 1991, the greatest numbers of wintering birds are concentrated primarily along the western Gulf of Mexico, particularly the south Texas coast. Typically, wintering birds located in Texas have been observed with 400+ in 1984 (Haig and Oring 1985), 834 from 22 sites in 1987 (Nicholls and Baldassarre 1990a), 1,904 birds located at 64 sites in 1991 (Haig and Plissner 1992, 1993), and 1,333 birds censused at 32 sites in 1996 (Plissner and Haig 1997).

In Florida, Nicholls and Baldassarre (1990a) found 375 birds at 39 sites in a winter survey conducted between December 1986 and March 1987. During the 1991 international winter census of piping plovers, 551 birds were seen on both the Atlantic and Gulf coasts (70 and 481 birds, respectively) (Haig and Plissner 1992). Sprandel *et al.* (1997) found 229 birds at 25 sites during a winter survey conducted between November 1993 and March 1994. For the 1996 international winter census, a total of 333 to 375 birds were counted on both coasts of Florida (18 to 24 on the Atlantic and 315 to 351 on the Gulf). The lower numbers of piping plovers between the two census intervals could be associated with fewer birds and/or a reduced censusing effort.

Florida counties where wintering piping plovers are usually seen include Bay, Brevard, Collier, Miami-Dade, Duval, Escambia, Franklin, Gulf, Hillsborough, Lee, Martin, Monroe, Okaloosa, (possibly) Palm Beach, Pasco, Pinellas, Santa Rosa, (possibly) Sarasota, St. Lucie, St. Johns, Taylor, Volusia, Wakulla, and Walton (Stevenson and Anderson 1994, Nicholls 1996) (Figure 1).

Habitat

At sites on the Gulf of Mexico and Atlantic coasts, piping plover wintering habitat includes beaches, mudflats, and sandflats, as well as barrier island beaches and spoil islands (Haig 1992). These birds may also be seen on ocean beaches and sand or algal flats in protected bays (Wilkinson and Spinks 1994). Nicholls and Baldassarre (1990b) surmise that environmental heterogeneity may be an important factor in winter piping plover distribution. On the Atlantic Coast, they found that piping plovers were most often found foraging in areas adjacent to large inlets and passes. On the Gulf Coast, preferred foraging areas were associated with wider beaches, mudflats, and small inlets.

More roosting sites for wintering birds need to be identified and described before conclusions can be made regarding their habitat associations (Nicholls

1996). Climo's (1998) landscape-level analysis of suitable wintering habitat indicates piping plovers selected landscapes or sites on the Gulf Coast that provided the greatest extent of open water, such as sand spits and barrier islands. Piping plovers seem to prefer landforms that provide tidal flats for foraging and open beaches for roosting within close proximity of each other. Johnson and Baldassarre (1988) observed that wintering piping plovers use sandflats and mudflats for feeding, whereas, sandy beaches are used for resting and probably roosting.

Behavior

Reproduction and Demography

Although piping plovers are only winter residents in Florida, an overview of their reproductive behavior is provided herein. Courtship rituals in piping plovers involve aerial displays by the male over his territory. These flights decrease after a mate has been secured and egg-laying is initiated. The male also exhibits a tilt display during courtship. He stands with head down and body at a 30 degree angle, and the female then stands beneath his tail (Haig 1992). Male piping plovers also perform nest-scraping displays, which involve excavation of prospective scrapes while vocalizing. Copulation follows a complex display involving tilting and posturing as the male approaches his mate. After copulation, both birds may "stone toss" small shells or stones into the prospective nest scrape, thus lining the nest with shells or stones (Wilcox 1959, Haig 1992). The male may also engage in this behavior early in the season, at which time it is usually associated with the tilt display (Haig 1992).

The pair bond established during courtship is maintained throughout the nesting season. Some birds change mates following nest losses. However, those that change mates produce fewer fledglings than those that retain their original mates. There is no evidence that pair bonds extend beyond the nesting season (Haig 1992).

Piping plover pairs generally raise one brood per year, with both sexes incubating the eggs. Females may renest several times, if their nests are destroyed. Nests are usually no closer than 30 m from the nearest neighbor and are usually more than 61 m (Wilcox 1959). The most common size of a clutch is four eggs. Eggs are laid every other day until the clutch is complete. Incubation most likely begins with the laying of the third egg or when the clutch is complete; most shorebirds with precocial young have synchronous hatching (Wilcox 1959). Incubation lasts between 27 and 31 days (Wilcox 1959).

Both parents brood the chicks, although the female may desert the brood within five to 10 days after hatching. Brooding is infrequent after 21 days posthatching and the young generally remain within the territory of the male parent (Wilcox 1959, Haig 1992). As in most shorebirds, the young are cryptically colored; they drop to the ground and become motionless when threatened.

Piping plovers may maintain family groups (made up of at least the male and chicks) and chicks are cared for and fed through fledging and sometimes until fall migration (Haig 1992). Fledglings leave the breeding grounds slightly later than adults (Patterson *et al.* 1990). Chicks fledge at different rates in different locations with a range of 21 to 35 days post hatching.

There is little information on immature postbreeding season movements or behavior. Site fidelity in adults varies, but is generally high (Wilcox 1959; Haig and Oring 1988a, 1988b; Haig 1992).

The piping plover is reported to be long-lived. During his 20-year banding study of piping plovers in the northeast, Wilcox (1959) found several birds that were at least 11 years of age at the end of his study. Clapp *et al.* (1982) noted that a 14-year-old bird was caught and released in the vicinity of its banding site in 1963. The average lifespan of the piping plover is less than 5 years (Wilcox 1959). Based on the resightings of 103 adults and 61 chicks color-banded between 1985 and 1988, the mean annual survival rate is estimated to be 0.74 for birds greater than 1 year old and 0.48 for chicks from the Atlantic Coast population (FWS 1996).

Foraging

The piping plover feeds primarily on marine, freshwater, and terrestrial invertebrates. A variety of invertebrates from the Mollusca, Annelida, Arthropoda, Crustacea, and Nematoda phyla have been found in fecal samples from Gulf of Mexico winter birds (Nicholls 1989). Foraging behavior consists of short pecks and runs, as well as “foot trembling” (vibrating one foot against wet sand, possibly in order to bring invertebrates to the surface or startle insects on the surface). Birds may also forage near nests in drier sand (Haig 1992, Nicholls 1996).

Piping plovers do not forage cooperatively, but may forage in small groups. Foraging also occurs at any time of day and may be influenced by tidal stage and other environmental factors (Haig 1992). Nocturnal foraging behavior of adults and chicks has been documented (Burger 1991, Staine and Burger 1994).

Piping plovers on their wintering grounds spend a greater portion of their time foraging in fall and winter than in the spring (Johnson and Baldassarre 1988). Greater energy requirements in winter weather may affect the duration or rate of foraging, although tidal stage, prey availability, breeding cycle stage, weather, and levels of human disturbance also influence the amount of foraging (Johnson and Baldassarre 1988, Haig 1992). In fact, tidal stage may influence piping plover behavior in all stages of its life cycle (Staine and Burger 1994).

Migration

Piping plover migration patterns are not well documented. Fall migration southward extends from late July through September, whereas migration north to the breeding grounds occurs from late February to early April (Haig 1992). Birds from the Great Lakes/Great Plains regions tend to stage on Texas beaches prior to moving north; a staging area has not been identified for the Atlantic Coast birds.

Specific routes of the Great Lakes/Great Plains birds are poorly understood, but it appears that the birds may fly nonstop to the Gulf Coast (Haig and Plissner 1993). Color-banded plovers have been observed at several sites in North Carolina and Florida, indicating their use by migrating and wintering birds (McConnaughey *et al.* 1990, FWS 1996). Generally, males arrive at the breeding grounds first in the spring, whereas females are the first to leave the breeding sites in the fall (Haig 1992).

Relationship to Other Species

Piping plovers may nest in tern colonies (*Sterna* spp.) or in close proximity to other shorebirds, such as the American avocet (*Recurvirostra americana*). Predators that take piping plover eggs include gulls, crows, raccoon (*Procyon lotor*), red fox (*Vulpes fulva*), opossum (*Didelphis marsupialis*), and skunks (MacIvor *et al.* 1990, Flemming 1991). In addition, rats (*Rattus* spp.) and house mice (*Mus musculus*) may be egg predators (Wilcox 1959, Dyer 1993). Adults may be taken by falcons and great horned owls (*Bubo virginianus*). Arctic terns (*S. paradisaea*) are aggressive toward piping plovers; the death of one individual from such an encounter has been reported (Flemming 1991).

Dunlins (*Calidris alpina*), western sandpipers (*C. mauri*), sanderlings (*C. alba*), least sandpipers (*C. minutilla*), semipalmated plovers (*C. semipalmatus*), snowy plovers, and black-bellied plovers (*Pluvialis squatarola*) as well as some colonial waterbirds, occupy the same winter habitats as piping plovers (Haig 1992, Sprandel *et al.* 1997). Wintering piping plovers are rarely found alone and are most often found within 1 km of four of the first five species listed above (Nicholls and Baldassarre 1990b).

Status and Trends

Historical piping plover population data are mainly qualitative. There is no estimate of total population size available prior to 1980. Historic data for the Atlantic Coast population indicates a decline since at least 1955 (Haig and Oring 1985, Wilkinson and Spinks 1994). Uncontrolled hunting and egg collecting were the primary cause of piping plover decline along this region prior to the passage of the Migratory Bird Treaty Act in 1918 (Dyer 1993, FWS 1996). The population rebounded somewhat from this decline until after World War II, when human development and dune stabilization in breeding areas increased in the Northeast (Raithel 1984, Haig and Oring 1985). Other regions (*e.g.*, the Great Lakes) have suffered significant declines (Haig and Oring 1985). The Northern Great Plains population was declining as a result of severe drought and incompatible water management practices (Haig 1992).

In 1985, breeding pair counts for the U.S. population of piping plovers ranged between 930 and 1,650. Total breeding pair counts varied from 1,649 to 1,939 (Haig and Oring 1985). A 1987 to 1991 census indicated the total number of pairs ranged from 2,065 to 2,334 with 1,266 to 1,589 pairs occurring in the U.S. (Haig 1992). The Atlantic Coast population ranged from 790 to 987 pairs for this period; whereas, from 1992 to 1997, the population ranged from 1,026 to 1,391 pairs (FWS 1998) (Table 1).

Table 1. Piping plover breeding pair estimates[1]

Year	Great Lakes	Great Plains	Atlantic Coast	Total
1986	16		790	
1987	16	1,258-1,326	790	2,064-2,132
1988	14	1,271	886	2,171
1989	15	1,007-1,064	957	1,979-2,036
1990	12	862	980	1,854
1991	17	1,372	987	2,376
1992	16		1,026	
1993	18		1,113	
1994	19		1,150	
1995	21		1,349	
1996	23	1,297	1,348	2,668
1997	23		1,391	
1998	24		1,372	1,396

[1] Breeding pair population estimates taken from Haig 1992; FWS 1996, 1998.

In Florida, wintering piping plovers have been extirpated from entire counties over the past 50 years. Museum records and Christmas Bird Count data indicate piping plovers regularly wintered in Bay, Brevard, Broward, Collier, Miami-Dade, Duval, Franklin, Gulf, Hillsborough, Indian River, Lee, Monroe, Nassau, Orange, Pinellas, St. Johns, St. Lucie, Sarasota, Taylor, Volusia, and Wakulla counties. During the 1991 and 1996 winter census, there were no records of piping plovers for Brevard, Broward, Miami-Dade, Hillsborough, Indian River, Nassau, Palm Beach, St. Lucie, Sarasota, and Wakulla counties; piping plovers were recorded in Martin and Monroe counties during the 1996 census (Howell 1932; FWS 1988, 1996; Nicholls 1989; Plissner and Haig 1997).

The significant alteration of sandy beaches and other littoral habitats due to recreational or commercial developments and dune stabilization in the Great Lakes region, Atlantic Coast beaches, and Gulf of Mexico winter sites is partly responsible for the decline of the species (Bent 1929, Russell 1983, Master and French 1984, Haig 1985, Haig and Oring 1985, FWS 1988, Burger 1991, Dyer 1993). As of the 1991 census, numbers of piping plovers declined to such levels that destruction of any part of their breeding or wintering habitat would significantly affect the species. Population viability anaylsis (PVA) modeling of the piping plover shows that extinction probabilities are sensitive to changes in survival rates (FWS 1996). PVA modeling results show a 4 percent extinction probability over 100 years for a 2,000-pair population based on survival rates of 0.74 for birds greater than 1 year old and 0.48 for chicks. When declines in adult (5 percent) and chick (10 percent) survival rates were modeled, the extinction probability increased to 32 percent (FWS 1996). Such declines in survival rates could occur due to the continued degradation and alteration of wintering habitat.

The Final Rule designating piping plover populations as endangered or threatened identified habitat disturbance and destruction, and human disturbance of nesting individuals as the greatest threats to the species (50 FR 50733). Human disturbance continues to be a major impediment to recovery at both breeding and wintering sites. Many of the remaining breeding and wintering locations available to plovers are plagued by various forms of human disturbance, which may include pedestrian recreationists, their pets, and off-road vehicle enthusiasts (FWS 1988, 1996; Haig 1992; Melvin *et al.* 1994; Staine and Burger 1994).

Human disturbance reduces the amount of time breeding plovers spend foraging (Burger 1991, Staine and Burger 1994), which could affect reproductive success as well as the ability of an individual to survive migration and winter (Burger 1991). Vehicle mortalities are an issue in the northeastern breeding areas. Melvin *et al.* (1994) described 14 vehicle mortality incidents in their study area; they believe that this is a larger problem than has previously been acknowledged. Human disturbance may also be a problem for wintering plovers. Recreational activity levels, including pedestrians and off-road vehicles, were higher on beaches without wintering piping plovers than on those that had wintering plovers (Nicholls 1989). It is important to note the type of human activity as well as the amount and duration of the activity when studying the effects of disturbance on wintering and breeding birds. Each of these types of activities has a different detrimental effect on piping plovers. In addition to human disturbance, predation continues to be a problem in some areas. Predator exclosure cages placed over the nests appear to be ameliorating this threat in the Atlantic Coast and Great Lakes areas (Haig and Plissner 1993).

Shoreline stabilization and erosion control efforts concurrent with urban development have dramatically reduced historic piping plover nesting habitat in Maine, Rhode Island, and the Great Lakes. A quantitative analysis of the effects of these types of activities in Canada has not been performed. Dune maintenance to protect roadways may also impact nesting plovers in New Jersey and Massachusetts. Water management practices (*e.g.*, reservoir construction, channelization, and modification of river flows) have eliminated many nesting sites along the Missouri and Platte Rivers in North and South Dakota, Iowa, and Nebraska (FWS 1988, 1996; Nicholls and Baldassarre 1990b; Loegering and Fraser 1991; Haig 1992).

Environmental contaminants do not appear to be adversely affecting piping plover populations, although high levels of selenium have been documented on the Missouri River and the Platte River (FWS 1991, 1993; Ruelle 1993). Oil spills pose a threat to piping plovers throughout their life cycle (FWS 1996). Dinsmore (1983) reviewed the impact of surface mining on piping plovers and concluded that there was potential for habitat destruction as well as enhancement in mining areas.

Management

Prior recovery plans prepared for piping plovers breeding on the Great Lakes and Northern Great Plains and the Atlantic Coast have outlined those tasks necessary to promote recovery of this species. The Great Lakes and Northern Great Plains Recovery Plan identified six major tasks that needed to be accomplished in order to facilitate recovery of the interior piping plover population. These tasks focused on determining the distribution and population trends of the piping plover; determining the habitat requirements and habitat status of the birds; protecting, enhancing, and increasing piping plover populations in this region; and preserving and enhancing habitat for the species. The Atlantic Coast Population Revised Recovery Plan recommended managing breeding piping plovers and habitat to maximize survival and recovery of the species; monitoring and managing wintering and migratory areas to maximize survival and recruitment to the breeding population; protecting essential wintering habitat by preventing degradation and disturbance of these sites; scientific investigations of factors that will facilitate recovery; developing and implementing a public information and education program; and reviewing the recovery progress annually and revising recovery efforts as appropriate (FWS 1988, 1996).

Both recovery plans concentrate on habitat protection and enhancement as a major factor in piping plover recovery nationwide. Habitat protection and enhancement could include maintenance of natural coastal formation processes, actual physical manipulation of the sites, predator control, minimization of human disturbance, and control of off-road vehicle access (FWS 1988, 1995; Patterson *et al.* 1990; Dyer 1993; Haig and Plissner 1993; Sidle and Kirsch 1993; Cox *et al.* 1994).

Piping plovers spend 7 to 8 months associated with their wintering areas (Haig and Oring 1985). The factors listed above can substantially affect their survival and recovery. Aside from piping plovers, wintering areas are also used by many other shorebirds.

In Florida, the focus of piping plover management has been the protection of specific wintering sites. The GFC can provide short-term protection by designating such sites as “critical wildlife areas,” a designation that affords some protection from disturbance and destruction with limited enforcement opportunities. At least one important wintering site in Collier County, Florida, has been designated as a critical wildlife area.

Another method for conserving piping plover populations is through land acquisition. A small key on the western end of the Seven-mile bridge in the lower Florida Keys, known as Ohio Key, is one such site that has been acquired by the FWS.

Additional surveys to locate other important wintering areas and analyze the essential components of those areas are needed. Once located, mechanisms to protect and enhance those areas must be implemented, such as the regulatory process under section 7 of the Endangered Species Act (Sidle *et al.* 1991).

The Atlantic Coast Revised Recovery Plan projects recovery by 2010 with the implementation of all the identified recovery actions. The Great Lakes and Northern Great Plains Recovery Plan does not identify a projected date for reclassification of the Great Lakes population to threatened status or recovery of the Great Plains population.

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Recovery for the Piping Plover

Charadrius melodus

Recovery Objective: DELIST.

South Florida Contribution: ASSIST in the long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

Recovery Criteria

The objective of this recovery plan is to support and contribute to the recovery of all populations of the piping plover through fulfillment of Criterion 5 in the Atlantic Coast Piping Plover Revised Recovery Plan (FWS 1996). This criterion identifies the need to maintain wintering habitat sufficient in quantity and quality to maintain survival of the Atlantic Coast population of piping plovers. Florida provides only wintering habitat, so no objectives related to reproductive success may be identified. Once wintering ecological needs are identified, measurable criteria may be defined for wintering populations of the piping plover in Florida.

Species-level Recovery Actions

S1. Determine the distribution and abundance of wintering piping plovers in Florida by surveying beaches and other suitable habitat to determine additional wintering sites. Only 63 percent of the known adult population has ever been accounted for during the winter period. Suitable habitat should be surveyed in a manner consistent with the Atlantic Coast Piping Plover Revised Recovery Plan (FWS 1996).

S2. Protect and enhance the wintering population in Florida by managing human use of beaches important to piping plovers. Human disturbance disrupts foraging and loafing patterns of wintering plovers. In addition, other human uses may limit suitable habitat for plovers by rendering some areas unusable. The effects of human activities on piping plovers have been investigated, but are not entirely understood.

S3. Conduct research on the wintering ecology of piping plovers in Florida.

S3.1. Investigate the wintering ecology of piping plovers. Research on the Texas coast will provide valuable information on piping plover wintering ecology. However, the Texas coastal system is complex, and habitat selection and use may be somewhat different from other areas along the Atlantic and Gulf Coasts. Possible research sites include: Ohio Key/Woman's Key/Boca Grande Key in the Florida Keys; Marco Island/Sand Dollar Island in Collier County; and Estero Island, Cayo Costa State Park, North Captiva Island, Bunches Beach in Lee County.

S3.2. **Determine the spatial and temporal use of wintering habitat.** Analysis of data from aerial photographs using computerized GIS may provide insight about the relative importance of the juxtaposition of roosting and foraging habitat (*i.e.*, how far will plovers travel between foraging and roosting sites). Time budget analyses and observations of marked birds may also yield more information on the spatial and temporal (tidal, year-to-year, wind-influenced) use of habitat, whether or not there are prime and alternate feeding and roosting sites, and importance of sites during weather and tidal extremes.

S3.3. **Investigate the effects of human disturbance on wintering plovers.** The degree to which human disturbance and off-road vehicles affect the distribution, habitat use, energetics, and survival of wintering piping plovers needs further study; investigation of the mechanisms by which human activities affect the birds is also needed.

S4. **Monitor known and potential wintering sites.** Recent wintering surveys have identified many new wintering sites, but there is a need for better information about spatial and temporal use patterns, habitat trends, and threats. This can be advanced through a continuing monitoring program.

S4.1. **Monitor abundance and distribution of known wintering plovers through periodic wintering surveys.** A comprehensive rangewide survey (*i.e.*, International Census) of wintering sites patterned after Haig and Plissner (1993) should be conducted at intervals of not more than 5 years to assess population trends, discover additional wintering sites, and determine relative site importance. Major wintering sites along both the Atlantic and Gulf coasts should be surveyed annually to provide additional information on site importance and to assess population fluctuations on a site-by-site basis.

S4.2. **Monitor human use of piping plover wintering sites.** Develop a program to monitor human use of important wintering piping plover sites. This information will assist agencies in determining the appropriate management of these sites.

S5. **Implement public information and education programs.** The Atlantic Coast Piping Plover Revised Recovery Plan (FWS 1996) and the Great Lakes and Northern Great Plains Recovery Plan (FWS 1988) identify the need for an education program and describes strategies for disseminating this information. This education program should be implemented in South Florida focusing on wintering habitat. Expanded efforts to increase public awareness of protection needs of piping plovers, other rare beach species, and the beach ecosystem are needed.

S5.1. **Develop piping plover information and education materials specific to Florida and wintering populations.** These materials should be designed to reach new target audiences, take advantage of advancing media, and stimulate continuing public interest and awareness. In addition, all materials must be kept reasonably current regarding the status of the species and protection efforts. At present, there is a need to integrate more information about the role of piping plover conservation efforts in protection of the beach ecosystem and the plight of other rare beach-dwelling species into plover informational and educational materials.

S5.2. **Establish a network for distribution of information and education materials.** While development of information and educational materials is a major task, distribution of these materials to target audiences requires an even larger commitment of time and other resources.

Habitat-level Recovery Actions

H1. Protect essential wintering habitat by preventing habitat degradation and disturbance. All known wintering areas are currently considered essential to piping plover conservation. Recovery of the three breeding populations is contingent on availability of wintering habitat for more than double the current number of piping plovers (FWS 1996). As information needed to accurately estimate carrying capacity of wintering habitat becomes available in the future, it may be possible to identify habitat that is not considered essential to plover conservation, but, for now, all known wintering sites are considered essential habitat and should be protected.

H1.1. Protect habitat from direct and indirect impacts of shoreline stabilization, navigation projects, and development. Coastal development projects should be carefully assessed with regard to this species. Recommendations from the FWS (under the Endangered Species Act and the Fish and Wildlife Coordination Act) and/or State agencies should focus on avoiding or minimizing adverse effects to wintering habitat. Where adverse effects cannot be avoided, agencies should document potential impacts so that cumulative effects on this species' habitat can be assessed.

H1.2. Utilize the section 7 consultation process to minimize the effects of Federal actions (beach renourishment, coastal armoring) on piping plover wintering habitat. Apprise resource and regulatory agencies of population status and threats to wintering piping plovers and their habitats. Periodic workshops should be held to inform resource management and regulatory agencies about threats, research and management needs, *etc.* A coordinated approach to conservation of plover wintering areas should be encouraged.

H1.3. Protect wintering habitat from disturbance by recreationists and their pets. More information about the mechanisms and effects of disturbance on wintering plovers and their habitat is needed. As information becomes available, it should be incorporated into conservation efforts since wintering sites in Florida currently face their greatest threats from human disturbance.

H1.4. Protect piping plovers and their wintering habitat from contamination and degradation due to oil or chemical spills. Contamination from oil or chemical spills or leaks poses a significant threat to wintering piping plovers. Efforts must be made to minimize the likelihood of such events in the vicinity of plover wintering areas. Oil/chemical spill emergency response plans should provide for protection of known plover wintering areas, as should State plover, shorebird, or coastal ecosystem protection plans. In the event of a spill in the vicinity of a known piping plover wintering area, surveys should be conducted and efforts should be made to prevent oil/chemicals from reaching plover use areas, and restoration efforts should begin expeditiously. If piping plovers or their habitats are damaged by an oil/chemical spill or leak, appropriate claims should be filed under the Natural Resource Damage Assessment regulations to recover damages and undertake relevant restoration work.

H1.5. Provide for long-term protection of wintering habitat, including agreements with landowners and habitat acquisition. Wintering areas deemed important (essential) should be protected through management plans and/or written agreements. Conservation easements and acquisition of wintering sites should be considered. Priority should be afforded to important sites facing the most imminent threats of permanent habitat loss or degradation.

H1.6. Compile management guidelines for wintering piping plovers. Use the information and data obtained under **S3** and **H2** to develop management guidelines that can be used by Federal, State, and local governments as well as private entities to implement conservation actions for wintering piping plovers.

H2. Conduct research on wintering habitat.

H2.1. Characterize wintering habitat. Research is needed to identify winter foraging and roosting habitat characteristics in Florida. Features should be identified on both the local (*e.g.*, substrate type) and landscape level (*e.g.*, the availability or diversity of microhabitats in coastal complexes). Information on habitat characteristics and use will help in locating new and protecting existing wintering sites.

H2.2. Identify factors limiting the quantity and quality of habitat or its use by piping plovers at specific wintering sites. Potential direct and indirect threats to wintering plovers and their habitat have been identified, but a better understanding of the exact mechanisms and degree of impacts on the birds is needed. Some of this information will be obtained through formal scientific investigations (discussed in **S3** of species-level recovery actions), but much information can and should be acquired through monitoring the response of habitat and birds to various factors, including natural coastal formation processes, dredging and other channel maintenance, beach renourishment, and recreational activities. Careful documentation of all observations is a key component of such monitoring. Opportunities to incorporate monitoring into plans for Federal activities subject to section 7 of the Endangered Species Act, such as dredging and discharges regulated by the COE, should be sought. For example, a 1994 biological opinion regarding the reopening of Packery Channel, between Mustang and North Padre Islands, Texas, recommended that the COE conduct pre- and post-project monitoring of the area’s tidal amplitude, size of intertidal flats, salinity, vegetation, and invertebrate populations.

H2.3. Evaluate impacts of artificial inlet closure and other beach stabilization projects on piping plover wintering habitat suitability. Piping plovers nest and forage in storm-maintained habitats, including sandspits, overwashes, and blowouts, and the species’ survival and recovery as well as the well-being of other early succession beach-dwelling species is dependent on the maintenance and perpetuation of these habitat characteristics. Beach stabilization projects, such as renourishment and coastal armoring are sometimes implemented despite their deleterious effects on plovers and sea turtles. Additional information is needed to more fully determine the type, extent, and duration of impacts from these types of coastal modifications and to facilitate more complete analysis of impacts on wintering piping plovers. Such studies should also seek to define possible project modifications that will minimize adverse impacts on piping plovers, other Federally threatened species, and the beach ecosystem. Studies may also facilitate creation and enhancement of wintering habitat to mitigate unavoidable adverse effects of artificial beach stabilization.

H3. Monitor and manage wintering and migration areas to maximize survival and recruitment into the breeding population. The probability of persistence of Atlantic Coast and Great Plains piping plover populations are highly sensitive to changes in survival rates. Since piping plovers spend 55 to 80 percent of their annual cycle associated with wintering areas, factors that affect their well-being on the wintering grounds can substantially affect their survival and recovery. Piping plover wintering areas are also used by many other shorebirds; their protection will contribute to the conservation of a richly diverse and important ecosystem.

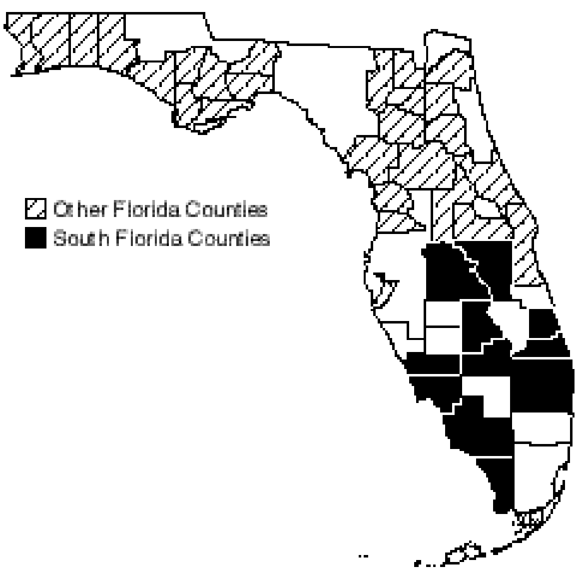
H4. **The Recovery Team recommends integrating the monitoring and protection tasks specified below into a State action plan for the piping plover.** A State action plan that includes all shorebirds or entire coastal systems may be an effective vehicle for piping plover protection. The State action plan should identify several specific needs: (1) monitoring--a program to monitor the size of the wintering population of piping plovers should be developed. This monitoring program could be derived from several index beaches or areas to provide a qualitative measure of population fluctuations; (2) identification of protection and management needs--management plans should be developed and implemented for wintering beaches that have special management needs or special management conflicts; (3) education needs--the need for meetings or workshops to train personnel from regulatory agencies on the needs of piping plovers on their wintering grounds should be conducted in Florida. For example, a 1991 workshop was held in North Carolina specifically for representatives of the regulatory agencies to inform them of the plover's habitat needs and ecology, and requirements to protect and consult on this species; (4) recognition of important sites--a mechanism for providing special recognition or designation of sites that are critical for the survival and recovery of piping plovers should be developed and implemented.

Red-cockaded Woodpecker

Picoides borealis

Federal Status:	**Endangered (October 13, 1970)**
Critical Habitat:	**None Designated**
Florida Status:	**Threatened**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. Florida distribution of the red-cockaded woodpecker.



The red-cockaded woodpecker is one of 22 species of woodpeckers native to North America. Its historic range encompassed the southeastern U.S. from eastern Texas and Oklahoma to New Jersey, and it was characterized as "abundant" in 19th century literature. Throughout the 20th century, however, the species' distribution within its historic range has become fragmented, and its total population numbers have decreased drastically due to the destruction of it's habitat. The red-cockaded woodpecker was federally listed as endangered in 1970, and currently is classified as threatened by the State of Florida. The primary threat to the species continues to be destruction or degradation of its habitat as a result of timbering and other land-clearing activities. Although South Florida is not a designated recovery population for red-cockaded woodpeckers, the area contains significant support populations for recovery of the species in the southeast. Additional surveys are needed to assess the current status of the birds in South Florida so that conservation measures used elsewhere can be implemented here.

This account represents South Florida's contribution to the range-wide recovery plan for the red-cockaded woodpecker (FWS 1985).

Description

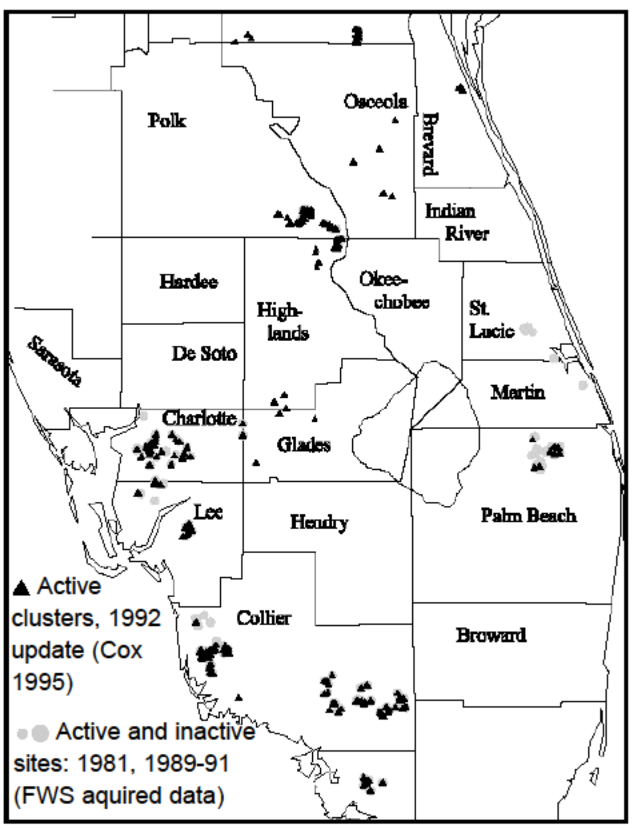
Adult red-cockaded woodpeckers (*Picoides borealis*) are approximately 18 to 20 cm in length and have a wingspan that ranges between 35 to 38 cm. The weight of the adult red-cockaded woodpecker is approximately 45 g; males are slightly larger than the females (Porter 1984). The woodpecker nearest in size to the red-cockaded in Florida is the hairy woodpecker, which is slightly larger. The red-cockaded woodpecker is easily distinguished from the hairy woodpecker, however, by its large, conspicuous white cheek patches, black cap and neck, and black-and-white barred back and wings (Jackson 1994). The only other woodpecker in Florida with a black-and-white barred back is the red-bellied woodpecker (*Melanerpes carolinus*), but that species is substantially larger than the red-cockaded, and a considerable amount of red is visible on its head and nape; no red is readily visible on adult red-cockaded woodpeckers.

Male red-cockaded woodpeckers have a few red feathers slightly above and behind each eye (the "cockades"), but that red spot is essentially covered by black feathers and rarely visible in the field, usually only when the male is displaying; otherwise, adult males and females are black and white in coloration and essentially indistinguishable from each other. The sex of nestlings and fledglings can be distinguished because males have scarlet crown patches until their first molt in the fall, whereas females lack any red coloration throughout their lives (Hovis and Labisky 1996).

Taxonomy

The red-cockaded woodpecker (Order Piciformes; Family Picidae) is one of nine *Picoides* congeners. Jackson (1971) provides a thorough discussion of the taxonomic history of *Picoides*. The red-cockaded woodpecker was formerly recognized in the genera *Picus* by Vieillot in 1807, and in the genera *Dendrocopos* by Peters in 1948. Interestingly, in 1941, Wetmore divided the red-cockaded woodpecker into two races, and described a separate subspecies from southern Florida with the subspecific name *hylonomus*. He described this race as similar to *borealis*, but with much shorter wings. These two subspecies were included as northern and southern races in the 1957 AOU checklist. The three-toed woodpeckers were later grouped with typical *Dendrocopos* woodpeckers, and the red-cockaded woodpecker's name was eventually changed to *Picoides borealis*.

Figure 2. Active and inactive clusters for red-cockaded woodpeckers in South Florida.



Distribution

The red-cockaded woodpecker probably once occurred in all 67 Florida counties, with exception of the Florida Keys in Monroe County (Hovis and Labisky 1996). The southernmost historic record is from the Florida City area in Miami-Dade County (Howell 1921). This species is still widely distributed in the state, but substantial populations now occur only in the Panhandle; elsewhere, populations are relatively small and disjunct. The estimated breeding population of the red-cockaded woodpecker in Florida is 1,500 pairs, with about 75 percent of that total occurring in the Panhandle (Cox *et al.* 1995). The population centered in the Apalachicola National Forest (680 active clusters as of 1996) is the most substantial population in the species' entire remaining range in Florida (R. Costa, FWS, personal communication 1997).

Red-cockaded woodpecker. *Original photograph courtesy of U.S. Forest Service.*

In South Florida, the status and distribution of the red-cockaded woodpecker is uncertain, particularly in Highlands, Glades, Hendry, St. Lucie, Martin, and Sarasota counties, because of the inability to access and survey private lands that may support suitable habitat. The current range and distribution of red-cockaded woodpeckers in South Florida is shown in Figures 1 and 2. The most current information on the numbers of active clusters in South Florida was obtained from Cox *et al.* (1995), and updated during the FWS South Florida Multi-Species Recovery Team meeting in 1996 (Table 1).

Habitat

Pine stands, or pine-dominated pine/hardwood stands, with a low or sparse understory and ample old-growth pines, constitute primary red-cockaded woodpecker nesting and roosting habitat. The low or sparse understory affords unimpeded access to cavities. Red-cockaded woodpeckers will abandon otherwise suitable nesting/roosting areas when the understory approaches cavity height (Wood 1996).

Nest and roost cavities are almost always excavated in old-age living pines; the average nest tree typically ranges between 63 and 130 years in age for longleaf pine (*Pinus palustris*) and between 62 and 149 years in age for other pine species (Hopkins and Lynn 1971, Wood 1983, Rudolph and Conner 1991). Longleaf pine is preferred where available (Hopkins and Lynn 1971, Lennartz *et al*. 1983, Hovis and Labisky 1985), however cavities are also constructed in all other pine trees in Florida with the exception of sand pine (*P. clausa*) and spruce pine (*P. glabra*). The old-age living pines selected for cavity excavation characteristically have thinner sapwood and greater heartwood diameter than other mature pines (Conner

Table 1. Known active clusters of red-cockaded woodpeckers in South Florida.

County	Location	Number of Clusters
Polk	KICCO WMA	1 active cluster
Osceola	Three Lakes WMA	34 clusters
Highlands	Avon Park Air Force Range	20 active clusters
	River Ranch	12 active clusters
	Venus Flatwood	1 cluster
St. Lucie	Campbell property	12 clusters
	The Reserves	1 cluster of 1 bird
Martin	Babcock Ranch	unknown number
Palm Beach	Corbett WMA	14 clusters
Glades	Walter Johnson Tract	estimate 4 clusters
Charlotte	Cecil M. Webb WMA	estimate 27 clusters
	Charlotte Harbor Flatwoods	5 to 6 clusters
	Fairway Woodlands	2 clusters
Collier/Monroe	Naples	estimate12 clusters
	Big Cypress National Preserve	33 active clusters
	Golden Gate Estates, north and south blocks	unknown number

et al. 1994). Many cavity trees are also typically infected with a fungus (*Phellinus pini*) that decays the heartwood, thus facilitating cavity excavation (Jackson 1977, Conner and Locke 1982, Conner *et al.* 1994).

In south central Florida, at Avon Park AFR, cavities are excavated only in longleaf pine, even though active red-cockaded woodpecker clusters occur in mixed longleaf/slash pine stands (Bowman and Fitzpatrick 1993). South of the longleaf pine range, red-cockaded woodpeckers can only excavate cavities in slash pine. In this region, cavity trees selected by red-cockaded woodpeckers are typically shorter and smaller in dbh, on average, than cavity trees elsewhere in the Southeast (Shapiro 1983, Bowman and Huh 1995).

In her survey of five wildlife management areas in South Florida, Shapiro (1983) compared the characteristics of cavity trees and vegetation used by red-cockaded woodpeckers in South Florida with that reported elsewhere in the literature; her results are reproduced in Table 2. The overstory vegetation surrounding cavity trees in South Florida is also very sparse. Red-cockaded woodpecker clusters are typically found in the older or oldest, sparsely stocked pine stands, where cavity trees are more widely spaced than trees found further north. Shapiro (1983) attributed the differences in cavity trees and vegetation to the poor site quality and growth conditions of South Florida flatwoods, and historic timber management practices.

Bowman and Huh (1995) also found that hydric slash pines greater than 60 years old were significantly smaller in dbh and height and tended to have smaller crown to bole ratios than either mesic slash or longleaf pines of the same age. They also found that hydric slash pine had more heartwood rot than the other pines.

Older growth pine or pine-dominated stands are also needed for foraging, but not to the extent needed for nesting or roosting. Red-cockaded woodpeckers will forage to some degree on hardwood trees and even in bayheads and cypress domes, but in general, mature pines constitute the primary foraging substrate. This habitat, in association with or proximal to nesting/roosting habitat, is necessary for population survival. In South Florida, red-cockaded woodpeckers need more habitat for foraging than in areas farther north because of the poor habitat quality (less than 7 m^2/ha pine basal area) (Hovis and Labisky 1996).

In southwest Florida (Charlotte, Collier, and Lee counties), the hydric slash pine (*P. elliotii* var. *densa*) flatwoods provide the preferred critical nesting and

Table 2. Characteristics of red-cockaded woodpecker cavity trees in south-central and South Florida and elsewhere in the literature [Adapted from Shapiro (1983)].

	South Florida			Literature		
Parameter	Longleaf	Slash	Mixed	Longleaf	Slash	Mixed
dbh (cm)						
x	32.1	33.8	27.9	39.4	40.6	43.7
N	133	168	42	770	15	729
Range	20.8-48.3	22.3-51.4	20.3-33.8	----	––	––-
Source[1]	----	----	----	4,5,7	7	2,5
Height (m)						
x	13.5	15.3	15.9	21.7	25	20.5
N	139	169	42	764	15	723
Range	6.7-24.1	2.7-30.2	8.8-28.0	----	––	––-
Source	----	----	----	4,5,7	7	2,5
Age (years)						
x	103.5	102.7	109.5	86	70	84
N	105 (+ 8 heartrot)[2]	91 (+ 20 heartrot)	39 (+ 3 heartrot)	610	15	627
Range	55-142	57-182	80-137	----	––	––-
Source	----	----	----	3	3	3
Cavity Height (m)						
x	4.9	7.8	6.4	7.4	No Data	7.9
N	156	191	45	70	––	1,164
Range	1.4-9.1	1.8-21.7	2.7-12.2	----	––	––-
Source	----	----	----	1,5,6	––	2,5
Cavities/Tree						
x	1.1	1.2	1.3	1.01	1.0	1.6
N	145	165	42	560	15	815
Source	----	----	----	7	7	2

2] = Baker, 1971; 2 = Carter, 1974; 3 = Wood, 1975; 4 = Hopkins and Lynn, 1971; 5 = Lay and Swepston, 1973; 6 = Ligon, 1970; 7=Thompson and Baker, 1971.
2Trees with heartrot could not be aged.

foraging habitat for red-cockaded woodpeckers (Beever and Dryden 1992). This community has been maintained by fire and hydroperiod, and therefore does not have the dense midstory more typical of xeric and mesic flatwoods in southwest Florida. Also, hydric pine flatwoods were not as accessible to historic forestry, agriculture, and land clearing practices as the xeric and mesic communities.

A common cavity tree is 20.5 to 30.8 cm dbh (Beever and Dryden 1992); the smallest cavity tree observed in southwest Florida was 15.4 cm dbh, the largest was 35.9 cm dbh (153 years old). Good quality hydric pine habitat in southwest Florida has approximately 133 trees/ha, 5 to 8 pine stems of 25.8 cm or larger in dbh, and a basal area of approximately 4.6 m^2/ha (Beever and Dryden 1992). Given this, foraging habitat per group would be estimated at

46.8 ha based on total pine stems, 183.6 ha based on pine stems greater than or equal to 25.8 cm, and 171.9 ha based on basal area.

The spatial extent needed to sustain red-cockaded woodpeckers depends primarily on habitat quality. Home ranges in optimal habitat in the Carolinas average 70 to 90 ha. In most of Florida, however, habitat quality is considerably lower than the optimal conditions in the Carolinas, as well as other areas within the species' range. Home ranges for red-cockaded woodpeckers in northern Florida average 120 to 140 ha (Porter and Labisky 1986). Habitat quality in southern and central Florida is particularly marginal in that respect; home ranges average 140 to 160 ha, but can exceed 200 ha (Patterson and Robertson 1981, Nesbitt *et al.* 1983, DeLotelle *et al.* 1987, Wood 1996). Territory sizes for red-cockaded woodpeckers in South Florida have been reported as large as 300 to 400 ha in Big Cypress National Preserve, because the pinelands are not contiguous (D. Jansen, Big Cypress National Preserve, personal communication 1996). At Avon Park AFR, the largest home range size reported was 360 ha, with an average of 160 ha. In constrained territories, home range is limited to 70 ha (Paul Ebersbach, Avon Park AFR, personal communication 1996).

Behavior

Social Structure

Red-cockaded woodpeckers are non-migratory, territorial, and live in cooperative breeding social units called groups. Such groups are typically comprised of a breeding pair and up to three "helpers," which are usually males (juvenile females disperse or are expulsed from the breeding groups) and most often offspring of the mated pair from previous years (Jackson 1994). In central Florida, however, the frequency of female helpers is higher than what is reported for populations elsewhere (DeLotelle and Epting 1992). Helpers assist in defending territories (territorial disputes between neighboring groups are common) and in feeding and otherwise caring for the young. Mated pairs usually remain together until one dies, but some inter-group movement of breeding adults occurs (Walters *et al*. 1988). Breeding groups average 2 to 4 birds prior to breeding and 4 to 6 afterward, but groups numbering up to 8 to 10 birds have been observed.

The cooperative breeding social structure of the red-cockaded woodpecker is comparable to the social structure of the Florida scrub-jay (*Aphelocoma coerulescens*), whose breeding groups likewise typically consist of a breeding pair and helpers. The red-cockaded woodpecker and the acorn woodpecker (*Melanerpes formicivorus*), which occur in western North America, are the only cooperatively breeding woodpeckers in North America, but breeding units of the acorn woodpecker commonly have more than one breeding male and/or female.

Cavity Excavation

The red-cockaded woodpecker is the only North American woodpecker which excavates its roost and nest cavities in living trees. Cavities are typically excavated on the west to southwest side of a mature pine tree. They are typically located 10 to 13 m above the ground and are found just below the lowest branches, although cavity height can range from less than 1 m up to almost 100 m (Jackson 1994). Once a cavity is completed, small, conical "resin wells" are excavated above, alongside, and below the cavity, as well as on the opposite side of the tree (Jackson and Thompson 1971). Resin wells are continuously maintained to sustain exudation of sap for the life of the tree. The resulting resin flow gives the tree a glazed, "candle-like" appearance, which makes it unmistakable as a red-cockaded woodpecker cavity. The resin flow is an effective deterrent to rat snakes (*Elaphe guttata*) and perhaps other predators of cavity-nesting birds (Jackson 1974, Rudolph *et al*. 1990).

In south-central Florida, in both hydric and mesic habitats, red-cockaded woodpeckers excavate cavities in trees with the crown-bole ratios associated with the maximum resin flow (Bowman and Huh 1995). Red-cockaded woodpeckers also chip away the bark from the immediate vicinity of cavities, creating a smooth "plate." Red-cockaded woodpeckers can excavate cavities within a few months, but more typically take 1 to 3 years. It is also possible for a "start hole" to be created that remains unattended for several months or even years before excavation is resumed; the heartwood may be initially too hard for successful cavity completion, but will soften over time.

Cavity trees tend to be aggregated into geographic areas known as "clusters" (Walters 1990) which support a breeding group. The number of cavity trees in these clusters usually exceeds the size of the breeding group, which allows the breeding group to grow in size and shift its nest locations. Within an active cluster, cavities under construction are called "starts," while those that have been completed and are in use are called "active" (FWS 1985). It is also typical for a cluster to have a number of trees with start holes and several abandoned cavity trees. Abandoned or inactive trees are often trees that have died (red-cockaded woodpeckers typically abandon cavity trees soon after they die) and/or trees with cavities that have been enlarged or taken over by other species.

Reproduction and Demography

Red-cockaded woodpeckers attain breeding age at 1 year; however, reproductive success improves with increased age (Walters 1990). The nesting season in Florida is late April through early June. The nest cavity is usually the roost cavity of the breeding male (Ligon 1970, Lennartz *et al.* 1987). The red-cockaded woodpecker is monogamous, and essentially single-brooded, although rare instances of double-brooding in a given year have been documented (Jackson 1994, Schillaci and Smith 1994). Clutch size is normally two to four eggs (Ligon 1970), and incubation is 10 to 11 days; this is one of the shortest incubation periods among birds (Ligon 1970, Crosby 1971). Both parents and helpers incubate the eggs (Jackson 1994). Usually one to three young fledge at 26 to 29 days of age (Ligon 1970), but they are dependent to some degree upon their parents and any helpers for 2 to 5 months thereafter (Jackson 1994). Although not all groups produce young, in South Florida, 81 percent of groups were found to be successful.

The red-cockaded woodpecker is long-lived for a bird its size; banded birds in the wild have reached 15 years of age, and a captive-reared bird was documented at 13 years (Jackson 1994).

Dispersal

Most female red-cockaded woodpeckers disperse within 1 year after fledging. They may attain breeding status in another territory or become "floaters" that are not definitively associated with a particular group of birds or cluster of cavity trees (Hovis and Labisky 1996). Some fledgling males also disperse to become breeders or floaters, or to establish and defend a territory, while others remain on their natal territory as helpers until a breeding opportunity arises (Walters *et al.* 1988). There is little information on dispersal distances for birds in South Florida; however, a dispersal distance of 17 km was reported from Avon Park AFR (P. Ebersbach, Avon Park AFR, personal communication 1996).

Foraging

Red-cockaded woodpeckers forage primarily on arthropods, taken by chipping away the outer layer of tree bark and gleaning what they find underneath. They will occasionally feed on vegetative matter such as pine mast and fruits (Jackson 1994). They have also been observed taking flying insects on the wing. Red-cockaded woodpeckers typically forage in larger pines in pine-dominated habitat (90 percent), rather than in hardwoods (Ramey 1980, Bradshaw 1990). Male red-cockaded woodpeckers tend to forage primarily on the branches and upper trunk of pines, whereas females forage primarily on the trunk below the lowest branches (Ligon 1968, Ramey 1980, Jackson and Parris 1995). As stated previously, because of the poor habitat quality in South Florida, more habitat is needed for foraging than in areas farther north (Beever and Dryden 1992).

Relationship to Other Species

The hairy woodpecker (*P. villosus*) and downy woodpecker (*P. pubescens*) are two closely related species that coexist with the red-cockaded woodpecker throughout Florida. Other species compete with the red-cockaded woodpecker for cavity use, including the flying squirrel (*Glaucomys volans*), red-bellied woodpecker, red-headed woodpecker (*M. erythrocephalus*) and pileated woodpecker (*Dryocopus pileatus*) (Jackson 1994, Kappes and Harris 1995). Those species will usurp red-cockaded woodpecker cavities, either temporarily or permanently, particularly if the invading species enlarges the cavity. Competition for foraging areas may also occur between red-cockaded woodpeckers and red-bellied woodpeckers, although the effects on reproductive success of red-cockadeds have not been documented.

The Florida grasshopper sparrow (*Ammodramus savannarum floridanus*) occurs with the red-cockaded woodpecker at Three-Lakes WMA and Avon Park AFR in transitional flatwoods/dry prairie habitat. In scrubby flatwoods/high pine habitat, the red-cockaded woodpecker may occur with the Florida scrub-jay.

Status and Trends

The red-cockaded woodpecker was federally listed as endangered in 1970 due to documented declines in local populations, presumed reductions in available nesting habitat, and because of its perceived rarity (35 FR 8495). As a result of its listing, research efforts were initiated on the biology, status, and distribution of the species.

Jackson (1978) estimated the total population of red-cockaded woodpeckers to be between 1,500 to 3,000 clusters and 4,500 to 10,500 birds, based upon extensive literature reviews and questionnaire surveys. This was revised from his earlier estimate of 2,939 birds-a conservative estimate based upon limited data.

The most extensive, rangewide population surveys for red-cockaded woodpeckers have been conducted on federal lands. In 1979, the FWS southeast region and the USFS initiated a rangewide survey of clusters on federal lands in the Southeast. The results of this effort estimated 2,677 (+/- 456) active red-cockaded woodpecker clusters on the lands censused (Lennartz *et al.* 1983). With the addition of a few federal properties not included in the census, the population was subsequently estimated to exceed 3,000 active clusters (FWS 1985). Among the federal lands censused (national forests, military bases, national wildlife refuges), the largest number of active clusters (2,121) was found on national forests. More recent surveys estimate the rangewide population at 4,694 active clusters (Costa and Walker 1995).

In Florida, the largest population of red-cockaded woodpeckers (~590 active clusters) is on the Apalachicola National Forest, and the second largest population (~208 active clusters) is on Eglin Air Force Base; both populations are in the northwestern part of the state (Cox *et al.* 1995). The population on the Apalachicola NF is also the largest for the red-cockaded woodpecker throughout its range. Statewide, the population size has been estimated as 2,646 birds (943 active and inactive clusters) between 1969-1978 (Baker *et al.* 1980); 2,262 to 3,431 birds (1,139 active clusters) in 1983 (Wood and Wenner 1983); and, 1,146 active clusters in 1992 (Cox *et al.* 1995). The apparent increase in population size between the first and latter estimates reflects improved survey techniques (Wood and Wenner 1983; Cox *et al.* 1995).

In South Florida, the status of the red-cockaded woodpecker is still uncertain, particularly on private lands in Highlands, Glades, St. Lucie, Martin, and Sarasota counties. Populations on private lands in the Naples area (Collier County), however, are declining (K. Dryden, GFC, personal communication 1996). Populations on public lands at Avon Park AFR, River Ranch, Three Lakes Wildlife Management Area, and Big Cypress National Preserve are presently stable (J. Pederson, Three Lakes WMA, personal communication 1996; D. Jansen, Big Cypress National Preserve, personal communication 1996).

Throughout its range, the red-cockaded woodpecker is threatened by habitat loss and fragmentation and lack of fire or infrequent fire that maintains habitat quality; in Florida, invasion by exotic vegetation is also a problem. In South Florida, destruction and fragmentation of pine flatwoods habitat on private lands due to urbanization is a major threat, particularly in southwest Florida. In addition, trees in foraging habitat, as well as cavity trees, have been illegally removed, and landowners are using a variety of tactics to discourage use by red-cockaded woodpeckers.

The loss of habitat on private lands has demographically isolated red-cockaded woodpeckers remaining on public lands, which could affect the genetic viability of these birds. Historically, and even as recently as 30 years ago, there was probably genetic interchange among red-cockaded woodpeckers in South Florida. Increasing isolation from current rates of habitat loss could lead to inbreeding and genetic depression.

Changes in hydrology in South Florida have resulted in the loss of pineland habitat. Hydrologic changes have caused a major loss of pines in the Lostman's Pines area of Big Cypress National Preserve (D. Jansen, Big Cypress National Preserve, personal communication 1996). Alteration of the hydroperiod for residential housing construction has killed a large area of pines on Cecil M. Webb WMA. The restoration of Golden Gate Estates, Collier County, may help red-cockaded woodpeckers in Belle Meade through draining, and all of the south blocks area of Golden Gate Estates through an increase in hydroperiod or surface water.

Management

Management for the red-cockaded woodpecker should include efforts to ensure the long-term survival and viability of the species. The carrying capacity of red-cockaded woodpecker habitat is directly correlated with habitat quality — the availability and abundance of old-age, living pines for nesting and roosting in combination with the availability and abundance of pines for foraging. The most critical factor is the abundance and availability of old-age, living pines. Not only do such trees constitute ideal foraging substrates, they are required for nesting and roosting. Red-cockaded woodpeckers abandon cavity trees soon after the trees die, therefore suitable potential replacement trees must be available. Red-cockaded woodpeckers will not persist where the abundance of mature pines is insufficient to offset the loss of cavity trees that die, regardless of the amount of otherwise suitable foraging habitat that may be available.

Effective management strategies for the long-term survival and viability of red-cockaded woodpecker populations, as adapted from (Wood 1996), are discussed below. They are presented in descending order of importance based on efficacy and logistical implications.

Understory Control: Red-cockaded woodpeckers will abandon cavity tree clusters when the height of the understory/midstory approaches cavity heights. The most effective method for controlling understory growth is to burn nesting/roosting habitat every 3 to 5 years (Komarek 1974). Cavity trees, including abandoned trees and trees with start holes, should be afforded some degree of protection during such burns, by manually removing fuel from their vicinity, creating fire lanes (but not so near cavity trees as to damage root systems), and/or executing burns when climatic conditions would minimize their vulnerability. Existing snags should likewise be afforded the same protection so as to provide nest/roost substrates for other cavity-nesting species that would otherwise compete with red-cockaded woodpeckers. Such precautions may be logistically prohibitive in areas supporting large numbers of cavity tree clusters, but in such instances the loss of a few cavity trees would be offset by the benefits of burning. Manual removal of understory and midstory vegetation may be needed in cavity tree clusters or in the immediate vicinity of individual cavity trees when such vegetation is approaching cavity heights and burning has been ineffective in killing it. Foraging habitat should be similarly burned, to reduce fuel that could eventually result in a devastating crown fire, and to promote potential nesting/roosting habitat conditions.

While burning and thinning are recommended to maintain proper spacing and species composition, such treatments should be scheduled outside the nesting season-which occurs from April through June-to avoid possible disruption of reproductive activities. Considerable caution and skill is required when using fire to control hardwoods in clusters. Beckett (1971) noted that when the resin or pitch flow on cavity trees ignites, cavity trees can be damaged and cavities burnt out and enlarged. Hopkins and Lynn (1971) suggested that combustible materials be raked away from the base of cavity trees to reduce the probability of damage. Connor and Locke (1979) and Stamps *et al.* (1983) have documented, however, that even raking out cavity trees will not protect against fire damage where the fuel load around trees is heavy or when fires become too hot due to wind and other weather conditions. A direct effect of raking is that resins may build up on the base of the tree and eventully lead to a very hot fire directly on the tree trunk. Raking too deeply can also remove wiregrass so the areas will not burn as well. The best solution for preventing fire damage to cavity trees is to burn frequently enough that fuel loads do not become excessive. Where hardwoods have become well developed in a stand, and a hotter than normal burn is required to control them (*i.e.*, a spring or summer fire), or where understory fuel loads are especially heavy (*e.g.*, dense palmetto), the protective measures suggested by Connor and Locke (1979) and Stamps *et al.* (1979) are recommended. These intensive protective measures are probably also warranted on areas supporting just a few active clusters, where the loss of just a few trees could have a significant impact on the local population.

Tree Thinning: Dense stands of young pines (10 to 30 years old) should be thinned to create better foraging habitat. This opens up the habitat and also ensures long-term foraging value by increasing the growth rate of the remaining trees.

Artificial Start Hole Creation: Suitable, sufficient substrate for cavity excavation can be a limiting factor in localized situations. To increase the number of cavities, artificial start holes can be excavated in selected trees both in clusters and in suitable but unoccupied nesting/roosting habitat. Selected trees should be >50 years old and/or >23 cm dbh, and the hole should be situated on the southwesterly side of trees 1 to 3 m below the lower crown branches. Individual holes should be 5.7 cm in diameter and deep enough to penetrate the heartwood. In active clusters, selected trees should be near active cavity trees, and in unoccupied areas selected trees should be grouped into a simulated cluster. In South Florida, artificial start holes are being used at Big Cypress National Preserve (D. Jansen, Big Cypress National Preserve, personal communication 1996) and at Three Lakes WMA (M. Salyer, GFC, personal communication 1996).

Artificial Cavity Creation: When the availability of trees suitable for cavity excavation in a cluster is severely restricted, or when a management objective is to induce occupation of an unoccupied but suitable area within a short period of time, artificial cavities can be drilled in available trees (Copeyon 1990, Taylor and Hooper 1991) and/or artificial "cavity inserts" can be installed (Allen 1991). Both techniques have been demonstrated to be effective in terms of red-cockaded woodpeckers adopting them (Copeyon *et al.* 1991, Richardson and Stockie 1995, Watson *et al.* 1995). However, the cavity insert technique requires relatively large trees, at least 38 cm in diameter at the height of the planned insert, and the cavity excavation technique requires trees at least 75 years old with 25 cm of heartwood. In South Florida, cavity inserts are being used at Big Cypress National Preserve, in trees in Islesworth and Naples, and they are being considered at Avon Park AFR.

Installing Cavity Restrictors: Where competition for cavities from other species is a significant problem, or when rehabilitation of cavities in living trees that have been enlarged by competitors is needed, cavity restrictor devices can be installed on cavities. This technique can significantly reduce cavity competition and/or render previously unsuitable *(i.e.,* enlarged) cavities suitable for occupancy by red-cockaded woodpeckers (see Carter *et al.* 1989 for methodology).

Augmentation: Small, isolated populations are prone to eventual extinction due to stochastic events, demographic problems and/or a lack of genetic vigor. When the management objective is to maintain such populations, translocations of individual birds can be employed. The most effective technique for translocating red-cockaded woodpeckers is capturing and relocating juvenile females to groups comprised of bachelor males. This technique is only effective, however, when it also has been shown that relocating juvenile males to single female groups, and simultaneously translocating unrelated juvenile males and females to recruitment clusters, is effective in establishing new potential breeding groups (Rudolph *et al.* 1992, Costa and Kennedy 1994). When isolated populations are extremely small and destined to extirpation, it may be best to translocate the juveniles in those populations, as long as they persist, and introduce them into other, more secure populations.

Survey/Monitoring Techniques

Red-cockaded woodpecker cavity trees are so conspicuous and unmistakable that determining whether or not a particular area is being used for breeding is relatively simple. Habitats that warrant surveying include old growth (>50 years old) pinelands or pine-dominated pine/hardwood stands, or younger stands with scattered mature pines. Walking linear transects, spaced according to the visibility afforded by the vegetation present, usually 30 to 80 m apart, is the most effective technique for locating cavity trees. Helicopter transects can also be effective in some situations.

Cavities can be treated as active if the tree is living and the resin is flowing. Cavities in living trees that have not been enlarged by other species but with dry, caked and discolored (usually grayish or greenish) resin can be treated as inactive. Such cavities, however, may be reactivated by red-cockaded woodpeckers even after several years of inactivity. Cavities in dead trees and enlarged cavities usually have little direct benefit to red-cockaded woodpeckers, and for most purposes can be considered permanently abandoned. Inactive/abandoned cavities have indirect benefits, however, in that they provide nest/roost sites for species that might otherwise compete with red-cockaded woodpeckers, and thereby should be considered in management strategies.

The number of birds comprising a given group can be determined by positioning observers at cavity trees during morning departure times and/or evening return times. Several observers would normally be needed in that regard to ensure all occupied trees in a given cluster are under observation.

It is more complex to determine whether or not an area is being used as foraging habitat by red-cockaded woodpeckers. More specific guidelines for determining foraging areas in South Florida need to be developed. In general, any area dominated by mature pines which are proximal to nesting/roosting habitat is potentially suitable for foraging. There are subtle indications of red-cockaded woodpeckers foraging in an area, particularly if the area is heavily used. For example, observation of trees with smoother bark and a more reddish appearance (caused by the birds chipping away bark during foraging) can be a good indication of foraging habitat. A more definitive technique, although not altogether effective, is to play a tape recording of red-cockaded woodpeckers calls at stations throughout potential nesting/roosting or foraging habitat. Tape-recorded calls will often elicit a territorial response by any red-cockaded woodpeckers within hearing distance. However, this technique is only effective in the morning hours during the breeding season, and requires daily repetition for several consecutive days. Otherwise a group foraging out of hearing distance may not be detected.

Demographic monitoring typically requires banding red-cockaded woodpeckers. In banding operations, adults can be captured most effectively by deploying a mist net or mosquito net hoop connected to a pole over an occupied cavity either prior to the resident bird's morning departure, shortly after dawn, or just after its evening return near dusk. Hitting the tree trunk with a solid object will usually induce the bird to exit the cavity into the netting. Adults can also be captured, although much less effectively, by deploying a standard mist net in a cavity tree cluster and playing a tape recording of red-cockaded woodpecker calls under or very near the net. Resident birds will attempt to seek out and expel the "intruders," and in so doing may fly into the net. When color-banding red-cockaded woodpeckers (or any other species of woodpecker), red bands should not be used. The color red is a behavioral trigger for most woodpecker species, and red bands could disrupt social behavior patterns. State and Federal permits must be obtained prior to banding any birds.

Banding nestlings or inspecting nest contents requires climbing cavity trees with Swedish climbing ladders to reach cavities. A flashlight and mirror are needed to view the contents, and nestlings can be extracted with monofilament line snares (see Jackson 1982 for methodology).

Conservation

The conservation and management of red-cockaded woodpeckers in South Florida has not been seriously addressed. These efforts should focus on managing and restoring habitat. Additional surveys are needed to update our information on the status of active and inactive clusters, as well as the availability of suitable unoccupied habitat throughout South Florida. We also need to evaluate the potential carrying capacity for red-cockaded woodpeckers on existing public lands where suitable or restorable habitat exists.

Involvement and cooperation of private landowners is essential for the conservation of red-cockaded woodpeckers on private lands. Private lands can provide corridors of habitat or island populations between or in close proximity to other support populations, and can support juveniles to maintain demographic and genetic health, and increase population size (Costa and

Edwards 1997). Prior to 1991-1992, there was no comprehensive plan to address the management of private lands for red-cockaded woodpeckers. In 1992, the FWS developed a conservation strategy to address red-cockaded woodpecker losses on private lands, economic impacts to private landowners of providing habitat, and cooperative conservation efforts between the public and private sectors. This strategy contains a draft red-cockaded woodpecker procedures manual for private lands (Costa 1992) and discusses statewide Habitat Conservation Plans and Memorandums of Agreement (MOA) between private landowners and the FWS for habitat management and monitoring (Costa 1995). A number of incentives have been proposed to compensate private landowners willing to manage for red-cockaded woodpeckers.

One such mechanism that involves cooperation with landowners is the FWS Safe harbor Policy. This policy encourages private landowners to manage their properties for red-cockaded woodpeckers by providing assurances that the establishment of additional groups on their property will not result in further land use restrictions. Upon enrollment for Safe Harbor, private lands are surveyed for red-cockaded woodpeckers and the numbers of groups using the property at the time of enrollment are determined to be the “baseline.” If better land management subsequently results in the establishment of additional groups above the baseline, the landowner has no responsibility, under the Safe harbor agreement, to maintain them. The Safe Harbor approach provides assurances to land owners about land uses, reduces uncertainty about the ESA requirements, and benefits red-cockaded woodpeckers by increasing available habitat. The Safe Harbor concept could work in South Florida for the large tracts of private pine flatwoods, such as in the southwestern part of the state. This program could be a key to maintaining population exchange of red-cockaded woodpeckers in South Florida and lend more demographic stability to population centers. It also may help curtail illegal activities that have harmed the woodpecker by removing the “fear” of the ESA.

In addition, land acquisition programs for suitable habitat in South Florida are being implemented through state efforts such as the Conservation and Recreation Lands (CARL) and Save Our Rivers programs. Lands identified for acquisition should be located adjacent to or be contiguous with publicly owned conservation lands or other lands proposed for acquisition that contain red-cockaded woodpecker clusters (Beever and Dryden 1992). Two properties in South Florida identified through the CARL program to benefit red-cockaded woodpeckers are the Belle Meade and Charlotte Harbor Flatwoods parcels in Collier and Charlotte counties, respectively (DEP 1995). The GFC also identified numerous other parcels that may benefit red-cockaded woodpeckers if they are acquired and managed properly (Cox *et al*. 1994).

As the human population continues to increase in South Florida, there will be an increasing demand for residential, commercial, and agricultural uses of South Florida’s pinelands. It is likely that many of these uses will be incompatible with red-cockaded woodpecker habitat needs; therefore, unavoidable adverse effects to the species are likely. Where adverse effects cannot be avoided, measures must be taken to minimize on-site disturbance, and compensate or mitigate for the impacts that remain. On-site minimization measures can include relocating certain portions of projects to conserve the most suitable areas for red-cockaded woodpeckers, connecting portions of project areas to preserves, and establishing preserves similar in size to the amount of suitable habitat affected by a particular project.

Habitat compensation results in the protection and management of suitable red-cockaded woodpecker habitat in another area. The FWS generally recommends that areas used as habitat compensation be located in the vicinity of the affected habitat, where appropriate, to avoid further fragmentation and isolation of existing habitat. Mitigation must at least replace each red-cockaded woodpecker group in-kind (*i.e.,* potential breeding pair or solitary bird) from the affected property onto another property, either by creating artificial recruitment clusters and/or by the translocation of an adequate number of juveniles to existing recruitment clusters. Other examples of mitigation include purchase of portions of areas identified for acquisition as key conservation lands, or contributions toward the perpetual management of existing conservation lands. For off-site mitigation, the FWS is recommending requiring a management endowment to accompany the mitigation package to be used by the entity receiving the birds or cluster(s), in addition to the approximate average figure of $4,400 for each new cluster created.

In areas where habitat is so threatened that red-cockaded woodpeckers would not be able to survive, translocation of birds to protected areas of suitable habitat is an option under a number of conservation strategies through the FWS. Translocation of red-cockaded woodpeckers has been successful elsewhere in their range (Rudolph *et al.* 1992, Costa and Kennedy 1994, Reinman 1995). The translocation of red-cockaded woodpeckers from threatened private lands is intended to result in a net gain of red-cockaded woodpeckers on public lands or in establishment of larger, more secure private populations (Costa 1995).

Habitat restoration is also an important component of red-cockaded woodpecker conservation. Management activities in South Florida should promote regeneration and encourage establishment of the more densely stocked pine stands that occurred historically (Shapiro 1983). It is important to remember, however, that these areas are less than what is reported as optimal or acceptable habitat in other areas. The Federal guidelines for evaluating red-cockaded woodpecker habitat to prepare biological assessments (Henry 1989) are inadequate for South Florida, particularly the hydric slash pine flatwoods in southwest Florida. At least half of the areas in southwest Florida would fail to meet the 23.1 cm dbh criteria for determining suitable habitat, and more than half of the cluster sites would fail to meet the standard for identifying suitable cavity trees (Beever and Dryden 1992). As mentioned previously, good quality hydric slash pine habitat in southwest Florida has approximately 133 trees/ha, 5 to 8 pine stems of 25.8 cm or larger dbh, and a basal area of approximately 4.6 m^2/ha (Beever and Dryden 1992). Given this, foraging habitat per group would be estimated at 46.8 ha based on total pine stems, 183.6 ha based on pine stems greater than or equal to 25.8 cm, and 171.9 ha based on basal area. The FWS, in cooperation with the GFC and others, needs to work toward revising these guidelines to be beneficial for red-cockaded woodpeckers in South Florida.

Although South Florida is not a designated recovery population for red-cockaded woodpeckers (250 breeding pairs or groups based on the need for ~400 potential breeding pairs), it contains significant support-populations. A goal for this area should be to establish additional populations of red-cockaded woodpeckers on public and private lands, where feasible, and create as much habitat connectivity as possible, to maximize dispersal opportunities. Efforts should focus on protecting habitat for the birds on private lands where medium-sized populations (10 to 30 groups) are known to exist (*e.g.* Belle Meade, River Ranch, *etc.*), and expanding populations on key public lands. To achieve this, the FWS is undertaking a landscape approach, using GIS and spatially-explicit models, to identify important conservation areas for red-cockaded woodpeckers, including corridors to allow for interchange among populations, and conservation areas necessary for the long-term survival of red-cockaded woodpecker populations.

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Recovery for the Red-cockaded Woodpecker

Picoides borealis

Recovery Objective: RECLASSIFY to threatened.

South Florida Contribution: ESTABLISH support populations to facilitate range-wide recovery.

Recovery Criteria

South Florida can contribute the establishment of one or more viable populations of red-cockaded woodpeckers toward the overall recovery goal for the species throughout its range. In particular, we should focus on increasing numbers of birds in the hydric pine flatwoods community of southwest Florida; South Florida is the only place where red-cockaded woodpeckers inhabit this community type throughout their range.

This objective will be achieved when: a reserve design for South Florida is developed that identifies patches of suitable-size nesting and foraging habitat (stands of old-age, mature pines of adequate size) essential for preventing further declines in the population; when any further loss and fragmentation of habitat within these reserves has been prevented; when suitable, occupied habitat within the reserves is protected through appropriate management on public and private lands, land acquisition, and cooperative agreements with private landowners; when additional nesting and foraging habitats are created or restored adjacent to existing clusters; when augmentation or artificial cavities are successfully implemented where needed to establish new groups; and when groups of red-cockaded woodpeckers within the reserves sustain a rate of increase (*r*) greater than 0.0 as a 3-year running average for at least 10 years.

Species-level Recovery Actions

S1. Determine the distribution and status of red-cockaded woodpeckers in South Florida. The status of the red-cockaded woodpecker in South Florida will remain uncertain and controversial until reliable census data are acquired. A range-wide survey was completed for most Federal lands in 1982. Additional surveys are needed on public and private lands to update our information on the status of active and inactive clusters, as well as the availability of suitable unoccupied habitat throughout South Florida.

S1.1 Conduct surveys on Federal and other public lands. Current surveys should be expanded to include Federal properties not included in the original survey as well as other public lands such as state forests, parks, wildlife management areas, and conservation lands.

S1.2. Conduct surveys on private lands. Develop non-invasive techniques (*i.e.* use of aerial photography) to identify potentially suitable habitat on private lands that could be occupied by red-cockaded woodpeckers. Work with landowners to obtain access to survey those lands and other private properties where red-cockaded woodpeckers are known to occur.

S1.3. **Repeat surveys at 5 to 10 year intervals.** Surveys should be repeated at 5 to 10 year intervals to determine local trends and to maintain consistency with region-wide surveys.

S1.4. **Use survey techniques that are consistent with region-wide surveys.** Use of standardized procedures in censusing local populations will facilitate communication among investigators, managers, and policy makers, and permit the integration of South Florida data into regional and range-wide estimates. Use these data to determine population status and trends.

S1.5. **Maintain red-cockaded woodpecker distribution data in a GIS database.** Update the existing GIS database by including information on the distribution of known clusters of red-cockaded woodpeckers and the current status of pine flatwoods communities throughout South Florida.

S2. Protect red-cockaded woodpeckers in South Florida.

S2.1. **Develop a reserve design for red-cockaded woodpeckers in South Florida using landscape maps, GIS and spatially explicit models.** Design reserves to consist of areas identified as critical to the survival of the red-cockaded woodpecker in South Florida. Large, contiguous patches of pineland habitat are ideal. Non-contiguous patches must be large enough to support at least short-term viable populations of at least 10 clusters, or must have corridors to link to additional suitable habitat.

S2.1.1. **Identify all public lands, other conservation lands, and private lands where red-cockaded woodpeckers currently exist.** Determine the current status and distribution of red-cockaded woodpeckers on protected and private lands from S1.5.

S2.1.2. **Identify all unoccupied, potentially restorable pineland areas on public and other conservation lands.** Work with Federal, State, and county agencies and NGOs to identify areas where management is needed, and where such management would benefit red-cockaded woodpeckers.

S2.1.3. **Identify additional key privately owned lands that could enhance existing red-cockaded woodpecker preserves on conservation lands, that would serve as source sites for red-cockaded woodpeckers, or that would provide corridors to facilitate dispersal between occupied conservation lands.**

S2.1.4. **Use spatially explicit models with the existing information on suitable and restorable pineland habitat remaining in South Florida, and data on red-cockaded woodpecker biology, to identify the most suitable and feasible alternative for development of a reserve design to conserve red-cockaded woodpeckers in South Florida.**

S2.2. **Protect, manage, and enhance red-cockaded woodpecker populations on public lands.** In South Florida, red-cockaded woodpeckers are Federally protected on Avon Park AFR and Big Cypress National Preserve, and also occur on state-administered lands. The survival of the red-cockaded woodpecker depends to a large extent on maintaining and enhancing clusters on these public lands.

S2.2.1. **Develop management plans for red-cockaded woodpeckers where they occur on public lands.** With assistance from the FWS, each public property manager should develop a long-term management plan designed to protect and enhance red-cockaded woodpecker clusters on their property. The plans should include fire and/or mechanical management to maintain the habitat in a suitable condition, as well as the use of starts or artificial cavities where feasible. Monitoring should be incorporated in the plan as feedback for adaptive management.

S2.2.2. **Implement management plans for red-cockaded woodpeckers on public lands.** Public land managers should coordinate efforts to ensure that the implementation and timing of management actions on adjacent properties are not in conflict, and that equipment and personnel are used effectively and efficiently.

S2.3. **Encourage protection and management of red-cockaded woodpeckers on private lands**. In 1992, the FWS began developing a conservation strategy to address red-cockaded woodpecker losses on private lands, economic impacts to private landowners of providing habitat, and cooperative conservation efforts between the public and private sectors (Costa 1995). A number of incentives have been proposed to compensate private landowners willing to manage for red-cockaded woodpeckers.

S2.3.1. **Develop Memorandums of Agreement between the FWS, private landowners, and other cooperators.** Agreements should specify management actions needed to protect the species and identify the party responsible (landowner or Federal agency) for implementing the various actions. Agreements should set forth the total commitments of the two parties including land base, funds, equipment, manpower, and time period, and provide a means and time frame for terminating the agreement.

S2.3.2. **Implement Safe Harbor Policy for red-cockaded woodpeckers where it would benefit recovery.** The Safe Harbor concept could work in South Florida for the large tracts of privately held pine flatwoods, such as in the southwestern part of the state. This program could be a key to maintaining population exchange of red-cockaded woodpeckers in South Florida and lend more demographic stability to population centers.

S2.3.3. **Recognize or reward protection and management efforts.** Management efforts on private lands should be recognized and rewarded in any way possible in light of the limited legal responsibilities involved.

S2.3.4. **Develop and implement other conservation programs.** The opportunities for a model tax incentive program at State and Federal levels should be explored and implemented if feasible.

S2.3.5. **Provide information on management and legal requirements to private landowners and managers.**

S2.3.5.1. **Continue development of information articles and management guidelines oriented to private lands.** These articles and guidelines should include information and visual aids to identify habitat of the species, detailed information for managing the species by an array of options depending on the total land management objectives of the owner or manager, and specific information on the legal responsibilities of private landowners through section 9 of the ESA. Legal responsibilities under section 7 of the ESA should also be detailed to explain the different obligations when there is Federal involvement of any kind.

S2.3.5.2. Distribute information to private landowners and managers through professional and industrial associations. The information developed in **S2.3.5.1.** should be distributed through a variety of professional and trade associations and agencies, such as the State and Private Forestry branch of the USDA Forest Service, county agricultural extension agents, and state forestry associations.

S2.4. Enforce available protective measures. Employ local, State and Federal regulations and guidelines to protect red-cockaded woodpeckers and their habitat.

S2.4.1. Initiate section 7 consultation when applicable. All Federal agencies must consult with the FWS on any of their activities (authorized, funded, or carried out) that might adversely affect resident red-cockaded woodpecker populations. Such activities include (among others) pesticide use, road construction, military training exercises, and clearing of land for new buildings and runways. Implement on-site minimization through section 7 when needed.

S2.4.2. Implement on-site minimization, habitat compensation, and mitigation on private lands through section 10 when needed. Where adverse effects cannot be avoided, measures must be taken to minimize on-site disturbance, and compensate or mitigate for the impacts that remain. The FWS generally recommends that areas used as habitat compensation be located in the vicinity of the affected habitat, where appropriate, to enhance existing clusters, and avoid further fragmentation and isolation of existing habitat.

S2.5. Revise the Federal guidelines for evaluating red-cockaded woodpecker habitat in South Florida. The FWS needs to work toward revising the Federal guidelines (Henry 1989) to be beneficial for red-cockaded woodpeckers in South Florida. These guidelines are inadequate for South Florida, particularly for the hydric slash pine flatwoods in southwest Florida. At least half of the areas there would fail to meet the 23.1 cm dbh criteria for determining suitable habitat, and more than half of the clusters would fail to meet the standard for determining suitable cavity trees (Beever and Dryden 1992).

S3. Conduct research on the life history and population dynamics of red-cockaded woodpeckers in South Florida. Although red-cockaded woodpeckers have been well studied, very little is known about the life history and subsequent management needs of birds in South Florida.

S3.1. **Gather basic life history and demographic data, such as reproductive success, juvenile and adult survival and mortality, juvenile recruitment into the breeding population, the role of helpers, home range size requirements, and dispersal of birds within the various subpopulations in South Florida.**

S3.2. **Conduct risk assessment analysis to determine the probability of persistence of red-cockaded woodpeckers in South Florida,** given the current amount of available, suitable pineland habitat. Include pineland areas that could be restored or enhanced to become suitable habitat.

S3.2.1. **Identify which subpopulations of red-cockaded woodpeckers are considered "viable" according to our recovery criteria, and which subpopulations or groups of birds are most vulnerable to extinction.**

S3.2.2. **Incorporate results of this effort into the reserve design for red-cockaded woodpeckers to assist with project review and consultation purposes.**

S3.3. **Study the effects of habitat fragmentation due to urbanization.** On a landscape level, determine how residential development affects the metapopulation dynamics of red-cockaded woodpeckers. On a population level, identify the conditions that red-cockaded woodpeckers can tolerate and adapt to in a suburban setting, in addition to the conditions that significantly alter their vital rates, such as reproductive success, growth, and survival.

S3.4. **Determine the biological and ecological conditions necessary to ensure natural colonization following habitat restoration.** Describe the conditions that are conducive to natural immigration of red-cockaded woodpeckers after restoration of unoccupied pineland communities. Collect life history information on red-cockaded woodpeckers that naturally immigrate to restored habitat, including immigration, habitat use, territoriality, reproduction, adult and juvenile survival, dispersal, and recruitment.

S3.5. **Research feasibility of translocation of red-cockaded woodpeckers in South Florida.** Translocation of red-cockaded woodpeckers has been shown to be successful in areas outside of South Florida, and has not yet been attempted here. Explore opportunities for translocating red-cockadeds to establish new populations, to enhance gene flow, or to salvage groups permitted for incidental take.

S3.5.1. **Identify areas in South Florida where red-cockaded woodpeckers occur in small, isolated populations that are subject to eventual extinction, or where habitat is so threatened that birds would not be able to survive due to stochastic events, demographic problems and/or a lack of genetic vigor.**

S3.5.2. **Conduct an experimental translocation of birds from one of the areas identified in 3.5.1. to an area with suitable habitat that can support additional birds. Follow the protocols established for red-cockaded woodpeckers that have been successful elsewhere (Costa and Kennedy 1994).**

S4. Monitor red-cockaded woodpecker subpopulations.

S4.1. Monitor representative groups within each subpopulation in South Florida to collect data on habitat use, reproduction, survival, mortality, dispersal, and recruitment. Use these data to determine the status and trends of birds throughout South Florida.

S4.2. Monitor birds in urban areas for changes in their vital rates, such as reproductive success, growth, and survival, as urbanization affects territory size.

S4.3. Monitor natural immigrants and translocated birds. Collect data as in **S4.1** to determine the success of birds that inhabit newly restored habitat as well as birds that have been translocated to new areas.

S5. Inform and involve the public. This is an ongoing task. Particular emphasis should be placed on explaining the status, importance and biological needs of red-cockaded woodpeckers and the legal responsibilities for the species' protection.

S5.1. Prepare informative articles for the news media and popular publications. Information articles for the news media and popular publications should be prepared. The news media should be contacted and encouraged to utilize the information articles as prepared or incorporate all or part of the information in articles prepared by news media staff.

S5.2. Distribute information to the public via mailings to conservation groups and individuals and through public meetings. The popular publications should be distributed to the public via mailings to conservation groups and individuals, and through public meetings. Availability of the publications should be publicized and the public encouraged to request copies.

Habitat-level Recovery Actions

H1. Prevent degradation of existing red-cockaded woodpecker habitat in South Florida. The long-term survival of the red-cockaded woodpecker is dependent upon the immediate protection of as much of the remaining occupied and suitable, unoccupied pineland communities as possible, given biological, social, economic, and legal constraints.

H1.1. Prioritize areas identified in reserve design for management and acquisition. Large, contiguous habitat patches are the most ideal for conserving red-cockaded woodpeckers. High priority should be given to areas contiguous with, or within short dispersal distance of, existing conservation lands where red-cockaded woodpeckers occur. High priority should also be given to areas adjacent to suburban sites where red-cockaded woodpeckers occur, allowing natural dispersal of birds from suburban areas to protected habitat.

H1.2. Protect red-cockaded woodpecker habitat on private lands through easements, acquisitions, and donations. Lands identified for acquisition should be located adjacent to, or be contiguous with, publicly owned conservation lands or other lands proposed for acquisition that contain red-cockaded woodpecker clusters. Lands containing red-cockaded woodpeckers should receive special consideration where these lands would consolidate Federal ownership or control and contribute to overall resource management objectives of the agencies.

H1.2.1. Support State acquisition efforts. The Florida Conservation and Recreation Lands (CARL) program has a number of ongoing projects and proposals for the acquisition of threatened vegetative communities in Florida. Florida's Save Our Rivers (SOR) acquisition program administered by the water management districts targets wetlands for protection but some sites also contain xeric uplands, and potentially red-cockaded woodpecker habitat that could benefit from the SOR program.

H1.2.2. Encourage acquisition by Non-Governmental Organizations. Occupied and suitable, unoccupied areas not targeted in Federal and State acquisition programs may become available for private purchase and management.

H1.2.3. Pursue acquisition of lands identified as necessary for developing red-cockaded woodpecker reserves that are not covered under H1.2.1 or H1.2.2 .

H1.2. Maintain adequate nesting habitat in addition to currently active clusters, to replace clusters abandoned or lost through mortality, and to provide for population expansion. Cavity trees can be provided by lengthened rotations, by leaving old-growth remnant trees well distributed throughout younger stands, by perpetuating small remnant stands or patches of old-growth throughout the forest area, or by a combination of these methods. Manage clusters as stands rather than as individual trees and avoid isolating clusters from adjacent forest cover and foraging habitat. Burn or otherwise treat clusters to control hardwood stocking. Potential nesting habitat should be burned and thinned similarly to clusters.

H1.3. Maintain adequate foraging habitat to support existing groups and to facilitate establishment of new territories. Although the loss of nesting habitat is the most serious threat to red-cockaded woodpeckers, groups cannot survive without adequate foraging habitat as well. In South Florida, because of the difference in habitat structure and composition, more habitat is needed for foraging than in areas in the northern portion of the species' range (Hovis and Labisky 1996; Beever and Dryden 1992).

H1.4. Prevent loss or fragmentation of pine flatwoods within reserves identified in S2.1. Ensure that no habitat gaps are created within reserves that might preclude dispersal by red-cockaded woodpeckers.

H2. Restore and enhance red-cockaded woodpecker habitat.

H2.1. Use artificial starts in suitable areas. Suitable substrate for cavity excavation is a limiting factor in localized situations, so artificial starts should be excavated in selected trees both in clusters and in suitable but unoccupied nesting/roosting habitat.

H2.2. Create artificial cavities in suitable areas. When the availability of trees suitable for cavity excavation in a cluster is severely restricted, or when the management objective is to induce colonization of an unoccupied but suitable area, artificial cavities can be created in suitable trees (Copayon 1990; Allen 1991; Taylor and Hooper 1991).

H3. Conduct research on habitat needs and management for red-cockaded woodpeckers in South Florida.

H3.1. Determine the amount of foraging habitat needed to sustain a group of woodpeckers in South Florida in both mesic and hydric pine flatwood habitats. The current Federal foraging guidelines for red-cockaded woodpeckers are unsuitable for use in South Florida because of the significant differences in habitat quality. These data are needed to produce guidelines specific to South Florida.

H3.2. Investigate the best method(s) to provide and manage nesting habitat. Determine whether successful ongoing management activities for red-cockaded woodpeckers elsewhere are suitable for use in South Florida, or how they may be modified for use here.

H3.3. Determine the potential carrying capacity for clusters of red-cockaded woodpeckers on existing public and private lands where suitable or restorable habitat exists.

H3.4. Assess the biological processes associated with cluster abandonment (*e.g.*, interspecific competition, predation, *etc.*), and methods for preventing abandonment.

H3.5. Determine whether retention of snags and dead and abandoned cavity trees within clusters increases or decreases competitive pressure on red-cockaded woodpeckers.

H4. Monitor xeric communities that provide red-cockaded woodpecker habitat.

H4.1. Monitor pineland habitat that is occupied by red-cockaded woodpeckers to ensure public lands are managed to maintain habitat in suitable condition for red-cockaded woodpeckers, and to assess when unmanaged areas become unsuitable. Also monitor to ensure the site is not becoming a population "sink".

H4.2. Monitor unoccupied pine flatwood communities following restoration to collect data on habitat characteristics upon immigration and establishment of red-cockaded woodpeckers. This will provide information on the habitat conditions that are suitable for red-cockaded woodpeckers following restoration.

H4.3. Maintain red-cockaded woodpecker habitat data in a GIS database. Update the existing GIS database by including information obtained from surveys in **S1.1** on the current status of pineland habitat in South Florida. Record the condition of the habitat, and the type and timing of all pertinent management actions.

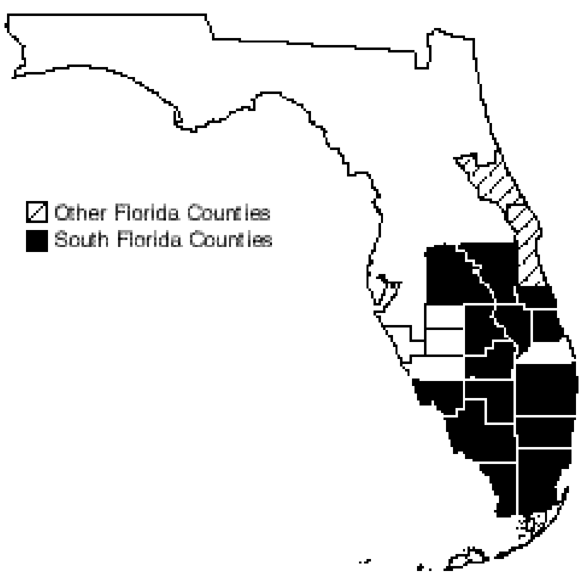
H5. Increase public awareness of pine flatwoods communities. Efforts should highlight habitat acquisition initiatives, importance of biodiversity, and biology of pineland-dependent species. Federal, State, and county governments, as well as private organizations, should support the development and dissemination of educational materials pertaining to the conservation of the remaining pine flatwoods in South Florida. Materials such as brochures, posters, postcards, slide programs and videotapes can improve public understanding of and increase appreciation for protection of this community. Environmental education programs throughout South Florida should be encouraged to distribute materials or develop lesson plans on the pine flatwoods community, highlight species such as the red-cockaded woodpecker, and discuss the importance of maintaining biological diversity.

Everglade Snail Kite

Rostrhamus sociabilis plumbeus

Federal Status:	**Endangered (March 11, 1967)**
Critical Habitat:	**Designated (August 1977)**
Florida Status:	**Endangered**
Recovery Plan Status:	**Revision (May 18, 1999)**
Geographic Coverage:	**Rangewide**

Figure 1. Florida distribution of the Everglade snail kite.



The Everglade snail kite (*Rostrhamus sociabilis*) is a wide-ranging New World raptor species found primarily in lowland freshwater marshes in tropical and subtropical America from Florida, Cuba, and Mexico south to Argentina and Peru. The subspecies from Florida and Cuba *(Rostrhamus sociabilis plumbeus)* was first listed as endangered pursuant to the Endangered Species Conservation Act in 1967. The common name used in the original listing was Everglade snail kite and this remains unchanged in the official FWS Code of Federal Regulations, even though the official name for the species is now simply snail kite (AOU 1983).

The Florida population of snail kites is considered to be a single population with considerable distributional shifts. The combination of a range restricted to the watersheds of the Everglades, lakes Okeechobee and Kissimmee, and the upper St. Johns River, with a highly specific diet composed almost entirely of apple snails (*Pomacea paludosa*), makes the snail kite's survival directly dependent on the hydrology and water quality of these watersheds. Each of these watersheds has experienced, and continues to experience, pervasive degradation due to urban development and agricultural activities.

This account represents a revision of the existing recovery plan for the Everglade snail kite (FWS 1986).

Description

The snail kite is a medium-sized raptor, with a total body length for adult birds of 36 to 39.5 cm and a wingspan of 109 to 116 cm (Sykes *et al.* 1995). In both sexes, the tail is square-tipped with a distinctive white base, and the wings are broad, and paddle-shaped. Adults of both sexes have red eyes, while juveniles have brown eyes (Brown and Amadon 1978, Clark and Wheeler 1987). The slender, decurved bill is an adaptation for extracting the kite's primary prey, the apple snail; the bill is a distinguishing character for field identification in both adults and juveniles.

Sexual dimorphism is exhibited in this species, with adult males uniformly slate gray and adult females brown with cream streaking in the face, throat, and breast. Most adult females have a cream superciliary line and cream chin and throat (Sykes *et al.* 1995). Females are slightly larger than males. Immature snail kites are similar to adult females but are more cinnamon-colored with tawny or buff-colored streaking rather than cream streaking. The legs and cere of females and juveniles are yellow to orange; those of adult males are orange, turning more reddish during breeding (Sykes *et al.* 1995).

In the field, the snail kite could be confused with the northern harrier (*Circus cyaneus*), a similarly sized hawk with a white rump. The northern harrier has a longer and narrower tail, with longer and narrower wings held in a dihedral. The snail kite's flight is slower and characterized by more wing flapping, with the head tilting down to look for snails; the northern harrier has a gliding, tilting flight. At a closer distance, the long, curved beak of the snail kite allows it to be easily distinguished from the northern harrier (Sykes *et al.* 1995).

Taxonomy

Three subspecies of the snail kite are currently recognized (Amadon 1975), but a larger sample size of body measurements is needed to confirm if the separation into three subspecies is valid (Sykes *et al.* 1995). These subspecies are: *Rostrhamus . s. plumbeus*, from peninsular Florida, Cuba, and northwestern Honduras; *R. s. major*, from Mexico, Guatemala, and the northern half of Belize; and *R .s. sociabilis*, from southern Nicaragua, through Panama and into South America as far south as northern Argentina. The *plumbeus* subspecies in Florida has a larger body size than that of *R. s. sociabilis*, with a beak of similar size. However, the validity of these subspecies remains a subject of debate; Beissinger (1988) is among those who question the validity of these designations.

The closest related species is the slender-billed kite (*R. hamatus*) from eastern Panama and South America (Ridgely and Gwynne 1989). The slender-billed kite, like the snail kite, feeds on snails of the genus *Pomacea*, but inhabits swamps or wet forests (Beissinger *et al.* 1988, Ridgely and Gwynne 1989).

Distribution

As noted above, the subspecies *R. s. plumbeus* occurs in Florida, Cuba (including Isla de la Juventud) and northwestern Honduras. There is no evidence of movement of birds between Cuba and Florida, but this possibility has not been ruled out (Sykes 1979, Beissinger *et al.* 1983).

In Florida, the original range of the snail kite was larger than at present. Historically, snail kites were known to nest in Crescent Lake and Lake Panasoffkee in north-central Florida and as far west as the Wakulla River (Howell 1932, Sykes 1984). Information on changes in distribution and abundance is in the Status and Trends section of this account.

Everglade snail kite.
Original photograph by Betty Wargo.

The current distribution of the Everglade snail kite in Florida (Figure 1) is limited to central and southern portions of the State. Six large freshwater systems are located within the current range of the snail kite: Upper St. Johns drainage, Kissimmee Valley, Lake Okeechobee, Loxahatchee Slough, the Everglades, and the Big Cypress basin (Beissinger and Takekawa 1983, Sykes 1984, Rodgers *et al.* 1988, Bennetts and Kitchens 1992, Rumbold and Mihalik 1994, Sykes *et al.* 1995). Habitats in the Upper St. Johns drainage include the East Orlando Wilderness Park, the Blue Cypress Water Management Area, the St. Johns Reservoir, and the Cloud Lake, Strazzulla, and Indrio impoundments. In the Kissimmee Chain of Lakes, snail kites are found at Lake Pierce, Lake Tohopekaliga, East Lake Tohopekaliga, Cypress Lake, Lake Hatchineha, Lake Marion, Lake Marian, Lake Kissimmee, Tiger Lake, Lake Arbuckle, and Lake Istokpoga. Lake Okeechobee and surrounding wetlands are major nesting and foraging habitats, particularly the large marsh in the southwestern portion of the lake and the area southwest of the inflow of the Kissimmee River. In the

Loxahatchee Slough region of Palm Beach County, snail kites are found at the West Palm Beach Water Catchment Area, the Pal-Mar Water Conservation District, and borrow lakes on property belonging to the Solid Waste Authority of Palm Beach County and the City of West Palm Beach. Wetlands in the Everglades region supporting the snail kite are the Arthur R. Marshall Loxahatchee NWR (including WCA 1, WCA 2, WCA 3), Shark River Slough and Taylor Slough in Everglades National Park, and the C-111 basin west of U.S. Highway 1. In the Big Cypress basin, snail kites use the Lostman's and Okaloacoochee sloughs, Hinson Marsh, and the East Loop and Corn Dance units of Big Cypress National Preserve. The Savannas State Preserve, in St. Lucie County, the Hancock impoundment in Hendry County, and Lehigh Acres in Lee County are among the smaller more isolated wetlands used by snail kites (Sykes *et al.* 1995). Although the above list generally describes the current range of the species, radio tracking of snail kites has revealed that the network of habitats used by the species includes many other smaller widely dispersed wetlands within this overall range (R. Bennetts, University of Florida, personal communication 1996, Bennetts and Kitchens 1997a).

Habitat

Snail kite habitat consists of freshwater marshes and the shallow vegetated edges of lakes (natural and man-made) where apple snails can be found. These habitats occur in humid, tropical ecoregions (Bailey 1978) of peninsular Florida and are characterized as palustrine-emergent, long-hydroperiod wetlands (Cowardin *et al.* 1979) often on an organic peat substrate overlying oolitic limestone or sand or directly on limestone or marl (Davis 1946).

Suitable foraging habitat for the snail kite is typically a combination of low profile (< 3 m) marsh with an interdigitated matrix of shallow (0.2-1.3 m deep) open water, which is relatively clear and calm. The marsh vegetation is dominated by spike rush (*Eleocharis cellulosa*), maidencane (*Panicum hemitomon*), sawgrass (*Cladium jamaicense*), and/or cattails (*Typha* spp.). The shallow open-water areas are with or without sparse vegetation, such as white water lily (*Nymphaea odorata*), arrowhead (*Sagittaria lancifolia*), pickerel weed (*Pontederia lanceolata*), and floating heart (*Nymphoides aquatica*). Giant bulrush (*Scirpus validus*) often grows at the deep-water edge of marshes in the lakes. Low trees and shrubs also are often interspersed with the marsh and open water. These often include willow (*Salix caroliniana*), dahoon holly (*Ilex cassine*), pond apple (*Annona glabra*), bald cypress *(Taxodium distichum*), pond cypress (*T. ascendens*), wax myrtle (*Myrica cerifera*), buttonbush (*Cephalanthus occidentalis*), and *Melaleuca quinquenervia*, an invasive exotic species.

Snail kites require foraging areas that are relatively clear and open in order to visually search for apple snails. Therefore, dense growth of herbaceous or woody vegetation is not conducive to efficient foraging. The interspersed emergent vegetation enables apple snails to climb near the surface to feed, breathe, and lay eggs. Nearly continuous flooding of wetlands for > 1 year is needed to support apple snail populations that in turn sustain foraging by the snail kite (Sykes 1979, Beissinger 1988). Cultural eutrophication of water bodies in Florida is occurring through disposal of domestic sewage and runoff of nutrient-laden water from agricultural lands. This degradation of water quality promotes dense growth of exotic and invasive native plants, particularly, cattail, water lettuce (*Pistia stratiotes*), water hyacinth (*Eichhornia crassipes*), and hydrilla (*Hydrilla verticillata*). Dense growth of these plants reduces the ability of snail kites to locate apple snails.

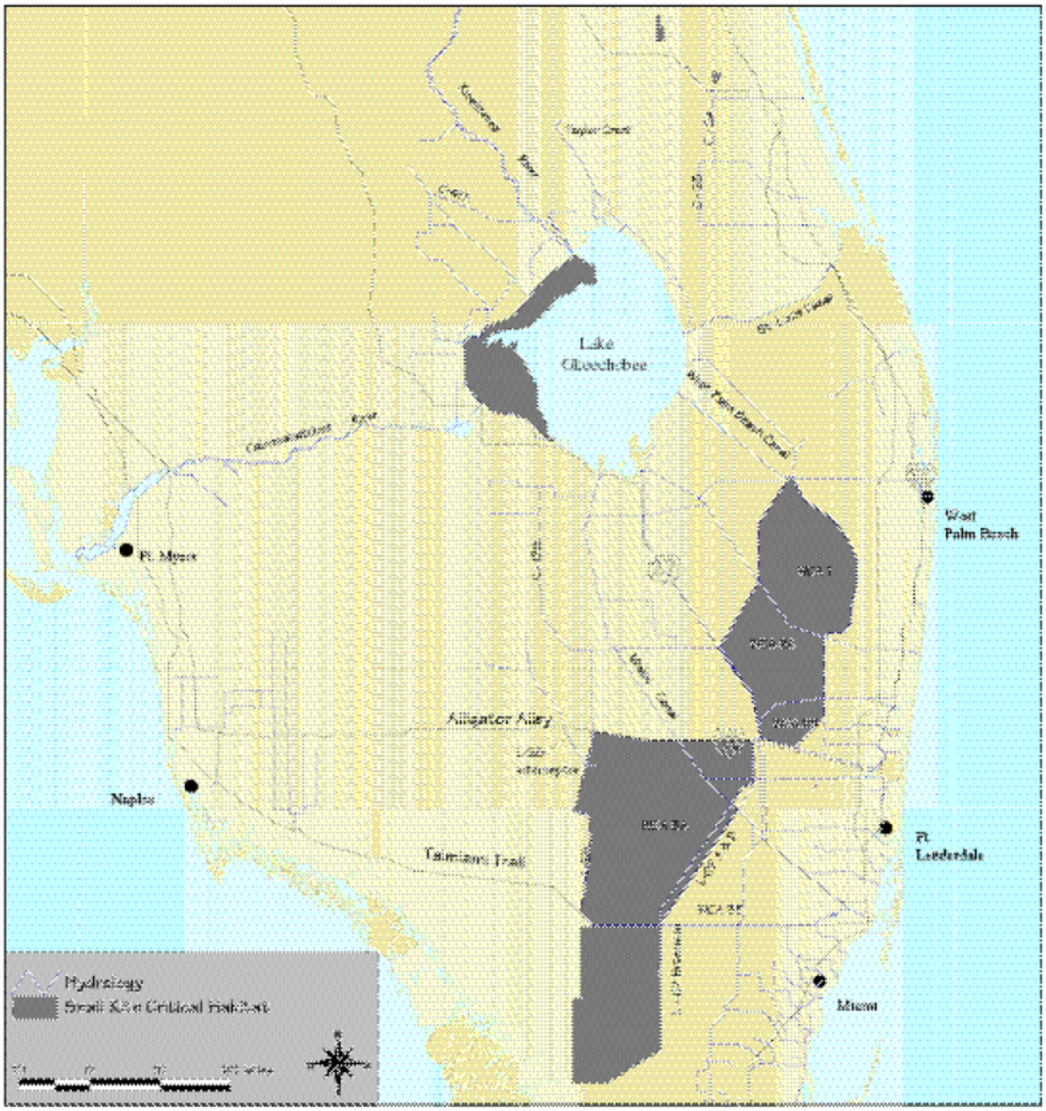
Nesting almost always occurs over water, which deters predation (Sykes 1987b). Nesting substrates include small trees (usually < 10 m in height), including willow, bald cypress, pond cypress, *Melaleuca*, sweetbay (*Magnolia virginiana*), swamp bay (*Persea borbonia*), pond apple and dahoon holly. Shrubs used for nesting include wax myrtle, cocoplum (*Chrysobalanus icaco*), buttonbush, *Sesbania*, elderberry (*Sambucus simpsonii*), and Brazilian pepper (*Schinus terebinthifolius*). Nesting also can occur in herbaceous vegetation, such as sawgrass, cattail, bulrush, and reed (*Phragmites australis*) (Sykes *et al.* 1995). Nests are more frequently placed in herbaceous vegetation around Lake Kissimmee and Lake Okeechobee during periods of low water when dry conditions beneath the willow stands (which tend to grow to the landward side of the cattails, bulrushes and reeds) prevent snail kites from nesting in woody vegetation. Nests constructed in herbaceous vegetation on the waterward side of the lakes' littoral zone are more vulnerable to collapse due to the weight of the nests, wind, waves, and boat wakes, and are more exposed to disturbance by humans (Chandler and Anderson 1974; Sykes and Chandler 1974; Sykes 1987b; Beissinger 1986, 1988; Snyder *et al.* 1989a). It is important to note that suitable nesting substrate must be close to suitable foraging habitat, so extensive areas of contiguous woody vegetation are generally unsuitable for nesting.

Roosting sites are also almost always located over water. In Florida, 91.6 percent are located in willows, 5.6 percent in *Melaleuca*, and 2.8 percent in pond cypress. Roost sites are in the taller vegetation among low-profile marshes. Snail kites tend to roost around small openings in willow stands at a height of 1.8 to 6.1 m, in stand sizes of 0.02 to 5 ha. Roosting in *Melaleuca* or pond cypress is in stands with tree heights of 4 to 12 m (Sykes 1985a).

Critical Habitat

Critical habitat was designated for the snail kite in 1977 and, since then, has not been revised. Critical habitat (Figure 2) includes the Arthur R. Marshall Loxahatchee NWR, WCA 2, portions of WCA 3, portions of Everglades NP, western portions of Lake Okeechobee, the Strazzulla and Cloud Lake reservoirs in St. Lucie County, and portions of the St. Johns Marsh in Indian River County. A complete description of the critical habitat is available in 50 CFR 17.95. Although snail kites have nested in several lakes (particularly East Lake Tohopekaliga, Lake Tohopekaliga, and Lake Kissimmee) in the headwaters of the Kissimmee River since the early 1980s, at the time of designation of critical habitat, potential habitat around these lakes was used only sporadically by snail kites, and was not included in the critical habitat.

Figure 2. Snail kite critical habitat.



Behavior

Non-breeding snail kites use communal roosts throughout the year in association with other birds, particularly anhingas (*Anhinga anhinga*), herons, and vultures. The snail kite can nest solitarily, but more often in uneven clusters, and often hunts in close proximity without defending a foraging territory. However, defense of feeding territories, outside of the breeding season, occurs more often than previously thought; typically, however, these birds display no territorial behavior and feeding areas overlap (Stieglitz and Thompson 1967; Sykes 1979, 1985a, 1987a, b, c; Beissinger 1983, 1984, 1988).

Courtship

Pair bonds are formed by a series of behaviors with each nesting. Males often begin construction of the nest prior to attracting a mate. Materials are gathered with feet or bill and are carried in the bill one piece at a time to the nest site. The nest is a bulky loosely woven structure of dry sticks and other dry plant material. Thirty-two species of plants are known to be used in construction, with sticks from willow and wax myrtle the most common material (Sykes 1987b). Snail kites often use green nest material, especially the upper lining that forms a cup for holding the eggs; this functions to insulate the otherwise porous structure of dry sticks. Males display either in the air or at perch near the chosen nest site. Aerial displays often include carrying a stick in the bill and vocalizing; these displays may include skydance or undulating flight, deep wing beats, pendulum, mutual soaring, tumbling, and grappling. The male may feed the female a snail or bring her a stick. In Florida, most pair bonds form from late November to early June. Once a pair bond is established, the female may spend time at or near the nest site and may assist the male in completing the nest (Beissinger 1987a, 1988; Sykes 1987c).

Reproduction

Copulation can occur from early stages of nest construction, through egg-laying, and during early incubation if the clutch is not complete. Egg laying begins soon after completion of the nest or is delayed a week or more. An average 2-day interval between laying each egg results in the laying of a three-egg clutch in about 6 days. The clutch size is 1 to 5 eggs, with a mode of three (Sykes 1987c, Beissinger 1988, Snyder *et al.* 1989a). Incubation may begin after the first egg is laid, but generally after the second egg (Sykes 1987c). In Florida, the incubation period lasts 24 to 30 days (Sykes 1987c). Incubation is shared by both sexes, but the sharing of incubation time between sexes varies among nests (Beissinger 1987b).

Hatching success is variable from year to year and between areas. In nests where at least one egg hatched, hatching success averaged 2.3 chicks/nest. The most successful months for hatching are February (19 percent), March (31 percent), and April (23 percent) (Sykes 1987c).

The breeding season varies widely from year to year in relation to rainfall and water levels. Ninety-eight percent of the nesting attempts are initiated from December through July, while 89 percent are initiated from January through June (Sykes 1987c, Beissinger 1988, Snyder *et al.* 1989a). Snail kites often renest following failed attempts as well as after successful attempts (Beissinger 1986, Snyder *et al*. 1989a), but the actual number of clutches per breeding season is not well documented (Sykes *et al.* 1995).

Foraging

The snail kite feeds almost exclusively on apple snails (*Pomacea paludosa*) in Florida. The snail kite uses two visual foraging methods: course-hunting, while flying 1.5 to 10 m above the water surface, or still-hunting from a perch. While course-hunting, the flight is characterized by slow wing beats, alternating with gliding; the flight path is usually into the wind, with the head oriented downward to search for prey. Snails are captured with the feet at or below the surface, to a maximum reach of approximately 16 cm below the surface. Snail kites do not plunge into the water to capture snails and never use the bill to capture prey. Individuals may concentrate hunting in a particular foraging site, returning to the same area as long as foraging conditions are favorable (Cary 1985). Capture rates are higher in summer than in winter (Cary 1985), with no captures observed at a temperature less than 10°C. Snail kites frequently transfer snails from the feet to the bill while in flight to a perch. Feeding perches include living and dead woody-stemmed plants, blades of sawgrass and cattails, and fence posts.

The snail kite is known to feed on the introduced snail *Pomacea bridgesi* (Takekawa and Beissinger 1983). On rare occasions, snail kites in Florida prey on small turtles (Sykes and Kale 1974, Beissinger 1988, Bennetts *et al.* 1988). Snail kites have also been observed feeding upon crayfish (*Procambarus* spp.) and a speckled perch (*Pomoxis nigromaculatus*) (Bennetts *et al*. 1994).

Migration

Snail kites in Florida are not migratory. They are restricted to South and central Florida. Snail kites are nomadic in response to water depths, hydroperiod, food availability, and other habitat changes (Sykes 1978, 1983a; Beissinger and Takekawa 1983; Bennetts *et al.* 1994). Radio-tracking and sighting of marked individuals have revealed that nonbreeding individuals disperse widely on a frequent basis (Sykes 1979, 1983a; Beissinger 1988; Snyder *et al.* 1989b; Bennetts and Kitchens 1992; Bennetts *et al.* 1994). Shifts in distribution can be short-term, seasonal, or long-term, and can take place between areas from year to year (Rodgers *et al.* 1988), between areas within a given nesting season (Beissinger 1986), within areas in a given nesting season, and within or between areas for several days to a few weeks (Sykes (1983a) noted that during colder winters, snail kites will shift their distribution more to the southern part of their range. As noted above, there is no evidence of movement between Florida and Cuba, but the possibility has not been ruled out (Sykes 1979, Beissinger *et al.* 1983).

Rearing

The mating system of snail kites is characterized by sequential polygamy (ambisexual mate desertion). Desertion occurs in years with abundant food supply, but not during drought years. The deserted mate continues to tend the nest until independence of the chicks, which is for another 3 to 5 weeks (Beissinger 1984, 1986, 1987b; Beissinger and Snyder 1987). Young are fed through the nestling period and after fledging until they are 9 to 11 weeks old (Beissinger and Snyder 1987, Beissinger 1988). Chicks assume food begging postures and vocalizations when the tending adult approaches the nest with a snail. As the chicks mature, the food progresses from pieces of torn snail fed bill to bill, whole snails removed from the shell and with operculum removed, to completely intact snails (Beissinger 1988). When food is scarce, larger siblings may dominate the food supply brought to the nest. While rearing young, the adults forage no more than six km from the nest (Beissinger and Snyder 1987), and generally less than a few hundred meters

Relationship to Other Species

Snail kites and limpkins (*Aramus guarauna*) both feed on apple snails; habitat partitioning occurs between the two species where they feed in the same areas.

Limpkins feed tactually in dense emergent or floating vegetation as well as in open patches (Snyder and Snyder 1969), while snail kites feed visually in open water with a range of water depths.

When nesting, snail kites drive off turkey vultures (*Cathartes aura*) within 20 to 30 m of the nest. Aggressive behavior by snail kites near nests has been observed directed against other birds, including black-crowned night herons (*Nycticorax nycticorax*), ospreys (*Pandion haliaetus*), red-shouldered hawks (*Buteo lineatus*), limpkins, and boat-tailed grackles (*Quiscalus major*) (Sykes 1987b). Red-shouldered hawks, fish crows (*Corvus ossifagus*), and boat-tailed grackles are known to drive snail kites from a perch (Sykes *et al.* 1995).

Snail kite eggs are taken by fish crows, boat-tailed grackles, rat snakes (*Elaphe obsoleta*), and raccoons (*Procyon lotor*) (Chandler and Anderson 1974; Beissinger 1986, 1988; Sykes 1987c; Snyder *et al.* 1989a). Nestlings are lost to rat snakes and cottonmouths (Beissinger 1986, 1988; Sykes 1987c; Bennetts and Caton 1988), despite the fact that snail kites select nest sites in flooded wetlands, which tends to make the nests less vulnerable to predation.

The ranges of the endangered wood stork (*Mycteria americana*) and Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) overlap the range of the snail kite. While hydrological conditions most favorable to one species may not be most favorable for another, all of these animals survived the hydrologic variability characteristic of the natural system. The reduced heterogeneity and extent of the present system make these species more vulnerable to natural and man-caused threats. Management actions may be required on a temporary basis to protect a particular species from a high risk of extinction, but long-term management goals should not be driven by protection of a single species, because such actions may threaten the sustainability of the entire ecosystem.

Status and Trends

When the snail kite was listed as endangered in 1967 (32 FR 4001), the species was considered to be at an extremely low population level. In 1965, only 10 birds were found, eight in WCA2A and two at Lake Okeechobee. A survey in 1967 found 21 birds in WCA2A (Stieglitz and Thompson 1967). On this basis, the snail kite was included in the first group of species to be listed under the Endangered Species Conservation Act, the predecessor to the current Endangered Species Act. The publication Threatened Wildlife of the United States (Bureau of Sport Fisheries and Wildlife 1973) cited the following as the status of the snail kite:

> Jeopardized because of the very small population and increasingly limited amount of fresh marsh with sufficient water to ensure an adequate supply of snails on which it depends for food.

Historic records of snail kite nesting include areas as far north as Crescent Lake and Lake Panasoffke in north-central Florida and as far west as the Wakulla River (Howell 1932, Sykes 1984). Several authors (Nicholson 1926, Howell, 1932, Bent 1937) indicated that the snail kite was numerous in central and South Florida marshes during the early 1900s, with groups of up to 100 birds. Sprunt (1945) estimated the population to be 50 to 100 individuals. The snail kite apparently plummeted to its lowest population between 1950 and 1965. By 1954, Sprunt estimated the population at no more than 50 to 75 birds

(Sprunt 1954). Stieglitz and Thompson (1967) reported eight birds in 1963 at the Loxahatchee NWR, 17 on the refuge and two at Lake Okeechobee in 1964, eight in WCA2A and two at Lake Okeechobee in 1965, and 21 in WCA2A in 1966. Limited resources were available at that time for researchers to reach potential snail kite habitats, and the resulting low level of survey effort may have biased these low snail kite population estimates. However, there is no doubt that the snail kite was severely endangered at that time and that its range had been dramatically reduced.

Sykes (1983b) mentioned two reports, by other observers, of lone snail kites at Lake Kissimmee in 1973 and 1980. Sykes (1984) reported the range of the snail kite in Florida, as of 1980, included the following areas: southwestern Lake Okeechobee (Glades County), portions of WCAs 1, 2B, and 3A (Dade, Broward, and Palm Beach counties), the Lake Park Reservoir (Palm Beach County), the northern portion of Everglades National Park just south of Tamiami Trail (Miami-Dade County) the Savannas (St. Lucie County), and the headwaters of the St Johns River (Indian River and St. Lucie counties). Sykes (1984) did not mention the two isolated reports at Lake Kissimmee. Beissinger and Takekawa (1983) report that 3 to 25 snail kites were observed on Lake Kissimmee and 6 to 32 were sighted on Lake Tohopekaliga in 1981-1982, and classified these among a number of “drought related habitats.” The first reported nesting of snail kites occurred on these two lakes during that period. Rodgers (1994) has continued to find significant nesting and foraging by snail kites in the Kissimmee Chain of Lakes into the mid-1990s, which he characterized as a reoccupying of a portion of the species’ historic range.

Prior to 1969 the snail kite population was monitored only through sporadic and haphazard counts (reviewed by Sykes 1984). From 1969 to 1994, an annual quasi-systematic mid-winter snail kite count was conducted by a succession of principal investigators. Counts since 1969 have ranged from 65 in 1972 to 996 in 1994. Bennetts *et al.* (1993, 1994) caution that the 1993 and 1994 counts were performed with the advantage of having numerous birds radio-tracked. This certainly influenced the total count, because radio-instrumented birds could be easily located and often led researchers to roosts that had not been previously surveyed. Bennetts and Kitchens (1997a) and Bennetts *et al.* (1999a) have analyzed these counts and have analyzed the sources of variation in these counts, including observer effects, differences in level of effort, and sampling error. This analysis provides a convincing argument that these data could provide a crude indication of trends, provided that all influences of detection rates had been adequately taken into account. The sources of variation should be recognized prior to using these data in subsequent interpretations, especially in attempting to determine population viability and the risk of extinction. Table 1 presents the annual count data for the period 1985 to 1994.

While acknowledging the problems associated with making year-to-year comparisons in the count data, some general conclusions are apparent. Lake Okeechobee apparently retains some suitable snail kite habitat throughout both wet and dry years. In contrast, kite use of WCA3A fluctuates greatly, with low use during drought years, such as 1991, and high use in wet years, such as

Table 1. Mid-winter Everglade snail kite survey, 1985-1994.

Location	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	10-yr. Mean
St. Johns Marsh	8	6	7	30	38	68	81	81	10	27	36
L. Kissimmee	38	28	42	33	73	61	49	38	38	46	45
L. Tohopekaliga	17	13	1	1	19	118	2	19	2	7	20
East L. Tohopekaliga	0	0	0	0	18	30	5	9	24	21	11
L. Okeechobee	108	71	94	175	122	83	146	216	113	129	126
WCA2A	1	1	0	4	11	20	14	42	1	0	9
WCA2B	16	58	4	48	0	0	10	2	32	142	31
WCA3A	170	353	117	166	166	13	7	113	345	470	192
WCA3B	24	13	11	9	0	1	2	2	10	11	8
Big Cypress NP	0	0	0	0	0	0	0	32	28	43	10
Everglades NP	1	1	6	10	3	1	3	67	16	29	14
The Pocket	7	9	19	9	3	0	20	11	89	1	43
Other sites	10	10	24	13	11	27	17	113	139	70	43
Total for Year	400	563	325	498	464	422	356	745	847	996	562

1994. However, we caution against using these figures as absolute values for shifts in habitat use or measures of changes in total population. Although sharp declines have occurred in the counts since 1969 (for example, 1981, 1985, 1987), it is unknown to what extent this reflects actual changes in population. Rodgers *et al.* (1988) point out that it is unknown whether decreases in snail kite numbers in the annual count are due to mortality, dispersal (into areas not counted), decreased productivity, or a combination of these factors. Despite these problems in interpreting the annual counts, the data since 1969 have indicated a generally increasing trend (Sykes 1979, Rodgers *et al.* 1988, Bennetts *et al.* 1994). The degree of this apparent increase in the snail kite's population needs to be confirmed with alternative methods of estimating population size.

Bennetts and Kitchens (1997a) found that radio telemetry is an effective, but costly, method for estimating survival of snail kites. They suggest that mark-resighting is an effective and statistically reliable method for determining survival and population size. The FWS endorses the proposal to replace the annual snail kite counts with the mark-resighting methodology. This will require a continued commitment to support this work to ensure that a sufficient number of birds are marked. As the number of marked birds increases over several continuous years of marking, the number of resightings should increase, and this will allow a population estimate with a reasonable level of precision.

It is difficult to identify any long-term trend in reproductive success, because of the considerable variability in nest success among years, locations, and local nest environments (Sykes 1979, 1987c; Beissinger 1986; Bennetts *et al.* 1988; Snyder *et al.* 1989a), but several of these researchers have attributed the variability to water levels. As noted above, part of this effect, particularly in the lakes, is attributed to differences in nest site selection (more herbaceous substrates in low-water years versus a higher proportion of woody substrates in high-water years). The basis of comparison is between high-water years versus low-water years, rather than within-year differences between water depth at nest sites. Drought may affect nesting success by depressing apple snail populations (Kushlan 1975, Beissinger and Takekawa 1983) and through increased access by terrestrial predators (Beissinger, 1986).

Collapse of nests constructed in herbaceous vegetation is also cited as a cause of increased nest failure during low-water years. This is because the water table is usually below the ground surface at willow heads and other stands of woody vegetation during drought, causing snail kites to nest in herbaceous vegetation, where the nests are more vulnerable to collapse. This effect is more prevalent in the lakes than in the Everglades. Weather causes great variability in nesting success; wind storms cause toppling of nests, particularly on Lake Okeechobee and Lake Kissimmee due to the long wind fetch across these large lakes. Cold weather can cause nest failure, either through decreased availability of apple snails or mortality of young due to exposure. Abandonment of nests before egg-laying is common, particularly during drought or following passage of a cold front. The overall fledging success to a nestling age of 6 weeks in the 1980 to 1993 period was 0.83 fledgling/nest or 0.29 fledgling/egg ($n = 776$ nests) (Sykes *et al.* 1995). Although considerable variability (due to natural and man-caused variation in water levels) should be expected in future years of monitoring, this may serve as a baseline to compare the relative productivity of the snail kite population.

The snail kite has apparently experienced population fluctuations associated with hydrologic influences, both man-induced and natural (Sykes 1983a, Beissinger and Takekawa 1983, Beissinger 1986), but the amount of fluctuation is debated. The abundance of its prey, apple snails, is closely linked to water regime (Kushlan 1975; Sykes 1979, 1983a). Drainage of Florida's interior wetlands has reduced the extent and quality of habitat for both the snail and the kite (Sykes 1983b). The kite nests over water, and nests become accessible to predators in the event of unseasonal drying (Beissinger 1986, Sykes 1987c). In dry years, the kite depends on water bodies which normally are suboptimal for feeding, such as canals, impoundments, or small marsh areas, remote from regularly used sites (Beissinger and Takekawa 1983, Bennetts *et al.* 1988, Takekawa and Beissinger 1989). These secondary or refuge habitats are vital to the continued survival of this species in Florida.

The principal threat to the snail kite is the loss or degradation of wetlands in central and South Florida. Nearly half of the Everglades has been drained for agriculture and urban development (Davis and Ogden 1994). The Everglades Agricultural Area alone eliminated 8,029 km^2 of the original Everglades, and the urban areas in Miami-Dade, Broward and Palm Beach counties have also reduced the extent of habitat. North of Everglades National Park, which has preserved only about one-fifth of the original extent of the Everglades, the remaining marsh has been dissected into shallow impoundments. The Corps of Engineers' Central and Southern Florida Project encompasses 46,600 km^2 from Orlando to Florida Bay and includes about 1,600 km each of canals and levees, 150 water control structures, and 16 major pump stations. This system has disrupted the volume, timing, direction, and velocity of freshwater flow.

The natural sheet flow pattern under which the Everglades evolved since about 5,000 years ago has not existed for about 75 years (Parker *et al.* 1955, Leach *et al.* 1972, Klein *et al.*1974). The loss of fresh water to seepage, flood control releases to tidal waters, and extraction for irrigation and urban water supply has led to saltwater intrusion in some portions of the former Everglades. Although the major drainage works completed conversion of wetlands to agriculture in the Everglades Agricultural Area by about 1963, loss of wetlands continues to the present at a slower, but significant, rate. In the entire State of Florida between the mid-1970s to the mid-1980s, 105,222 ha of wetlands (including marine and estuarine offshore habitats) were lost (Hefner *et al.* 1994); we do not have an estimate for the loss of freshwater wetlands specifically in central and South Florida in those years.

Degradation of water quality, particularly runoff of phosphorous from agricultural and urban sources, is another threat to the snail kite. The Everglades was historically an oligotrophic system, but major portions have become eutrophic. The concentration of total phosphorus in Lake Okeechobee almost doubled from 49 µg/L in 1973 to 98 µg/L in 1984 (Janus *et al.* 1990). Most of this increase has been attributed to non-point source runoff from agricultural lands north of the lake, in the Kissimmee River, Taylor Slough and Nubbin Slough drainages (Federico *el al.* 1981). Eutrophication also is a concern in the Kissimmee chain of lakes. Nutrient enrichment leads to growth of dense stands of herbaceous emergent vegetation, floating vegetation (primarily water hyacinth and water lettuce) and woody vegetation, which inhibits the ability of snail kites to find food (See also Habitat section above).

Regulation of water stages in lakes and the WCAs is particularly important to maintain the balance of vegetative communities required to sustain snail kites. This is discussed in the Management section of this account.

Shooting of snail kites has been cited in the early literature as a threat (Sprunt 1945; Stieglitz and Thompson 1967; Sykes 1978, 1979). Although waterfowl hunting, particularly on Lake Okeechobee, may lead to shooting of snail kites, there are no recent documented cases (J. Rodgers, GFC, personal communication 1995).

Contaminant analyses have been conducted on snail kites and apple snails, and all contaminant residues (DDT, DDD, DDE, dieldrin, PCBs, mercury, lead, and arsenic) have been found at low levels (Stickel *et al.* 1969, 1970, 1984; Lamont and Reichel 1970; Wiemeyer *et al.* 1980; Patee *et al.* 1981; Sykes 1985b; Sykes *et al.* 1995; Eisemann *et al.* 1997).

Demographic concerns appear to outweigh immediate genetic threats for the snail kite in Florida. Rodgers and Stangel (1996) performed electrophoresis on samples from 150 snail kite nestlings at four wetland sites: Lake

Kissimmee, Lake Okeechobee, WCA2B, and WCA3A. They found short genetic distances among snail kites at the four wetlands, suggesting little differentiation within Florida. Despite the historic reduction in the snail kite population to low levels, heterozygosity in the snail kites at these locations varied from 4.1 percent to 5.2 percent, which is within typical values for birds. If the snail kite population were to decline in the future, this study provides a baseline to determine if heterozygosity has been reduced. However, there is no immediate concern about reaching a genetic bottleneck.

Management

Water management actions in the Everglades and in the lakes are the most important human-controlled factors in survival and recovery of the snail kite. A balanced approach to water level management is required to maintain favorable habitat conditions for the snail kite. Nearly continuous flooding of wetlands for > 1 year is needed to sustain apple snail populations (Sykes 1979, Beissinger 1988). Prolonged drying of wetlands, especially in an impounded area with little variation in water depth, can cause the local depletion of apple snails. Snyder *et al.* (1989a) attributed poor reproductive success of snail kites in WCA3A in years following drought to a lag time between re-flooding and recovery of apple snails to levels that allow higher nesting success.

When low-water stages occur during the nesting season on Lake Okeechobee and the Kissimmee Chain of Lakes, snail kites frequently nest in the waterward edge of herbaceous vegetation, where nests are more vulnerable to collapse due to the inability of the vegetation to support the nest and the greater exposure to wind, waves, and boat wakes. The location of the nests closer to open water during periods of low water also exposes snail kites to a potentially greater level of human disturbance. A water stage of 4.42-4.57 m on Lake Okeechobee is recommended near the beginning of the snail kite nesting season during most years (Sykes *et al.*1995, Rodgers 1996, J. Rodgers, GFC, personal communication 1996). The water stages can be allowed to recede gradually during the February through May period, to allow for successful foraging by wading birds, but should not be allowed to decline rapidly. However, prolonged periods (1 or 2 years) of water stages over 4.57 m are considered adverse to maintaining marshes in the littoral zone of Lake Okeechobee. Extended periods of high-water stages in Lake Okeechobee will drown out vegetation in the littoral zone. The lake is surrounded by a levee; above a water elevation of 4.57 m, water begins to rise against the levee, and there is no opportunity for marsh vegetation to expand to higher ground elevations. Rodgers (GFC, personal communication 1996) has initiated a similar analysis intended to correlate water stages in Lake Kissimmee with successful nesting. However, it should be noted that Lake Kissimmee is not surrounded by a levee, and although extended high-water stages might temporarily disrupt existing vegetation patterns, wetland vegetation could adjust in the longer term by shifting landward to higher ground elevations. In impounded areas, such as the WCAs and the St. Johns marshes, extended periods of high water can drown out willow or other woody vegetation. The availability of woody vegetation often results in higher fledging success through reduced nest collapse, which is more prevalent in non-woody substrates.

Lake Kissimmee and the surrounding lakes have been restricted to narrow water regulation schedules when compared to their natural degree of variability in years prior to regulation. Overly dense concentrations of vegetation begin to grow in the littoral zone, which restricts water flow and leads to the buildup of organic sediment in bands around the lakes' shorelines. This pattern is harmful to the overall productivity of the lakes. Ideally, lake management schedules throughout the Kissimmee Chain of Lakes should be modified to resemble the degree and timing of water level fluctuations in the pre-management period. However, water regulation schedules are now restricted by the proximity of floodable structures to shorelines and by water supply considerations.

Because these societal constraints make it impractical to fluctuate water levels according to historic cycles of flooding and drought, the SFWMD and the GFC have proposed periodic extreme drawdowns, with or without physical removal of organic sediment. Drawdowns were conducted on Lake Tohopekaliga in 1986 and East Lake Tohopekaliga in 1990. Snail kites did not resume nesting after the 1986 drawdown at Lake Tohopekaliga until 1990. The drawdown at East Lake Tohopekaliga caused the abandonment of 10 of 12 nests in 1990 (Rodgers 1994). The reason for the delay in resumption of nesting after the 1986 drawdown at Lake Tohopekaliga is not fully understood. However, snail kites have returned to nest in that lake in recent years, so the impact appears to be temporary. The loss of snail kite nests at East Lake Tohopekaliga in 1990 apparently was caused by the inability to remove the water quickly enough to below the level of the waterward edge of the littoral marsh before snail kites began to nest. Emergency dredging of an outlet canal was required to accelerate the drainage of water beyond the edge of the marsh. Lake Kissimmee was drawn down 1.5 m below its normal regulation schedule in 1977 and again in 1996. No recent snail kite nesting occurred on Lake Kissimmee prior to 1982. In 1996, dredging across a shoal occurred prior to commencement of the drawdown to speed up the drainage. Lake Kissimmee water stages were drained quickly enough before February 1996 such that snail kites did not attempt to nest there; presumably, snail kites dispersed to other suitable areas to nest. Snail kites returned to nest in Lake Kissimmee in 1997 and 1998, following the 1996 drawdown.

With adequate planning, extreme drawdowns can apparently be carried out without adversely affecting the snail kite and can enhance foraging conditions by opening up the dense vegetation. Any restrictions preventing rapid drainage of water need to be removed in advance. To date, the FWS has recommended that drainage should be initiated immediately after the threat of hurricanes has passed (around November 30) and that the water should be lowered beyond the extent of herbaceous vegetation prior to February 1 to discourage nesting of snail kites in areas where nests are likely to collapse. However, recent research by Darby *et al.*(1997) indicates that early drying may be far more detrimental to apple snail populations (and by extension, detrimental to snail kites) than the incidental take of snail kite nests that early drying is intended to avoid. Darby *et al.*(1997) suggest that the adverse impact on apple snails is lessened when drying occurs after the snails have completed their reproductive cycle and the young are of sufficient size to withstand a drying event. Not suprisingly, this point is "normally" reached during late May or June, the time that the natural system reached its minimum water levels. Further research on apple snail biology and the effects of the timing of drying events on snail kite nesting is needed to provide water managers guidance on the timing of intentional drawdowns that will maximize the long-term benefits on habitat structure while minimizing the short-term adverse impacts on snail kites and apple snails.

Anthropogenic drying of snail kite habitat in one watershed (*e.g.* St. Johns Marsh) should not coincide with natural drying in another watershed (*e.g.* Everglades). Although long-range prediction of drought and wet cycles is still not exact, consideration of the periodicity of these cycles should be factored into planning for periodic drying of managed areas. A strong correlation between the *El Niño*-Southern Oscillation (ENSO) cycle and precipitation in Florida was reported by Hanson and Maul (1991). Zhang and Trimble (1996) used three indicators of global climate cycles (sunspot number, geomagnetic activity, and the Southern Oscillation Index) in a neural network computing environment to predict inflows to Lake Okeechobee. Neidrauer *et al.* (1997) suggest that a combination of these indices can be used in water management decisions for Lake Okeechobee, based on a 6-month inflow forecast. These models should be refined and further tested, and as suggested by Zhang and Trimble (1996), the model's forecast horizon should be extended to determine how reliably it can predict longer-term shifts in rainfall patterns. The FWS recommends that this be based not only on inflows to Lake Okeechobee, but also be calibrated against other gages in the C&SF system. Because strong *La Niña (*conditions oposite to *El Niño*) conditions are generally associated with drought in Florida (Zhang and Trimble 1996), these indices may be useful in planning several years into the future to reduce the probability of human-caused drawdowns in one watershed coinciding with drought in another watershed. Human-caused drawdowns might be most adverse to the snail kite at the onset of multiple-year droughts, because it may be difficult to refill lakes or marsh impoundments during the following years, and the snail kite will have reduced opportunity to find suitable habitat.

Reduction of nutrient loading to marshes is needed to slow the growth of dense vegetation which hampers efficient foraging by snail kites. Efforts to reduce nutrient loading are being conducted to benefit the South Florida Ecosystem as a whole, and will have benefits to a number of fish and wildlife species in addition to the snail kite. Best Management Practices (BMPs) have been effective in reducing nutrient input to Lake Okeechobee from the Kissimmee River, Taylor Slough, and Nubbin Slough drainages. BMPs are included in implementation provisions of the Everglades Forever Act of 1994 (Chapter 373.4593 FS), as are the construction of Stormwater Treatment Areas. More effort needs to be directed at identifying and rectifying problems with nutrient inputs to the peripheral habitats so critical to the snail kite during drought.

Control of aquatic weeds has probably improved foraging conditions for the snail kite in a few localized areas by opening up dense growths of water hyacinth, water lettuce, and *Hydrilla.* However, spraying should not occur near snail kite nests located in non-woody species (*e.g.*, cattail, bulrush). The SFWMD, the GFC, and the DEP have cooperated in closing areas to herbicide spraying around snail kite nests, which reduces the risk of nest collapse in Lake

Okeechobee and Lake Kissimmee. However, more research is needed on the long-term effects of the herbicides being used on the aquatic food web in general, and particularly apple snails with respect to snail kites.

Nest baskets have been used effectively to reduce the collapse of nests in herbaceous substrates along the northwestern shoreline of Lake Okeechobee (Sykes and Chandler 1974). Similar nest supports have been used by GFC on Lake Tohopekaliga and East Lake Tohopekaliga. Although use of nest baskets may be a useful management technique in specific areas and instances (for example, to protect nests during a drawdown), their use on a routine basis is now considered to provide limited benefits relative to the intensive effort required (R. Bennetts, University of Florida, personal communication 1996; J. Rodgers, GFC, personal communication 1996).

Because snail kites use habitats with long hydroperiods, fire is not normally considered a management concern. However, fire is a natural component in the ecology of the Everglades and all of South Florida, and it is reasonable to expect that intense fires occurred historically during periods of drought in the snail kite's habitat. Intense fires that burn peat can transform habitats in the Everglades; dense sawgrass marshes having heavy fuel loads can be converted into a spikerush (*Eleocharis*) marsh, which will not carry fire for many years (Craighead 1971, Hoffman *et al.* 1994). Although such a fire would most likely eradicate apple snails from a particular location, its conversion to a spikerush marsh would, following recolonization by apple snails, make the area more suitable for foraging by snail kites. Prescribed burning could be implemented in conjunction with the intentional drawdowns mentioned above and in selected areas during drought.

The challenge for land managers is that intense fires are more difficult to control. Peat fires can smolder for weeks after initial passage of the fire (Craighead 1974, Robertson 1955); it may be difficult to prevent such fires from entering tree islands and hammocks, which may be of concern to managers if these areas are not the intended targets of the burn. Monitoring of vegetation, apple snails, and snail kite foraging in test plots before and after prescribed burns would provide useful information for refining fire management practices. Use of fire as a management tool in lakeshore environments may be more predictable and desirable than in the Everglades, where muck fires are considered to be damaging to tree island habitats and probably contributing to invasion of cattails.

Some authors have emphasized the importance of the availability of suitable habitat during periods of drought, which were thought to be a limiting factor in the population (Beissinger 1986, Sykes 1987b). Drainage of Florida's interior wetlands has reduced the extent and quality of habitat for both the snail and the kite (Sykes 1983b). Also, the kite nests over water, and nests become accessible to predators in the event of unseasonal drying (Beissinger 1986, Sykes 1987c). In dry years, the kite depends on water bodies which often are suboptimal for feeding during periods of normal rainfall, such as canals, impoundments, or small marsh areas, remote from regularly used sites (Beissinger and Takekawa 1983, Bennetts *et al.* 1988, Takekawa and Beissinger 1989). Beissinger and Takekawa (1983) and Takekawa and Beissinger (1989) divided snail kite habitat into “primary,” secondary” and “drought-related” areas. Bennetts (University of Florida, personal communication 1996) disagrees with characterizing any particular area into those categories; he believes that snail kites spread the risk of fluctuating habitat conditions by their ability to move long distances across the landscape within a “network” of habitats. Bennetts and Kitchens (1997b) hypothesize that the spatial extent and heterogeneity of habitat quality throughout the snail kite’s range buffers the risks that may be posed by droughts, because the spatial extent and duration of drought conditions will vary across the species’ range. Protection of both larger and smaller wetlands in several subregions (St. Johns Marsh, Kissimmee Chain of Lakes, Lake Okeechobee, Loxahatchee Slough, and Everglades/Big Cypress) is required to maintain this spatial heterogeneity and spatial extent. Because the 1992 to 1995 duration of Bennetts’ study did not include a period of drought, continued radio tracking of snail kites during a drought will be necessary to confirm this hypothesis.

Bennetts *et al.* (1988) found that snail kites nesting in WCA3A used wetlands having multi-year hydroperiods ranging from about 84 percent to 99 percent. However, Bennetts and Kitchens (1997a) have emphasized that foraging snail kites use a heterogeneous mosaic of wetlands. Snail kites will forage in shorter hydroperiod portions (wet prairies) within larger areas of longer hydroperiod (predominance of slough or lacustrine communities). Snail kites will also forage in smaller sloughs within areas that are primarily wet prairies. Therefore, in defining the desired future condition of the WCAs following hydropattern restoration, one must recognize the importance of a heterogeneous landscape within wetlands of relatively long (>85 percent) average hydroperiod. One must also acknowledge that these areas will dry out periodically. In evaluating the effects of these drying events on the demography of the snail kite, one must consider the average interval between drying events, their duration, and their spatial extent. Localized drying events are thought to have little adverse effect on the snail kite population, but droughts across the region extending from the St. Johns Marsh and the Kissimmee Chain of Lakes to the southern Everglades are likely to have adverse effects, particularly if the droughts occur in 2 or more consecutive years (Bennetts and Kitchens 1997a, 1997b).

Another factor to be considered in evaluating restoration of the WCAs is water depth. The compartmentalized system of WCAs differs from the natural system in at least two ways. First, increasing water flows in the natural system resulted in spreading of water across the landscape. In the managed system, water is confined within levees; increased water volumes result in water depths greater than those found in the natural system. Second, the levees surrounding the WCAs result in over-drained conditions at the upstream northern ends, and deeper water accumulation at the southern ends of the WCAs. The duration of these deep water conditions behind the levees is artificially prolonged relative to historic conditions (Gunderson and Loftus 1993). The appropriate restoration target for major portions of the WCAs is a heterogeneous wetland having a prolonged hydroperiod over most of the area, but without extended periods of deep water.

Another factor in restoration of the WCAs that will affect the habitat conditions for the snail kite and a variety of Everglades fauna is the effect of hydropattern restoration on growth of cattails. Rehydration of currently drained portions of the WCAs, such as northern WCA3A, will most likely result in growth of cattails, due to elevated phosphorus levels in the soil. The extent of the affected area and the time period that the cattail stands will persist is currently being debated. This effect must be considered in predicting habitat conditions in the WCAs following hydropattern restoration.

The Everglade snail kite population is now considered more resilient than previously thought to natural climatological fluctuations, but the resilience of kites to human-induced changes is less certain (Bennetts *et al.* 1994). The species is adapted to "boom and bust" cycles, and any consideration of recovery must be based on long-term (at least 5- to 10-year) averages in population levels and/or reproductive success. Radio telemetry indicates that snail kites use a broader network of wetland habitats than was previously recognized. Additional research is needed on survival following periods of drought. Previous opinions regarding the amount of mortality following drought may have been biased by lack of knowledge about the full range of dispersal of the species; mortality may have been overestimated because widely dispersed individuals were living in habitats not regularly searched (Bennetts *et al.* 1999a; Valentine-Darby *et al.* in prep.). Despite the previously mentioned problems in interpreting the annual counts, the general consensus is that the snail kite population has been at least stable since 1969, and has likely increased, on average, within a broad range of fluctuation (Bennetts *et al.* 1999a).

Anticipated restoration projects should benefit the Everglade snail kite. The FWS has predicted that the Kissimmee Headwater Lakes Revitalization Project and the Kissimmee River Restoration will benefit a variety of fish and wildlife, including the snail kite. Restoration of the Everglades should provide opportunities for recovery of the kite, but Bennetts *et al.* (1994) point out:

> Undoubtedly, compromise solutions will need to be identified in order to accommodate increasing demands for water, habitat for snail kites, and flow systems that will maintain the unique Everglades environment. Almost any proposed solution to the problems of the Everglades and the kite will meet with opposition from individuals or groups with differing objectives or viewpoints. Current restoration planning in the southern Everglades is no exception. Arguments can easily be made for restoring longer hydroperiods in the historic Shark River Slough. It is likely that the deeper areas of the slough and other pools within the Everglades basin were once used extensively by kites. It can also be argued, however, that the impoundments of the WCAs now serve this role and that substantial reductions in hydroperiod in these impoundments may, at least in the short term, have a negative impact on kites. It is not even clear that substantial reductions in hydroperiod would occur in the specific areas that are used most heavily by kites. What is certain is that whatever plans are adopted, they will not be unopposed.

It is appropriate to cite the fate of the WCAs as an example of likely controversy in Everglades restoration; the Central and Southern Florida Project Comprehensive Review Study (C&SF Restudy) must carefully consider the design of hydropattern restoration in the WCAs.

Another controversial issue not addressed in the above quotation is the management of water stages in Lake Okeechobee with respect to the downstream portions of the C&SF system. Opinions vary on the degree to which the ecological values of the littoral zone of Lake Okeechobee (which includes a portion of the Everglade snail kite's critical habitat) can be sacrificed to create increased water storage capacity to drive restoration of the Everglades. This and possibly many other pivotal issues must be evaluated through the C&SF Restudy.

A balanced restoration plan for the Everglades must be found that will mimic the hydrologic variation and other habitat characteristics of the natural system. We believe the restoration can be planned and carried out without conflicts among the recovery goals for listed species.

Because of the particular habitat requirements of the snail kite, the loss of spatial extent of the wetlands throughout the species' range, and the possibility of back-to-back catastrophic events, it may not be possible to remove the species entirely from protected status. {We believe the prognosis for recovery of the snail kite from endangered status to threatened by 2020 is good.}. The recovery goal should not be based solely on population estimates, but should also include measures of survivorship and fecundity. Reclassification to threatened could occur with a minimum population size of 650 individuals over a 10-year period, with a multi-year average finite rate of population change (λ, lambda) greater than or equal to 1. The breeding population should be distributed over enough individual "colony" sites and over a broad enough total area to ensure survival through catastrophic events, but until more precise stochastic modeling is available, we do not have a specific recovery criterion of this type. If the species meets these goals for reclassification as threatened, the FWS would then consider requirements for de-listing.

Recent biological studies of the Everglade snail kite indicate the species is highly mobile and adaptable, which might support a more optimistic view of the status and prognosis for the snail kite. However, recent information on the apple snail indicates that the species suffers high post-breeding mortality each year regardless of the hydrological condition, and may suffer poor recruitment of juvenile snails in the year following a drydown (P. Darby, University of Florida, personal communication 1997). Apple snails are stranded by receding water levels, even along a lake shore, where presumably snails could migrate to the remaining pool. Adult snails survived an average of 4 weeks under drydown conditions at the St. Johns Marsh (Darby *et al.* 1996a) and at Lake Kissimmee (Darby *et al.* 1996b, 1997). The vulnerability of apple snails to localized severe population declines must be considered in water management policy and in assessment of threats to the snail kite.

Continued monitoring of the snail kite population will be needed before, during, and after implementation of the many elements presently under consideration that together will result in restoration of the South Florida Ecosystem. Among the factors favoring the selection of the snail kite as a key indicator of success are the following:

a. The snail kite is an endangered species and is reasonably familiar to a large segment of the public.

b. In the United States, the snail kite is found only in the central and South Florida Ecosystem, making it a suitable biological symbol for the ecosystem as a whole.

c. The snail kite is a species adapted to the variable climatic conditions in central and South Florida, and the Everglades in particular. Water management in the restored ecosystem must be flexible enough to ensure survival and recovery of the snail kite through climatological extremes. Successful recovery of the snail kite should be included as one of several indicators of restoration of the dynamic variability of the long hydroperiod wetlands within South Florida.

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Recovery for the Everglade Snail Kite

Rostrhamus sociabilis plumbeus

Recovery Objective: RECLASSIFY to threatened once recovery criteria are met.

Recovery Criteria

The objective of this recovery plan is to restore the Everglade snail kite to a stable, secure and self-sustaining status allowing the reclassification of the species from endangered to threatened under the ESA. Due to the limited distribution of the species, its specialized ecological niche, and the irreversible loss of a significant portion of the Kissimmee/Okeechobee/Everglades watershed, the FWS believes it unlikely that the snail kite will ever be elevated above the threatened status. This objective will be achieved when: the 10-year average for the total population size is estimated as greater than or equal to 650, with a coefficient of variation less than 20 percent for the pooled data over the 10-year period; no annual population estimate is less than 500 in the 10-year period; the rate of increase of the population to be estimated annually or biannually, and over the 10-year period, will be greater than or equal to 1.0, sustained as a 3-year running average over 10 years; the feeding range of snail kites will not decrease from its current extent, including as a minimum, the St. Johns Marsh, the Kissimmee Chain of Lakes, Lake Okeechobee, Loxahatchee Slough, Loxahatchee NWR, all of the water conservation areas, Everglades National Park, Big Cypress National Preserve, Fakahatchee Strand, Okaloacoochee Slough, and marshes surrounding the Corkscrew Swamp; and snail kite nestings regularly occurs over the 10-year period in the St. Johns Marsh, Kissimmee Chain of Lakes, Lake Okeechobee, and at least one of the present compartments of the water conservation areas.

The FWS recognizes that the snail kite is a resilient species in a highly changeable environment and that to some degree a “boom and bust” population fluctuation is characteristic of the species. The above criteria for reclassification to threatened are flexible enough to allow substantial declines in population within a given year, while setting goals over a 10-year period. The global climate fluctuations that are correlated with cycles of flood and drought in South Florida occur on a periodicity of 9 to 14 years (Zhang and Trimble). 1996. The use of 650 individuals as a criterion for recovery needs to be supported by improved techniques of Population Viability Analysis (**H3.1**, below). Beissinger (1995) suggested that snail kite populations become viable above a minimum population size of 300 individuals, but this PVA needs to be re-evaluated based on the more precise population estimates anticipated from mark/resight techniques.

Species-level Recovery Actions

S1. Maintain information on the distribution and status of the Everglade snail kite. The present distribution of the snail kite and its recent history of distribution are well documented. Distribution must be monitored in the future. Radio-telemetry has provided information on movement of individuals within the species’ range, but would not be continued on a routine basis.

S1.1. Estimate population size, through mark/resighting of banded individuals. This method is considered technically superior to counts of snail kites at index locations because it allows estimation of the proportion of kites not observed and is less subject to certain errors, such as those caused by differences in experience among individuals conducting the counts and by year-to-year differences in the level of effort. Annual counts of snail kites at index locations do not provide a reliable estimate of population size, nor do they allow estimation of the coefficient of variation (Bennetts *et al.* 1999a), which is an integral part of the recovery criteria expressed above. An ongoing pilot study by Victoria Dreitz indicates that the mark/resighting techniques used by Bennetts *et al.* (1999b) to estimate survival is promising as a methodology to estimate population size (R. Bennetts, Station Biologique de la Tour du Valat, personal communication 1998). This method requires considerable commitment of resources to annually mark sufficient numbers of snail kites; this level of funding and personnel may be difficult to sustain in the long term.

S1.2. Continue surveys of nesting effort and success at the principal breeding areas. Monitoring of breeding should continue at principal breeding sites, such as the St. Johns marsh, Kissimmee Chain of Lakes, Lake Okeechobee, and Water Conservation Areas 2 and 3.

S1.3. Expand and refine existing information on movements and distribution of the snail kite, particularly changes attributable to drought. Radio telemetry has provided information on movements of snail kites within South Florida; it is expensive and labor-intensive. It may be logistically impractical to design and implement a radio telemetry study quickly enough to respond to a specific drought event. Additional radio telemetry studies should be initiated only to test specific hypotheses that cannot be tested through other methods.

S1.4. Organize and maintain a network of biologists to report Everglade snail kite sightings to a clearinghouse. In the past, information on snail kite sightings was requested from the general public, which led to unreliable reports. However, professional biologists can often provide reliable and useful sighting information, particularly when snail kites are dispersed during droughts.

S2. Protect and enhance the existing population. Because of the nomadic nature of snail kites, they integrate habitat conditions over a large geographic area and are dependent on natural and human-caused environmental conditions throughout the South Florida Ecosystem. The majority of management activities to protect and enhance the snail kite population must occur at an ecosystem level (see below). Actions at the level of the individual or groups of individuals included in the 1986 recovery plan are now considered extremely labor-intensive and would have limited benefit to the species. Such activities include installation of artificial perches and installation of artificial nest structures. Limited experimentation with captive propagation has shown it to be difficult, and the snail kite population is now considered more resilient and not currently in need of such emergency measures. Only two species-specific recovery tasks in this category are considered necessary at this time:

S2.1. Update the critical habitat designation for the Everglade snail kite. Critical habitat has not been modified since its original designation in 1977 and is in need of revision. Earlier publications correctly pointed out the importance of Lake Okeechobee and the Everglades as snail kite habitat. However, more recent information suggests that although restoration of Lake Okeechobee and the Everglades must be compatible with snail kite recovery, greater emphasis must be placed on larger wetland systems in the species, range and on smaller peripheral wetlands. Nesting of snail kites in Lake Kissimmee, Lake Tohopekaliga, and East Lake Tohopekaliga since the early 1980s is a significant change that should be considered in revising critical habitat. Although a portion of the St. Johns Marsh south of State Road 60 is included in the current critical habitat, the principal areas being used by snail kites north of that highway need to be included. Other areas outside of the Okeechobee/Everglades basin that should be considered for designation are the Big Cypress National Preserve and marshes surrounding the Corkscrew Swamp.

S2.2. **Use provisions of section 7 of the ESA to protect the Everglade snail kite**. Water management of the COE's C&SF project is critical to the survival and recovery of the snail kite. The SJRWMD and SFWMD are involved with the COE in water management decisions subject to section 7 consultation. The FWS needs to provide conservation recommendations to enhance habitat conditions for the snail kite throughout the C&SF project. Specific guidance should include water regulation of the St. Johns Marsh impoundments, Kissimmee Chain of Lakes, Lake Okeechobee, Loxahatchee NWR, Water Conservation Areas 2 and 3, Everglades National Park and Big Cypress National Preserve.

S3. Continue or initiate research on the life history of the Everglade snail kite.

S3.1. **Expand information on survival of juvenile and adult snail kites.** Although snail kites have been banded for decades, intensive banding for estimation of survival has occurred only since 1992. Intensive banding must be continued through long-term meteorological cycles to estimate the effects of drought on snail kite survival. This is a key unknown element in the life history of the species that has significance in assessing opportunities for recovery and probability of extinction relative to natural cycles and water management policy.

S3.2. **Develop and validate a snail kite model that can evaluate both stochastic natural events and human-caused modifications of habitat throughout the species' range.** An individual-based spatially explicit snail kite model is being developed as part of the Across Trophic Level System Simulation (ATLSS). The geographic scope of ATLSS does not include the Kissimmee Chain of Lakes or the St. Johns Marsh. While complete modeling across all trophic levels will not include these northern areas, they should be appended to the boundaries of the model at levels dealing with snail kite dispersal, reproduction, and survival, to model the snail kite population as a whole.

S3.3. **Investigate the genetic variability of the Everglade snail kite.** Analysis by electrophoresis has not indicated the potential for a genetic bottleneck in the snail kite population. Although additional genetic research does not appear to be a high recovery priority, analysis of heterozygosity using DNA analysis would be desirable.

S4. Monitor trends in Everglade snail kite population and levels of contaminants.

S4.1. **A mark-resighting effort will provide estimates of both total population size and survival.** Because marking of birds is most often conducted at nesting aggregations, routine monitoring has included counting the total nests and determining nesting success. However, there is general agreement among researchers that changes in the kite population is more sensitive to survival than reproduction. Although researchers should continue to monitor reproduction at the major nesting areas, the emphasis of long-term monitoring should be estimation of total population size and survival.

S4.2. Conduct periodic monitoring of contaminant levels in apple snails and Everglade snail kites. The limited sampling of apple snails and Everglade snail kites to date has emphasized the potential risks of methylmercury contamination. Although this limited sampling has not suggested an immediate threat to snail kites from mercury contamination, additional studies should be conducted on a regular basis in the long term (approximately 5 to 10 year intervals). Apple snails can be collected specifically for analysis, whereas analysis of snail kites is generally limited to occasional discovery of dead specimens or analysis of shed feathers. More emphasis must be placed on detection of herbicides in both apple snails and snail kites. Snail kites can ingest apple snails containing herbicides (such as bypiridyls), applied in agricultural fields and transported by runoff into the aquatic food web, or herbicides (such as fluoridone), applied to control aquatic vegetation.

S5. Increase public awareness about Everglade snail kites. A snail kite brochure has been distributed via donations from the St. Johns River Water Management District, Palm Beach County Solid Waste Authority, and Florida Power and Light Co. This material should be reviewed, updated, and published as a second edition. The GFC is developing signs to inform ORV users at launching sites along I-75 about responsible ORV use, including protection of the snail kite. Funding is needed to produce and install similar signs informing the public about protection of snail kites at boat launching sites in the Kissimmee Chain of Lakes, St. Johns marsh, and Lake Okeechobee. Information on the biology of the snail kite and the threats it faces should be included in middle school and high school curricula.

Habitat-level Recovery Actions

H1. Prevent degradation of existing Everglade snail kite habitat.

H1.1. Plan and carry out periodic extreme drawdowns of individual lakes on a rotational basis in the Kissimmee Chain of Lakes. These projects involve extensive cooperation and cost sharing among a number of agencies, often including simultaneous lake management activities, such as muck removal, discing, burning, and aquatic weed control. Water levels must be lowered early enough to avoid initiation of nesting by snail kites and thus prevent incidental take of nests. Cooperation is needed between the water management districts to ensure that no more than one human-caused drawdown occurs simultaneously among the principal habitats for the snail kite.

H1.2. Control or remove exotic vegetation in wetlands. The long-term direct and secondary effects on snail kites or apple snails of spraying aquatic weeds are poorly known. Research on these long-term impacts should be initiated. Current control programs are mainly directed at *Melaleuca quinquenervia*, *Schinus terebinthifolius*, and *Hydrilla verticillata.*

H1.3. Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes. Burning can be accomplished under natural low water conditions or in conjunction with the extreme drawdowns mentioned above. Although controlled burns with the presence of surface water or saturated soils may be beneficial, it would probably not be practical or advisable to attempt to change plant communities through uncontrollable muck fires in the Everglades.

H1.4. Ensure that information on wetlands of importance to Everglade snail kite nesting and feeding is considered in review of regulatory permits. The COE and DEP are preparing GIS data layers that will be routinely available to regulators. Information on snail kite nesting areas and other important habitats needs to be included.

H1.5. Prevent cultural eutrophication of lakes and marshes. Addition of nitrogen and phosphorus from agricultural and residential areas is accelerating eutrophication of Florida's lakes and marshes. Long-term degradation of habitat caused by eutrophication leads to buildup of organic muck, overly dense herbaceous and shrubby vegetation, and oxygen depletion. Moderate eutrophication may not harm the snail kite, but in the long term, both the abundance of apple snails and the ability of snail kites to locate snails in dense vegetation is reduced. Reduction of nutrient inputs at the source needs to be addressed by best management practices, including rates of application and stormwater retention on site. Construction and maintenance of wastewater treatment plants must be improved to control discharge of nutrients in lakes and streams.

H1.6. Evaluate effects of Lake Okeechobee's regulation schedule on Everglade snail kite habitat. Observations since 1992 suggest a general degradation of nesting habitat in the littoral zone of Lake Okeechobee from the loss of willows in nesting areas (R. Bennetts. Station Biologique de la Tour du Valat, personal communication 1998). Modification of the regulation schedule to increase water storage could cause additional loss of vegetation in the littoral zone, which would be adverse to the ecology of the lake as a whole, including the snail kite. Conversely, extending periods of low water in the lake through a combination of agricultural, urban, and environmental restoration demands would also be detrimental to the snail kite. Evaluation of proposed changes to water regulation in Lake Okeechobee must consider the effect on the snail kite in the context of protection of all the fish and wildlife resources in the lake and elsewhere in the C&SF system. Long-term monitoring of changes in wetland vegetation in relation to water management practices needs to be conducted throughout the C&SF system as indicators of habitat suitability for snail kites, rather than relying on short-term changes in snail kite population, distribution, or reproduction.

H2. Restore areas to suitable habitat.

H2.1. Reverse the expansion of cattails as a dominant plant in portions of the Everglades through reduction in nutrient loading from agricultural and urban sources. Portions of the Water Conservation Areas and the Holey Land WMA are now relatively unsuitable habitat for the snail kite due to growth of dense monocultures of cattails. The Everglades Construction Project and additional treatment areas (such as portions of the Water Preserve Areas in the C&SF Restudy) need to be implemented. The influence of nutrient levels bound in the soil on the persistence of cattails after water quality improvement needs to be predicted and then determined empirically.

H2.2. Construct and operate the Modified Water Deliveries to Everglades National Park and C-111 projects. These projects will restore flow patterns to northeast Shark River Slough and other portions of the southern Everglades, enhancing Everglade snail kite habitat.

H2.3. **Through the C&SF Restudy, investigate, plan, and carry out restoration projects in the Kissimmee/Okeechobee/Everglades watershed.** As a whole, restoration projects proposed through the C&SF project should restore water quantity, water quality, timing, and sheetflow, as opposed to flow through canals Wherever practical, impoundment of water behind levees should be reduced, provided that this action does not overdrain areas upstream of the presently impounded areas. The establishment of Water Preserve Areas and additional compartments for storage and treatment of water should be reviewed for management opportunites that may support recovery of the Everglade snail kite.

H3. Conduct research on the biology and life history of the Everglade snail kite.

H3.1. **Complete and use ATLSS modeling of the snail kite to predict the response of snail kites to changes in hydropattern anticipated for specific water management proposals.** In addition to the need to correctly describe the life history of the snail kite itself, the ATLSS modeling must include linkage to apple snail distribution and abundance, vegetation characteristics in the landscape influencing the snail kite's successful foraging, and linkage of all these factors to hydrology. ATLSS simulations (and/or other Population Viability Analysis models) can also provide estimates of the vulnerability of the snail kite population as a whole to extinction. Such information should be used to refine, if necessary, our use of 650 birds as a recovery criterion.

H3.2. **Continue and expand research on the effects of natural and human-caused hydrologic events on the ecology of the apple snail.** This research will provide needed information for the ATLSS modeling described above, and even before completion of ATLSS, this research can be used in decisions on water management.

H3.3. **Evaluate the effectiveness of long-term climate predictions to reduce the likelihood of coincidence of human-caused drawdowns and drought.** Prediction of long-term climate patterns is still inexact, but climatological monitoring can increasingly predict the probability of *El Niño* events perhaps 1 or two years in advance. Florida's subtropical climate is significantly affected by these global shifts, and this may be useful in adjusting water regulation schedules according to anticipated "wet" or "dry" years. Human-caused drawdowns should be avoided prior to entering a drought, because snail kites will have fewer options for refuge from drought and because refilling of drained lakes or marshes will be prolonged during drought.

H3.4. **Perform a detailed statistical analysis of rainfall records throughout central and South Florida to identify the intensity and spatial and temporal extent of droughts.** This information will provide an estimate of the threat to the snail kite from region-wide drought. It will be used to estimate the probability of extinction over long time scales in response to severe drought under a range of future land use scenarios.

H3.5. **Evaluate the need for secondary treatment in addition to the nutrient removal afforded by macrophytic stormwater treatment areas.** Determine effective methods of treatment to reduce nutrients below levels affecting the ecology of the Everglades.

H4. Monitor habitat/ecological processes. Expansion of existing monitoring programs throughout the C&SF system is expected as restoration projects are generated through the C&SF Restudy, with an increased emphasis on adaptive management. The snail kite should be included in monitoring of ecological indicators along with analysis of vegetation patterns and hydrology throughout the system.

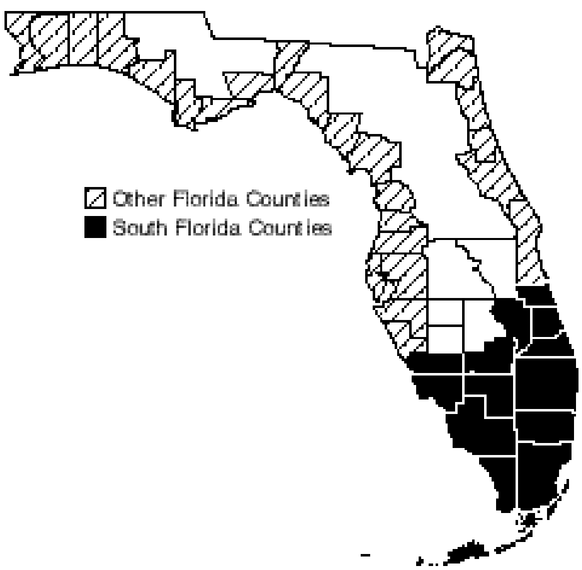
H5. Increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem. Because the range of the snail kite coincides closely with the C&SF system and because it is endangered, it can serve as a symbolic species for restoration efforts in South Florida. Information on the kite's status, threats, and its ecological relationship with other species should be integrated in public education on restoration activities. Public outreach can include newsletters, newspapers, magazines, the worldwide web, and classroom materials.

West Indian Manatee

Trichechus manatus

Federal Status:	**Endangered (March 11, 1967)**
Critical Habitat:	**Designated (1976)**
Florida Status:	**Endangered**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. Florida distribution of the West Indian manatee; inland counties include Lake Okeechobee and connecting rivers.



Once mistaken as a mermaid by sailors of the past, the West Indian manatee (*Trichechus manatus*) is one of the largest coastal mammals in North America. This unusual marine mammal with its massive, seal-like body, has been able to adapt well to its marine environment. Manatees migrate seasonally to adapt to changing water temperatures. West Indian manatees roam in fresh, brackish, and marine waters throughout Florida, the Greater Antilles, Central America, and South America. Intensive hunting pressures between the 1500s to 1800s reduced the number of manatees. The West Indian manatee is one of the most endangered marine mammals in coastal waters of the United States. This group includes a separate subspecies called the Florida manatee (*Trichechus manatus latirostris*) that appears to be divided into at least two somewhat isolated subpopulations-one along the Atlantic coast and the other on the Florida Gulf of Mexico coast.

This recovery plan represents South Florida's contribution to the recently published 1996 West Indian Manatee Recovery Plan (FWS 1996).

Description

The West Indian manatee is an aquatic mammal with a robust, fusiform body that is compressed dorsoventrally. Its grey to grey-brown, thick, tough skin is sparsely covered with small, thick hairs (3.0 to 4.5 mm) (Husar 1978) and is sometimes covered with barnacles and algae. The rounded body of the manatee has no hind limbs, but it has paddle-like forelimbs or flippers with three to four nails present on the dorsal surface of each flipper. The body tapers to a spatulate, dorsoventrally flattened tail. Females have a single prominent mamma or teat behind the axilla of each flipper and a relatively short anal-genital distance (Rathbun 1984). The urogenital opening in males is located just behind the navel.

The average adult manatee is 3.5 m long and weighs 1,000 kg. Male and female manatees are similar in size and appearance (Rathbun 1984). Newborn calves are, on average, 1.2 to 1.4 m long and weigh an average of 30 kg (Odell 1981).

Manatees have a dense skeleton. The massive skeletal bones lack marrow cavities in the ribs and forelimbs (Odell 1982). Similar to other marine mammals, manatees have large blubber stores.

The deeply-set, small eyes have no visible upper or lower lids, but instead have a nictating inner membrane capable of covering the eyeball for protection. Manatees can see for considerable distances, although their depth perception may be limited (Reynolds 1979). Manatees can hear well even though their inconspicuous ears have no external pinnae or earlobe flaps. Manatees communicate through different squeaks, chirps, grunts, and groans, that are within human audible range (Ketten *et al*. 1992). Two nostrils are located on the long upper snout that are capable of opening and closing by muscular valves. Manatees have an enlarged, lobed upper lip with short, stiff bristles and two muscular projections or prehensile pads that aid them in bottom feeding (Odell 1982).

To compensate for the excessive tooth wear caused by the tough vegetative matter they feed upon, manatees replace old, worn-down teeth with new ones. In a manner that is similar to a conveyor belt, their teeth move forward horizontally through their jawbones until worn-down teeth fall out and are replaced by new teeth in the back of their mouths. This replacement process occurs at a rate of about one mm per month. Manatees may use 30 or more molars in a lifetime (Domning and Hayek 1986).

Sea cows (*Protosiren*) first appeared during the Eocene period about 55 million years before the present when flowering plants first evolved. The family Trichechidae appeared in South America in the early Miocene (15 million years before present), about the same time as whales, apes and grazing animals (Domning 1982, Domning *et al.* 1982). During the Pliocene (12 million years before present), the time period when large carnivores evolved, members of Trichechidae first appeared in Atlantic North America (Reinhart 1951, 1959). Pleistocene *Trichechus* fossils have been recovered from the United States' east coast from Florida to Maryland (Simpson 1932).

Taxonomy

The mammalian Order Sirenia has two recent families, three recent genera and five recent species (Rathbun 1984). The two recent families: Dugongidae and Trichechidae have two genera with four living species and one extinct species. The Family Dugongidae contains two genera *Dugong* and *Hydrodamalis* and two species; of which *Dugong dugon* is the only living species of this family. The second species, Steller's sea cow (*Hydrodamalis giga),* was hunted to extinction by 1768 (Reeves *et al.* 1992). The family Trichechidae was described by Gill in 1872 (Rathbun 1984). The second living genus, *Trichechus,* includes three

West Indian manatee.
Original photograph courtesy of U.S. Fish and Wildlife Service.

allopatric species: the Amazonian manatee (*T. inunguis*), the West African manatee (*T. senegalensis*), and the West Indian manatee (*T. manatus*). The West Indian manatee is represented by two subspecies, the Florida manatee (*T. manatus latirostris*) and the Antillean manatee (*T. manatus manatus*) (Hatt 1934). *T. manatus* was described by Linneaus in 1758, and further distinguished as *T. m. latirostris* in 1924 (Harlan 1924). The four living sirenian species are geographically isolated, and listed as threatened or endangered (32 FR 4001, 35 FR 8495, 44 FR 42911). The closest, living terrestrial mammalian relative to the manatee is the elephant.

Distribution

The global distribution of sirenians, including dugongs and manatees, includes coastal waters, estuaries, and freshwater rivers. Dugongs can be found in marine habitats from eastern Africa to the Ryukyu Islands, Indo-Australian Archipelago, western Pacific and Indian oceans. Manatees can be found in tropical western Africa, including the Niger-Benue Basin, the tropical western Atlantic coast, the Caribbean Sea, and in the Amazon and Orinoco River basins (Rathbun 1984). The extinct Steller's sea cow range included the Bering Sea.

The present distribution of the West Indian manatee includes the coasts and rivers of Florida, the Greater Antilles, eastern Mexico and Central America and northern and eastern South America (Husar 1977, Lefebvre *et al.* 1989). *T. manatus latirostris* ranges from Texas to Rhode Island. The cooler winters along the U.S. coast of the Gulf of Mexico, in combination with the deep water and strong currents of the Straits of Florida, create a barrier between the Antillean and Florida manatee; the resulting isolation contributes to their status as subspecies (Domning and Hayek 1986).

The seasonal distribution of the manatee is affected by water temperatures. Waters colder than 20 degrees C increase the manatees' susceptibility to cold-stress and cold-induced mortality. Because of this temperature restriction, manatees seek out warm water refuges to help reduce energetic maintenance costs.

The manatee occurs throughout the southeastern United States. The only year-round populations of manatees occur throughout the coastal and inland waterways of peninsular Florida and Georgia (Hartman 1974). During the summer months, manatees may range as far north along the East Coast of the U.S. as Rhode Island, west to Texas, and, rarely, east to the Bahamas, FWS 1996, Lefebvre *et al.* 1989). There are reports of occasional manatee sightings from Louisiana, southeastern Texas, and the Rio Grande River mouth (Gunter 1941, Lowery 1974).

In Florida, manatees are commonly found from the Georgia/Florida border south to Biscayne Bay on the east coast and from Wakulla River south to Cape Sable on the west coast (Hartman 1974, Powell and Rathbun 1984) (Figure 1). Manatees are also found throughout the waterways in the Everglades and in the Florida Keys. Although temperatures are suitable for manatees in the Florida Keys, the low number of manatees has been attributed to the lack of fresh water (Beeler and O'Shea 1988). Manatees also occur in Lake Okeechobee.

In warmer months (April to November), the distribution of manatees along the east coast of Florida tends to be greater around the St. Johns River, the Banana and Indian rivers to Jupiter Inlet, and Biscayne Bay. On the west coast of Florida, larger numbers of manatees are found at the Suwannee, Crystal and Homosassa rivers, Tampa Bay, Charlotte Harbor/Matlacha Pass/San Carlos Bay area, the Caloosahatchee River and Estero Bay area, the Ten Thousand Islands, and the inland waterways of the Everglades.

On the west coast, manatees winter at Crystal River, Homosassa Springs, and other warm mineral springs (Powell and Rathbun 1984, Rathbun *et al.* 1990). In the winter, higher numbers of manatees are seen on the east coast at the natural warm waters of Blue Spring and near man-made warm water sources on or near the Indian River Lagoon, at Titusville, Vero Beach, Ft. Pierce, Riviera Beach, Port Everglades, Ft. Lauderdale, and throughout Biscayne Bay and nearby rivers and canals (FWS 1996). They also aggregate near industrial warm water outflows in Tampa Bay, the warmer waters of the Caloosahatchee and Orange rivers (from the Ft. Myers power plant), and in inland waters of the Everglades and Ten Thousand Islands.

Manatees frequently migrate throughout the waterways in South Florida. The South Florida Ecosystem region is home to the most resident manatee populations and transient migrants in Florida. In South Florida, manatees are most prominent year-round in the following areas: Indian River, Biscayne Bay, Everglades and Ten Thousand Island area, Estero Bay and Caloosahatchee River area, and Charlotte Harbor area. Some of the largest winter aggregations (50 or more manatees) occur in south and central Florida (FWS 1996).

Habitat

Manatees occur in both fresh- and saltwater habitats within tropical and subtropical regions. They depend on areas with access to natural springs or manmade warm water refugia and access to areas with vascular plants and freshwater sources (Humphrey 1992). Several factors contribute to the distribution of manatees in Florida. These factors are habitat-related and include proximity to warm water during cold weather, aquatic vegetation availability, proximity to channels of at least 2 m in depth, and location of fresh water sources (Hartman 1979).

Manatees are also dependent upon location of foraging sites. Normally, manatees feed on a variety of submergent, emergent, and natant (floating) vegetation. Manatees usually forage in shallow grass beds that are adjacent to deeper channels (Hartman 1979, Powell and Rathbun 1984). The proximity of these deeper channels may allow easy access to and from feeding areas.

Manatees often seek out quiet areas in canals, creeks, lagoons or rivers. These areas provide habitat not only for feeding, but also for resting, cavorting, mating, and calving. Deeper channels are often used as migratory routes (Kinnaird 1983). Natural or artificial freshwater sources are sought by manatees, especially manatees that spend time in estuarine and brackish waters (FWS 1996).

Critical Habitat

Critical habitat was designated for the manatee in the early 1970s, although no specific primary or secondary constituent elements were included in the designation (50 CFR 17.95). Critical habitat for the manatee identifies specific areas occupied by the manatee, which have those physical or biological features essential to the conservation of the manatee and/or may require special management considerations.

Behavior

Manatees have low metabolic rates indicating a possible adaptation to their large size and low nutrient food sources, or to permit long dives, since manatees have less advanced diving abilities than other marine mammals. Manatees can remain submerged for several minutes, with the longest submergence record lasting 24 minutes (Reynolds 1981). Manatees increase submergence times while feeding and resting. Female manatees coordinate their breathing and submergence times with their calves. Manatees do not appear to be fast swimmers, but they usually swim 4 to 10 km an hour and may attain faster speeds in short bursts (Husar 1977).

Manatees are not overly gregarious, but they do aggregate at warm-water refugia and during mating. Manatees have been observed displaying playful behaviors such as chasing, tumbling, and nuzzling (Hartman 1979, Bernier 1985).

Reproduction

The manatee population sex ratio is considered to be 1:1 for both adults and calves (Rathbun *et al*. 1992). Females reach sexual maturity at 3 to 5 years of age (Marmontel 1993) and males may reach sexual maturity at 3 to 4 years of age. Individuals at least 275 cm in length may be reproductively mature, although the modal female may not successfully rear young until 6 years or older (Marmontel 1993). Manatee longevity has been estimated at 50 years or more and they appear to be able to reproduce their entire adult life (Marmontel *et al*. 1992). Odell *et al*. (1995) reported a captive female manatee reproduced throughout its 34 years at the Miami Seaquarium.

The combination of suitable seagrass beds, nearby deeper water access, and minimal boat traffic may be indicative of important mating, calving, and nursery grounds for manatees (Smith 1993). Reproduction can occur throughout the year, although sperm production in male manatees is low during the winter (Hernandez *et al*. 1995). Most manatee calves are born in the spring or early summer (Irving and Campbell 1978). Breeding usually commences when one or more males are attracted to an estrous female, but permanent pair bonds are not formed (Marmontel *et al*. 1992). Manatees may form large breeding herds. Larger, presumably older males, dominate mating herds and may be responsible for most pregnancies (Rathbun *et al*. 1992).

The minimum interval between manatee birth is 2 years, but not all female manatees are this fecund. On average, 33 percent of mature, female manatees may be pregnant, which suggests a 3-year interval between calving (Marmontel 1993). If the interval between calving is 3 years and continues over a 36-year period, a female manatee could produce approximately 12 calves during her lifespan (Marmontel 1993). Calving intervals may be affected by the age and health of the female manatee. Although sexual activity may occur, female manatees may experience infertile estrous periods (Hartman 1979). Injuries caused by watercraft may also disrupt the manatee's estrous cycle (Marmontel 1993).

Gestation of the single calf takes 12 to 14 months (Reid *et al*. 1992). Age to weaning varies from 1 to 2 years. Calves usually stay close to their mothers during their first several years. Twin calves have been reported (D. O'Dell, Sea World, personal communication 1998).

Per capita reproductive rates in Florida manatees have been estimated from a low of 0.15 ($\pm$0.060) in the Blue Spring population to a high of 0.19 ($\pm$0.009) in the Atlantic coast population (Eberhardt and O'Shea 1995). The maximum potential rate of population increase has been estimated at 2.0 to 7.0 percent; this rate is most sensitive to changes in adult survival and, secondarily, subadult survival (Packard 1985, Marmontel 1993). For many years, the FWS (among others) has expressed concern about how the mortality rate will affect the survival and recovery of the manatee. These concerns were confirmed by the population viability analysis conducted by Marmontel (1993), which evaluated the probability of the manatee's persistence and the mean time to its extinction.

Foraging

Manatees feed with the help of their two muscular lips, which are flexible and move independently, in a fashion similar to an elephant's trunk or human fingers. The lips are capable of manipulating food: grasping and moving food into the mouth. Manatees also use their forelimbs to dig into the sediment to remove seagrass rhizomes or roots (Hartman 1979, Provancha and Hall 1991, Lefebvre and Powell 1990). Manatees usually spend more time foraging in the late autumn (6.9 hours/day) than in early spring (3.2 hours/day)(Bengston 1983). Manatees must eat large amounts of aquatic vegetation to meet their metabolic requirements and may consume up to 20 percent of their body weight per day in aquatic plants (Zieman 1982).

These animals frequently forage at depths of 1 to 3 meters where aquatic vegetation is abundant. Manatees are opportunistic herbivores and feed on a variety of submerged, emergent, or floating aquatic plant species, including seagrasses, bank grasses, and overhanging mangroves (see Hurst and Beck 1988, and Smith 1993 for complete review). They may also feed on algal complexes attached to rocks, pilings, and dams (Reynolds 1981), and may occasionally eat fish or invertebrates while feeding on floating or submerged vegetation (Powell 1978, Smith 1993). In South Florida, manatees feed primarily on submerged vegetation such as turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), Cuban shoal grass (*Halodule wrightii*), and *Halophila* spp., although a variety of other emergent and floating vegetation is also eaten. Manatees may also forage on a variety of shoreline vegetation including red mangrove (*Rhizophora mangle*) leaves and cordgrass (*Spartina alterniflora*) (Longieliere 1994). In fresh water, manatees feed primarily on submerged aquatic macrophytes such as *Myriophyllum* spp. and hydrilla (*Hydrilla verticillata*).

Preferred manatee habitat in South Florida is characterized by the availability of submerged aquatic vegetation (SAV) (Smith 1993). Due to light limitations, most SAV, such as seagrass beds, are limited to shallow, nearshore waters. Seagrasses comprise the largest component of the manatee’s diet, especially in South Florida (Hartman 1979, Zieman 1982, Smith 1993). Some manatees have been observed to return to the same seagrass beds to feed year after year and may show preferences for certain areas (USGS/BRD 1993, Smith 1993). Preference may also be shown for areas with healthy seagrass beds adjacent to relatively deeper waters with little boat traffic (Kadal and Patton 1991,USGS/BRD 1993). Manatees exhibit diel feeding patterns during the winter; they rest in warm waters during the day and head out in the late afternoon to feed in surrounding, sometimes, cooler areas (Bengston 1981).

Migration

Manatees normally migrate along shorelines and use deeper corridors to access shallow-water feeding and resting areas (Kinnaird 1983). Telemetry research suggests that calves learn migratory patterns from their mothers (USGS/BRD 1993). Migration patterns often vary between individuals. Some manatees may undertake extensive migrations along the coast and up rivers and canals (Reeves *et al*. 1992). Manatees may travel 40 km/day for several consecutive days, usually traveling directly and rapidly to a particular destination site, with males ranging longer distances than females (Bengston 1981, USGS/BRD 1993). On the east coast manatees migrate northward in the springtime and southward in the fall and winter (Moore 1951). Manatees do not range far offshore, but may travel along the coast (Beeler and O'Shea 1988).

The increase in the number of manmade warm-water sources over the years has influenced manatee migratory patterns. Manatees frequent coastal, estuarine, and riverine habitats and are capable of extensive north-south migrations throughout the year (Reeves *et al*. 1992). Manatees have been observed migrating great distances northward in the springtime and southward in the fall and winter (Longieliere 1994); and as a result, abundances in regional populations change seasonally (Hartman 1974). There are 17 major aggregation sites in Florida (Garrott *et al.* 1994). These aggregation sites occur at or near manmade or natural warm-water refugia. Manatees will migrate to these warmer areas when water temperatures drop below 20 degrees C. Large aggregations of manatees occur at these warm-water areas. With the rise in water temperatures in the spring, some manatees may begin to migrate away from their winter refugia, while others remain relatively close. Manatees often return to the same winter refugia each year (Powell and Rathbun 1984, Reid *et al*. 1991). In the winter, manatees stay closer to warm-water during the day, then move to vegetated areas in the late afternoon or at dusk to feed.

Warm-water sources offer manatees refugia to escape the stresses of cold water temperatures. Most research has concentrated on developing methods to determine population trends at these sites, but little work has investigated manatee behavior in relation to man-made water sources.

Boat channels are often used by manatees to travel from one region to another (Curran 1989, USGS/BRD 1993). Although these channels may provide deeper waters for manatees to avoid or escape oncoming boats, for reasons not yet understood, they do not always move out of the way of approaching boats. Manatees are also vulnerable to collisions with boats in narrow waterways and shallow water areas. During high tide, manatees are able to access foraging habitat that is normally inaccessible during low tide (Smith 1993). Although watercraft may utilize deeper navigation channels, coastal shallow areas are used intensively for fishing and general sightseeing. The shallow depths of these areas increase the likelihood of manatee injury or death if a powerboat passes over them.

Relationship to Other Species

The manatee is an indicator species for aquatic habitats, including seagrasses and mangroves, in the South Florida Ecosystem. Because this species is dependent upon the health of its entire habitat, the status of the manatee acts as a signal for the condition of many of the other flora and fauna that rely upon aquatic systems. For example, seagrass beds and mangroves provide important areas for manatee foraging, calving, resting, and mating. They also provide important habitat resources for other aquatic species such as wading birds, crocodiles *(Crocodylus acutus)*, turtles, fish and invertebrates. The stability of these aquatic communities is essential for manatees and many other species.

Manatees have no known predators, except for humans. Manatees and their habitats are continually threatened by human activities, such as habitat loss for residential and commercial purposes, increased turbidity levels from upland urbanization activities, pollution from sewage discharge and stormwater runoff, aquatic recreational and commercial activities, and alterations of natural hydrology. Several threatened and endangered sea turtles use the same seagrass beds as manatees for juvenile refugia and feeding. In addition, many migratory birds, and fish rely on the aquatic habitats manatees use. Habitat requirements of all of these species need to be considered and balanced in order to conserve and protect these resources.

Human interferences with natural water flows have affected the dynamics of vegetative communities in the South Florida Ecosystem. Changes in these flow regimes may affect not only manatees but other species as well, including the endangered American crocodile and pink shrimp (*Penaeus duorarum*), an important fishery species. Returning hydrologic flows to mimic more natural conditions will allow more fresh water into northeastern Florida Bay and may increase the amount of suitable crocodile nesting habitat. A decline in the pink shrimp fishery has been attributed to a lack of freshwater inflow into Florida Bay and a loss of seagrass habitat. The effects of hydrologic conditions on manatees is not well known; but effects on habitat have been observed.

Although reactions may be different, manatees are susceptible to the same natural and human disturbances other aquatic organisms experience, such as changes in water quality, loss of habitat, and susceptibility to diseases and natural catastrophes. Considering man is the only known predator of manatees, it is our responsibility to ensure our actions do not jeopardize the continued existence of this species nor those other species that share its home.

Status and Trends

The Federal government has recognized the threats to the continued existence of the Florida manatee for over 30 years. The West Indian manatee was first listed as an endangered species in 1967 under the Endangered Species Preservation Act of 1966 (16 U.S.C. 668aa(c)) (32 FR 48:4001). The Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa(c)) continued to recognize the West Indian manatee as an endangered species (35 FR 16047), and the West Indian manatee was also among the original species listed as endangered pursuant to the Endangered Species Act of 1973. Critical habitat was designated for the manatee in 1976. The justification for listing as endangered included impacts to the population from harvesting for flesh, oil, and skins as well as for “sport,” loss of coastal feeding grounds from siltation, and the volume of injuries and deaths resulting from collisions with the keels and propellers of powerboats. Manatees are also protected under the provisions of the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.) and have been protected by Florida law since 1892.

Historic information on *T. manatus* distribution indicates manatees were once more common in pre-Colombian times. Manatees were highly utilized for their meat, oil, bones, and hide; hence, their early decline has been attributed to overhunting (Lefebvre *et al.* 1989). Extirpation and range contraction is evident throughout the manatee's range; areas previously with abundant populations now contain few or none. For example, manatees have been extirpated from some coastal areas in Mexico, Virgin Islands, and Honduras.

Florida is at the northern limit of *T. manatus'* year-round range. Exact estimates of the historic manatee population are uncertain, but overhunting between the 1700s and 1900s is believed to be responsible for reducing the manatee population to only a few relict groups (Hartman 1979).

The geographic distribution of manatees within Florida has changed since the 1950s and 60s (Lefebvre *et al.* 1989) and prominent shifts in seasonal distribution are also evident. Before man introduced warm effluents from power plants to the natural environment in the early 1950s, the winter range of the manatee in Florida was most likely limited on its northern bounds by the Sebastian River on the east coast and Charlotte Harbor on the west coast (Moore 1951). Since that time, manatees altered their normal migration patterns and appreciable numbers of manatees began aggregating at new sites. As new powerplants became operational, more and more manatees began taking advantage of the sites by traveling great distances just to bask in the warm waters. The introduction of powerplants and paper mills in northern Florida, southern Georgia, Louisiana, and Texas has given manatees the opportunity to expand their winter range to areas not previously frequented (Hartman 1979).

As discussed earlier, determining exact population estimates or trends is difficult for this species. The best indicator of population trends is derived from mortality data and aerial surveys (Ackerman *et al.* 1992, Ackerman *et al.* 1995, Lefebvre *et al.* 1995). Aerial surveys conducted over the past 19 years have shown an increase in numbers, but this information is not an accurate account of trends since data has been obtained using different survey methods. O'Shea (1988) found no firm evidence of a decrease or increase between the 1970s and 1980s, even though aerial survey counts have increased. Increases in the number of recovered dead manatees have been interpreted as evidence of increasing mortality rates (Ackerman *et al*. 1992, Ackerman *et al.* 1995). Because manatees have low reproductive rates, these increases in mortality may lead to a decline in the population (O'Shea *et al.* 1988, 1992). Until better survey techniques are developed, efforts to reduce human-caused manatee deaths, like boat strikes, need to continue.

Although there are no accurate estimates of manatee population size, DEP's 1996 synoptic aerial surveys conducted between February 18-19, determined there were at least 2,639 manatees in Florida's waters. DEP conducted two synoptic surveys in 1997. The January survey determined that 2,229 manatees were present in Florida's waters: 900 on the east coast and 1,329 manatees on the west coast. The February survey determined that 1,709 manatees were present in Florida's waters: 791 manatees on the east coast and 918 on the west coast.

Surveys conducted by DEP in 1996 and 1997 determined that numbers of manatees on the east coast and west coasts of Florida are almost equal (Rathbun *et al.* 1992). These estimates represent the minimum number of manatees in Florida waters and may not represent the total population size (for discussions on bias in aerial surveys, see Garrott *et al.* 1995 and Lefebvre *et al.* 1994). Although this has been the highest estimate of manatees since the synoptic surveys were started, the results of these surveys may vary because of such factors as sampling methodology, manatee behavior, and weather conditions. Because of this variation and the high degree of uncertainty in surveying, it is difficult to correlate these manatee population estimates with overall manatee population trends (Ackerman *et al.* 1995).

Despite the lack of accurate estimates of the manatee population size, human activities have significantly affected manatees by eliminating or modifying suitable habitat, altering migratory access routes, increasing mortality, and decreasing abundance, all of which in turn, can affect manatee reproduction, recruitment, distribution, and behavior. To understand manatee mortality trends in Florida, Ackerman *et al.* (1995) evaluated the number of recovered carcasses between 1974 and 1992 and categorized the causes of death. During that time interval, the number of manatees killed in collisions with watercraft increased each year by 9.3 percent. The number of manatees killed in collisions with watercraft each year correlated with the total number of pleasure and commercial watercraft registered in Florida (Ackerman *et al.* 1995). Other human-related threats include manatee death or injury from flood-control structures and navigational locks, entanglement in fishing line, entrapment in culverts, and poaching. These other threats accounted for 162 known mortalities between 1974 and 1993.

Deaths from flood control structures and other human-related deaths did not change significantly but deaths due to these categories decreased more than deaths from other causes (Table 1). Of interest is the increase in the number of perinatal deaths of 11.9 percent/year. The frequency of perinatal deaths (stillborn and newborn calves) has been consistently high over the past 5 years and represented 24 percent of all manatee deaths in 1994. This estimate may not be a true representation of the actual number of perinatal deaths that occur because the carcasses of these young animals may not be recovered. The cause of the increase in perinatal deaths is uncertain, but may result from a combination of factors that includes pollution, disease, or environmental change (Marine Mammal Commission 1992). It may also result from the increase in collisions between manatees and watercraft because some newborn calves may die when their mothers are killed or seriously injured by boat collisions, when they become separated from their mothers while dodging boat traffic, or when stress from vessel noise or traffic induces premature births (Marine Mammal Commission 1992). As a result of the high perinatal death rate, there are fewer young age classes present in the population.

Of the 1,907 manatee carcasses that have been recovered in Florida between 1989 and 1997, (DEP 1998) nearly half were female. The reduction of mature females places an additional burden and pressure on younger, less-experienced females to be the foundation for population growth. Younger females may be more apt to abandon their calves and less successful in calf rearing (Marine Technical Advisory Council 1994). A loss of mature, experienced males may also reduce the likelihood of successful mating.

The greatest present threat to manatees is the high rate of manatee mortalities caused by watercraft collisions. O' Shea *et al.* (1985) recognized the dramatic increase in the rate of boat use in manatee habitat and, consequently, the increase in the potential of boat-related manatee injury or death. Between 1986 and 1992, watercraft collisions accounted for 37.3 percent of all manatee deaths, where the cause of death could be determined (Ackerman *et al.* 1995).

The significance of manatee mortalities related to watercraft appears to be the result of dramatic increases in vessel traffic. Ackerman *et al.* (1995) showed a strong correlation between the increase in recorded manatee mortality and increasing boat registrations. In 1960, there were approximately 100,000 registered boats in Florida; by 1990, there were more than 700,000 registered vessels in Florida (Marine Mammal Commission 1992, Wright *et al.* 1995). Approximately 97 percent of these boats are registered for recreational use. The most abundant number of registered boats are in the 16 foot to 26 foot size class. Between 1974 and 1997, there were 3,270 known manatee mortalities in Florida. Of these, 749 were watercraft-related. Since 1974, an average of 31 manatees have died from watercraft-related injuries each year; between 1983 and 1993, manatee mortalities resulting from collisions with watercraft reached record levels (DEP 1994). Approximately twice as many manatees died from impacts suffered during collisions with watercraft than from propeller cuts; this has been a consistent trend over the last several years. Most lethal propeller wounds are caused by medium or large-sized boats, while impact injuries are caused by fast, small to medium-sized boats (Wright *et al.* 1992). Watercraft-related mortalities were most significant in the southwest and northeast regions of Florida; deaths from watercraft increased from 11 to 25 percent in southwestern Florida. In all of the counties that had high watercraft-related manatee deaths, the number of watercraft and the seasonal abundance of manatees was high (Ackerman *et al.* 1995).

In addition to direct collisions with boats, secondary effects from boating activity include such stresses as disruption of normal breeding behavior, disruption of cow-calf bonding, interference with migration routes and patterns, and the loss of feeding areas. An increase in these effects is likely to increase the probability of unsuccessful mating, perinatal mortality, prevention of reaching freshwater resources and warm-water refugia, and decreasing the availability of food resources. In addition, these effects are likely to decrease the recruitment of young manatees into the breeding population and decrease the number of successful reproductions.

Table 1. Number of manatee (*Trichechus manatus*) deaths in Florida (1974-1997). Adapted from DEP (1998).

Year	Watercraft collision	Flood gate/canal lock	Other human-related	Perinatal	Other Natural	Undetermined	Total
1974	3	0	2	0	0	2	7
1975	6	1	1	7	1	13	29
1976	10	4	0	14	2	32	62
1977	13	6	5	9	1	80	114
1978	21	9	1	10	3	40	84
1979	24	8	9	9	4	23	77
1980	16	8	2	13	5	19	63
1981	24	2	4	13	9	64	116
1982	20	3	1	14	41	35	114
1983	15	7	5	18	6	30	81
1984	34	3	1	25	24	41	128
1985	33	3	3	23	19	38	119
1986	33	3	1	27	13	45	122
1987	39	5	2	30	16	22	114
1988	43	7	4	30	24	25	133
1989	50	3	5	38	32	40	168
1990	47	3	4	44	67	41	206
1991	53	9	6	53	14	39	174
1992	38	5	6	48	20	46	163
1993	35	5	6	39	24	36	145
1994	49	16	5	46	37	40	193
1995	42	8	5	56	35	55	201
1996	60	10	0	61	118	166	415
1997	54	8	8	61	46	65	242
Total	749	136	86	688	561	1,037	3,270

The second most significant threat to manatees is the loss and degradation of habitat, due primarily to direct damage by aquatic recreational and commercial boating activity, coastal construction, and pollution from sewage discharge and stormwater runoff (Marine Mammal Commission 1992, Smith 1993). Coastal land conversion accompanying the growth of Florida's human population has occurred largely along coastal waters and rivers used by manatees. Siltation, eutrophication, other forms of water pollution, and the destruction or degradation of wetlands to promote shoreline development degrade the coastal and riverine communities. This degradation reduces manatee food supplies and eliminates the secluded areas that are used by manatees to mate, calve, and nurse (Marine Mammal Commission 1992).

In Florida, manatees rely primarily on seagrass beds for foraging, mating, and calving. These seagrass beds incur most of their direct damage from boat propellers (Zieman 1982). Boat-induced turbidity results from propeller dredging of bottom habitats and propeller wash and wave wake disturbance. Sediments around seagrasses become unconsolidated and suspended, delaying recolonization for 2 to 5 years or longer, depending upon species type. Several bays in Florida formerly possessed extensive seagrass resources, but dredge and fill operations as well as other human disturbances have greatly reduced their extent (Zieman 1982).

Seagrasses along the coast of Florida have been declining since the 1950s. In Tampa Bay, about 16,188 ha of seagrass flourished along the shallow shelf of the bay. By 1982, only 8,741 ha remained baywide (Tampa Bay National Estuary Program 1995). In Sarasota Bay, seagrasses have declined by 30 percent (Sarasota Bay National Estuary Program 1994). From 1945 to 1982, seagrass acreage declined by 29 percent in Charlotte Harbor; with an additional 809 to 3,238 ha of seagrasses destroyed or damaged by boat propellers (Haddad and Sargent 1994). More than 100,000 acres of seagrasses have "died off" in Florida Bay since 1987 (FWS 1994). For the Indian River Lagoon, the total coverage of submerged aquatic vegetation (seagrasses and macroalgae) in the 1970s was 31,777 ha. In 1992, the total coverage decreased to 28,385 ha, an 11 percent reduction in seagrass distribution (Indian River Lagoon National Estuary Program 1994).

An unusual manatee mortality event was detected in southwest Florida in 1996. Between March 5 and April 29, 149 manatee deaths were attributed to this unusual die-off. Most of the manatee carcasses were recovered from Lee County followed by Collier, Charlotte, and Sarasota counties. After thorough investigations, red tide was indicated as the cause. Final reports on the 1996 manatee die-off concluded that brevetoxins from a bloom of dinoflagellates (*Gymnodinium brevii*), more commonly known as red tide, were responsible for the deaths of those manatees. Brevetoxins were found in the manatee carcasses in liver, kidney, and lung tissues and also in stomach contents. The majority of animals that died were large animals (greater than 275 cm long), although some smaller (younger) animals also died. The sex ratio of dead manatees was nearly one to one. High concentrations of red tide organisms were also found in water samples taken in the geographic vicinity of the die-off. Researchers continue to look for the cause of the red tide outbreak, method of toxicity, organ selection of the toxin, and most importantly, ways to minimize the effects of another red tide event.

Other threats to the manatee include natural catastrophic events such as low temperatures, and hurricanes (Ackerman *et al.* 1995). Most catastrophic mortality, however, is due to low temperatures (O'Shea *et al.* 1985). Lethal temperatures and lethal exposure times are not well known, but manatees cannot survive indefinitely in water colder than 16 degrees C (Ackerman *et al.* 1995). Although deaths from natural weather events cannot be prevented by humans, these mortalities must be considered because they play an important factor in the overall status of the manatee.

The FWS has concentrated on controlling those factors that will respond to direct human intervention. The FWS has worked with the State to minimize the number of mortalities caused by watercraft collisions, and with the COE to reduce the number of manatees killed by floodgates and canal locks. The number of manatees killed by floodgates and canal locks has declined from a high of 8.8 percent (between 1976 and 1980) to 3.2 percent. The FWS is continuing to work with the COE to develop new technologies to further reduce the number of manatees killed in these water control structures. The FWS has also worked to reduce the number of manatees killed by other human causes. Since 1973, the number of manatees killed by poaching, net entanglement, and vandalism has declined from a high of 8.3 percent to 2.6 percent by 1992 (Ackerman *et al.* 1995).

Marmontel's (1993) population viability analysis (PVA) model discussed previously suggest that a 10 percent mortality rate is probably a critical threshold for the survival and recovery of manatees. Although the minimum population estimate reached a record high in 1996 with approximately 2,639 manatees, the number of manatees killed in the first quarter of 1996 almost equals 10 percent of that minimum population estimate. According to DEP, 415 manatees died in 1996.

Although Marmontel's (1993) PVA had limitations resulting from the lack of specific life history information on the manatee, her simulations represent the best information available regarding the consequences of human activities on the manatee. First, she noted that the small population size of the manatee lessens their probability of persistence and increases the chances that the populations will be adversely affected by environmental variation or additional mortalities. Second, her simulations projected that a 10 percent increase in overall manatee mortality would reduce the manatee below the critical threshold of 500 animals in about 100 years. Finally, her simulations projected that reducing the mortality of adult manatees by watercraft would be the most productive mechanism to increase the probability of manatee survival and recovery.

Management

Perhaps the first management action taken to conserve manatees was the 1892 prohibition on killing instituted by Florida law. The manatee was federally listed as an endangered species in 1967. Some of the first research conducted on manatees began in the mid-1960s (Hartman 1979). Additional research continued in 1974 when the University of Miami and Gainesville Field Station of the FWS began focusing their efforts on manatee research. These efforts provided a foundation for later research and management activities. By 1978, Florida passed the Florida Manatee Sanctuary Act and by 1984, Florida Department of Natural Resources (now DEP) dedicated more resources to protect the manatee.

In 1980, the first manatee recovery plan was approved and a manatee coordinator was hired by the FWS to oversee the recovery of the manatee. The recovery plan was revised in 1989 and again in 1996. The primary goal for recovery of the manatee is to restore manatee populations to sustainable levels that will permit their reclassification from endangered to threatened. To progress with the recovery goals, the FWS's 1996 recovery plan for the manatee established four objectives: (1) identify and minimize causes of manatee disturbance, injury, and mortality, (2) protect essential manatee habitat, (3) determine and monitor the status of manatee populations and essential habitat, and (4) coordinate recovery activities, monitor and evaluate progress, and update and/or revise the recovery plan (FWS 1996).

Building upon efforts that began in the 1960s, an array of Federal, State, local, and private groups have contributed to the protection of the manatee. A considerable collaborative effort has been put forth and continues today to minimize human-induced effects on manatees and assist in its recovery. Current efforts include manatee salvage programs, population biology research, population surveys, habitat protection, public awareness programs, and growth management activities. Thirteen counties in Florida were designated in 1989 as "key" counties by the Governor of the State of Florida. This designation recognized the necessity of implementing protection measures in these counties, where 80 percent of the manatee mortalities occurred.

Accomplishments resulting from this collaboration include: (1) the protection of essential and critical manatee habitat, (2) implementation of speed zones in manatee-sensitive areas, (3) increased public awareness and support, (4) the initiation of a manatee rescue, rehabilitation and release network, and (5) advanced techniques for surveying and tracking manatees (FWS 1996).

Identify and Minimize Causes of Manatee Injury and Mortality

In response to the high number of manatee deaths due to floodgates and navigation locks, efforts began in the early 1980s to modify gate opening procedures to ensure manatees were not killed. A task force with representatives from the FWS, SFWMD, the COE, the DEP, and the Miami-Dade County DERM are overseeing ways to reduce these deaths. As a result of these efforts, the number of manatees killed by floodgates and canal locks declined between 1976 and 1980. The COE, SFWMD, and Harbor Branch Oceanographic Institution are developing and testing automatic reversal mechanisms to prevent manatee deaths. When these technologies become available, the COE will retrofit the structures with the mechanisms, in accordance with section 1135 of the Water Resources Development Act of 1986, as amended.

The FWS, through section 7 of the ESA, reviews permit applications for various projects that may affect manatees. As part of these reviews, the FWS recommends ways to avoid, reduce, or minimize the effects of projects on manatees. In addition, the FWS has developed speed and access rules for motorboats within the boundaries of Merritt Island NWR, and similar guidelines are being recommended for other Federal facilities in manatee habitat. The DEP, through its manatee protection plan, is developing guidelines to reduce manatee watercraft injuries and deaths by implementing waterway speed and access (*e.g.*, no entry) zones in the 13 key counties.

Public education is an important management tool in protecting and recovering the manatee. Several groups, especially the Save the Manatee Club, have participated in the efforts to educate the public about manatee protection and habitat conservation, including ways to decrease the number of boat-caused manatee deaths, improve water quality, and reduce habitat degradation. The FWS is coordinating with the COE to develop manatee education and boating programs for proposed projects such as marinas, boating facilities, and boat ramps in an effort to reduce the number of manatees killed in collisions with watercraft.

Protect Essential Manatee Habitat

Through the NWR System, the FWS has acquired thousands of acres of land important to manatees in the Crystal, Homosassa, and Suwannee rivers. Three new manatee sanctuaries have been established in Florida, as well as a motorboat-prohibited area in the Merritt Island NWR and the Kennedy Space Center. The State of Florida has several programs to protect and acquire lands including the Conservation and Recreational Lands (CARL) Program which dedicates five percent of its program budget to habitat-related purchases for the manatee.

Determine and Monitor the Status of Manatee Populations

Several groups have contributed to the overall understanding and information available on the life history of the manatee, including the FWS, Sirenia, DEP, Georgia DNR, academic institutions, and marine zoological parks. Important components of past and ongoing research efforts include the carcass recovery and necropsy program, radio tracking and satellite telemetry studies on manatee movements and habitat use, the manatee individual photo-identification system (MIPS), aerial surveys to determine minimum population size and identify distribution patterns, a geographical information system (GIS) database to integrate available manatee information, and several additional studies on manatee biology and ecology.

Advance Techniques to Protect Manatees

The FWS established the Interagency/Oceanaria Working Group to coordinate captive manatee management and rehabilitation. An extensive program is now in place to facilitate the rescue, rehabilitation, and release of manatees. Several long-term captive manatees have been direct-released in Everglades NP, and monitoring of these individuals continues.

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Recovery for the West Indian Manatee
Trichechus manatus

Recovery Objective: RECLASSIFY to threatened, then delist.

South Florida Contribution: Reduce human-related mortality in South Florida; control or reduce threats to essential manatee habitat in South Florida.

Recovery Criteria

The statewide manatee recovery plan states that the West Indian manatee can be considered for reclassification to threatened when data and population models are available to assess population size and trends; when analyses indicate that the population is growing or stable; when mortality factors are controlled at acceptable levels or are decreasing; and when critical habitats are secure and threats to them are controlled or decreasing (FWS 1996).

Species-level Recovery Actions

S1. Support the investigation of the distribution and status of the manatee and its habitat in South Florida by continuing flying synoptic statewide aerial surveys. Aerial survey sighting data have provided and continue to provide useful data on manatee distribution and, in some situations, relative abundance. When combined with telemetry data, certain types of aerial sightings provide a sound basis for determining habitat use patterns. Aerial sightings also provide useful information on the proportion of calves. Because of uncertainty in the number of animals not seen in turbid water, uncertainty as to the proportion of the population within a survey area, and other problems, however, aerial sighting data generally do not permit scientists to estimate or detect trends in population size.

S1.1. Continue flying synoptic statewide aerial surveys. In 1991, the Florida Marine Research Institute began flying coordinated statewide aerial surveys of all known winter manatee habitat. The surveys are flown following cold fronts when manatees aggregate at warm water refuges in greatest numbers. They involve large numbers of observers flying simultaneously over different segments of known winter manatee habitat. Although problems limit the use of this sighting data to measure population size or trends, the surveys have provided high counts that improve the lower bound of the range of the estimated number of animals. If correction factors for uncertainties noted above can be developed, the resulting data also may be used in the future to determine population trends. As appropriate, such surveys should be continued. For South Florida, aerial surveys should emphasize both manmade and natural warmwater sites; particularly the waterways of Florida Bay and Everglades NP.

S1.2. Undertake regional or local aerial surveys. In some areas, aerial surveys are needed to improve information on local habitat use patterns. The information obtained through these surveys has been an important basis for developing and analyzing new speed zones and other management measures. As appropriate and possible, local aerial surveys should be undertaken or continued in the Indian, Miami, and Caloosahatchee rivers; Sarasota, Estero, and Rookery bays; Coral Gables Waterway, Ten Thousand Islands region, and Whitewater Bay as well as other areas to improve information on local habitat use patterns and trends in relative abundance.

S1.3. Continue aerial surveys of aggregation sites after cold fronts. Florida Power & Light Company has supported aerial surveys of manatees at warm-water powerplant outfalls each winter since 1977. In addition to data on the numbers of animals sighted at these warm-water refuges, this long-term data set includes calf counts that provide valuable information on reproduction. If correction factors can be developed to account for sighting uncertainties, the data may be useful in the future for assessing past population trends.

S1.4. Support a dedicated aerial survey specialist and convene an Aerial Survey Working Group. During a 1992 workshop on manatee population biology (O'Shea *et al.* 1992), participants reviewed aerial survey methodology and identified steps that might be taken to improve information generated by aerial surveys. Participants concluded that better interpretation of aerial data could help detect regional (though perhaps not statewide) trends in abundance. Improvements are needed in stratifying survey effort by type, refining information on diving behavior, defining acceptable sighting conditions, and testing strip transect methodology. A dedicated aerial survey specialist should be supported to monitor progress on aerial survey research, improve survey methodology, and develop correction factors for sighting uncertainties. In addition, an Aerial Survey Working Group chaired by the specialist should be convened at least annually to provide further advice and assistance.

S1.5. Analyze available aerial survey data. Re-evaluate the results of past aerial surveys to improve estimates of selected parameters and population trends. Aerial survey data sets should be evaluated regionally to determine whether they are sufficiently complete and up-to-date. Areas that need to be resurveyed should be identified. In addition, new methodologies and analytical techniques might be applied to ongoing aerial surveys. As possible, such analyses should be undertaken.

S2. Protect and enhance existing populations by identifying and minimizing causes of manatee injury, mortality, and disturbance. Manatees are killed and injured as a result of interactions with boats, floodgates, navigation locks, marine debris, and fishing gear. In rare cases, manatees are killed by vandals and poachers. Additional mortalities, from natural causes such as severe cold weather or red tide, may also significantly affect the status of the manatee population. To permit growth of the manatee population and reach an optimal sustainable population level, such causes of mortality must be reduced. This section of the recovery plan identifies activities needed to monitor and reduce such sources of mortality.

S2.1. Maintain and improve the salvage and necropsy program. The manatee salvage/necropsy program is fundamental to identifying causes of manatee mortality and injury. The program is responsible for collecting and examining virtually all manatee carcasses reported in the southeastern U.S., determining the causes of death, monitoring mortality trends, and disseminating mortality information. Program data help identify, direct, and support essential management actions (*e.g.*, promulgating watercraft speed rules and reviewing permits for construction in manatee habitat). The program was begun by the Sirenia Project and the University of Miami in 1974. Procedures and protocols to standardize necropsies were developed in the early 1980s (Bonde *et al*. 1983) and expanded significantly early in the 1990s. Now part of the DEP's Florida Marine Research Institute, the major program duties include: receiving manatee carcass reports from the field; collecting and examining dead animals; maintaining accurate mortality records; and carrying out special studies to improve understanding of mortality causes, rates, and trends. Program staff also coordinate rescues of injured or distressed manatees.

S2.1.1. Ensure prompt and complete reporting of manatee carcasses. To obtain manatee carcasses for necropsy, the carcass recovery and necropsy program relies on reports of carcasses from members of the public. These reports are usually provided through the Florida Marine Patrol, officers in the GFC, or local officials. To provide the best possible understanding of manatee mortality causes and trends, it is important not only to obtain as many reports as possible, but also to assure that reports are received promptly so that carcasses are as fresh as possible when necropsied. The following tasks will facilitate reporting from the field.

S2.1.1.1. Provide training for law enforcement officials on carcass reporting procedures. Most manatee carcasses are found by the public and reported to the Florida Marine Patrol or local law enforcement officials. To ensure that program staff are notified of all reported carcasses, officials likely to receive such reports need to be advised and reminded of the data needs and procedures for reporting carcasses to the salvage and necropsy program staff and the importance of doing so promptly. Periodic presentations by program staff and/or mailings should be made to the Florida Marine Patrol Academy, to Florida Marine Patrol officers in the field, and to other law enforcement groups, such as the GFC, the U.S. Coast Guard, local police departments, and county sheriffs. To maintain interest and involvement, efforts to provide feedback to law enforcement officials on the results of necropsies and program findings should be undertaken routinely.

S2.1.1.2. Encourage public reporting of carcasses. Most manatee carcasses are found by boaters, shoreline residents, and other members of the public frequenting waterways and shorelines. To increase public reporting, information on procedures for reporting carcasses and the importance of doing so promptly should be included in posters and appropriate public education materials. Periodic mailings and/or presentations and public service announcements targeting appropriate groups such as homeowners associations, boating, diving, and fishing groups, and others should be prepared and sent.

S2.1.2. **Maintain salvage and necropsy field stations and staff.** The salvage and necropsy program includes a central necropsy facility operated by DEP at Eckerd College in St. Petersburg, three field stations on the east coast located at Jacksonville, Melbourne, and Tequesta, and one field station on the west coast at Port Charlotte. The stations collect, examine, and dispose of carcasses, and record, analyze, and distribute mortality data. Support must be provided to maintain an adequate program staff and provide the necessary equipment.

S2.1.2.1. **Provide support for salvage and necropsy program staff and equipment**. Salvage and necropsy program staff are part of DEP's Florida Marine Research Institute. Field station personnel are responsible for promptly collecting dead animals and related data in the field and transporting the carcasses to the central necropsy facility. The central facility's staff is responsible for conducting all necropsies; collecting, examining, and archiving tissue samples; distributing tissue samples to other researchers; photo-documenting wounds and scars on all salvaged carcasses; recording and analyzing data; performing special studies; preparing monthly and annual mortality summary reports; and administering and coordinating all salvage and necropsy program work. Staffing must be continued to properly conduct this program. In addition, annual funding is needed to repair, replace, upgrade, and otherwise maintain such equipment and supplies necessary to carry out necropsy work.

S2.1.2.2. **Develop and coordinate out-of-state salvage efforts. During summer, some Florida manatees migrate north into Georgia, South Carolina, North Carolina, and Virginia or west into Alabama and Louisiana. To maintain accurate mortality data, arrangements are needed to collect carcasses and data from animals that die in these areas. This requires (1) alerting State and local officials in these areas of the importance of reporting dead manatees, and (2) supporting travel and other expenses associated with collecting carcasses and mortality data. The FWS and the salvage and necropsy program staff should cooperate in contacting appropriate officials outside of Florida to alert them as to reporting needs and procedures for manatee carcasses found in their respective areas, and ensuring funds are available for collecting manatee carcasses and mortality data promptly.**

S.2.1.3. **Undertake special studies and analyses to improve understanding of mortality causes and trends. Special studies are needed to better define and explain various factors, phenomena, or events influencing poorly understood mortality trends.**

S2.1.3.1 **Assess manatee carcass reporting rates.** While it is believed that most dead manatees are found and reported, an unknown proportion go unreported, resulting in an under-representation of annual manatee mortality totals. To assess the number of manatee carcasses that go unreported, studies of carcass detection and reporting rates should be undertaken.

S2.1.3.2. **Undertake a workshop and/or studies to identify the proximal cause(s) of perinatal mortality.** In recent years, perinatal mortality has increased at a rate greater than any other mortality category and now constitutes approximately 25 percent of the total annual mortality. The causes of increased perinatal mortality are uncertain. It may be related to pollution, injuries and stress from increased vessel traffic and other human activities, changes in the age structure of mature breeding females, habitat changes, or some combination of these and other possible causes. It also may be due to a greater number of births. A workshop should be held to investigate available information on perinatal mortality, research needs, and mitigation measures. Possible contributing factors and any regional differences should be examined.

S2.1.3.3. **Undertake routine and periodic tissue analyses.** To obtain maximum information from carcasses and wild and rescued manatees, it is necessary to examine and analyze tissues for contaminant levels, reproductive status, age at death, *etc.* In addition, to improve understanding of disease and immunotoxicological processes, salvaged tissues, organs, and organ systems should be studied. Serum from wild and rescued manatees should also be screened to assess the incidence of exposure to various viral, bacterial, parasitic and other pathogenic organisms. A centralized serum bank should be established to analyze diseases.

S2.1.3.4. **Investigate and respond to potential unusual mortality events.** From time to time there are unusual mortality events in which large numbers of manatees die or become moribund. For example, over 45 animals died in association with a severe cold front in late December 1989, and at least 149 animals died in association with a red tide event that struck southwest Florida populations in 1996. A plan for responding to such an event has been prepared by the FWS as required by the Marine Mammal Stranding Act of 1992. If a large-scale mortality event occurs, the FWS and the salvage and necropsy program will need to coordinate response efforts using contingency plans and funding specifically designed for these events.

S2.2. Minimize collisions between manatees and watercraft. The largest source of human-related manatee mortality is collisions between manatees and watercraft. Known watercraft deaths now constitute at least 20 to 22 percent of the total known annual mortality. Watercraft may cause additional deaths or reduced population growth due to indirect effects of injuries and stress on the reproductive success of mature females (Marine Mammal Commission 1993). Actions to address specific needs are discussed below.

S2.2.1. **Develop and refine State waterway speed and access rules.** The State of Florida has begun promulgating waterway speed and access rules to reduce the number of collisions between manatees and watercraft. The rules seek to create a system of speed and access zones tailored to local manatee habitat use-patterns and boating needs. Rulemaking is an intensive process that requires compiling and reviewing voluminous site-specific environmental data, particularly on manatee habitat-use patterns and boating activity; extensive coordination between county and DEP officials to develop rule provisions; public hearings and review; and approval by the Secretary of DEP. As directed by the Florida Governor and Cabinet in 1989, priority attention has been focused toward 13 key counties. Rules for 12 of the 13 key counties are complete. Over the next 5 years, the need for manatee protection measures in the remaining key county and some 20 other counties with important manatee habitat should be considered. Also, rule refinements likely will be needed to increase rule and sign uniformity and to reflect new information on manatee habitat-use patterns and boating activity.

S2.2.2. **Develop and refine Federal waterway speed and access rules.** For certain Florida waterways, particularly those in or adjacent to NWRs, the FWS has promulgated Federal rules regulating vessel speed and access. These rules, which complement State rules, are issued under authority of the ESA, the Marine Mammal Protection Act, and/or the NWR System Administration Act. Federal rules issued by the COE to control vessel speeds adjacent to navigation locks also may enhance manatee protection. Although the principal purpose of the latter rules is vessel safety around navigation locks, they also reduce the risk of manatee-vessel collisions and should be encouraged for both reasons at locks used by manatees along the Okeechobee Waterway, Cross Florida Barge Canal, and elsewhere. As necessary and appropriate, such Federal rules should be modified and new rules promulgated in cooperation with the State of Florida and other concerned parties.

S2.2.3. **Post and maintain regulatory signs.** To advise watercraft operators of speed and access restrictions, regulatory signs are posted strategically along waterways. As proper posting is a prerequisite for enforcing and prosecuting violations, signage is as important as the rules themselves. The extensive new rules necessitate posting thousands of new signs along thousands of miles of waterway. On the east coast, the Florida Inland Navigation District is responsible for sign posting and maintenance. Elsewhere the task is shared by the DEP, the West Coast Inland Navigation District, and the counties. Once county rules are adopted, the DEP's Office of Protected Species Management develops or reviews signage plans, the Florida Marine Patrol issues permits for sign placement, and the entity responsible for printing and posting then proceeds with actual posting. As rules are completed or modified, signs should be posted promptly by the responsible agency. Once posted, they should be inspected periodically and repaired or replaced as needed. Signage changes may be warranted based on enforcement or navigation needs or efforts to make sign messages clearer and more uniform.

S2.2.4. **Enforce and encourage manatee protection regulations.** The Florida Marine Patrol is the principal agency in Florida responsible for enforcing speed and access rules as well as other manatee protection rules. Federal and State officers assigned to selected parks, refuges, and reserves, the GFC, and the U.S. Coast Guard also assist with enforcement. Effective enforcement requires training to ensure that officers are aware of the purposes and provisions of the rules and how to enforce them. It also requires cooperation among various Federal and State enforcement officials, and the judiciary.

S2.2.4.1. Focus and increase officer time dedicated to enforcing manatee protection rules. Manatee protection rules are but a few of the myriad of rules which law enforcement officers must enforce. To maximize the effectiveness of enforcing rules concerning manatees, steps should be taken to: (1) concentrate efforts at times and areas where boat and manatee densities are greatest; (2) increase the amount of time dedicated to enforcing manatee protection rules; and (3) provide speed guns and training to appropriate field officers. The Florida Marine Patrol, GFC, the Office of Protected Species Management, and the FWS should periodically review needs and strategies for concentrated enforcement efforts.

S2.2.4.2. Develop and implement a strategic plan to strengthen cooperative interagency enforcement. Enforcement of manatee protection rules involves field officers in various Federal, State, and local agencies as well as judicial, legislative, and regulatory support. Although waterway speed and access rules demand the greatest time and effort to administer, rules for poaching, incidental take in fisheries, harassment, *etc*., also require attention. A strategic enforcement plan should be developed and implemented to establish a cooperative interagency field enforcement network that is backed by a supportive judiciary and legislature. The strategic plan should address interagency agreements as may be needed for effectively cross-deputizing and coordinating Federal, State, and local field officers; develop and update officer training programs and explanatory materials on manatee protection rules and enforcement needs; conduct periodic training and refresher courses for enforcement units at all levels; coordinate interagency enforcement exercises; make regulations as clear and as uniform as possible; educate the judiciary and otherwise facilitate prosecutions of manatee-related rule violations; and work with the legislature to ensure fines, penalties, and other statutory provisions are clear and as effective as possible.

S2.2.4.3. Conduct surveys to assess compliance with rules. Field surveys should be done to monitor the extent to which watercraft comply with regulatory measures. Periodic surveys on selected waterways in each key county should be undertaken.

S2.2.4.4. **Encourage and cooperate with efforts to develop unified statewide boating safety measures.** Proposals for state-wide speed limits, boat operator licenses, and mandatory boater education have been considered in the past. Such measures would complement and enhance efforts to reduce watercraft-related manatee deaths by offering opportunities to educate boaters about manatees. Although such boating safety measures have been rejected to date, similar measures may be proposed and adopted in the future. To the extent possible, new proposals to establish statewide boating safety measures should be encouraged. Particular efforts should be made to integrate manatee protection concerns into any new boater education programs.

S2.2.5. **Establish policies for authorizing boat races and other water sport events.** Certain organized water sports events, such as boat races, water-ski contests, and fishing tournaments, involve boats traveling at high speed. In certain areas and times, these activities pose threats to manatees. Permits for such events typically are required from the U.S. Coast Guard. The U.S. Coast Guard considers advice from the FWS and DEP on whether a permit should be granted, denied, or granted conditionally given possible effects on manatees. To help planning for boat races, representatives from DEP, the FWS, and boat racing organizations developed guidelines on when, where, and under what conditions such events could be held consistent with manatee protection objectives. The guidelines are used by the FWS and DEP to review permit requests and by event organizers to plan events. The FWS and DEP should keep such guidelines under review and modify or expand them as needed to address other types of water sport events. The FWS, and the U.S. Coast Guard should continue to consult on the issuance of permits for sporting events that involve high speed boats in manatee habitat.

S2.2.6. **Indicate speed and access zones on nautical charts.** NOAA publishes nautical charts and a “Coast Pilot” to help vessel operators navigate in coastal waters. As new speed and access rules are adopted, NOAA and other organizations publishing navigation charts should update their publications.

S2.2.7. **Assess and reduce mortality caused by large vessels.** Large slow-moving ships (*e.g.*, tugs and cargo vessels) are known to kill manatees. Some animals appear to be pulled into propeller blades by the sheer power of generated water currents and others are crushed between the bottom and the hull of deep-draft ships. When moored, large vessels also can crush manatees between their hulls and adjacent wharves or ships. To prevent the latter problem, some ports (*e.g.*, the Mayport Naval Station) have begun using fenders to maintain minimum stand-off distances between moored vessels and wharves. To address the threat of propellers on large tugs operating at the Kings Bay Naval Base, the Navy recently designed and installed propeller shrouds on its C-tractor tugs. These approaches may be useful in other areas.

To consider applying such measures more widely, a study should review mortality data for evidence of deaths attributable to large vessels; examine barge, tug, and other large vessel traffic patterns relative to manatee distribution; assess the feasibility and cost of installing propeller guards or shrouds on large vessels or tugs routinely plying waterways used by manatees; consider rules to require fenders when mooring large vessels in manatee habitat; evaluate ways to educate harbor pilots about the threats large vessels pose for manatees; and identify other possible mitigation measures. Actions to implement appropriate measures should be taken based on study findings.

S2.2.8. Evaluate the feasibility of propeller guards or alternative propulsion technology for small watercraft. In the past, propeller guards have been examined as a possible solution to recreational watercraft-related manatee mortality. They also have been considered for improving human safety and protecting seagrass beds. While new designs are developed periodically, their effect on vessel speed and steerage have discouraged general use. Broad use of propeller guards should reduce propeller-caused manatee injuries; however, it may only marginally reduce overall injuries and deaths since the impact of a propeller guard on a fast-moving boat is as injurious to manatees as the wounds from propellers. Nevertheless, as new designs are developed, they should be tested and evaluated. Once efficient and effective guards are available, incentive-based programs should be explored to encourage greater use of propeller guards.

S2.2.9. Continue section 7 and State reviews of boating facilities and watersport events. Marinas, boat ramps and other boating facilities increase local boat traffic. They can therefore influence the frequency of watercraft collisions with manatees in areas where manatees are common. Facility construction and the resulting traffic also can degrade habitat features, such as seagrass beds, which are important to manatees. Such facilities require permits from the COE, environmental resource permits from the DEP, and submerged land leases from Florida's Board of Trustees. As noted above, watersport events also may affect manatees and require permits from the U.S. Coast Guard. Under section 7 of the ESA and other Federal regulations, the FWS reviews and comments on permit applications whenever they may affect endangered species and other natural resources. This formal review process is a fundamental part of the manatee recovery program and must be continued.

S2.3. Minimize manatee deaths in water control structures. Late in the 1970s, eight to nine manatees per year were killed in floodgates and navigation locks. To reduce this mortality, steps were taken to modify gate opening procedures. Annual mortality initially decreased in the early 1980s. The number of deaths subsequently increased and in 1994, 16 deaths were recorded. An ad hoc interagency task force was established with representatives from the SFWMD, the COE, the FWS, and DEP to examine other steps to prevent such deaths. Support the development, testing, and implementation of new alternative measures at water control structures to reduce the number of manatee injuries and deaths. Coordinate with the South Florida Ecosystem Restoration Task Force to ensure alterations in the quantity or quality of water flow do not negatively affect the manatee and its habitat (*i.e.*, effects of alterations of water flow in the C & SF, Caloosahatchee River, St. Lucie Waterway, and Whitewater Bay).

S2.3.1. **Develop, test, and implement new alternative measures.** The interagency task force has identified several possible alternatives to reduce floodgate and navigation lock deaths. They include adjusting gate opening sequences, installing slotted gates or gates with new top-flow designed structures, adding detection devices to alert gate operators when manatees are present, and/or installing automatic door reversing mechanisms similar to safeguards on elevator doors. A pressure-sensitive unit has been designed and tested on two water control structures by the SFWMD with inconclusive results. The COE is preparing a Section 1135 Project Modification Report on Manatee Protection at Select Navigation and Water Control Structures. The devices and techniques that resulted from this study should be installed, tested for effectiveness, and implemented in a timely manner.

S2.3.2. **Promptly investigate structure-related deaths.** Gate-and lock-related manatee mortality should be kept under continual review by FWS, DEP, and the agencies directly responsible for the structures. Structures at which multiple deaths occur should be investigated immediately to identify and correct contributing factors.

S2.4. **Assess and minimize manatee injuries and deaths caused by fisheries.** In some years, as many as six manatees have been killed in commercial fishing gear. Most are caught and drowned in nets of inshore shrimp boats in northeast Florida; others are entangled in float lines for crab traps. Commercial fisheries in coastal Florida are managed cooperatively by the Florida Marine Fisheries Commission and the DEP. To minimize adverse interactions between fisheries and manatees, the following steps are needed.

S2.4.1. **Minimize manatee drownings in shrimp nets.** The Florida Marine Fisheries Commission has completed portions of a statewide shrimp fishery management plan. The Commission, DEP, and FWS should review and, as necessary, update measures to prevent manatees from being caught and drowned in shrimp nets. As an initial step, DEP has printed and distributed brochures to advise shrimp fishermen of the problem and the steps they can take to minimize drownings (*e.g.*, reducing tow times and immediately retrieving nets when heavy objects are encountered). If such education efforts do not resolve the problem, other measures (*e.g.*, gear, season, and/or area closures) should be considered, incorporated into the plan, and implemented.

S2.4.2. **Minimize injuries and deaths in crab pot lines and other fishing gear.** Manatees are entangled in crab pot float lines, various types of fishing nets, and monofilament line used by recreational fishermen. Information on interactions with such fishing gear should be kept under review by DEP and FWS. Steps should be taken to improve reporting of animals caught in fishing gear, particularly those that are released or escape alive.

Steps to identify and implement measures to reduce or avoid such interactions should be taken, if needed.

S2.4.3. **Identify locations where fishing gear impacts manatees and implement measures to mitigate impacts.** In certain areas where commercial and recreational fishing is particularly heavy and/or where manatees tend to aggregate, interactions with fishing gear may be particularly common. At some east coast aggregation sites, manatees are snagged by lines, lures, and treble hooks of recreational fishermen. These sites should be identified and, as warranted, steps should be taken to assess and implement actions to prevent potentially threatening interactions with fishing gear.

S2.5. **Investigate and prosecute all incidents of poaching and malicious vandalism.** Poaching, shooting, butchering, and other malicious vandalism against manatees are rare occurrences. All reports and evidence regarding such incidents should be turned over to the FWS's law enforcement agents for investigation and prosecution to the fullest extent of the law. As appropriate, a reward system should be established to help investigate and prosecute violations.

S2.6. **Rescue, rehabilitate, and release distressed manatees.** Reports of injured or distressed manatees are frequently received by officials in the manatee recovery program. While many prove false, some form of rescue action is deemed necessary in about 15 to 25 cases per year. In some cases, animals are treated and released immediately. In others, rehabilitation in captivity is needed and marine zoological parks make facilities, resources, and expertise available to transport and care for animals prior to their release back into the wild. Such actions help reduce manatee mortality but require extensive cooperation among Federal and State agencies, zoological parks, and other institutions and organizations. The FWS, with the assistance of an Interagency/Oceanaria working group, maintains oversight of work to rescue, rehabilitate, and release animals. The Florida Marine Research Institute's manatee salvage and necropsy program has agreed to coordinate rescue response work on a day-to-day basis. The FWS's Jacksonville field office coordinates captive program activities and manatee releases. In addition, under state law, DEP has been authorized and directed to provide partial reimbursement to cooperating parks and organizations to help defray rescue and rehabilitation costs. This program should continue.

S2.6.1. **Authorize cooperative participation in the manatee rescue/ rehabilitation network.** The FWS has overall responsibility for work to rescue, rehabilitate, and release injured or otherwise distressed manatees. To meet this obligation, the FWS's Office of Management Authority issued an endangered species/marine mammal enhancement permit to authorize related work by cooperating facilities and organizations. Letters of authorization under this permit are issued by the FWS to qualified groups interested in participating in the rescue/rehabilitation network. The letters set forth the scope of their respective involvement in (1) verifying, (2) rescuing and transporting, and/or (3) treating and maintaining distressed animals. Activities under letters of authorization need to be reviewed continually. Every effort should be made to provide training opportunities to members of authorized groups to ensure continuous improvement in local rescue assessment and logistic capabilities. The FWS should update or modify the terms of existing letters and/or issue new authorization letters to additional qualified facilities or organizations as such needs are identified.

S2.6.2. **Coordinate and oversee day-to-day rescue operations.** To assure prompt, effective responses to distressed manatees, a rescue coordinator has been designated to receive initial reports of such animals and to mobilize and coordinate rescue network teams. The Director of the Florida Marines Research Institute's manatee salvage and necropsy program currently serves as the rescue coordinator. Reports of distressed animals should continue to be directed to the rescue coordinator who in turn contacts authorized rescue network teams to organize a response for verification, rescue, and transport to available treatment facilities as necessary, and notifies the FWS of ongoing rescue operations, and unusual or significant incidents as necessary.

S2.6.3. **Ensure adequate rehabilitation facilities.** In the past the number of captive manatees has ranged from about 40 to 50 animals. Three "Pre-Act" animals (animals brought into captivity prior to enactment of the ESA) have been in captivity for several decades. Some captives have been judged unreleasable due to the nature of their injuries or concern about their ability to adapt to the wild (*e.g.*, long-term captive animals that were born in captivity), and the remainder are animals in varying stages of rehabilitation.

Captive Florida manatees are held at eight marine facilities and zoological parks:

1. Sea World of Florida* - Orlando, Florida
2. Miami Seaquarium* - Miami, Florida
3. Lowry Park Zoo* - Tampa, Florida
4. Homosassa Springs State Wildlife Park - Homosassa Springs, Florida
5. Epcot's Living Seas - Lake Buena Vista, Florida
6. South Florida Museum -Bradenton, Florida
7. Sea World of California - San Diego, California
8. Mote Marine Laboratory - Sarasota, Florida

(* = Critical Care Treatment Facility)

Space for captive animals is limited and maintenance costs to feed and care for them are relatively high (at least $ 25-40,000 per animal per year). To assure space is available to maintain animals rescued in the future, steps are being taken to return rehabilitated animals to the wild as quickly as possible. To provide additional options for management, captive maintenance facilities at the Homosassa Springs State Wildlife Park and elsewhere should be expanded and improved, as needed.

S2.6.4. **Convene periodic meetings of the Interagency/Oceanaria working group and the Captive Manatee Planning Committee.** The FWS convenes periodic meetings of an Interagency/Oceanaria working group to help coordinate rescue, rehabilitation, and release work and to manage captive maintenance activities in ways that will best meet manatee recovery objectives. Among other things, the working group reviews the status of manatee rescue and rehabilitation work; maintains records of captive manatees; charts the progress of animals towards their release; assists the FWS in developing and reviewing protocols and criteria for the rescue, transport, rehabilitation, maintenance, and release of animals; and exchanges information and expertise with respect to rescue, rehabilitation, maintenance, and release procedures.

Captive manatees also provide unique opportunities to study physiological processes and other aspects of manatee ecology that may add to the information base on habitat requirements and recovery needs. Such work, however, should not impede rehabilitation and release of captive animals. To help evaluate and direct research on captive animals the FWS has established a Captive Manatee Planning Committee. In part, the Committee is responsible for reviewing all research proposals and management options involving captive manatees and making recommendations to the FWS's manatee coordinator. At least two meetings per year of both the full working group and its planning committee should be held.

S2.6.5. Facilitate and evaluate animal releases. As soon as animals taken into captivity for rehabilitation or care are judged suitable for release back into the wild, steps should be taken to do so. Decisions on releases should be made by the FWS in coordination with the facility maintaining the animal and the Interagency/Oceanaria working group following established criteria.

S2.6.5.1. Develop protocols and criteria to govern releases and evaluate the manatee's readaptive success. To assure that released animals will readjust to the wild, criteria and protocols need to be developed and kept under review for assessing the physical health of animals in release pens and their fitness to be released. The guidance in these criteria and protocols should be modified as necessary based on the success or failure of animals with different histories and medical records to adapt to wild conditions. Veterinarians in the Interagency/Oceanaria working group, in coordination with the FWS, should develop and keep such protocols and criteria under review. Similar guidance also should be developed to help with decisions on whether and when to recapture animals not satisfactorily acclimating to the wild.

S2.6.5.2. Radio-tag and track released manatees. To help assess readjustment and survival of rehabilitated manatees returned to the wild, certain released animals should be followed by telemetry upon release and all released animals should be tagged with Passive Integrated Transponders (PIT) tags. This will aid in assessments of whether animals adopt normal habitat-use patterns, interact with other manatees, and readapt successfully to the wild. If problems arise, it also may help in locating and recapturing animals. Over the next five years, 5 to 10 animals are expected to be released annually. Telemetry tags, staff, and other support needed to track about 5 to 7 released animals annually will be required.

S2.7. **Minimize other human-related disturbances and harassment.** Disturbance and harassment by boaters, divers, fishermen, and others can alter manatee behavior and reduce the suitability of some areas as manatee habitat. Waterway speed and access restrictions partially address causes of disturbance and harassment. However, general guidance and advice for certain user groups and the general public also are needed on ways to minimize or avoid interactions that alter natural behavior and movement of manatees. The following tasks are needed to develop regulations, guidelines, and/or practical principles that define proper conduct by divers, boaters, and others with respect to feeding, watering, approaching, viewing, or otherwise interacting with manatees.

S2.7.1. **Prepare and adopt guidelines for the development of manatee viewing areas.** Interest in developing facilities to allow members of the public to view wild manatees is increasing. While such facilities offer public education and awareness opportunities, they also increase the potential for harassment of animals and perhaps even malicious injuries. Proposals for such facilities need to be examined carefully. To respond to future proposals to create manatee viewing facilities, guidelines should be prepared for determining when such facilities would be consistent with manatee recovery objectives and what design features or other conditions should be required.

S2.7.2. **Prepare and adopt guidelines or regulations on feeding and watering manatees.** Even when well-intentioned, public feeding or watering of wild manatees may alter natural behavior in ways that ultimately change manatee distribution patterns or place individual animals at risk. It may condition animals to approach boats or areas that are hazardous, or encourage them to remain in areas during times that could expose them to thermal stress. The development of guidelines and public education programs and, if necessary, regulations to discourage such activities should be evaluated and implemented. Enforcement policies must be adopted by responsible agencies. Special attention is needed at areas where feeding or watering by the public is done routinely.

S2.7.3. **Develop and keep under review guidelines governing close approaches to manatees.** At times, manatees and people, particularly divers, come in close and even direct physical contact with one another. While manatees occasionally invite such contact, people often chase after manatees that are trying to avoid them. This constitutes harassment, which is a violation of Federal law and may cause animals to leave preferred habitats. The latter is an issue of particular concern at the Crystal River NWR. The FWS has prepared a brochure advising divers at Crystal River on proper conduct when encountering wild manatees. Current policies and provisions governing close encounters between manatees and people in the wild should be kept under continuing review and their form and content modified if they are found to afford inadequate protection for manatees.

S2.7.4. **Coordinate with the FWS' Contaminant Program and other entities to minimize contaminant effects on the manatee in South Florida.** Investigate contaminant effects on the manatee, including red tide, nutrients, and heavy metals. Support the development and implementation of management actions to minimize negative effects from contaminants.

S3. **Support research on the physiology, life history, and ecology of the manatee.** Studies of physiology, life history, and ecology are needed for understanding population status and trends, and to help assess what habitats are most important to manatees and why. Collect additional biological information on number of individuals, age-class structure, habitat use, reproductive viability, food use and availability, and threats.

S3.1. **Maintain and analyze manatee "scar catalog" data.** Many manatees have scars from boat strikes or other sources. When carefully photographed, they provide a means of identifying individual animals. Photographs of distinctively marked animals collected by researchers in the field are compiled in a manatee scar catalog held by the Sirenia Project with support from the Florida Power & Light Company. The catalog has been expanded and improved and is now a computerized system of photos on compact-disc, the Manatee Individual Photo-identification System. The Florida Marine Research Institute now assists in maintaining portions of the catalog. The data provide valuable information on movements, site-fidelity, age at first reproduction, calving intervals, and other vital parameters. Recent analyses indicate resighting data can be used to derive survival rates. This database should continue to be maintained and analyzed.

S3.1.1. **Continue to collect photographs of individually identifiable manatees in the field.** Photographs of individually identifiable manatees should be routinely collected from the field. In particular, photographs should be obtained at winter aggregation sites. The routine collection of photographs from the field and their incorporation into the catalog will ensure that information on movement patterns, site-fidelity, reproductive histories, survival rates, and related databases remains current.

S3.1.2. **Maintain staff support to collect, enter, check, retrieve, and analyze scar catalog data.** Some 6,000 new photographs are submitted annually by field researchers for inclusion in the catalog. Comparison of photographs with previously identified animals, proper entry of new data, and retrieval of data for analyses requires a dedicated staff member who is proficient and familiar with both the classification system and the identified individuals. Continued support, including a dedicated scar catalog archivist, to maintain and upgrade the scar catalog for both the east and west coasts should be provided. Standardized protocols for describing and coding data collected by photographers have been distributed for use by all cooperators submitting photographs to the catalog. Distribution of photographs of carcasses must continue so that dead manatees can be removed from the active catalog files.

S3.1.3. **Upgrade and maintain computer/camera equipment for the scar catalog.** The scar catalog is presently maintained as a computer-based system that uses a CDROM. The catalog now includes over 1,000 animals and nearly 15,000 sighting and resighting records (Beck and Reid 1995). Computer and camera equipment to store, sort, and retrieve photographs and sighting data must be purchased, maintained, and upgraded to facilitate and enhance use of the catalog's data.

Photographs of carcasses taken by the Florida Marine Research Institute should be shared with the Sirenia Project so that dead animals can be removed from the active scar catalog. It will also provide information on minimum ages of manatees in the system, permitting analysis of age-specific reproduction and survival. Carcass recovery data may also be combined with resighting data in some recently developed survival models to further enhance the accuracy and precision of survival estimates.

S3.1.4. **Analyze scar catalog data to determine annual survival rates and other population parameters.** One of the most important parameters for estimating trends in population status is age-specific survival. Scar catalog data on animals at Crystal River, Blue Spring, and along Florida's east coast are now sufficiently extensive to estimate survival rates in those areas (O'Shea and Langtimm 1995). Analyses of survival rates, as well as calving intervals, age of first reproduction, and other parameters should be undertaken and/or refined as new records are entered.

S3.2. **Continue and expand long-term studies of individual animals.** Long-term studies of the reproductive traits, behavior, and life history of individual females provide data on age-specific birth rates and success in calf rearing. Such data, in turn, are important for assessing potential population growth rates. Although long-term records on individual females are best from Crystal River and Blue Spring, useful data also have been collected at other locations. Relevant data are included in the scar catalog, in long-term telemetry results for individual females through routine monitoring programs at major warm-water refuges, by long-term telemetry studies on selected manatees, and through reports from various researchers. Efforts to gather and analyze data on the reproductive history and behavior of known females should be continued and expanded to other study areas. Research should address the behavioral/ environmental causes of perinatal mortality by focusing on cow-calf behavior and interaction with conspecifics, especially during the perinatal period.

S3.3. **Analyze data on calf production.** The total number of calves produced is uncertain and may vary regionally. Calf counts from research at Crystal River and Blue Spring and from aerial surveys and data on the reproductive status of females recovered in the salvage necropsy program should be analyzed to estimate and identify possible regional differences in reproductive rates.

S3.4. **Continue aerial photogrammetry analyses.** Aerial photographic techniques to estimate the size, and hence age class, of individual animals are being investigated as a way to determine the age-structure of manatee populations. If the results suggest that further work is needed, studies should be designed, and equipment and support should be provided to collect and analyze aerial photogrammetric data.

S3.5. **Continue opportunistic deployment of passive integrated transponder (PIT) tags.** PIT tags are small tags inserted under the skin of animals to identify them if they are recaptured or recovered in the salvage and necropsy program. By comparing data on an animal's size, reproductive status, and general condition between time of tagging and recovery, one can increase the amount of information obtained on life history parameters. PIT tags are applied opportunistically by the Florida Marine Research Institute, the Sirenia Project, or an authorized veterinarian whenever animals are caught for radio tagging or rehabilitation or released from captivity. PIT tags should continue to be applied as opportunities arise and PIT tag readers should be purchased and made available to individuals and groups likely to handle manatees.

S3.6. **Conduct additional physiological studies of thermal tolerances.** Although it is known that manatees are sensitive to cold stress, precise information on thermal tolerances and the effects of cold on physiological processes of different manatee age and sex classes is not known. Such information may be useful for assessing the percentage of the manatee population likely to aggregate at warm-water refuges at different ambient water temperatures, when different age/sex groups are likely to arrive at and depart from refuges, when emergency situations are likely to arise from unexpected changes in thermal discharges, *etc*. Studies to assess thermal tolerances and physiological effects of cold stress should be designed and undertaken.

S3.7. **Conduct additional studies to assess hearing capabilities.** Manatees, particularly mothers and calves, communicate vocally. Noise from boats or other sources may interfere with such communications or be a source of stress. Hearing capabilities, however, have been poorly understood. Recent studies indicate that manatees may have a wider range of hearing than previous studies suggested (Gerstein 1994). There is a need for further research on hearing capabilities and the effects of noise on manatees.

S3.8. **Complete and conduct additional studies of manatee food habits.** Nutritional characteristics of manatee food plants and the importance of different food sources for different age and sex classes in various regions are poorly understood. Such information is needed to help assure that adequate food resources are protected in different portions of the population's range. Ongoing studies should be completed to identify manatee food habits and feeding patterns, the nutritional value of different aquatic plants important to manatees, and the regional food resources most in need of protection and management.

S3.9. **Continue genetic analyses from manatee tissue samples.** New molecular techniques to examine genetic material provide an opportunity to update information on the genetic sub-structure of manatee populations, male mating success, paternal contributions, and frequencies of kinship that vary within social groups. This genetic analysis also identifies regional homozygosity and possible effects due to localized matrilineages, *etc*. Such information could improve understanding of the structure and social interactions of populations, influencing management objectives for different groups of manatees.

These studies should also be interrelated to physiological findings; management efforts should reflect an accurate assessment of the influence that the existing gene pool may have on lowered reproductive potential, enhanced susceptibility to disease, and other factors. Research to examine a number of these points has already been initiated. In addition, a number of researchers are interested in conducting other analyses. For some questions, the genetic data alone will not yield insights into manatee biology without a simultaneous field effort to collect the appropriate behavioral data. To determine the role of kinship in social interactions it will be necessary to collect data on association patterns and interactions among known individuals. Likewise, assessment of paternity for a large number of males will provide data on variance in male reproductive success but will not shed light on factors affecting male success. Associated data on male physical characteristics (*e.g.*, size, body condition, age) and behavioral traits (*e.g.*, movement patterns, "dominance" in a mating herd), as well as extended observations of mating herds will be important for understanding reproductive activity among males. Tasks that facilitate and coordinate research related to manatee genetics should be initiated.

S3.10. Conduct additional studies to identify requirements for fresh water. In estuarine and marine areas manatees are attracted to, and drink from, freshwater sources. While this attraction is well known, the physiological need for fresh water is not clear. Studies have been initiated to examine processes by which manatees regulate internal salt levels and the physiological role of drinking fresh water. The results of these studies should be reviewed and, if warranted, further research should be undertaken.

S3.11. Convene a population status working group to develop methodology, data and models to assess population size and trends. Information on trends in the size of Florida manatee populations is essential for assessing the effectiveness of manatee recovery actions. It also is needed to develop objective, measurable criteria required by the ESA for determining when manatee populations may be reclassified as threatened or removed from the endangered species list. Given the present difficulty in measuring population size and trends directly, assessments of these parameters in the foreseeable future will benefit from information derived from population models. Models should use estimates of mortality, reproduction, survivorship, age/sex structure that stem from various other research tasks. Models should be developed, evaluated, and improved as needed.

As more information on manatee life history parameters is obtained, population models will tend to become highly complex. It is important for those developing manatee population models to coordinate their activities, and interact directly with biologists who have collected manatee life history data or who are authorities on manatee ecology. Biologists will better understand how models were derived, and the modelers will obtain feedback on the validity of their assumptions and interpretation of their results. The working group should be convened at least once every 2 years chaired by the staff of the Sirenia Project.

S3.12. Conduct research to better understand manatee-boat interactions. More data is needed to assess how manatees respond to a variety of boat types and traffic patterns. Innovative research techniques such as remote observations using airships should be investigated. Research should be conducted to develop various devices, such as propeller guards, in an effort to minimize manatee injury or death caused by passing boats.

S4. Support the monitoring of manatee populations in South Florida. The success of efforts to develop and implement measures to minimize manatee injury and mortality and to protect manatee habitat will depend on the accuracy and completeness of data on manatee life history and ecology, population status, and habitat condition. Good data in these areas are needed to identify and define problems, make informed judgments on appropriate management alternatives, establish an information base to justify selected actions, and provide a basis for determining whether or not the actions taken are achieving the desired result**.**

S4.1. Maintain a manatee telemetry program. Telemetry programs are currently the only reliable means by which to generate detailed information on manatee movement and habitat-use patterns. Manatees are netted, belted, and tagged with transmitters for remote and visual monitoring. These monitoring programs provide information used to identify key use areas and travel corridors, and to tabulate reproductive histories, monitor use of powerplant effluents, and trace the progress of re-introduced captive manatees. This information is used to develop specific recommendations for manatee protection and to support habitat management initiatives.

S4.1.1. **Maintain adequate telemetry capabilities.** Telemetry studies require personnel, tags, tag attachments, receivers, boats, vehicles, airplanes and other equipment to capture and tag animals and to retrieve or replace transmitting units. They also require computer hardware and software and personnel to process the data and funding for the cost of satellite data retrieval. Presently the Sirenia Project and the Florida Marine Research Institute can track up to 20 and 15 animals, respectively. This level of capability should be maintained exclusive of telemetry needs for tracking released rehabilitated animals, work in Puerto Rico (see the Puerto Rican manatee recovery plan), or cooperative studies in other countries.

S4.1.2. **Enter telemetry locations into the manatee Geographic Information System (GIS) database.** Accurate information on manatee habitat-use patterns provides a sound scientific basis for identifying and supporting management decisions on waterway speed and access rules, permits for facility construction in manatee habitat, *etc*. To assure access to new data by managers, telemetry data should be processed by researchers for entry into the Florida Marine Research Institute's GIS. A standardized methodology to interpret and display telemetry data should be developed with the results distributed to the appropriate management agencies and cooperating groups annually through the Manatee GIS Working Group.

S4.1.3. **Prepare and distribute monthly updates, annual progress reports, and final summaries of telemetry results.** To keep managers and researchers involved in the recovery program abreast of progress and new findings from manatee tagging and tracking studies, monthly updates on the status of tagged manatees should be compiled and distributed. Summary progress reports should be circulated annually and final research findings and conclusions should be made available as soon as possible following the completion of regional study elements.

S4.1.4. **Develop regional atlases of telemetry location data.** Telemetry research has proceeded as a series of regional studies with tracking work concentrated in different areas over time. To date, studies have been conducted or are underway in the upper St. Johns River, along the east coast of Florida and southeastern Georgia, in the Crystal River area, Lee County, Tampa Bay area, and along the southwest Florida coast. Upon the completion of a regional study, an atlas of telemetry results should be compiled to summarize habitat-use patterns of different age and sex classes by season.

S4.1.5. **Develop a long-term strategy for telemetry studies.** Presently, telemetry studies are being done on the east coast by the Sirenia Project and along the west-central Florida coast by the Florida Marine Research Institute. In the future, telemetry work may be needed in areas of the State not well studied (*i.e.*, Everglades, Okeechobee Waterway and Lake

Okeechobee) as well as in areas that have been previously studied. The latter is important to identify possible shifts in habitat use patterns over time. To ensure telemetry capabilities address recovery program data needs as effectively as possible, a set of goals with a long-term strategy for telemetry work in Florida should be developed. The goals and strategy should be reviewed by FWS, the Sirenia Project, and the Florida Marine Research Institute and updated as needed. A working group composed of FWS, Sirenia Project, and the Florida Marine Research Institute should be formed to develop the long-term strategies for telemetry studies.

S4.2. Maintain and improve the GIS for data on manatees and manatee habitat. The Florida Marine Research Institute has developed a GIS to store, synthesize, and retrieve large volumes of data on manatees and manatee habitat. This data management system can store, manipulate, analyze, and display site-specific data on manatee carcass recovery sites; manatee sighting data from aerial surveys, ground research, telemetry studies; water depths, vegetation coverage, waterway speed and access zones, shoreline characteristics and development patterns, etc. The hardware, software, and database are used by Federal, State, and local officials for scientific analyses, permit reviews, developing waterway speed and access rules, and preparing county manatee protection plans.

S4.2.1. Maintain the hardware, software, and expertise to operate the GIS. Hardware, software, personnel, and training to access the GIS should be provided and maintained by involved agencies. GIS work stations already exist at the DEP's Florida Marine Research Institute and Office of Protected Species Management, and the FWS's Jacksonville field office, and Sirenia Project. Other work stations should be established and maintained at appropriate agency offices (*e.g.*, COE District Office and other divisions of DEP). These agencies should assign trained staff to serve as GIS operators and analysts responsible for providing maps and data summaries needed by staff planners, managers, and scientists. DEP and/or FWS should provide sufficient staff support to respond to requests for needed information from cooperating agencies and organizations which lack the hardware, software, or expertise necessary to use the database (*e.g.*, some county planners).

S4.2.2. Convene regular meetings of the Manatee GIS Working Group. Optimum use of the GIS database requires that the staff of agencies, offices, laboratories, and organizations responsible for key research and management tasks have access to GIS databases pertinent to their analytical needs. To promote interactions between system users and system curators, a GIS Working Group composed of representatives from governmental agencies and interest groups wanting to use manatee GIS data should be convened on a regular basis. The Working Group should meet to review data processing needs, access procedures, and available data; encourage and organize cooperative efforts to acquire ancillary data sets that would contribute to the manatee GIS; and provide opportunities to instruct users in the use of available data and new technologies. Working Group members should be responsible for overseeing their agency's participation in manatee GIS-related work. Funding to convene this group should be provided as needed.

S5. Increase public awareness. Develop curricula and educational materials for schools and host public workshops to increase awareness about the manatee and instill a sense of stewardship for the protection of this endangered species. Increase the availability of manatee education services and materials in South Florida to provide better technical assistance to the public. Design and implement a program to evaluate the effectiveness of education in recovering the manatee. Initiate and implement a standard education program for marinas and develop standards for evaluating the effectiveness of this education program. It is essential that the public be made aware of the manatee and the efforts to protect and maintain the population.

S5.1. Develop curricula and materials for schools. Most manatee protection and conservation measures need to remain in place indefinitely. To provide a sound base of understanding and support for conservation measures by future generations of Floridians and Georgians, materials and curricula on manatees and manatee conservation should be updated periodically and made available for use at various academic levels from elementary to high school.

S5.2. Develop and update materials for target user groups. Information important to achieve manatee conservation objectives differs for different user groups (boaters, divers, fishermen, commercial ship operators, shoreline owners) and different areas (people using a particular protected area, residents of coastal areas in Florida, tourists). By the same token, appropriate media (films, posters, brochures, public service announcements, personal presentations) also differ according to user groups and areas. Agencies and organizations carrying out public education and outreach programs should cooperate in assuring that pertinent information in appropriate formats is made available to relevant sectors of the public.

S5.3. Maintain avenues to encourage and direct voluntary contributions in support of needed recovery work. A significant amount of the funding to support the State of Florida's manatee recovery work is obtained from voluntary contributions in the form of a special state license plate and an optional contribution on boat registration applications as authorized by the Florida Legislature. Some equipment and funding also are provided from donations to the Save the Manatee Club and other environmental organizations. These voluntary contributions form a significant part of the funding base for the recovery program and permit much work to be done that would not otherwise be possible. Innovative approaches to obtain and direct voluntary support to needed program work should be tested and maintained**.**

S6. Coordinate recovery activities, monitor and evaluate progress, and update/revise this narrative. The actions necessary to support and implement recovery are beyond the abilities or scope of any one agency. They require the participation and cooperation of many Federal, State, and local agencies, as well as public, private, and industry organizations. To ensure that the work of involved agencies and groups is carried out in a timely, cost-effective manner that addresses priority recovery needs, the following administrative and coordination tasks should be carried out.

S6.1. Maintain Federal and State manatee coordinator staff positions. Given the central role of the FWS and the DEP, each agency should designate a full-time manatee coordinator and provide basic support staff. The level of support must be adequate to carry out administrative functions for which each is responsible and to work directly with involved agency and organization officials on a day-to-day basis.

The primary responsibility of the **FWS' manatee coordinator** and support staff is to provide Federal oversight, guidance, and support for the overall manatee recovery effort as outlined in the recovery plan. Additional responsibilities include preparing rules for Federal Manatee Sanctuaries; reviewing and providing guidance on development permits and section 7 consultations; assisting and monitoring recovery-related work by participating agencies and organizations; developing a die-off response plan; overseeing efforts to rescue, rehabilitate, and release distressed manatees; assisting and coordinating manatee land acquisitions; helping develop state waterway speed and access regulations and county manatee protection plans; assisting in the development of manatee-related provisions, programs and facilities at NWRs; updating the manatee recovery plan and preparing annual status reports; and chairing and convening meetings of the manatee recovery team.

Tasks for the **State manatee coordinator** and support staff include developing state waterway speed and access rules and overseeing efforts to post and enforce established zones; reviewing environmental resource permits and state submerged land leases; providing advice and assistance to responsible agencies on resolving mortality caused by flood gates and fishing gear; assisting and coordinating manatee-related land acquisition; assisting in the development of manatee-related provisions, programs, and facilities at state parks, reserves, and aquatic preserves, and other State lands; assisting counties in developing county manatee protection plans; serving as staff for the Manatee Technical Advisory Committee; and carrying out relevant public education and awareness work.

S6.2. **Convene periodic meetings of the Florida Manatee Recovery Team and Manatee Technical Advisory Council.** The FWS has constituted and periodically convenes meetings of a Manatee Recovery Team composed of the principal involved agencies and groups. Chaired by the FWS's manatee coordinator, the team reviews progress on the recovery program tasks; develops advice on program priorities and needs; and helps coordinate work and support on recovery tasks among involved agencies and groups. In addition, DEP has established a Manatee Technical Advisory Council. The Council provides advice to the Secretary of this agency on progress and priority needs with respect to DEP involvement in the manatee recovery program. Both groups complement each other. They meet at times when advice and assistance is most timely and have become an important means of reviewing, guiding, and coordinating ongoing activities. The FWS's manatee coordinator provides staff support for the recovery team and DEP's manatee coordinator serves as staff for the Advisory Council. Support to convene periodic meetings of both groups should be provided.

S6.3. **Develop an annual progress report.** As a means of documenting and monitoring progress on recovery tasks, the FWS, with the assistance of involved agencies and groups, prepares annual progress reports reviewing activities on all identified tasks. The annual reports provide a means of tracking ongoing work, identifying areas in need of further attention, and projecting priorities for the coming year. The preparation of annual status reports should continue.

S6.4. **Update the Florida Manatee Recovery Plan.** The Florida Manatee Recovery Plan identifies and interrelates fundamental recovery tasks. It also identifies task priorities, agency involvement, and funding needs for a 5-year period. Agency involvement and funding projections are included as guides rather than commitments and are provided solely for planning purposes. In this regard, it is used by the FWS and other agencies as a principal reference to develop annual budget requests for manatee-related work. Given progress on listed tasks, new information on manatees, environmental changes, changes in agency administration, and other factors that are difficult or impossible to predict accurately more than a few years in advance, the plan is limited to a 5-year period and should be updated at least once every 5 years. Responsibility for doing so rests with the FWS, with assistance from the Florida Manatee Recovery Team.

S6.5. Convene a panel or workshop to evaluate the effectiveness of the manatee recovery program. The revised recovery plan assumes that more extensive boat speed regulations will minimize the major source of human-related mortality, and that local manatee protection plans, land acquisition, and development permit reviews will achieve adequate manatee habitat protection. While these assumptions seem reasonable and appropriate, it remains to be demonstrated that they will in fact be successful. A workshop or panel should be convened prior to the next revision of the recovery plan to identify and evaluate fundamental issues in the Florida Manatee Recovery Program, to evaluate whether present strategies and assumptions prove ineffective. To obtain a fresh, independent assessment of options, the panel or workshop should be heavily weighted toward expert scientists and wildlife managers not directly involved in the manatee recovery program.

S6.6. Share experience and expertise developed through the manatee recovery program. The Florida Manatee Recovery Program is a model for potential or evolving manatee recovery programs in other countries. The experience and expertise that has been gained in Florida should be applied to other southern states and U.S. territories with sirenian populations to encourage conservation efforts.

S6.6.1. Develop cooperative agreements with other states and countries. Manatees also occur in Georgia, occasionally in other southeastern states, and in Puerto Rico. Research and management techniques developed to protect manatees in Florida could be applied to protect manatees in those areas as well. Steps should be taken to establish working relationships with appropriate officials in other states or territories to transfer expertise and experience.

Similarly, other countries developing manatee conservation programs should be encouraged to enter into agreements with the FWS and the Sirenia Project to facilitate the transfer of information, experience, and expertise related to manatee research and management. Such agreements might involve the exchange of personnel for training purposes or cooperation in carrying out specific projects. Where opportunities arise to establish such agreements, they should be pursued and supported.

S6.6.2. Participate in and assist with manatee-related work under the Caribbean Environment Program. Under a regional SEAS program sponsored by the United Nations Environment Program, nations in the wider Caribbean region, including the U.S., cooperate in the Caribbean Environment Program. The program is guided by provisions set forth in an action plan and the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean (*i.e.*, the Cartagena Convention). In 1991, parties to the Convention signed a Protocol on

Specially Protected Areas and Wildlife. Convention members have an interest in the development of national or regional recovery plans for manatees. Participants in the Florida manatee recovery program should assist in recovery programs envisioned under this protocol and the Caribbean Environment Program.

S6.6.3. **Participate in national and international manatee conservation and research activities.** Results from the manatee recovery program are of interest not only to scientists and managers involved in manatee conservation, but also to other scientists and resource managers. In addition, the experience of other wildlife scientists and managers may provide insights of value to the manatee recovery program. Agencies should encourage individuals involved in the recovery program to present papers or otherwise participate in national and international activities involved in wildlife research and management, including conferences, training, and technical assistance.

Habitat-level Recovery Actions

H1. Prevent degradation of existing manatee habitat in South Florida. In addition to controlling direct sources of manatee injury and mortality, manatee recovery depends on maintaining the availability of habitat suitable to support a larger manatee population. Manatee habitat requirements include adequate sources of aquatic vegetation for food; sources of fresh water; secluded areas in which to mate, bear and nurse their young, and rest; warm-water refuges during cold periods; and safe travel corridors between these areas. Availability of these habitat features may be affected by coastal development and human activity patterns along waterways used by manatees. The challenge for managers is to provide for human needs while, at the same time, protecting the availability and quality of a network of essential habitat components. These essential habitat components reflect seasonal manatee movement patterns and maintain a full complement of habitat needs throughout the principal range of both the east and west coast manatee populations. This section of the recovery plan identifies the tasks needed to protect essential manatee habitat.

Ongoing dredge-and-fill and water quality permit review programs involving the FWS, the COE, the NMFS, and the EPA at the Federal level (section 10 of the Rivers and Harbors Act, section 404 of the Clean Water Act, and section 7 of the ESA), DEP and water management districts and Georgia Department of Natural Resources at the State level, and local environmental permitting agencies, should continue to review and comment on permit applications that have the potential to adversely impact manatees and/or their habitat.

H1.1. **Support the acquisition of manatee habitat in South Florida.** Federal and State systems of refuges, reserves, preserves and parks in Florida contain important manatee habitat. Management of those areas offers assurance that habitat will be maintained so as to protect the features (*e.g.*, grassbeds, quiet secluded waterways, warm-water springs, *etc*.) important to manatees. In the last 10 years, considerable cooperative effort has been devoted to acquiring essential manatee habitat and adding it to Federal and State protected area systems. These efforts are beginning to form regional protected area networks that contain many important habitat features essential for the long-term survival of manatee populations. These efforts need to continue as well as efforts to manage key protected areas in ways that enhance achievement of manatee recovery objectives.

H1.1.1. Support the acquisition and incorporation of essential manatee habitats to the NWR, park, and preserve system. Several NWRs managed by the FWS contain essential manatee habitat and are adjacent to other essential manatee habitat that is not similarly protected. Expanding refuges to add these areas would significantly improve protection not only for manatees, but also for many other species. Particularly important areas in this regard are along the Crystal River near the Crystal River NWR; Homosassa River near the Chassahowitzka NWR; and St. Johns River and associated waterways in and adjacent to the Lake Woodruff NWR. As possible, the FWS should pursue acquisitions, in cooperation with the State of Florida, to expand these and other refuges.

H1.1.2. Support the acquisition and incorporation of essential manatee habitats to state reserve, preserve, and park systems. Florida's Conservation and Recreation Lands (CARL) Program and the Save Our Rivers Programs administered by the five regional water management districts have acquired many areas that will further manatee habitat protection. They also have many important acquisition projects in varying stages of development. As possible, administrators of the two State programs, in cooperation with the FWS, should place special emphasis on completing acquisition projects important to manatees.

H1.1.3. Review and provide advice on priority habitat acquisitions relative to manatees. The CARL trust fund provides a significant source of funding for manatee habitat acquisition projects. In allocating these funds, the Office of Protected Species Management in the DEP provides comments and advice to the Division of State Lands and the Program's Land Acquisition Advisory Council on listed acquisition projects of particular importance to manatees. DEP and the FWS should continue to provide advice to this program and the Save Our Rivers program. Particular efforts should be made to solicit acquisition advice from manatee biologists with the DEP's Florida Marine Research Institute and field research biologists with the USGS/BRD’s Sirenia Project.

H1.1.4. Identify and propose new land acquisition projects. As new information on manatee habitat-use patterns and essential habitat becomes available, new areas for acquisition may be identified. New land acquisitions can connect areas of essential manatee habitat to create regional protected systems. Periodic efforts should be undertaken to review manatee distribution and movement patterns to identify and propose new land acquisition projects. A task force to undertake this work should be created and convened as necessary.

H1.1.5. Encourage and coordinate Federal, State, and private land acquisition efforts. Manatee-related land acquisitions that help create regional networks of essential manatee habitat are particularly important. In this regard, identification of priority areas must include regional manatee habitat requirements and relationships among essential manatee habitats. To promote and guide complementary projects, the FWS and the

DEP should designate an individual to convene meetings, act as a clearinghouse on the status of manatee acquisition projects, and otherwise help coordinate relevant land acquisition by Federal and State agencies, The Nature Conservancy, and others.

H1.2. Protect and manage habitat in South Florida.

H1.2.1. Support the designation, management, and maintenance of Federal manatee sanctuaries and refuges in South Florida. Under authority of the Marine Mammal Protection Act and the ESA (50 CFR Part 17), the FWS may designate certain waters as manatee sanctuaries (areas in which all waterborne activities are prohibited) or manatee refuges (areas in which certain waterborne activities may be regulated). Six seasonal manatee sanctuaries have been designated by the FWS (FWS 1995). Established areas must be posted and enforced. As necessary, the FWS should modify existing rules and designate other sanctuaries or refuges.

H1.2.2. Support the maintenance of safe, reliable artificial warm-water refuges in South Florida. Many Florida manatees have come to rely on warm-water outfalls from certain power plants and other industrial facilities to avoid thermal stress during periods of extreme winter cold. If warm-water discharges used regularly by manatees are disrupted or otherwise fail to provide needed warmth during the winter, animals which have learned to use them may be exposed to cold stress and perhaps die before they can find or reach alternative heat sources. In addition, water intake canals, pipe openings, *etc*. could trap manatees attracted to these facilities. Management agencies should conduct a review of these artificial warm-water discharges and develop recommendations based on the importance of each outfall to the long-term survival of the manatee. For those discharges that are determined to be essential for the survival of the manatee, written agreements should be established between the FWS and relevant industries on appropriate courses of action.

To minimize discharge interruptions and other threats to artificial refugia, National Pollution Discharge Elimination System permits issued by the EPA or the DEP should be reviewed by the FWS pursuant to its authority under the ESA and the Clean Water Act. Manatee site protection plans should be developed by permittees as requirements of issued permits and should address such issues as: (1) disruptions to warm-water outflows during winter; (2) inadequate discharge temperatures to sustain manatees during extreme cold events; (3) precautions to minimize hazards to manatees at intake and outfall areas; and (4) timely communication to manatee recovery program personnel of any long-term changes in the availability of warm-water discharges and/or unanticipated problems that may affect manatees in outfall areas.

H1.2.3. Protect and promote regeneration of seagrass beds in South Florida. Implement new measures to protect and recover seagrasses. Particular attention should be given to establishing monitoring procedures and standards for water clarity in areas of existing or historic seagrass beds. In addition, guidelines should be established to assist in the review of applications for state environmental resource permits issued by the DEP and requests for state submerged lands leases issued by the Florida Board of Trustees that may affect the quality of seagrass beds important as manatee feeding areas. Assess threats to seagrass habitats and develop protection strategies. Develop and implement alternative measures to mitigate threats to, and promote regeneration of, seagrasses. Primary areas in need of protection include Lee, Collier, and Miami-Dade counties.

H1.2.4. **Support the review and implementation of aquatic plant control programs.** Essential freshwater food supplies for manatees outside of protected areas may be damaged by dispersal of herbicides to control exotic aquatic plants. The FWS and the DEP Office of Protected Species Management should routinely review treatment plans developed by aquatic plant control programs to ensure that neither manatees nor their essential food sources are adversely affected by these herbicides. Mechanical or biological plant control alternatives should be considered, if possible. Such alternatives may not always be appropriate. For example, mechanical plant removal may be inadvisable in some areas when manatees are present in large numbers.

H1.2.5. **Incorporate manatee protection measures into management systems for protected areas and State-owned submerged lands.** Depending on local conditions and human activity patterns, management measures may be needed to ensure that activities and development projects within protected area boundaries or affecting state-owned submerged lands do not adversely affect manatees or their essential habitat.

H1.2.5.1. **Include manatee protection and monitoring measures in management plans for Federal and State protected areas.** As appropriate and possible, managers of Federal and State refuges, reserves, parks, *etc*. should adopt measures to develop and enforce waterway speed and access rules to avoid vessel traffic patterns that threaten manatees; manage aquatic plant control programs to avoid impacts to manatees or their food supplies; protect and monitor the quality and quantity of water flowing from natural warm-water springs used by manatees; and identify and avoid uses incompatible with protection of manatees and manatee habitat. They also should carry out programs to monitor and record manatee habitat-use patterns in and around unit boundaries. Such measures should be developed, reviewed, and modified periodically with the assistance of the FWS's manatee coordinator and the State's Office of Protected Species Management. Needed measures should be incorporated into unit management plans.

H1.2.5.2. **Develop policies and provisions to guide decisions on leasing State-owned submerged lands.** Most essential manatee habitat in Florida overlies publicly owned sovereignty submerged lands. Private use of these lands to construct marinas, docks or other facilities potentially affecting manatees requires a lease from the Florida Board of Trustees. To ensure that the use of such areas is consistent with manatee recovery objectives, there is a need to develop policies, guidelines, and/or other provisions to help review lease requests involving activities or projects that may directly or indirectly affect manatees and manatee habitat.

H1.2.6. Develop, implement, and update county manatee protection plans. To develop effective, fair manatee protection schemes, site-specific conditions and information should be reviewed and protection measures should be integrated into local policies and ordinances. Comprehensive, multi-faceted county manatee protection plans are considered appropriate and vital. It is anticipated that such plans would be implemented as amendments to local government comprehensive plans required by the State's Comprehensive Growth Management Act of 1985 and reviewed for consistency by DCA. Steps to encourage manatee protection plans already have been taken for the 13 key counties where manatee mortality has been greatest and manatees occur most frequently. Two of the most important components of these plans are county waterway speed zones and measures to balance plans for new boating facilities with manatee protection needs. Regarding the latter point, the Governor and Cabinet have directed that limits be placed on the construction and expansion of boating facilities pending the implementation of more comprehensive plans. Eventually, such plans should be prepared for all counties with important manatee habitat.

H1.2.6.1. Assist counties to develop manatee protection plans. To develop and approve manatee protection plans, county planners and DCA need reliable information on local manatee habitats and habitat-use patterns. To varying degrees, counties also may need help to identify and evaluate appropriate planning provisions. Such information and assistance should be provided by DEP’s Office of Protected Species Management, FWS's Jacksonville Field Office, and USGS’s Sirenia Project. The staff of these agencies should cooperatively synthesize and provide accurate, up-to-date data on manatee distribution and habitat within county boundaries to county officials and work closely with them to develop appropriate planning measures. DEP and FWS should coordinate with DCA to draft local, county or State manatee protection programs. Once completed, the plan should be approved and implemented. DEP, FWS, and the Sirenia Project must allocate the staff and resources needed to provide such assistance.

H1.2.6.2. Assist in implementing manatee protection plans. Approved manatee protection plans should be provided to Federal and State agencies to aid in decision making with regard to permitting, leasing submerged lands, project review, or other activities that may have an affect on manatees. Of particular importance in this regard are DEP, the COE, and FWS.

H1.2.6.3. **Periodically assess, review, and modify manatee protection plan provisions.** As new information becomes available, there may be a need to modify manatee protection plans. One of the most critical needs in this regard is data on boating activity patterns. While efforts are underway to gather these data in the 13 key manatee counties, it should be collected state-wide. Accordingly, the Office of Waterway Management and the Office of Protected Species Management in DEP should cooperate in developing a state-wide database that includes data on: (1) boat traffic patterns; (2) areas of concern for boating safety; (3) the location of existing marine facilities; and (4) proposed sites of future marine facilities. Based on this and other relevant data, county officials and staff of DCA, the Office of Protected Species Management, and FWS should periodically review county manatee protection plans.

Modification of county plans may be called for in the future, based on changes in available information. Plans would need to be strengthened as needed should human-caused mortality increase. Similarly, modifications to accommodate boaters may be warranted where manatee use of speed zone areas is demonstrated to be significantly less than previously documented.

H2. Restore and create manatee habitat in South Florida.

H2.1. Support the maintenance and restoration of water quality in freshwater sources. Coordinate with the South Florida Restoration Task Force to restore natural tidal flow and hydrology in manatee habitat. Maintain minimum flows and levels in manatee use areas.

H2.2. Enhance manatee habitat in South Florida. Improve habitat by planting or encouraging native plant species, such as seagrasses and mangroves. Wetland restoration in the Indian River Lagoon area may significantly benefit the manatee. Coordinate with the FWS's Coastal Program and other pertinent groups to conduct manatee habitat restoration efforts.

H3. Support research on manatee habitat in South Florida and how it affects the manatee's persistence. Ongoing research on manatee-seagrass grazing interactions should be continued and completed. Investigations of manatee grazing effects and seagrass recovery, using both exclosures and enclosures, have been conducted in the Banana River in Brevard County. Results from these studies should provide information useful in design of monitoring studies, estimation of manatee carrying capacity of seagrass beds in key areas, and better understanding of the manatee's role in maintaining healthy, diverse seagrass communities.

H3.1. Investigate how manatees use different habitat components for survival. Investigate the effect of habitat change in South Florida on the manatee. Determine how manatee distribution and abundance is affected by increased mortality, habitat degradation, and hydrological changes.

H3.2. Determine an index of habitat fragmentation in South Florida.

H3.2.1. Investigate movement patterns and the spatial use of habitat to identify important core areas and corridors in South Florida.

H3.2.2. Determine if the amount and configuration of habitat is sufficient to support a stable or increasing population of manatees in South Florida.

H4. Develop and implement a manatee habitat monitoring program. In addition to efforts to monitor the status of manatee populations, work should be undertaken to monitor the condition and status of manatee habitat. Information from such a program could provide an early warning of future threats to manatee populations and help explain observed manatee population trends. Presently, there is no systematic approach to monitoring the condition of key manatee habitats.

H4.1. Develop methodology and expertise to monitor the condition of essential manatee habitats. While basic manatee habitat requirements have been identified and many, if not most, of the essential areas providing those requirements are known, there is no systematic approach for monitoring the condition of those habitat features. For example, the condition of essential grassbed feeding areas and the discharge rates and water quality at natural warm-water refuges are not routinely monitored. To provide a means of detecting potential problems in the capacity of such areas to support manatee populations, methodologies and expertise to monitor the condition of essential manatee habitat features should be identified and tested.

H4.2. Coordinate and implement a long-term habitat monitoring program. A long-term program should be initiated to monitor key parameters, such as the species composition and extent of aquatic plant species at vital feeding areas and the discharge rates and water quality at warm-water refuges. To the extent possible, such efforts should rely on habitat monitoring programs and research already undertaken by Federal and State agencies or academic institutions.

H5. Establish effective manatee management programs at Federal and State protected areas. After essential manatee habitats are acquired and added to Federal and State holdings, the agencies responsible for administering those areas should incorporate manatee protection and public awareness measures into unit administration programs.

H5.1. Develop and maintain public education programs at selected protected areas. Because Federal and State protected areas attract thousands of visitors each year, those containing essential manatee habitat offer valuable opportunities for interpretive programs on manatee conservation. Visitors to refuges, preserves, and parks with essential manatee habitat must be made aware of special measures to protect manatees within these areas.

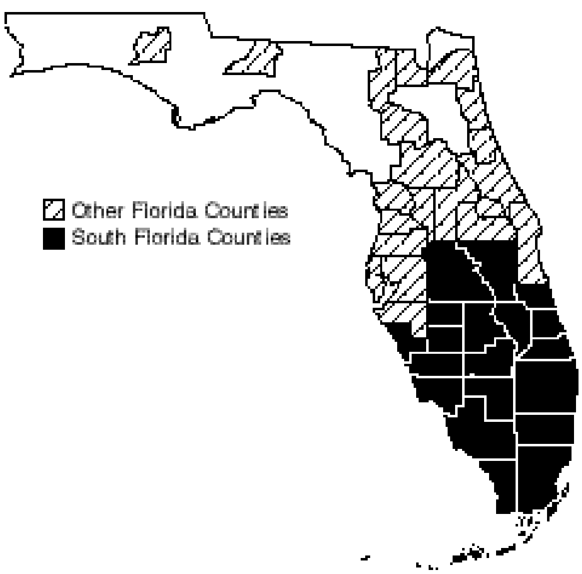
H5.2. Develop public awareness/education programs at other parks and refuges. FWS and the State should develop and maintain displays and education programs explaining manatee conservation issues at other refuges, reserves, preserves, and parks that include essential manatee habitat. This should also be a priority at manatee aggregation sites where managed public viewing and education opportunities exist.

Wood Stork

Mycteria americana

Federal Status:	**Endangered (Feb. 28, 1984)**
Critical Habitat:	**None Designated**
Florida Status:	**Endangered**
Recovery Plan Status:	**Contribution (May 1999)**
Geographic Coverage:	**South Florida**

Figure 1. Florida distribution of the wood stork.



O Wood storks (*Mycteria americana*) are one of two species of storks that breed in North America. This large, long-legged inhabitant of marshes, cypress swamps, and mangrove swamps reaches the northern limit of its breeding range in the southeastern U.S., where it breeds in colonies with great egrets, snowy egrets, white ibises, and many other species. The unique feeding method of the wood stork gives it specialized habitat requirements; the habitats on which wood storks depend have been disrupted by changes in the distribution, timing, and quantity of water flows in South Florida. The population declines that accompanied this disruption led to its listing as an endangered species and continue to threaten the recovery of this species in the U.S.

This account represents South Florida's contribution to the rangewide recovery plan for the wood stork (FWS 1997).

Description

The wood stork is a large, long-legged wading bird, with a body length (head to tail) of 85 to 115 cm and a wingspan of 150 to 165 cm. Their plumage is white, except for iridescent black primary and secondary feathers and a short black tail. On adult wood storks, the rough scaly skin of the head and neck is unfeathered and blackish in color. Their legs are dark with dull pink toes. The bill color is blackish. Male and female wood storks are similar in appearance, although male wood storks tend to be larger, have longer wingspans and weigh more.

Immature storks, up to the age of about 3 years, differ from adults in that their bills are yellowish or straw colored and they exhibit varying amounts of dusky feathering on the head and neck. During courtship and the early nesting season, adults have pale salmon coloring under the wings, fluffy undertail coverts that are longer than the tail, and toes that brighten to a vivid pink.

In the field, wood storks are distinctive among North American wading birds due to their long, heavy bills, black primary and secondary feathers, and black tails. Few other North American wading birds, except sandhill cranes (*Grus canadensis)*, whooping cranes (*Grus canadensis americana*), white ibises (*Eudocimus albus)*, and roseate spoonbills (*Ajaia ajaja)* fly with their necks and legs extended. Wood storks can be distinguished from sandhill cranes by their white plumage; they can be distinguished from whooping cranes by their size (the body of wood storks are 89 to115 cm while whooping cranes are 127 to151 cm), black secondary feathers, and black tail feathers. White ibises and wood storks both have black flight feathers on the wing tips. However, the wood stork is easily distinguished by its black head and its heavy bill. The roseate spoonbill is characteristically pinkish in color and has a spoonbill. At large distances, soaring white pelicans (*Pelecanus erythrorhynchos*) and storks appear similar; both soar in flocks at great heights and have similar color patterns.

Taxonomy

The wood stork is one of 17 species of true storks (Ciconiidae) in the world. The wood stork is one of three stork species found in the western hemisphere and is the only one that breeds north of Mexico (Ogden 1990). The wood stork has no described subspecies, races, or distinctive subpopulations (Palmer 1962).

Distribution

Breeding populations of the wood stork occur from northern Argentina, eastern Peru, and western Ecuador north to Central America, Mexico, Cuba, Hispaniola, and the U.S. (AOU 1983). In the U.S., wood storks historically nested in all coastal states between Texas and South Carolina (Wayne 1910, Bent 1926, Howell 1932, Oberholser 1938, Dusi and Dusi 1968, Cone and Hall

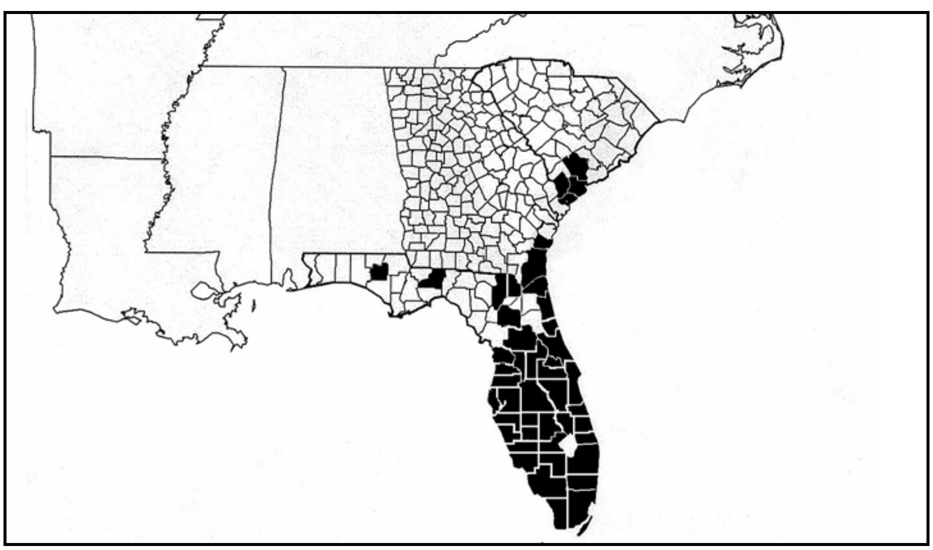


Figure 2. Breeding distribution of the wood stork in the United States (FWS 1996).

Wood stork.
Original photograph by Brian Toland.

1970, Oberholser and Kincaid 1974). Currently, wood storks breed in Florida, Georgia, and coastal South Carolina (Figures 1 and 2). Post breeding storks from Florida, Georgia, and South Carolina disperse occasionally as far north as North Carolina and as far west as Mississippi and Alabama.

In the U.S., the post breeding dispersal of the wood stork is extensive, with annual variation. The wood stork has been reported both as a casual and regular visitor, ranging from southern California and southern Arizona, north to northern California, southern Idaho, Montana, Colorado, Nebraska, southeastern South Dakota, Missouri, Illinois, southern Michigan, and southern Ontario, Canada; from the Gulf of Mexico north to Arkansas and western Tennessee; and along the Atlantic coast to Maine, southern New Brunswick, Canada, and New York, south to its breeding range in Florida, Georgia, and South Carolina. It is suspected that most wood storks sighted in Arkansas, Louisiana, Texas, and points farther west are birds that have dispersed from colonies in Mexico (FWS 1997). Some of the sightings in this region may also be wood storks dispersing from southeastern U.S. breeding colonies, but the amount of overlap or interchange between populations in the southeastern U.S. and Mexico is unknown.

In South Florida, breeding colonies of the wood stork occur in Broward, Charlotte, Collier, Miami-Dade, Hardee, Indian River, Lee, Monroe, Osceola, Palm Beach, Polk, St. Lucie, and Sarasota counties. Wood storks have also nested in Martin County, and at one time or another, in every county in South Florida. It is believed that storks nesting in north Florida, Georgia, and South Carolina move south during the winter months (December through February). Bancroft *et al* (1992) have shown that the number of storks feeding in the three WCA's of the central and northern Everglades varied greatly among winters, ranging from a low of 1,233 birds in a high-water year to 7,874 birds in a low-water year. In most of the study years, 1985 to 1989, the total number of storks in the WCA's increased substantially between December and January, and dropped off sharply after March. In some years, the inland marshes of the Everglades have supported the majority (55 percent) of the U.S. population of wood storks (FWS 1997).

Habitat

The wood stork is primarily associated with freshwater and estuarine habitats for nesting, roosting, and foraging. Wood storks typically construct their nests in medium to tall trees that occur in stands located either in swamps or on islands surrounded by relatively broad expanses of open water (Palmer 1962, Rodgers *et al.* 1996, Ogden 1991). Historically, wood storks in South Florida established breeding colonies primarily in large stands of bald cypress (*Taxodium distichum*) and red mangrove (*Rhizophora mangle*). The large, historic Everglades NP nesting colonies were in estuarine zones. These estuarine zones are also an important feeding habitat for the nesting birds. In one study of wood stork nesting throughout Florida, which was conducted prior to the 1960s, more than half of all wood stork nests were located in large bald cypress stands, 13 percent were located in red mangrove, eight percent in partially harvested bald cypress stands, six percent in dead oaks (*Quercus* spp.), and five percent in small pond cypress (*T. distichum* var. *nutans*) (Palmer 1962). Wood storks have also been observed constructing their nests in custard (pond) apple (*Annona glabra*), black gum (*Nyssa biflora*), buttonwood (*Conocarpus erectus*), black mangrove (*Avicenna germinans*), strangler fig (*Ficus aurea*), and southern willow (*Salix carolina*). Coastal nest sites occur in red mangroves and, occasionally, Brazilian pepper (*Schinus terebinthifolius*), cactus (*Opuntia stricta*), and Australian pine (*Casuarina equisetifolia*).

During the nonbreeding season or while foraging, wood storks occur in a wide variety of wetland habitats. Typical foraging sites for the wood stork include freshwater marshes and stock ponds, shallow, seasonally flooded roadside or agricultural ditches, narrow tidal creeks or shallow tidal pools, managed impoundments, and depressions in cypress heads and swamp sloughs. Because of their specialized feeding behavior, wood storks forage most effectively in shallow-water areas with highly concentrated prey (Ogden *et al.* 1978, Browder 1984, Coulter 1987). In South Florida, low, dry-season water levels are often necessary to concentrate fish to densities suitable for effective foraging by wood storks (Kahl 1964, Kushlan *et al.* 1975). As a result, wood storks will forage in many different shallow wetland depressions where fish become concentrated, either due to local reproduction by fishes, or as a consequence of seasonal drying.

The loss or degradation of wetlands in central and South Florida is one of the principal threats to the wood stork. Nearly half of the Everglades has been drained for agriculture and urban development (Davis and Ogden 1994). The Everglades

Agricultural Area (EAA) alone eliminated 802,900 ha of the original Everglades, and the urban areas in Miami-Dade, Broward and Palm Beach counties have contributed to the loss of spatial extent of wood stork habitat. Everglades NP has preserved only about one-fifth of the original extent of the Everglades, and areas of remaining marsh outside of the Everglades NP have been dissected into impoundments of varying depths.

The U.S. Army Corps of Engineers' (COE) Central and Southern Florida (C&SF) Project encompasses 4,660,000 ha from Orlando to Florida Bay and includes about 1,600 km each of canals and levees, 150 water control structures, and 16 major pump stations. This system has disrupted the volume, timing, and direction of fresh water flowing through the Everglades. The natural sheet flow pattern under which the Everglades evolved since about 5,000 years ago has not existed for about 75 years (Leach *et al*. 1972, Klein *et al.* 1974). The diversion of natural sheet flow to canals, the loss of fresh water to seepage and to pumping to tidal waters, and the extraction of fresh water for irrigation and urban water supply has led to saltwater intrusion in coastal counties from St. Lucie County on the east coast to Sarasota County on the west coast.

Although the major drainage works completed the conversion of wetlands to agriculture in the EAA by about 1963, loss of wetlands continues to the present at a slower, but significant rate. In the entire State of Florida between the mid-1970s to the mid-1980s, 105,000 ha of wetlands (including marine and estuarine offshore habitats) were lost; we do not have an estimate for freshwater wetlands in central and south Florida (Hefner *et al.* 1994).

Behavior

Courtship

Mating occurs after a period of highly ritualized courtship displays at the nest site (Kahl 1972). As a female bird approaches, male birds establish themselves at potential nest sites and perform ritualized preening behavior. Rival males will extend their necks, grab their opponents' bills, and clatter their bills loudly a few times. Females respond by bill gaping and a spread-winged balancing posture. Females will be turned away initially, but after repeated approaches, will respond by swaying their heads, preening, or playing with nearby twigs (Kahl 1972). During copulation, males loudly clatter their bills. Mated pairs greet each other with exaggerated, mutual up-down head movements and hissing calls.

Reproduction

Wood storks tend to use the same colony sites over many years, as long as the sites remain undisturbed and sufficient feeding habitat remains in the surrounding wetlands. Site turnover rates for the colonies in South Carolina are very low at 0.17 colonies per year. Current year colonies have an 89 percent likelihood of remaining active in consecutive years. However, many of these South Carolina colonies are relatively recent.

Traditional wetland nesting sites may be abandoned by storks once local or regional drainage schemes remove surface water from beneath the colony trees. Maintaining adequate water levels to protect nests from predation is a critical factor affecting production of a colony. The lowered water levels allow nest access by raccoons and other land-based predators. As a result of such drainages and predation, many storks have shifted colony sites from natural to managed or impounded wetlands. The percentage of wood storks that nested in either altered wetlands (former natural wetlands with impounded water levels) or artificial wetlands (former upland sites with impounded water) in central and north Florida colonies increased from about 10 percent in 1960 to between 60 and 82 percent between 1976 and 1986.

Wood storks are seasonally monogamous, probably forming a new pair bond every season. Three and 4-year-old birds have been documented to breed, but the average age of first breeding is unknown. Once wood storks reach sexual maturity they are assumed to nest every year; there are no data on whether they breed for the remainder of their life or whether the interval between breeding attempts changes as they age (FWS 1997).

Wood storks construct their nests in trees that are usually standing in water or in trees that are on dry land if the land is a small island surrounded by water. The nest are large rigid structures usually found in the forks of large branches or limbs. Storks may add guano to the nest to stabilize the twigs. (Rodgers *et al*. 1988). The nest may be constructed in branches that are only a meter above the water or in the tops of tall trees. They construct their nests out of sticks, with a lining of finer material. Their nests are flat platforms, up to 1 m in diameter, and are maintained by the adult storks throughout the breeding season. Although both adults maintain the nest, the male wood stork usually brings nest material to the female after they complete their courtship (Palmer 1962).

The date on which wood storks begin nesting varies geographically. In Florida, wood storks lay eggs as early as October and as late as June (Rodgers 1990). In general, earlier nesting occurs in the southern portion of the state (below 27°N). Storks nesting in the Everglades and Big Cypress basins, under pre-drainage conditions (1930s to 1940s), formed colonies between November and January (December in most years) regardless of annual rainfall and water level conditions (Ogden 1994 and 1998). In response to deteriorating habitat conditions in South Florida, wood storks in these two regions have delayed the initiation of nesting, approximately two months, to February or March in most years since the 1970s. This shift in the timing of nesting is believed to be responsible for the increased frequencies of nest failures and colony abandonment in these regions over the last 20 years; colonies that start after January in South Florida risk having young in the nests when May-June rains flood marshes and disperse fish.

Female wood storks lay a single clutch of eggs per breeding season. However, they will lay a second clutch if their nests fail early in the breeding season (M. Coulter 1996). Wood storks lay two to five (usually three) eggs depending on environmental conditions; presumably larger clutch size in some years are responses to favorable water levels and food resources. Once an egg has been laid in a nest, one member of the breeding pair never leaves the nest unguarded. Both parents are responsible for incubation and foraging (Palmer 1962). Incubation takes approximately 28 days, and begins after the first one or two eggs are laid; therefore egg-hatching is asynchronous.

Younger, smaller chicks are often the first to die during times of food stress (FWS 1997). It takes about 9 weeks for the young to fledge; once they fledge, the young stay at the nest for an additional 3 to 4 weeks to be fed by their parents. Parents feed the young nestlings by regurgitating whole fish into the bottom of the nest; parents feed the young three to 10 or more times per day. Larger nestlings are fed directly bill to bill. Feedings tend to be more frequent when young are small. Ogden *et al.* (1978) reported that only one to two feedings per day, per nest, have been recorded in South Florida colonies when adults were forced to fly great distances to locate prey. Kahl (1964) calculated that an average wood stork family (two adults and two nestlings) requires 201 kg (443 lbs) of fish during a breeding season, and that a colony of 6,000 nests therefore requires 1,206,000 kg of fish during the breeding season. A similar calculation for a typical Everglades NP or Corkscrew Swamp colony with 200 nests would require 40, 200 kg (88,600 lbs) of fish during the breeding season.

The production of wood stork colonies varies considerably between years and locations, apparently in response to differences in food availability; colonies that are limited by food resources may fledge an average of 0.5 to 1.0 young per active nest; colonies that are not limited by food resources may fledge between 2.0 and 3.0 young per active nest (Ogden 1996a).

Foraging

Wood storks use a specialized feeding behavior called tactolocation, or grope feeding. A foraging wood stork wades through the water with its beak immersed and partially open (7 to 8 cm). When it touches a prey item, a wood stork snaps its mandibles shut, raises its head, and swallows what it has caught (Kahl 1964). Regularly, storks will stir the water with their feet, a behavior which appears to startle hiding prey (Rand 1956, Kahl 1964, Kushlan 1979). Tactolocation allows storks to feed at night and use water that is turbid or densely vegetated. However, the prey must be concentrated in relatively high densities for wood storks to forage effectively. The natural hydrologic regime in South Florida involves seasonal flooding of extensive areas of the flat, low-lying peninsula, followed by drying events which confine water to ponds and sloughs. Fish populations reach high numbers during the wet season, but become concentrated into smaller areas as drying occurs. Consumers, such as the wood stork, are able to exploit high concentrations of fish in drying pools and sloughs. In the pre-drainage Everglades, the dry season of South Florida provided wood storks with ideal foraging conditions by concentrating prey species in gator holes and other drainages in the Everglades basin. In coastal areas, the tidal cycle strongly influences use of saltwater habitats by wood storks. The relatively great tidal amplitudes characteristic of coastal marshes in northeast Florida, Georgia, and South Carolina serve to concentrate prey. similarly to the seasonal drawdowns found in freshwater systems (FWS 1997).

Storks forage in a wide variety of shallow wetlands, wherever prey reach high enough densities, and in water that is shallow and open enough for the birds to be successful in their hunting efforts (Ogden *et al.* 1978, Browder 1984, Coulter 1987). Good feeding conditions usually occur in relatively calm water, where depths are between 10 and 25 cm, and where the water column is uncluttered by dense patches of aquatic vegetation (Coulter and Bryan 1993). In South Florida, dropping water levels are often necessary to concentrate fish to suitable densities (Kahl 1964, Kushlan *et al.* 1975). In east-central Georgia, where stork prey is almost twice as large as the prey in Florida, wood storks feed where prey densities are significantly lower than foraging sites in Florida (Coulter 1992, Coulter and Bryan 1993, Depkin *et al.* 1992). Typical foraging sites throughout the wood stork's range include freshwater marshes and stock ponds, shallow, seasonally flooded roadside or agricultural ditches, narrow tidal creeks or shallow tidal pools, managed impoundments, and depressions in cypress heads and swamp sloughs. Almost any shallow wetland depression that concentrates fish, either through local reproduction or the consequences of area drying, may be used as feeding habitat.

Wood storks feed almost entirely on fish between 2 and 25 cm in length (Kahl 1964, Ogden *et al.* 1976, Coulter 1987). In South Florida, Ogden *et al.* (1976) found that certain fish species were taken preferentially. Mosquito fish (*Gambusia affinis*) were under represented in the diet in proportion to abundance, whereas, flagfish (*Jordanella floridae)*, sailfin mollies (*Poecilia* l*atipinna)*, marsh killifish (*Fundulus confluentus*), yellow bullheads (*Ictalurus natalis)*, and sunfish (*Centrarchidae*) were over represented. Wood storks also occasionally consume crustaceans, amphibians, reptiles, mammals, birds, and arthropods. Fish densities at stork foraging sites varied from 15.6 individuals/m^2 in east-central Georgia to 40 individuals/m^2 in South Florida (Ogden *et al.*1978, Depkin *et al.* 1992).

Because wood storks rely on concentrated food sources which are patchily distributed over large areas, they need to be able to find new feeding grounds with minimal energy expenditure. Wood storks have soaring abilities that allow them to reach high altitudes and many kilometers without the energy expenditure of wing-flapping. A recent study suggested that soaring flight by storks can be accomplished at one-tenth the energetic cost of flapping flight (Bryan and Coulter 1995). The long distances they travel, however, shortens the time available to wood storks for feeding and reduces the number of times an adult stork can return to its nest to feed young (Kahl 1964). During the breeding season, feeding areas proximal to wood stork breeding colonies may play an important role in chick survival and provide enhanced opportunities for newly fledged birds to learn effective feeding skills.

Movements

During the non-breeding season (the summer to fall rainy season in South Florida), juvenile wood storks from South Florida colonies have been located throughout the Florida peninsula, southern Georgia, coastal South Carolina, central Alabama, and east-central Mississippi (Ogden 1996a). Additionally, marked individuals from a colony in east-central Georgia were found in the central Everglades during the winter. This information suggests that the southeastern population of wood storks is a single population that responds to changing environmental conditions through temporal relocation. Rodgers' (1996) data analysis of genetic variation in wood stork populations in South Florida, central Florida, north Florida, Georgia, and South Carolina support this evaluation.

Relationship to Other Species

Although the majority of nesting by the southeastern wood stork population no longer occurs in South Florida, the wetlands of the Everglades remain as important feeding areas for large numbers of storks during the dry season (winter-spring) (Bancroft *et al.* 1992). Wood storks may nest with many other wading bird species including white ibis (*Eudocimus albus*), tricolored herons (*Hydranassa tricolor*), snowy egrets *(Egretta thula)*, great egrets (*Casmerodius albus*), great blue herons (*Ardea herodias*), little blue herons (*Egretta caerulea*), and cattle egrets (*Bubulcus ibis*).

Suitable foraging habitat for the wood stork occurs in a specific band of the hydrologic and vegetative gradient of South Florida's landscape (see preceding discussions on foraging habitat and foraging behavior). Wood storks share that landscape with other species that occupy different (adjacent) positions along the same hydrologic and vegetative gradients. The endangered snail kite *(Rostrhamus sociabilis plumbeus)* is a nomadic species which moves throughout the South Florida landscape in response to changing habitat conditions. Optimal foraging conditions for the snail kite include areas of variable water depth that support apple snails. Conditions that provide good foraging habitat for the snail kite are too deep to provide optimal foraging conditions for the wood stork. The Cape Sable seaside sparrow (Ammodramus maritimus mirabilis) is another endangered species that utilizes the South Florida landscape and whose breeding success is dependent on hydrologic conditions that differ from those of the wood stork and the snail kite. The Cape Sable seaside sparrow requires short-hydroperiod dry marl prairie communities that are dominated by muhly grass (Muhlenbergia filipes) for their nesting cycle.

Historically, the large spatial extent and diverse environmental conditions of the South Florida landscape provided the different habitat requirements of these species (Davis and Ogden 1994). In the past century, draining and clearing activities dramatically reduced the spatial extent of the South Florida Everglades. At the same time, humans began to control the timing, distribution, and volumes of water in the South Florida landscape. These practices have resulted in a reduced diversity of environmental conditions and a resultant loss of heterogeneity in the South Florida landscape. The combination of reduced spatial extent and reduced landscape diversity now causes the environmental needs of these species to "conflict" in the current, less-diverse, managed landscape.

Status and Trends

The wood stork appears to be experiencing human population pressure throughout its entire New World range. Although specific information on the status and trends of breeding colonies is not available throughout its range, information that has been collected on specific colonies suggests that breeding and foraging habitats of the wood stork are declining in area and quality. Mexico listed its breeding population of the wood stork as endangered in 1991 because of dramatic population declines. The size of the most important breeding colonies for the wood stork in Mexico, which are located in the Usumacinta and Grijalva River Deltas in the states of Tabasco and Campeche, had declined from 10,000 to 15,000 pairs in 1979 (Luthin 1987) to 3,000 to 3,500 pairs by 1990. Ogden *et al.* (1988) report 6,000-8,000 pairs as the range from 1971 to 1979. The wood stork is considered an endangered species in Belize where all colonies that were identified in the 1970s had disappeared by the late 1980s (Luthin 1987). Only one stable breeding colony is known to exist in Costa Rica; elsewhere in Central America, its status is unknown. Wood storks in South America face similar threats; in Cienaga de Zapatosa (Colombia), wood storks are threatened by pollution in the Rio Magdalena; in the Santa Rosa wetlands of Machalilla NP (Ecuador), wood storks may be affected by the construction of an oil terminal. The enormous wood stork rookeries in the Pantanal (primarily in Brazil), which is the world's largest wetland, are threatened by expanding agriculture, water pollution, and a massive project to drain, dike, and channelize this massive wetland ecosystem (Alho *et al.* 1988).

The U.S. population of the wood stork was listed as endangered in 1984 because it had declined by more than 75 percent since the 1930s (49 FR 7335). At the time, the FWS believed that the U.S. breeding population would be extirpated by the turn of the century if it continued to decline at the same rate. The original listing recognized the relationship between the declining wood stork population, the loss of suitable foraging habitat, and colony nesting failures, particularly in the breeding colonies in South Florida where human actions have reduced wetland areas by about 35 percent (Ogden and Nesbitt 1979).

Table 1. Wood stork breeding population in the southeast U.S., 1991-1995 (1997 wood stork recovery plan).

Year	Number of nests in southeast U.S.	Number of nests in South Carolina	Number of nests in Georgia	Number of nests in Florida	Number of nests in South Florida Ecoregion
1991	3,933	664	942	2,327	1,339
1992*	4,084	475	1091	2,518	2,518
1993	7,278	806	1649	4,823	2,546
1994	5,768	712	1468	3,588	2,015
1995	7,853	829	1501	5,523	2,639

* No data available for central or north Florida

We are uncertain about the size of the U.S. breeding population of wood storks before the statewide surveys of the late 1950s. Published and unpublished estimates of the size of the U.S. breeding population of wood storks prior to the statewide surveys are contradictory. For example, Allen (in Palmer 1962) wrote that the number of breeding wood storks in Florida exceeded 150,000 individuals during the 1930s. However, Ogden *et al.* (1978) believed this number was an overestimate resulting from an inflated estimate of the Lane River colony. Ogden (1978, 1996a) concluded that the wood stork population in the 1930s was probably less than 100,000 individuals, or between 15,000 and 25,000 pairs. More recent survey data provided by FWS (1997) in the wood stork recovery plan give a U.S. breeding population of 4,073 nests in 1991, 4,084 nests in 1992, 6,729 nests in 1993, 5,768 nests in 1994, and 7,853 nests in 1995 (Table 1). These data suggest that the breeding population of wood storks is increasing although the number of nests per year varies considerably. The next regionwide census of the wood stork population is scheduled for completion in 1999.

Since the 1960s, the wood stork population has shown a substantial decline in southern Florida and a substantial increase in northern Florida, Georgia, and South Carolina (Ogden et al. 1987). The number of pairs nesting in the traditional colony sites located in the Everglades and Big Cypress regions of southern Florida

Table 2. Pairs of nesting wood storks in Florida, 1991-1995 (from FWS 1997 wood stork recovery plan).

Colony Name	GFC Number	County	1991	1992	1993	1994	1995
Micanopy River Styx	605011	Alachua	40		55	175	250
Moore Creek	612007	Brevard					
U.S. 192 East & West	612138	Brevard	12		60		75
Grant Farm	616004	Brevard	60		150	100	
Micco North & South	616102	Brevard					48
Valkaria	616119	Brevard					25
SW Lake Washington	No Number	Brevard	60		185	105	300
Bluebill		Brevard	4				
Hall Island		Brevard	1				
	612127	Brevard			110	140	275
Lake Mary Jane	612037	Orange			100	105	175
Subtotal - Central Florida East Coast			**177**	**0**	**660**	**625**	**1,148**
Croom	611015	Hernando					175
Weeki Wachee		Hernando			12	16	
Hillsboro River	611163	Hillsborough				8	115
Lake Yale	612027	Lake	40		275	90	65
Ayers Point		Manatee			140		33
Devils' Creek	611021	Pasco			120	160	210
Little Gator Creek	611024	Pasco			60	9	200
Subtotal - Central Florida West Coast			**40**	**0**	**607**	**283**	**798**
Oleno	605103	Columbia	42				
Falling Creek		Columbia	80		150	110	110
Dee Dot	594004	Duval	250		260	300	325
Cedar Point	594105	Duval	9		85	30	120
Nassauvillo	594103	Nassau	5				
	606109	St. Johns			170		60
Subtotal - North Central Florida			**386**	**0**	**665**	**440**	**615**
Ochlocknee River	592003	Leon	160		115	95	144
Chaires	592001	Leon	225		230	130	179
Subtotal - North Florida			**385**	**0**	**345**	**225**	**323**
El Clair Ranch	616016	Hardee	400		320	240	415
Reedy Creek	612048	Polk			230	230	190
Lake Rosalie	616037	Polk	20		80	50	115
Mulberry NE	616114	Polk			75	130	110
	28048122	Polk			230	210	
Subtotal - SFER Central Florida			**420**	**0**	**935**	**860**	**830**
Pelican Island	616007	Indian River	110		225	110	230
Sewel Point	616025	Martin					65
Wescott Grove	616108	St. Lucie	40		25		8
Cypress Creek	616047A	St. Lucie	150		375	265	10
Subtotal - Central Florida East Coast			**300**	**0**	**625**	**375**	**313**
Tamiami Trail East	620122	Dade		130			
Cuthbert Lake	620139	Dade	150	275			
L-28 Crossover		Dade		158			
Tamiami Trail West		Dade		123			
East River		Dade			15		
Rookery Branch		Monroe		9			
Rodgers River Bay		Monroe		22		50	
Lane River		Monroe		1			
Paurotis Pond		Monroe			25	110	105
Loxahatchee 1&2	619139	Palm Beach	34				
SWA Catchment	No Number	Palm Beach					27
Corkscrew	619018	Collier	300	1800	426	450	864
Subtotal - Everglades and Big Cypress			**484**	**2,518**	**466**	**610**	**996**
Morgantown	616165	Charlotte	60				
North Port Charlotte	615040	Sarasota	75		520	170	500
Subtotal - Central Florida West Coast			**135**	**0**	**520**	**170**	**500**
Florida Population			**2,327**	**2,518**	**4,823**	**3,588**	**5,523**
North Florida			**988**	**0**	**2,277**	**1,573**	**2,884**
South Florida			**1,339**	**2,518**	**2,546**	**2,015**	**2,639**

declined from 8,500 pairs in 1961 to fewer than 500 pairs from 1987 through 1995. During the same years, the number nesting in Georgia increased from 4 pairs in 1965 to 1,501 pairs in 1995, and the number nesting in South Carolina increased from 11 pairs in 1981 to 829 pairs in 1995.

Between 1957 and 1960, the Florida and National Audubon Societies conducted a series of statewide aerial wood stork surveys of all known or suspected stork nesting colonies. In 1974, Florida statewide aerial surveys were initiated and repeated, annually, until 1986 (Ogden and Nesbitt 1979, Ogden and Patty 1981). In 1959, 14 breeding colonies in Florida supported an estimated 7,657 pairs of wood storks ; in 1960, 15 breeding colonies supported 10,060 breeding pairs; in 1975, 15 breeding colonies supported 5,382 breeding pairs; and in 1976, 17 breeding colonies supported 5,110 breeding pairs. More recent data provided in the wood stork recovery plan (FWS 1997) give a Florida breeding population of 2,327 pairs in 1991, 4,823 pairs in 1993, 3,588 pairs in 1994, and 5,523 breeding pairs in 1995. Twenty-one breeding colonies were present in 1991, 28 breeding colonies were present in 1993, 26 in 1994, and 30 in 1995. Data collections in 1992 did not include north and central Florida populations and are not included for comparisons.

The South Florida Ecosystem's contribution to the Florida population of wood storks is presented in Table 1. On the average the South Florida subpopulation represents 53 percent of the Florida population and 34 percent of the southeastern U.S. population. These data show a nesting population of 1,339 nests in 1991, 2,546 nests in 1993, 2,015 nests in 1994, and 2,639 nests in 1995.

The historical data and the recovery goals in the wood stork recovery plan reference the South Florida population as the Big Cypress Basin system and the Everglades Basin system. These two basins account for, on the average, between 30 to 37 percent of the South Florida Ecosystem sub-population. Table 2 provides a breakdown of the wood stork colonies listed in the recovery plan by general basin boundaries. Based on this general categorization of the colonies, four South Florida Ecosystem colony groupings are identified. These are the Central Florida East Coast colonies, the Everglades and Big Cypress (ECB) basin colonies, the Central Florida West Coast colonies, and the Central Florida colonies.

Historical data on colony locations identify the Everglades basin colonies and the Corkscrew colonies as the primary nesting locations for wood storks in South Florida (Ogden and Nesbitt 1979). In the late 1950s and early 1960s, wood storks nesting in the Everglades basin accounted for 12 percent [1,000 out of 8,609 nests (two-year average)] of the Florida population. The 1991 to 1995 survey data reveal that the Everglades basin colonies represents on the average, 3 percent [129 out of 4,065 nests (four-year average)] of the Florida population. In the late 1950s and early 1960s data, the Corkscrew colonies accounted for 51 percent [4,350 out of 8,609 nests (two-year average)]. The survey data also show that the Corkscrew colonies represent on the average, 12 percent [510 out of 4,065 nests (four-year average)] of the Florida population. More recent data provided by Ogden (1998) on three-year averages on nesting pairs of wood storks in the Everglades Basin (Loxahatchee NWR, WCAs 2 and 3, and mainland Everglades NP) show 343 pairs for the 1994 to 1996 average, 283 pairs for the 1995 to 1997 average, and 228 pairs for the 1996 to 1998 average. These averages are higher than the three-year average for the base years, 1986 to 1995. The base year averages were a low of 130 pairs and a high of 294 pairs. In the 1998 nesting year, only 25 pairs of wood storks were recorded nesting in ENP.

Rodgers *et al.* (1995) pointed out shortcomings in the aerial surveys used to generate population estimates for storks in Florida, Georgia, and South Carolina. Rodger's study compared ground surveys of wood stork colonies with aerial surveys of the same colonies. The variability of the aerial estimates was very large. For example, an approximately 95 percent confidence interval for the 1993 Florida statewide nesting population was 3,807 to 12,653 nests. The aerial count was 4,262 nests. The greatest variability occurred in large colonies with a high proportion of other white-plumage nesting birds. The FWS acknowledges the limitations involved in relying on aerial surveys for developing population estimates. However, over the long-term, aerial surveys are the most cost-effective method for estimating population trends. Ground surveys, while providing greater individual colony accuracy, are more time consuming and expensive on a regionwide basis. Rodgers recommended the incorporation of ground counts at selected colonies, training observers in presurvey flights, and replicating counts for each colony as actions to minimize variability in aerial surveys.

Historically, wood storks were recorded nesting in all coastal states between Texas and South Carolina (Ogden et al. 1987, FWS 1997); however, the largest colonies were located in South Florida. Since the 1960s, the decline in the U.S. population size of wood storks has been accompanied by a change in the size and distribution of their breeding colonies. Since the 1970s, the number of wood storks breeding in South Florida has substantially decreased. In north Florida, Georgia, and South Carolina the number of breeding wood storks has significantly increased (Ogden et al. 1987). From 1958 to 1960, 80 to 88 percent of wood stork nesting pairs were located at six sites in South Florida. Surveys from 1976 showed a decline to 68 percent, with a further decline to 13 percent in 1986. Since the late 1970s, a majority of wood storks have nested in central and north Florida, and an increasing number have nested in coastal colonies in Georgia and South Carolina. Between 1965 and 1995, the number of wood storks nesting in Georgia increased from four pairs to 1,501 pairs; between 1981 and

1995, the number of wood storks nesting in South Carolina increased from 11 pairs to 829 pairs. Since the 1970s, associated with this shift to the north, the U.S. southeast wood stork population appears to be gradually increasing, from a low of 3,000 to 4,000 pairs in the late 1970s, to over 7,800 pairs in the mid-1990s.

From 1991 through 1995, the FWS coordinated a systematic multi-state survey of wood stork nesting colonies. The results of these surveys suggest that, on average, from 1991 to 1995, approximately 35 percent of the total nesting effort in the southeast U.S. occurred in South Florida (Table 1). Historically, South Florida supported greater than 70 percent of the total nesting effort in the southeast U.S.; if these data are indicative of the ability of degraded South Florida ecosystems to support wood stork nesting, then South Florida ecosystems are functioning at approximately 50 percent of their previous capabilities.

Both 1992 and 1995 were years with high nesting effort. In 1995, nesting effort in South Florida improved from the previous two years, most likely in response to improved foraging conditions as a result of a rapid dry-down following the high-water years. In Everglades NP, Big Cypress National Preserve, Corkscrew National Sanctuary, and Florida Panther NWR, there were a total of approximately 996 nesting pairs. The North Port Charlotte nesting colony, which is north of the Corkscrew National Sanctuary had a breeding population of 500 nest pairs.

Since the 1970s, wood storks have also shifted their nest sites to areas that are artificial impoundments or where islands have been created by dredging activities (Ogden 1991). The percentage of nests in artificial habitats in central and north Florida has increased from approximately 10 percent of all nesting pairs in 1959 to 1960 to 60 to 82 percent between 1976 and 1986 (Ogden 1991). Nests in these artificially impounded sites often support exotic species such as Brazilian pepper (*Schinus terebinthifolius*) or Australian Pine *(Casuarina spp.*). Ogden (1996a) has suggested that the use of these artificial wetlands indicates that wood storks are not finding suitable conditions within natural nesting habitat or that they are finding better conditions at the artificial wetlands.

The 1960s and 1970s were a period of transition for wood storks breeding in South Florida. The most significant change was a delay in the timing of colony formation, from November and December in most years prior to the 1970s, to a pattern of colony formation between January and March. During the late 1970s, delayed colony formation by wood storks became the norm (Ogden 1994). Historically, wood storks formed colonies in November and December and concentrated the majority of their feeding efforts within the estuaries at the time of traditional colony formation (J. Ogden, SFWMD, personal communication 1996b).

The November/December feeding efforts appear to historically correspond to the annual mullet runs that occur on both of Florida's coastal systems. Before spawning, which usually peaks from November through January, large schools and concentrations of mullet form in the estuarine habitat (J. Cato, et al. 1976). During low tide, these large schools of mullet, which are concentrated in the shallow estuarine bays and mud flats, provide a concentrated food source for the wood stork during the early nesting cycle.

By the time the young of the year were ready to fledge and begin foraging independently, the dry season in South Florida was well underway and fish were being concentrated in the interior freshwater sloughs, making feeding easy. Presently, wood storks in South Florida appear to be initiating nesting in response to the drying of the interior marshes in February to April; by the time the young fledge and begin foraging on their own, the wet season is underway, water levels in the interior marshes are rising, and many young starve. Such a change suggests that the estuarine habitats no longer provide suitable foraging conditions during the early dry season months, November to January.

The reproductive success of storks requires habitats that provide high concentrations of certain size-classes of fish, over a 125 to 150 day breeding cycle. Because seasonal and annual rainfall patterns are so variable in South Florida, the quantity of these foraging habitats also varies among years (J. Ogden, SFWMD, personal communication 1998). As a result, wood storks probably have always had highly variable reproductive success throughout their history, a phenomenon that is mitigated by the relatively long life spans of adult storks. Nevertheless, most authors agree that the decline of the U.S. wood stork population far exceeds the range of historic variability in total population size, and is correlated with water management activities in South Florida (Palmer 1962, Frederick 1993, Ogden 1996). During wet years, current water management practices prevent the formation of shallow pools that concentrate the fish on which wood stork forage. During dry years, current water management practices overdrain the freshwater sloughs, reduce freshwater flows into the mainland estuaries and reduce their ability to produce the fish on which wood storks forage.

As a result of these water management practices, wood storks in South Florida have experienced increased frequencies of nest failure. For example, in 1962, 1978, and 1983, wood storks in Everglades NP did not initiate nesting. In 1990, all nestlings in the Cuthbert Lake colony starved. In 1995, none of 250 nestlings survived in the Paurotis Pond colony. In the 1998 nesting year, only 25 pairs of wood storks were recorded nesting in ENP.

The threat of mercury contamination in the Everglades food web and its impact on the success of wood storks in South Florida is not clearly understood. Researchers have suggested that declines in wading bird populations may be partially a result of mercury toxicity (Frederick and Spalding 1994, Sundlof *et al.* 1994). In 1991, mercury contamination was documented in a wood stork carcass found in the Big Cypress basin (Facemire and Chlebowski 1991). The average mercury contents in the liver and feathers of the wood stork were 10.1 and 9.93 mg mercury per kg weight, respectively. The report concluded that, although the documented levels were generally less than those noted in the literature for fish-eating birds from mercury-contaminated freshwater systems, they were, most likely, sufficient to cause an adverse effect to the population. More recently, Beyer *et al.* (1997) found mercury concentrations in the livers of four wood storks collected in South Florida that were higher than the concentrations reported in seven other species of wading birds from South Florida. Frederick and Spalding (1994) reviewed the current knowledge on mercury contamination in wading birds, and concluded:

> In light of work that has been done in other species, it is not unreasonable to assume that high concentrations of mercury found recently in Everglades wading birds could result in the sublethal effects of reduced foraging and courtship ability. Each of these

> symptoms could result in reduced breeding effort and success and could be a powerful factor in explaining the reduced reproduction observed in the Everglades. The current state of knowledge on the effects of specific concentrations of mercury on wading bird behavior and survival is nonexistent.

Clearly much more specific research needs to be conducted on the levels of mercury in wood storks in the Everglades and the effects of these levels on the population. Potential impacts from contaminants need to be reconsidered in light of recent findings concerning the amount of mercury present in the Everglades ecosystem and the discovery of severe impacts of DDT/DDE-based estrogen-mimicking compounds on wildlife in a large Florida wetland (Guillette *et al*. 1994). The Science Sub-Group of the Interagency Task Force on the South Florida Ecosystem has acknowledged this in the section of their report dealing with threatened and endangered species. For the wood stork, the report calls for “a detailed study of the effects of mercury, other toxins, and parasites on the survivorship and reproductive success of wood storks” (Science Sub-Group, 1996).

Prognosis of the U.S. wood stork population between 1996 and 2020 is partially dependent on the success of the overall South Florida Ecosystem restoration effort. The freshwater flows need to be restored to more closely mimic the pre-drainage system; it is believed that by restoring the quantity, quality, timing, and distribution of flows in the remaining Everglades wetlands that the prey base so critical to wood storks during the breeding season will be recovered in both the estuarine and freshwater systems. Although we have lost approximately 35 percent of the original foraging grounds and the quality of much of the remaining wetlands has become degraded as foraging habitats, if our efforts to restore the South Florida Ecosystem are successful, we will re-create a system with heterogeneity and inherent variability, which should provide the prey base necessary to restore the wood stork in South Florida.

Management

South Florida has been severely degraded by the C&SF Project, which encompasses 4,660,000 ha from Orlando to Florida Bay and includes about 1,600 km each of canals and levees, 150 water control structures, and 16 major pump stations. This system has disrupted the natural volume, timing, quality and distribution of surface and ground water throughout South Florida. In recognition of the detrimental effects that this flood control system has had on the ecosystems in South Florida, numerous hydrologic projects, whose purposes are to aid in the restoration of South Florida’s ecosystems, while maintaining flood control, are in varying stages of planning and implementation.

The 1992 Water Resources Development Act (WRDA) authorized the Kissimmee River and the Kissimmee River Headwaters Revitalization Project. In 1994, a Project Cooperative Agreement between the COE and the local sponsor, the SFWMD, combined the two authorized projects into one project, the Kissimmee River, Florida Project. The purpose of the project is to provide the flows necessary to restore the Kissimmee River ecosystem. We have the ability to increase the spatial extent and quality of foraging habitat available to wood storks by returning the natural functions to the Kissimmee River basin.

The C-111 and Modified Water Deliveries Projects were congressionally authorized in 1994 and 1990, respectively. The purpose of these two projects is to begin the process of restoring freshwater flows into Everglades NP. This will be accomplished by modifying the structures, canals and levees that deliver water to Everglades NP, and by changing the operational schedules. The future breeding success of the wood stork in Everglades NP is closely tied to the success or failure of these two projects. While other aspects of the overall Everglades restoration will be necessary to re-establish pre-drainage-like flows, these two projects will set the precedent for the restoration of South Florida, including the restoration of the prey base available to breeding wood storks in the southern Everglades.

The Experimental Program of Water Deliveries to Everglades NP was authorized in 1983; its purpose is to provide a vehicle to field-test water delivery methods into ENP. Each iterative test builds on the results of the previous tests and is aimed at furthering the goal of restoring, to the extent practicable, the ecological integrity of the native fauna and flora within Everglades NP, including Florida Bay. As operational flexibility increases with the completion of the Modified Water Deliveries, C-111, and other restoration projects, the ability to implement an operational plan that optimizes ecological restoration will substantially increase, and with it, our ability to recover the wood stork in South Florida.

Water supply and water delivery programs are also addressing habitat degradation of wood stork nesting and foraging areas in the Big Cypress basin and in the Corkscew Regional Ecosystem Watershed. The hydrologic restoration of Southern Golden Gate Estates, a 113 square miles rehydration project being jointly designed by the SFWMD and the Corps of Engineers, will provide surface storage and aquifer recharge and water quality enhancement in the Big Cypress Basin.

WRDA further authorized a comprehensive review of the Central and Southern Florida Project. The purpose of the review is to develop a comprehensive plan to restore, preserve, and protect the South Florida ecosystem. This is to be accomplished through the restoration of more natural flows to the southwest coastal areas, including the Big Cypress basin, and through the Everglades NP to Florida Bay. The WRDA of 1996 accelerated this process and calls for a plan to be sent to Congress for authorization by September 30, 1999. This project, in combination with previously authorized projects, should result in the enhancement of nesting and foraging habitat that is necessary for the recovery of the wood stork subpopulations in South Florida.

In addition to hydrologic restoration projects, the State of Florida administers land acquisition programs that may enhance opportunities to restore wood storks in South Florida. The Save Our Rivers program identifies lands of environmental significance and prioritizes their acquisition. Of these lands identified, the Model Lands and Pennsuco wetlands in Miami-Dade County, the Golden Gate Estate wetlands in Collier County, and CREW wetlands in Lee and Collier counties are of significance to the wood stork for foraging. Public acquisition of these lands will increase our ability to manage them in an ecologically-sensitive fashion. The Conservation and Recreation Lands Acquisition program is an additional program that may provide some opportunities for wood stork recovery in South Florida, and should be acknowledged and incorporated into long-term planning efforts. Nesting habitat should be protected from disturbance and human alteration through purchase into the public lands system, easements, partnerships and private landowner/government assistance and agreements. Watersheds supporting natural nesting habitat should remain unaltered, or be restored to function as a natural system if previously altered.

Lands can be purchased by Federal agencies through section 104 of the Everglades NP Protection and Expansion Act of 1989 (P.L. 101-229) and section 390 of the Federal Agriculture Improvement and Reform Act of 1996 (P.L. 104-127).

The Everglades NP Protection and Expansion Act of 1989 authorized the purchase of lands to be added to the park that encompass approximately 44,379 ha within northeast Shark River Slough (NESS) and the East Everglades. The purchase of these lands and the hydrological improvements to these lands are critical to restoring ecosystem productivity in the southern Everglades and maintaining adequate freshwater inflow to the downstream estuaries along the Gulf of Mexico and Florida Bay. The purchase of these lands is necessary to limit further habitat destruction outside former boundaries and to restore natural water flow patterns that are critical to the long-term viability of the park.

Section 390 of the Federal Agriculture Improvement and Reform Act of 1996, referred to as Farm Bill 390, provides two distinct funding programs for land acquisition to support restoration of the Everglades. The first program provided $200,000,000 to the Secretary of the Interior to conduct restoration activities in the Everglades Ecosystem in South Florida, including acquisition of real property and interests in real property and resource protection and resource maintenance activities. An additional $100,000,000 is available under the Farm Bill 390 authorization from the sale of Federal surplus lands to purchase lands necessary for the Everglades restoration efforts.

The Corkscrew colony in Collier County continues to occasionally produce large numbers of young in South Florida (Table 2). The acquisition or preservation of this colony's habitat and recovery of more natural hydropatterns within the foraging grounds surrounding this colony, are critical to the recovery of wood storks in South Florida. Wood storks nesting at Corkscrew now show a similar pattern of delayed nesting in many years. Private lands initiatives, conservation easements, and mitigation banking should all be considered as viable opportunities for managing these lands.

Ogden (1990) developed a set of management guidelines for the FWS on wood stork nesting, feeding, and roosting habitats. The guidelines recommend buffer zones that may be necessary to reduce human disturbance of storks in feeding and roosting habitats. These efforts have substantially contributed to the protection of stork habitat, particularly where new developments have been proposed in areas used by storks. The buffer zones recommended in the management guidelines are larger than those recommended by Rodgers and Smith (1995) in their analysis. At the time the guidelines were developed, little empirical data were available on the response of wood storks to human activities. Rodgers and Smith analyzed only three types of human activities: walking, canoeing, and a small motorboat with two persons. They did not evaluate responses to other activities such as construction or aircraft. The current guidelines recommend buffer zones to protect colonies from many kinds of activities including human disturbance. Rodgers and Smith, (1997) study of human disturbance to foraging and loafing waterbirds recommends a buffer of about 100 meters.

An understanding of the relationships between storks and water conditions in the Everglades has provided a basis for restoration planning for the region. Wood storks have been recommended by the Science Sub-Group of the South Florida Ecosystem Restoration Task Force as a species to be used for measuring the success of the overall South Florida Ecosystem restoration. Everglades NP and SFWMD staff have used a 64-year record of stork nesting in the Everglades basin (1932-1995) for this purpose. The C-111 Project, Modified Water Deliveries Project, the Experimental Program of Water Deliveries to Everglades NP, and the regional water management plans being developed for the EAA, the Big Cypress basin and the CREW should eventually result in much improved habitat conditions for storks in South Florida. It is currently assumed, as a part of the restoration planning, that the recovery of increased volumes of freshwater flows through the Everglades marshes and into the estuaries of Florida Bay will increase primary and secondary production in these regions.

Regional surveys of nesting colonies conducted from 1957 through 1961, and again in the mid-1970s, have been essential for locating important habitats, and for understanding the threats to the southeastern population of storks. These surveys were the first to measure the status of the regional population of storks, and have been used to measure responses by nesting storks to water management practices in the Everglades region. Over the 5 years from 1991 to 1995, the FWS coordinated a systematic multi-state survey of stork nesting colonies (L. Finger, FWS, personal communication 1996). The census continued through the 1995 nesting season. After a 5-year hiatus where financial efforts were directed towards research, a new series of censuses began again in the year 1999.

Stangel *et al*. (1990) employed starch gel electrophoretic techniques to examine genetic variation in Florida wood stork colonies. This study did not indicate significant allozyme differences within or between colonies. In 1994, a genetics study incorporating DNA microsatellites of breeding storks in Florida, Georgia, and South Carolina was initiated to further investigate the geographic and genetic origins of wood stork colonies in the three states. By assessing the degree of genetic interrelatedness among wood stork colonies, vital information may be obtained concerning population movements, allowing us to determine whether the increase in numbers of storks breeding in the northern portion of their range is the result of high productivity in those colonies, increased immigration from Florida colonies, or both. However, the increase in the size and number of “northern” colonies almost certainly occurred too rapidly to be explained by local recruitment.

An effort should be made to place transmitters on juvenile wood storks in South Florida. This will help us to identify critical foraging grounds and gain insight into post-fledging survivorship.

A Wetlands-Wood Stork Summit was held on October 13-14, 1994 in Georgia. The Georgia Conservancy and Zoo Atlanta convened this summit to initiate a coordinated regionwide effort in wetlands education focusing on the wood stork. The initiative would be comprised of both an education and a research component. A grant proposal was submitted in early 1995 requesting support for this effort.

The informal Wood Stork Management Group, formed 3 years ago by the Georgia Conservancy and more recently hosted by the FWS, should continue to meet annually as a means for reviewing trends and assessing the influences of Everglades restoration projects relative to patterns by total stork populations in the Southeast.

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Recovery for the Wood Stork

Mycteria americana

Recovery Objective: **RECLASSIFY** to threatened, then delist.

South Florida Contribution: The former Science Subgroup (now Science Coordination Team) of the South Florida Ecosystem Restoration Task Force and Working Group prepared a set of recommendations for success measures for the South Florida Ecosystem restoration program. Included in these recommendations are targets for the recovery of nesting wading birds in the Everglades basin (WCAs and ENP). The Science Subgroup's measure of success for the wood stork is a breeding population between 1,500 to 2,500 pairs. The goal for wood stork recovery in South Florida is to support 2,500 nesting pairs in the Everglades and Big Cypress Basin systems and to support, as a South Florida Ecosystem component, 35 percent (3,500 nesting pairs) of the southeast United States recovery and delisting nesting population of 10,000 pairs.

Recovery Criteria

South Florida will contribute to the recovery of the total population, if the wood stork foraging and nesting habitat in the Everglades watershed is restored and/or enhanced as a result of the modified water storage and delivery programs being developed by the SFWMD and the COE. The recovery criteria as identified in the wood stork recovery plan, for the Everglades and Big Cypress Basin is a population of 2,500 nesting pairs. The recovery criteria for the South Florida Ecosystem populations, which also includes nesting colonies in coastal counties in central Florida and nesting colonies in the Kissimmee Basin, is 35 percent (3,500 nesting pairs) of the total recovery population of 10,000 pairs.

Species-level Recovery Actions

S1. **Determine the distribution and status of wood storks in South Florida**. All evidence suggests that the wood stork population in the southeast U.S. is a single population, with individuals moving throughout the landscape in response to habitat conditions; the recovery of wood storks depends on the success of the birds throughout their range. Historically, South Florida supported greater than 70 percent of the nesting wood storks in the Southeast. Recent nesting populations in South Florida average around 10 to 13 percent with the major nesting occurring at the Corkscrew colony. More recent data provided by Ogden (1997) also present evidence that South Florida provides winter foraging grounds for many of the recently developed northern breeding colonies in north Florida, Georgia, and South Carolina. The restoration and enhancement of the South Florida foraging habitat is important to the overall recovery of the wood stork population and the reversal of the decreasing nesting trends in South Florida. Distribution must be monitored into the future to determine wood stork response to Everglades restoration activities.

S1.1. Conduct wood stork annual nesting surveys within the Everglades and Big Cypress Basins and the east and west coast populations. The health and productivity of colonies must be known to evaluate the status and recovery of the wood stork. Long-term wading bird nesting data in South Florida suggest that the number of pairs of birds initiating nesting in a given year is a better indicator of ecosystem health than is nesting success. The number of pairs of wood storks attempting to breed in South Florida should be monitored annually to determine wood stork response to ecosystem conditions in South Florida. Conducting annual nesting surveys within these basins will provide information on annual nesting patterns for wood storks in South Florida and will allow us to best respond with the appropriate management strategies for the species. Much could be learned about wood stork ecology in the Everglades by detailed review of the multi-year systematic reconnaissance flight data. Detailed evaluation of these data is necessary.

S1.2. Locate foraging and roosting habitat. Wood storks take several years to mature to breeding age. The survival of birds during these years is critical. Research that gains a better understanding of where non-breeding birds go in Florida needs to be conducted. Research on what habitats are critical to their survival and what factors may be limiting their survival is also necessary. Identifying important foraging and roosting habitat is critical to the recovery of the wood stork. Recent studies along the Georgia and South Carolina coast have provided valuable information on roosting and foraging behavior (Bryan and Coulter 1995); additional work of this sort is needed in South Florida.

S1.3. Develop standardized census procedures for wood storks nesting in South Florida. Systematic nesting survey protocol should be developed for both the Everglades and Big Cypress basins. This protocol will allow for comparison between years and between basins.

S2. Protect and enhance wood storks in the South Florida Ecosystem through provisions of section 7 of the ESA. The majority of management activities to protect and enhance wood storks in the South Florida ecoregion must occur at an ecosystem level (see habitat-level recovery actions), not a species-specific level; wood storks respond to changing environmental conditions by integrating habitat conditions over a large geographic area and therefore will be more affected by large-scale management practices. However, the review of Federal water management practices through section 7 consultations is one vehicle whose implementation will be imperative to the survival and recovery of the wood stork. Much of the landscape utilized by wood storks in South Florida is subject to Federal and State water management practices; water management of the COE's C&SF project is critical to the survival and recovery of the wood stork. The FWS needs to provide conservation recommendations to enhance habitat conditions for the wood stork throughout the C&SF project. Specific guidance should include operational schedules (water regulation) for Lake Okeechobee, the WCAs, Everglades NP, and Big Cypress National Preserve. The Kissimmee River basin also supports important colonies of wood storks. The water management goals of the Kissimmee River basin may affect foraging and nesting success in these colonies. Proposed land management actions on these restoration lands need to be examined in relation to wood stork habitat requirements.

S3. Conduct research on the biology and life history of wood storks. Recovery efforts for wood storks will be more effective with a complete understanding of population biology, movement patterns, foraging ecology and behavior, the importance of roost sites, and the possible impacts of contaminants on South Florida wood storks. To date, information on nesting patterns and the number of wood storks initiating nesting in South Florida has been collected for some regions in some years. Additional information is needed on wood stork demographics and movement patterns between the colonies and foraging and roosting sites.

S3.1. Determine the productivity of wood storks nesting in South Florida. To estimate the productivity of wood storks, the number of fledged young per nest and the number of fledged young per successful nest must be determined for the major nesting colonies in South Florida during the same breeding cycle.

S3.2. Determine survivorship of wood storks in South Florida. This parameter is one of the least understood, and research on this topic may provide more new insights into population dynamics than any other effort. We need to determine survivorship of fledged young to adulthood to better gauge what amount of productivity is required to maintain or increase wood storks nesting in South Florida. This might be accomplished through a massive multi-year leg banding (or wing tagging) effort in multiple colonies, radio-instrumenting a certain number of birds (with mortality sensors) or possibly by surveys during the non-breeding season to determine the adult:sub-adult ratio.

S3.3. Determine the age structure of the wood stork population in the southeast U.S. This information will be necessary to determine whether the population is sustainable and can be delisted.

S3.4. Determine the movement patterns of South Florida wood stork fledglings and post-breeding South Florida adult wood storks. Movement patterns will provide information on behavior, habitat utilization, and potential critical foraging areas. The survival of fledgling wood storks is dependent on their ability to find suitable foraging areas when they first begin to forage independently. If fledglings must travel great distances to forage, their survival may be hampered. Additionally, understanding the movement patterns of adult wood storks after they complete breeding will answer questions such as: 1) Do adult wood storks “help” fledglings to find suitable foraging sites, and 2) Are there foraging sites within a “critical” distance from breeding colonies in South Florida, or do adult storks, upon completion of breeding, move out of South Florida?

S3.5. Determine foraging ecology and behavior of wood storks. The number of wood storks nesting in South Florida has greatly declined. Information on foraging by wood storks in South Florida needs to be completed to determine the inter-dependence of successful nesting by wood storks in South Florida and the availability of suitable foraging sites. Information from the systematic reconnaissance flights should provide information on foraging distribution for multiple years and should help to answer some questions on the foraging ecology of the wood stork, but additional work must be completed to understand the characteristics of the forage base that are necessary to provide functional wood stork foraging habitat in South Florida.

S3.5.1. Re-evaluate wood stork foraging studies in Everglades NP. Studies on the forage base available and utilized by storks in Everglades NP were done in the 1970s. A comparative study should be completed to determine if changes have occurred in the prey base available to wood storks. This issue should again be addressed since this ecosystem is vital to recovery goals, is important as a wintering area for all storks, and has recently been documented to have problems with mercury contamination (Sundlof *et al.* 1994).

S3.5.2. Conduct studies on the prey base available in areas identified as critical foraging sites during the breeding season. We need to collect information on the prey base available to wood storks at foraging areas receiving high use during the breeding season. This information should be compared to identical information collected at sites not utilized by wood storks during the same time period.

S3.5.3. Determine foraging requirements of wood storks during the non-breeding season. Research concerning the foraging ecology of this species should also examine foraging requirements during the wintering or non-breeding period. In some years, the inland marshes of the Everglades have supported the majority of the U.S. population of wood storks. During the non-breeding seasons in 1985 to 1989, up to 55 percent of the entire U.S. population may have relied on the WCAs (which comprise only a portion of the Everglades system) to meet their foraging requirements (Bancroft *et al.* 1992). Understanding the processes that determine whether storks in the non-breeding season are concentrated on a small area of habitat or dispersed throughout their entire winter range will provide management flexibility and decrease the likelihood of negative impacts to a large proportion of the population during a single season.

S3.5.4. Continue studies on wood stork nocturnal foraging activities. Preliminary studies by Bryan (1995) indicate that storks in South Carolina and Georgia are active nighttime feeders. The prevalence of nocturnal foraging activities by this species needs to be studied both seasonally and geographically in South Florida. Nocturnal feeding may be more important for wood storks feeding in tidal marshes than in freshwater marshes, but, if nocturnal feeding by wood storks is significant, regulatory decisions may need to reflect this information to protect wood stork foraging grounds from disturbance "around the clock".

S3.6. Determine the importance of wood stork roost sites. Recent surveys of the Georgia and South Carolina coast documented the presence of a large number of stork roost sites, but only a limited number of roosts were inhabited repeatedly by numerous storks. Research concerning the function and use of such sites and habitats in South Florida is needed. If important roost sites are identified in South Florida, protective measures should be developed. These studies could also assess foraging habitats utilized from these sites, thus providing important information about the non-breeding season.

S3.7. Determine the impacts of contaminants on wood storks in South Florida. Potential impacts from contaminants need to be reconsidered in light of recent findings concerning the amount of mercury present in the Everglades Ecosystem and the discovery of severe impacts of DDT/DDE-based estrogen-mimicking compounds on wildlife in a large Florida wetland (Guillette *et al.* 1994).

S3.7.1. Conduct mercury studies on wood storks in South Florida. Studies should be conducted in the South Florida E cosystem to document effects of mercury on wood storks.

S3.7.2. Conduct contaminant studies on wood storks throughout the region. Develop baseline contaminant information from a variety of colony sites throughout the region to determine if further studies are needed.

S3.8. Complete models for the wood stork population. Population viability assessment and risk analysis models should be performed for the wood stork population once the necessary information is acquired. Once completed, the relative importance of the South Florida Ecosystem, and the ability of the wood stork to successfully breed in South Florida, should be determined.

S3.9. Develop models of wood stork colony dynamics in South Florida wetlands. These models are needed as planning tools for improved ecosystem restoration programs. Potentially one important ecological model for the Everglades is a wood stork population dynamics model that is a part of the "Across-Trophic-Level System Simulation" (ATLSS) set of models being developed by the South Florida/Caribbean Field Station of the USGS, BRD.

S4. Monitor wood storks in South Florida. Annual nesting and foraging surveys should be completed for wood storks in South Florida. These surveys will provide the information necessary to monitor the success of ecosystem and species-specific recovery actions. Surveys should be performed on an annual basis within both the Everglades and Big Cypress basins until the species is delisted.

S4.1. Conduct long-term monitoring of the number of wood storks initiating nesting in South Florida, as described by tasks 1.1. and 1.2.

S4.2. Organize systematic censuses of wood stork foraging habitat in the Big Cypress region, comparable to existing censuses (systematic reconnaissance flights) in the Everglades basin. The fact that declines in nesting effort and delays in timing of colony formation have shown similar trends in the Big Cypress basin have been well documented in the Everglades basin suggests that the Big Cypress colonies are dealing with similar kinds of habitat deterioration on the foraging grounds. The location and relative importance of stork foraging grounds in the Big Cypress basin are much less known, and should be determined as a basis for developing protection strategies in this region; this survey would provide the information necessary to monitor the success of both ecosystem and species-specific recovery actions.

S4.3. Continue foraging surveys in the Water Conservation Areas and Everglades NP. This information is necessary to follow the trends of wood storks in South Florida and should be continued until the species is delisted.

S4.4. Initiate and continue demographic surveys, such as colony surveys to determine productivity; additionally, studies to determine survivorship should be continued until enough data have been collected to determine wood stork rates of growth, reproduction, and survival. This information will be critical to determine whether or not the species can be delisted.

S5. Increase public awareness. Wood storks are an indicator species of the Everglades Ecosystem; the health of the Everglades can be measured by the ability of the wood stork to successfully breed in the Everglades. The Maine coastal seabird colony restoration program uses the puffin as its symbol. The wood stork is a symbol of the health of the Everglades and Big Cypress basins and could be used as a barometer of the success of Everglades restoration projects.

S5.1. Increase awareness and appreciation of wood storks through educational materials. Wood storks utilize a variety of wetland habitats and have been identified as an indicator species for the Everglades. Additionally, they are visually unique and generate interest from the general public. Make the wood stork a symbol of the Everglades through the use of environmental education materials and programs.

S5.1.1. Develop and distribute educational materials. Currently, there are several brochures, videos, and educational packets available that focus on wood storks. This information needs to be kept up to date. New educational material should be developed to increase the awareness of a larger audience.

S5.1.2. Develop information for private landowners. Wood storks breeding in the Corkscrew Swamp and in the northern and central Big Cypress basin in South Florida forage in surrounding wetlands, many of which are on private lands. Material explaining wood stork ecology and suggesting management practices benefiting storks should be distributed to private landowners.

S5.1.3. Develop educational materials for schools. Since wood storks occur in Florida, Georgia and South Carolina, it would be cost-effective to develop educational materials that could be used in schools in all three states.

S5.1.4. Develop material for policy makers and elected officials. The wood stork should be included as part of a larger effort to inform and educate South Florida policy makers and elected officials of the importance of maintaining and protecting wetland habitats throughout the Big Cypress and Everglades basins.

S5.2. Provide opportunities for the public to view wood storks in captivity. Maintaining wood storks in captivity should be for the sole purpose of public education, awareness, and research to enhance survival of the species. Currently, there are nearly two dozen American wood storks in captivity in North American zoos and related facilities.

S5.2.1. Maintain captive populations for the purpose of education, awareness, and research. FWS draft policy on controlled propagation sanctions captive propagation of listed species when recommended in an approved recovery plan and supported by an approved genetics management plan. Captive propagation of wood storks is not considered necessary for the purpose of supplementing wild populations through reintroduction programs. Captive breeding and rearing efforts will not be made for this purpose. However, good captive management of wood storks may result in reproduction. The resulting progeny may be used to supplement other captive populations under approval of the FWS. If available space within captive facilities becomes saturated, further production of offspring should be prevented within the scope of laws governing captive endangered wildlife.

S5.2.2. Develop policy on rescue, rehabilitation and release of injured wood storks. The FWS, in conjunction with the American Zoological Association, should develop a policy for dealing with wood storks that are rescued from the wild. Adult wood storks are not as frequently received by licensed wildlife rehabilitators as other wetland bird species. Opportunities for rescue may most likely occur when field personnel are in the colonies and witness distress. This may be as a result of nest abandonment when food sources become scarce or when chicks fall out of the nest for reasons such as adult bird interactions or wind storms. Where possible, field personnel should return downed chicks to the nest. When replacement is not viable, the usual protocols for triage and rehabilitation should be followed in placement with a licensed wildlife rehabilitator.

Habitat-level Recovery Actions

H1. Prevent degradation of existing wood stork habitat in South Florida through identification and protection. At a minimum, for continued survival of the U.S. population, currently occupied nesting, foraging, and roosting habitat in South Florida must be protected from further loss or degradation. Watersheds supporting natural nesting habitat should remain unaltered, or be restored to function as a natural system if previously altered.

H1.1. Create distribution maps of important wood stork colony, foraging, and roosting sites in South Florida for protection and restoration. Important colony sites have been identified for the WCAs and Everglades NP. However, colony sites in the Big Cypress basin are not as well known. Very little is known about roosting sites in South Florida. Identifying all important colony sites, roosting sites, and foraging habitat is critical to the recovery of the wood stork. A GIS database should be developed from data collected by colony, roosting, and foraging surveys, as delineated by species-specific tasks **S1.1** and **S1.3**; a GIS database will aid recovery biologists in targeting areas in need of protection, restoration, or management, and will allow managers and private landowners to more efficiently protect and manage these lands for wood storks.

H1.2. Prioritize habitats that need protection. Develop a prioritization scheme to focus protection and restoration efforts on colonies and feeding sites with the greatest degree of threat. Efforts should be made to identify important foraging and roost sites associated with high priority colonies.

H1.3. Work with private landowners to protect habitat. Conservation agencies need to recognize the significant contributions that private landowners can make for the protection of wood storks. For example, many of the foraging grounds utilized by storks breeding at the Corkscrew colony in South Florida are in private ownership and are threatened by conversion to citrus farming; the future success of this colony is dependent on maintaining viable foraging habitat within the region.

H1.3.1. **Inform landowners.** Inform all landowners having critical foraging and roost sites (as defined in task **H1.2**.) on their properties. Encourage compliance with existing regulatory mechanisms (see task **H1.6.**).

H1.3.2. **Provide assistance and support to landowners in managing their property for the benefit of wood storks**. Assistance can be in the form of written material explaining best management practices, site visits, local recognition, tax and/or monetary incentives. State and Federal agencies should work with private landowners in an effort to incorporate wood stork feeding habitat into current management practices.

H1.3.3. **Develop management plans for private lands.** Conservation agencies should assist landowners in developing specific management plans for their properties. These management plans should adequately protect sites yet be flexible enough to respond to the changing needs of the landowner. The success or failure of management prescriptions for nesting, roosting, and foraging areas should be clearly documented and reported.

H1.4. **Protect sites from disturbance.** The FWS developed habitat management guidelines for wood storks (Ogden 1990) in an effort to reduce disturbance to colony sites. These management guidelines discuss various types of activities known to disturb nesting wood storks. Additionally, certain types of habitat management activities can adversely impact colony sites. Cypress logging is a potential threat to some colonies. Human disturbance causes wood storks to leave nests, exposing eggs to predation and exposure. Posting or other appropriate protection may provide some benefit to storks nesting or foraging within the Big Cypress and Everglades basins.

H1.5. **Use existing regulatory mechanisms to protect foraging habitat in South Florida.** The central and northern Big Cypress basin historically supported large numbers of nesting wood storks. Presently, much of this historic range is being converted to citrus and pasture for cattle grazing. Coordinated efforts should also be used to seize opportunities to provide enhanced feeding areas through the mitigation process.

H1.5.1. **Review Federal actions for impacts to wood storks.** Wetlands are altered for mining, agriculture, and residential purposes. Permitting authority over such activities is held by local governments, agencies in the State of Florida (DEP, SFWMD) and the Federal government (COE, EPA). Important feeding areas should be included as a category of waters for which the FWS receives COE pre-discharge notification pursuant to section 404 of the Clean Water Act. section 7 of the Endangered Species Act requires that all Federal agencies ensure that their actions are not likely to jeopardize the continued existence of any listed species or destroy or modify their critical habitat. Federal agencies conducting actions that may affect the continued existence of wood storks must consult with the Service.

H1.5.2. **Encourage conservation of wood stork habitat in conservation plans**. Section 10(a) (1)(B) of the Endangered Species Act provides for incidental take permits that have the potential to contribute to the conservation of listed species. If appropriate, applicants should be encouraged to consider conservation of wood stork habitat when preparing Habitat Conservation Plans.

H2. Restore and enhance habitat. A prerequisite for the recovery of wood storks in the southeastern United States is the restoration and enhancement of suitable habitat throughout the mosaic of habitat types used by this species. Historically, South Florida supported greater than 70 percent of the nesting by wood storks in the Southeast. The deterioration of the Everglades and Big Cypress basins has resulted in decreased nesting by wood storks in South Florida and increased nesting in northern Florida, Georgia, and South Carolina.

H2.1. Restore the South Florida Ecosystem. Recover traditional Everglades and Big Cypress colony locations. The water delivery formula and schedules developed by the Experimental Water Deliveries Program, the structural modifications to canals and levees proposed for ecosystem restoration of Everglades NP through the Modified Water Deliveries and C-111 Projects, and the regional Everglades restoration planning process (C&SF Restudy) conducted by the COE, should address the recovery of the ecological processes that made it possible for the pre-drainage Everglades basin to support large numbers of storks and other wading birds. These ecological processes were made possible by the large spatial scale of the pre-drainage Everglades, the strong between-year variation in surface water patterns, and the strong flows of surface water into the estuaries.

H2.1.1. Reevaluate the effectiveness of all authorized projects on restoring habitat in the Everglades basin. The Southern Everglades Restoration Alliance (SERA), a group of cooperating agencies, was created to oversee the implementation of authorized ecosystem restoration projects associated with the C&SF Project. SERA is presently re-evaluating projects in the southern Everglades for their effectiveness in ecosystem restoration. The FWS should be involved in project evaluations, and should determine whether recovery efforts will improve habitat conditions for the wood stork. If any authorized projects are found to lack the necessary components (including the appropriate operational schedules and regulatory components) to increase the ability of the wood stork to successfully nest or forage in South Florida, the FWS should help in the development of alternative designs that maximize ecosystem benefit.

H2.1.2. Develop operational criteria that re-establish hydropatterns of the pre-drainage system. Operational schedules will be the most important component of Everglades restoration efforts. Operational schedules must truly balance the needs for flood protection with those of the Everglades ecosystem.

H2.1.3. Restore the timing of nesting by wood storks in the southern Everglades through ecosystem restoration measures. Develop a restoration plan that includes the necessary addition or removal of structures, levees, and canals, to restore hydropatterns throughout the Everglades system; depths, period of inundation and sheetflow patterns should more closely match those of the pre-drainage system.

H2.1.4. **Provide feedback for adaptive restoration planning.** Monitor stork colony patterns during implementation and testing of future efforts to improve hydrologic conditions. Use information on the location, timing, size and success of stork colonies in the Everglades and Big Cypress basins to evaluate ecological responses to the restoration programs and as a basis for designing future iterations in the restoration process.

H2.1.5. **Analyze and report on existing record of stork colony patterns in the Everglades basin**, including the effects of initial restoration programs on the ecological recovery of Everglades NP. A report should be completed that incorporates all stork colony data from the Everglades basin and which assesses the impacts of past and current restoration programs, such as the Experimental Program of Water Deliveries to Everglades NP, on wood stork and wading bird colony patterns in Everglades NP; this report should be used to evaluate restoration efforts to date, and to improve future restoration programs.

H2.2. **Protect and enhance wood stork foraging habitat in private ownership in South Florida through partnership agreements**. Historically, South Florida supported greater than 70 percent of the wood stork nesting effort in the southeast U.S.; the number of wood storks nesting in South Florida has been reduced to a fraction of the historic number. Every effort should be made to protect and enhance that portion of the population that continues to breed and winter in South Florida. For example, the Corkscrew Swamp colony has consistently supported a significant number of nesting wood storks in South Florida. Many of the surrounding wetlands used for foraging by wood storks in this colony are in private ownership and are in danger of being converted to other land uses, such as citrus farming. Protecting these wetlands will be critical to protect the Corkscrew colony and help to preserve wood stork colonies in South Florida.

H2.3. **Acquire land identified as important habitat for wood storks in South Florida.** Federal and State conservation agencies and private conservation organizations should continue efforts to acquire important habitat utilized by wood storks in South Florida. Initial land acquisition efforts should be carefully targeted to sites having the greatest potential for maintaining storks over time. Large, stable colonies that are in immediate threat from disturbance either through direct threat to the colony site or through a loss of surrounding foraging habitat, should be of highest priority. Priority should also be given to larger colonies with a history of annual use, sites most in need of management, and colony sites where alternate habitat is not available.

H3. **Conduct research on the critical habitat components necessary to trigger successful nesting by wood storks in South Florida.** We do not know what specific habitat characteristics are necessary to trigger nesting by wood storks in South Florida. Wood storks could be responding to a suite of habitat characteristics such as water depth, photoperiod, rainfall patterns, prey densities, *etc*. Projects should be completed that will help to identify some of these habitat characteristics.

H3.1. **Determine the densities, species composition and size classes of fishes necessary to result in successful nesting by wood storks in South Florida.** Use information gathered in task **S3.5** (species-level) to establish study locations. Water management practices may have resulted in fish populations that no longer represent “natural” populations. This information may aid us in developing the appropriate operational criteria for the Everglades restoration. It will also establish a baseline from which to compare the effects of ecosystem restoration activities.

H3.2. **Determine the effects of natural and human-caused hydrologic events on the ecology of the prey base utilized by wood storks in South Florida.** This information can be used to determine the optimal operational schedules for South Florida's public lands.

H3.3. **Determine if reduced freshwater flows into the northern Florida Bay mainland estuaries, as a result of the South Dade Conveyance System and the Experimental Program of Water Deliveries to Everglades NP, have caused wood storks to delay nesting in South Florida.** These mainland estuaries historically provided important early dry season foraging habitat; reduced freshwater flows may have significantly altered available prey base.

H4. Monitor the status of areas identified as important wood stork habitat in South Florida. Monitor habitats identified by task **H1.1**. annually to determine whether changes are occurring in response to management actions. For example, habitats likely to be affected by hydrologic restoration projects should be monitored to determine impacts, both beneficial and adverse, on wood storks. The appropriate management decisions need to be considered, discussed, and implemented if adverse impacts are detected.

H5. Increase public awareness about wood storks as an indicator of the health of the Everglades Ecosystem. Educational materials should be developed that identify the importance of the wood stork as an indicator of the health of the Everglades Ecosystem. This information will be key to gain the necessary public support for the restoration of the Everglades. The wood stork is a highly visible component of the Everglades and is perfect to serve as an indicator species to the public.

APPENDIX H - PROJECT REVIEW CRITERIA

Permit Review Criteria
Operational Draft
July 2000

1. Purpose.
This document will be used by Corps Project Managers to identify the potential cumulative and indirect effects when reviewing applications for Department of the Army Permits under Section 404 of the Clean Water Act.

2. Area.
This document applies to the study area of the Environmental Impact Statement for Improving the Regulatory Process in Southwest Florida (EIS). The study area measures 1,556 square miles.

3. Format.
This document lists many issues. Each has its own map(s). For example, a particular species will have a map showing areas with a high probability that species habitat is present and a high potential that the loss of that habitat will adversely affect the species. The narrative accompanying each issue is divided into four paragraphs:

A description of the concern;

The site-specific characteristics to identify the applicability of the issue to the project;

A description of how the map was drawn; and,

Information on assessment of the effect of the project.

4. Status.
This document represents for a single point in time the state of analysis of the information found in the EIS. The document may be modified in the future, with appropriate NEPA analysis (if required), based on the availability of new information. Expected sources of new information include the following.

a. SLOPES.
The Corps and the U.S. Fish and Wildlife Service are developing Supplemental Local Operating Procedures for Endangered Species consultations. A key component is preparation of maps and guidance to assist the Corps in preparing the initial determination of effect of a proposed project on species under the Endangered Species Act. That process may result in modifications to this document since the SLOPES work will be looking at the entire range of the species instead of just the sub-area.

b. MSRP.
The U.S. Fish and Wildlife Service is also continuing work on the Multi-Species Recovery Plan. This will provide species specific recovery implementation measures that may result in modifications to this document.

c. Other.
The evaluation factors used to analyze the effects are not elaborate. Their purpose is to present the relationship of an individual permit to the whole. As these are used, the Corps will periodically evaluate, in cooperation with other agencies, the accumulation of permit decisions to evaluate trends. The Corps is committed to working with the U.S. Fish and Wildlife Agency, U. S. Environmental Protection Agency and others to develop more detailed analysis tools to be ultimately incorporated into the Corps' decision processes.

5. Updating Maps.

The map descriptions include references to the Florida Department of Transportation Land Use, Cover and Forms Classification System (FLUCCS). The maps are necessarily based on regional or statewide mapping programs. This was used since it is often used by applicants describing their project sites, and is thought to ease the convenience of future revisions of these maps with updated information. The Corps will use site-specific information provided by the applicant to confirm the map (for example, whether habitat is actually present) or finds the issue is not applicable due to the nature of the project.

6. Permit Review.

The Corps' decision whether to issue or deny a Permit is based on site and project specific information. The information is gathered to support the evaluation and weighing of the impacts and benefits of the proposed project on many factors, including but not limited to wildlife, endangered species, and water quality. The decision will consider both the direct and immediate effects and the indirect (cumulative and secondary) effects of the proposal. The Corps will use this document to focus effort on those issues relevant to the review of the individual projects. In geographic areas where there are few concerns, the Corps will reduce the processing time through administrative mechanisms such as General Permits. The number of issues applicable to a particular project will depend on how many of the individual maps intersect the project location. A location with a larger number of issues will receive a greater rigor of review. However, the maps do not predetermine the Corps permit decision. In addition, neither this document nor the Map applies to projects holding unexpired Department of the Army permits. This document only applies to applicants seeking authorizations for placement of fill in Waters of the United States under Section 404 of the Clean Water Act

7. Natural Resource Overlay Map

The many individual maps related to natural resource issues are overlaid on the following figure. The area shaded represent areas with high potential value for wildlife and other wetland functions compared to the remainder of the area. If a project in those areas requires a Corps permit, the Corps will subject that permit application to more rigorous review than an application for a permit in an area that has less potential value. In addition, if site specific information confirm the presence and value of the natural resource, the Corps will expect an analysis whether practicable alternative locations are available in areas of less value.

8. Cumulative Impacts.

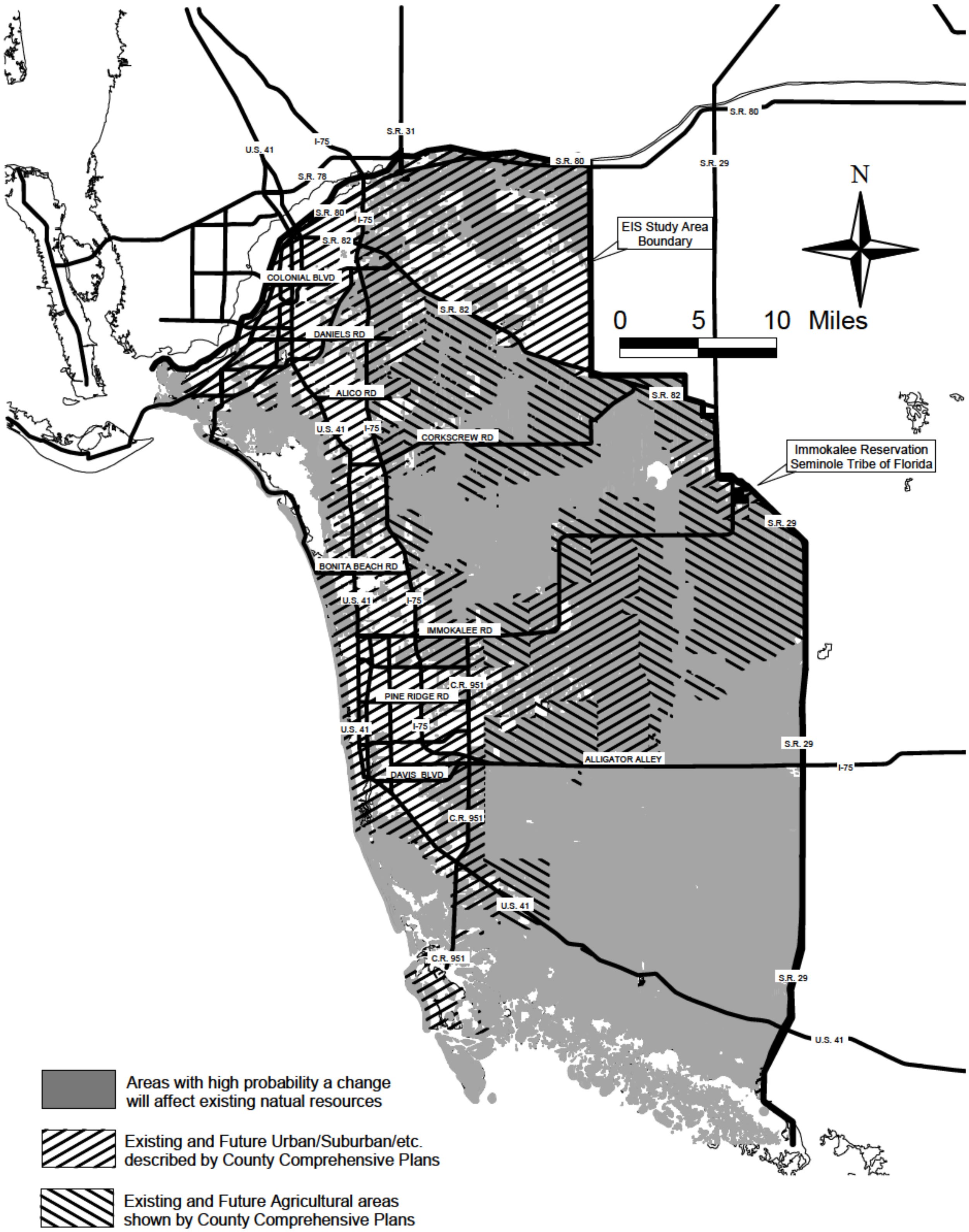
All the predicted futures describe changes in land cover within areas described by the Natural Resource Overlay Map as locations where change would potentially have an adverse effect. For the wildlife issues in particular the number of acres of predicted change is worrisome to the maintenance of current populations. The size of the potential change was one consideration by which an issue was included in the list of Permit Review Criteria. For the individual permit review of a particular natural resource issue, one approach to avoid cumulative impact is to seek alternative sites for the project in a location outside of the area mapped for that resource. If alternatives are impracticable, then one consideration for the evaluating proposed compensatory mitigation is whether it either restores/creates the resource function at a location within/adjacent to areas mapped for the natural resource.

9. Immokalee Reservation, Seminole Tribe of Florida.

The Immokalee Reservation is not assigned individual maps. Therefore, there is no prepared list of issues for reviewing the cumulative effects of projects proposed within the Immokalee Reservation. Corps Project Managers will continue to recognize the status, governmental authority, and powers of the Seminole Tribe of Florida and the rights under any tribal agreement with any agency of the U.S. Government.

Insert Overlay Map

Figure. Overlay of Natural Resource Issues.



Overlay of Natural Resource Issues

10. Audubon's crested caracara

Description. The primary cause for the decline of this species has been habitat loss. This species prefers native range and unimproved pasture for foraging. All the Ensembles predict a decline in existing agricultural area.

Site Identification. Dry prairies with wetter areas and scattered cabbage palm comprise typical habitat. Caracara also occur in improved pasture lands and even in lightly wooded areas with more limited stretches of open grassland.

Map. Caracaras are documented in the eastern portions of the EIS study area primarily in association with agricultural lands. Historically, caracaras were documented as far west as Colonial and Summerlin Boulevards in Ft. Myers. The map shows areas identified as rangeland, improved pasture and unimproved pasture (FLUCCS 211, 212, 213 and 300) that are east and north of I-75 and outside of Lehigh Acres.

Assessment of Effect. Small isolated patches are not likely to be used by this species unless near many other large patches that would form a potential home range (reported home ranges vary from 940 to 6,000 acres). Reduction of patch size will reduce the suitability of the remaining area. If loss cannot be avoided, provide replacement by restoring lands near existing populations. Also see the Audubon's caracara narrative of Section 4.3 of the EIS.

11. Bald eagle.

Description. Bald eagle population was decimated in the 19th and early 20th centuries by habitat destruction, hunting, pesticide use and lead poisoning. 26 active nests are recorded in the study area as of the 1996 winter census. Some of the nests will have future development occurring near them.

Site Identification. Nests typically occur in pines and cypress within the study area but occasionally eagles nest in Australian pines.

Map. Not all habitat has been surveyed. Nesting eagles in the study area are mainly concentrated along coastal areas. Map shows known nets with a 1,500 foot buffer.

Assessment of Effect. Use the Habitat Management Guidelines for the Bald Eagle in the Southern Region which recommends minimum buffer distances for construction and permanent activity near a nest site. It does not provide specific distances for protection of foraging areas or for flyways between nest and foraging areas. Projects will avoid disturbance of nest sites and of foraging and preserve patches of suitable trees along coast and waterways that may provide nesting opportunity. Also see the Bald eagle narrative of Section 4.3 of the EIS.

12. Management of Preserves.

Description. Preserves are affected by the compatibility of adjacent lands and by actions that directly degrade or improve the public lands proper. Maintenance of agriculture or expansion of the preserves is evaluated to be beneficial generally because these provide a buffer to suburban development.

Site Identification. Preserves are owned by government agencies or non-governmental organizations managed for natural resource values.

Map. All such lands were originally acquired for some purpose or multiple purposes, such as recreation, unique wildlife, water supply protection, or hunting. Their management reflects that. How a change in adjacent land use effects the managed land depends on the purpose. State parks are developing "green lines" that designate areas outside of boundaries that could affect the management purpose. The map included here at this time only shows the boundary of the managed lands without any "green line" or buffer.

Assessment of Effect. An activity proposed in the vicinity of an existing preserve will be assessed for compatibility with the management purpose of the preserve.

13. Public Acquisition Program

Description. Lands are identified under various programs for acquisition for various purposes. An application for a project proposed, for example, in the middle of a potential acquisition of a corridor could render pointless the remaining acquisition.

Site Identification. Proposals for acquisition are maintained on many separate lists. The goal of the Southwest Florida Regional Planning Council's Strategic Land Conservation Strategy is to coordinate these.

Map. Known proposals are shown.

Assessment of Effect. If an activity proposed is in the footprint of a potential acquisition, the remaining lands within the footprint will be evaluated to determine if purpose of acquisition can still be achieved.

14. Flowways

Description. The study area has many man-made changes to the historic flow patterns, including drainage canals, roads that block historic sheet-flow, and berms. Many ideas have been developed in the past to retrofit structures or to restore areas. Wider flowways or preservation of wetlands in flowways are evaluated to be beneficial generally because these actions reduce the potential for changes in flood depth, maintained historic flow patterns, and reduced reliance on structural water management solutions.

Site Identification. Within this area, lands typically drained to sloughs that eventually reached streams on the coast. Many sloughs have now been intercepted/converted to canals.

Map. Slough-shaped areas identified by FLUCCS codes for slough waters (560), inland sloughs (616), cypress (621), bottomland (615), and streams (510).

Assessment of Effect. Maintain or restore wetlands within the footprint of the slough of sufficient width for wet season flows. If a site has a canal, consider restoration of the original slough by partial blocking of the canal or other actions.

15. Habitat Fragmentation

Description. The area still has a wide variety and large population of wildlife. Suburban development has been expanding inland from the urban centers of Fort Myers, Bonita Springs, and Naples to meet with the build-out of Lehigh Acres and Golden Gate Estates. Large expanses of the historically characteristic pinelands are becoming more fragmented. Many species forage over large areas and require a mixture of vegetative communities for their life histories. Connections between the large islands of existing preserves are evaluated to be beneficial generally because they are considered to retain a sustainable fabric of habitat.

Site Identification. Typically are lands with natural plant community located between major preserves. These typically follow historic flowways.

Map. Areas identified as natural plant community (both upland and wetland FLUCCS 400 and 600) within 1000 feet of flowways.

Assessment of Effect. Maintain or restore native cover for the species expected to utilize the connection.

16. Marshes.

Description. Short hydropattern wetlands are foraging areas for a wide variety of wading birds, including the federally listed Wood stork and Snail kite, and are depended upon by other species. Because of their small size and shallow depth, these have been the ones most affected by drainage, direct fill, or changes in surrounding landscape. Preserving natural plant types around these wetlands is evaluated to be beneficial generally because that would maintain sheetflow connections between individual marshes, provide clean water runoff to hydrate the marshes, and provide cover for species. A large percentage of these marshes are expected to be surrounded in the future by development.

Site Identification. Herbaceous vegetation in shallow depressions surrounded by scrub and forest.

Map. Areas identified as marsh and wet prairie (FLUCCS 641 and 643).

Assessment of Effect. The key goal is production and concentration of forage fish for wading birds. Wetlands throughout the area hydrate and draw down at different times of the year depending on their location, size, and water supply. A mix of hydropattern is needed so that foraging is available throughout the year. Existing foraging locations should be preserved on-site or, if impact unavoidable, replaced near-site rather than off-site due to the difficulty of replicating the hydropattern and the danger of locating foraging into a few geographic areas. Physical characteristics that affect the forage value include: water source sheet flow (gradual hydration) or pulse (weir); water is runoff from native vegetation (marsh ready) or from development (metals, etc.); concentration pond present in winter or dries out in winter (no prey maintained) or is constant depth (no concentration); connected to other marshes (movement of fish); shallow littoral zone or a sharp edge only shallow part of year; shrub/tree buffer for resting/perching/cover. Also see the Wood stork and Snail kite narratives of Section 4.3 of the EIS.

17. Florida Panther.

Description. This wide ranging species uses large areas of a mixture of upland, wetland, and open cover types. Correlation of telemetry data from radio-collared panthers and plant cover plus other observations suggest preference for hardwood swamp, mixed hardwood swamp, cypress swamp, hardwood hammock, and pinelands. Panther will cross other lands that have low human presence to travel to other patches of forested cover. Also, prey are found at the edges of forested and range, prairie, and agricultural areas. Expansion of preserves and/or maintenance of existing levels of agricultural activity is evaluated to be beneficial generally because these maintain a contiguous mix of suitable cover types.

Site Identification. Patches of forested cover connected at any distance by any combination of range, prairie, agricultural and other forested areas to the Florida Panther NWR. Areas of residential or commercial development and major highways generally considered to be avoided by panther due to human disturbance or lack of prey.

Map. All lands except those with intense residential or commercial development that are east of I-75 and north of Tamiami Trail. Low density residential areas in western portions of Golden Gate Estates and northwestern portions of Lehigh Acres are shown as currently potential transit locations.

Assessment of Effect. If project results in direct loss of forested patch, or in separation of the patch by residential or commercial development, or in reduction of non-forested areas (particularly those near forested areas used by prey or for travel), then place emphasis on avoidance, or if this is not possible, consider replacement of the area lost by restoration or creation elsewhere in the range of the species. Any replacement area must meet or exceed the habitat functions lost. Also see Florida panther narrative of Section 4.3 of the EIS.

18. Shorebirds.

Description. Shorebirds in general, and the federally listed Piping plover in particular, use beaches within the study area. While direct impacts to these beaches are unlikely, indirect effects may occur as a result of human disturbance (pets, noise, nuisance animals) and fill activities associated with increased coastal development.

Site Identification. Sandy beaches, mudflats, and sandflats.

Map. 1,000 foot buffer around areas identified as beaches (FLUCCS 181 and 710) and tidal flats (651).

Assessment of Effect. Avoid disturbance in buffer along undeveloped beach stretches. See also the Piping plover narrative of Section 4.3 of the EIS.

19. Red-cockaded woodpecker.

Description. There are 40 known groups of this species in the study area. Not all habitat has been surveyed so other may exist, although there is only a limited amount of mature pine forests in the region. Foraging distances from cluster sites have included distances of 2 miles over open pasture. Dispersal into other suitable habitat has been described to vary from approximately 2 miles (frequent) to 7 miles (infrequent).

Site Identification. The preferred habitat is old growth pine.

Map. Larger contiguous patches of areas identified as pine flat (FLUCCS 411), cypress/pine (624), and wet forest mix (630) where the patch is within dispersal distance of existing cluster sites.

Assessment of Effect. For existing sites, preservation of foraging area. For potential areas, preservation of old-growth areas within dispersal distances of known groups or unsurveyed forest patches. See also the Red cockaded woodpecker narrative of Section 4.3 of the EIS.

20. Florida scrub jay.

Description. This species has very narrow habitat requirements, being endemic to Florida' relic dune ecosystems and scrub. Scrub habitats are considered to be among the most threatened natural systems. There are 26 known families of scrub-jays in the study area. Not all habitat has been surveyed, so others may exist, although there is only a limited amount of remaining scrub habitat.

Site Identification. Oak dominated scrub or xeric oak scrub plant cover on well drained sandy soils.

Map. Areas identified as xeric oak (FLUCCS 421), sand pine (413), shrub brush/rangeland (329 and 330), and pine-mesic oak (414) excluding the agricultural areas south of State Road 82.

Assessment of Effect. Preserve scrub-jay habitat in foraging needs if existing family present. Preserve potential habitat if within dispersal of existing families. Also see the Florida scrub jay narrative of Section 4.3 of the EIS.

21. Coastal.

Description. These areas serve as nursery areas for commercial and recreational fishing, assimilate pollutants, provide detrital export to support estuarine food chain, among other functions. Preservation along the coastal areas is evaluated to be beneficial generally because of preservation of ecotone and waterflow characteristics maintained the shoreline ability to maintain aquatic nursery and foraging habitat.

Site Identification. Coastal forests and marshes and adjacent natural upland plant communities.

Map. Areas identified as mangrove (FLUCCS 612), saltwater marsh (642) and emergent vegetation (644) plus natural plant areas (upland and wetland) within 1/2 mile of these.

Assessment of Effect. If preservation is unavoidable, maintain a buffer sufficient to provide upland ecotone and surface runoff characteristics.

22. Strategic Habitat Conservation Area (SHCA) Lands.

Description. The Florida Game and Freshwater Fish Commission report Closing the Gaps in Florida's Wildlife Habitat Conservation System identified the minimum quantity of land that would maintain Florida's animal and plant populations at levels sustainable into the future. This area is called the Strategic Habitat Conservation Area (SHCA). 8.2% of the statewide SHCA is found in the EIS study area. Expansion of public preserves is desirable.

Site Identification. The SHCA is composed of overlaying maps of potential habitat for each species. Each map is based on areas identified as having plant covers and other characteristics that are thought to indicate the location may used by the species. The mapping was based on interpretation of satellite images so actual site plant cover and characteristics must be compared to the species models in the report.

Map. From the report. The individual maps for federally listed species are also shown. These maps were not included in the Overlay of Natural Resources to avoid double-counting species ranges.

Assessment of Effect. Although the statewide mapping has some errors and the estimates of land required are simple, this report is the only report that essentially prioritizes the habitat value of land statewide. Absent any additional species-specific analysis, this report will be used as a framework to coordinate regulatory actions with land management and acquisition initiatives. If plant cover or other characteristics for one or more species is present on the site, then provide replacement cover elsewhere in area mapped for that species.

23. Wading Bird Rookeries.

Description. There are several reported rookeries in the study area. Additional wildlife surveys could document additional locations. Development may occur near some of the rookeries that introduces visual or noise disturbance or introduce domestic animals that render the site less attractive for continued use.

Site Identification. Large group of nesting birds.

Map. 2,000 foot area around reported locations.

Assessment of Effect. Preserve actual rookery location and areas used for foraging or transit by providing buffers of native vegetation. Buffers sized to protect rookery from visual and noise disturbance (size depending upon nature of activity in proposed project and type of native vegetation) and arranged to discourage people visiting the site.

24. High Proportion Wetland.

Description. Corps regulations, including the Section 404(b)(1) Guidelines, require an analysis that shows the proposed project is the least damaging practicable alternative. The analysis is performed in sequence: (1) demonstration that no other sites are available to avoid the wetland impact, or if available, have greater impact; (2) demonstration that the selected site and selected site plan has the minimum impact compared to other alternatives; and (3) compensation for the resulting unavoidable impacts is provided. The U.S. EPA may formally raise concerns with the alternative analysis by writing comment letters as provided by the 404q MOU. Existing urban/suburban infrastructure has largely drained, fragmented, or otherwise impacted wetland areas so there is less impact to avoid. Also, these areas have this infrastructure because Comprehensive Planning processes have designated them for development. Projects in locations that have a large proportion of wetland will have a more difficult time avoiding wetland impacts.

Site Identification. Site with high proportion of wetland and little surrounding development and/or infrastructure.

Map. Locations with large proportion of areas identified as wetland (FLUCCS 600).

Assessment of Effect. Projects in areas with higher proportion of wetlands provide analysis of alternative sites inside urban/suburban areas.

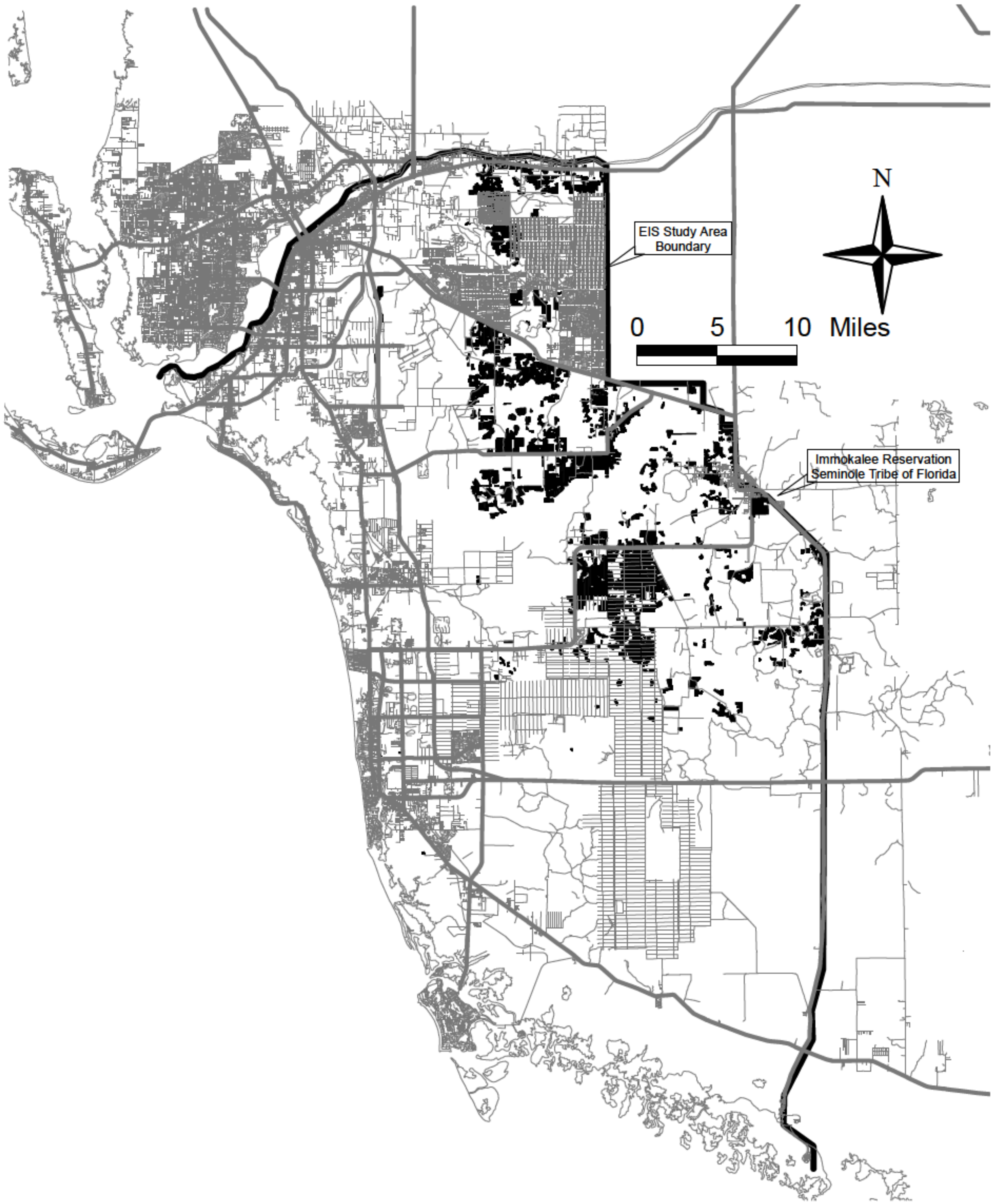
25. Water Quality

Description. Thirteen subbasins in the EIS study area are reported by FDEP in the 1998 305(b) Report and on the 1998 303(d) List as either Partially or Not meeting FDEP waterbody designated use classifications and/or State of Florida water quality standards .Section 4.10.3 of the EIS suggests greater implementation of BMPs or a reduction in the wetland fill would result in is less degradation as measured by IWQ.

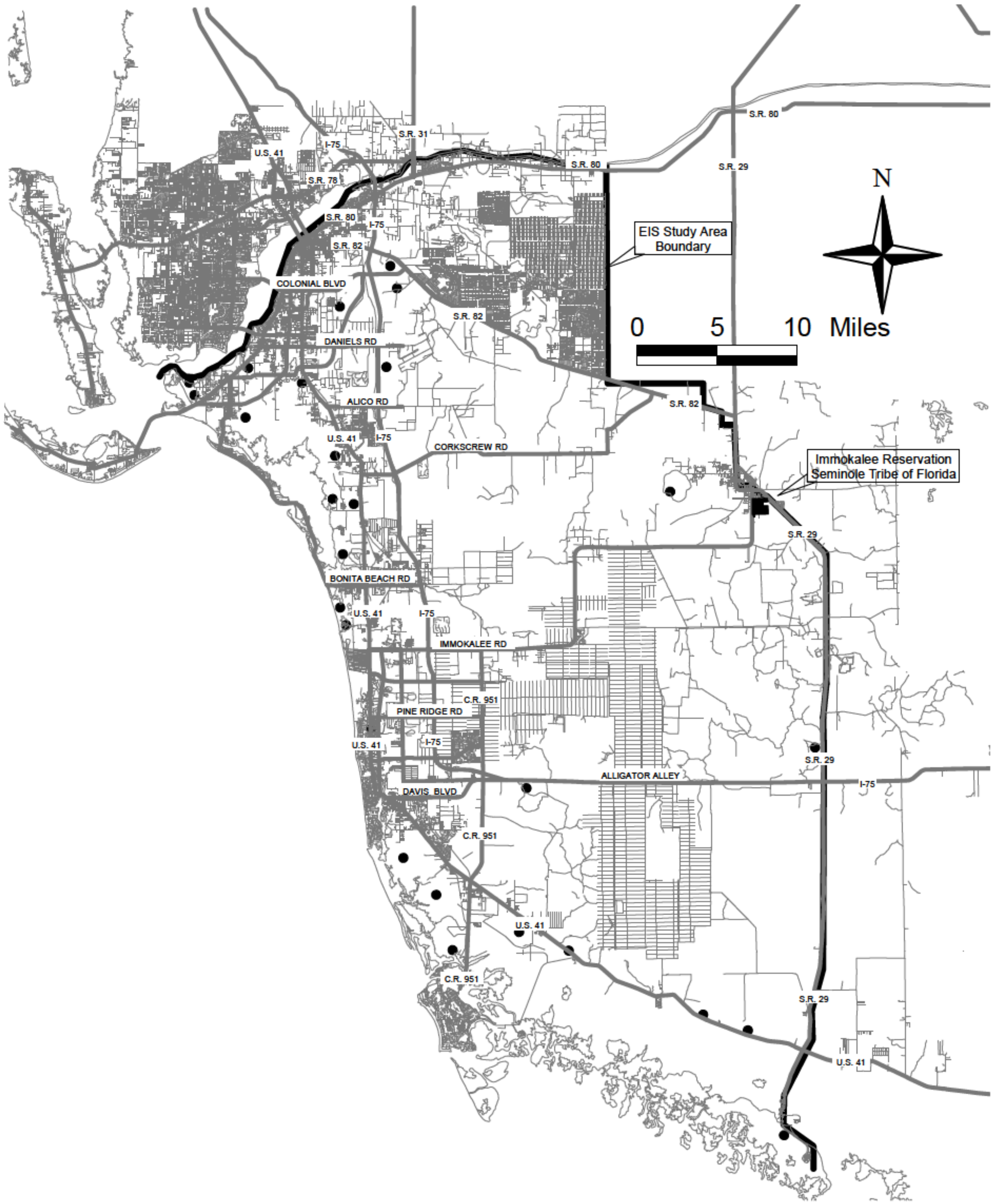
Site Identification. Located in a basin defined by FDEP's 305(b)/303(d) list report that does not or only partially meets FDEP waterbody designated uses and water quality standards or in an EIS watershed defined by USEPA as demonstrating continuing 1990's water quality degradation based on the WQI score.

Map. Maps from the appropriate FDEP and US EPA water quality evaluations.

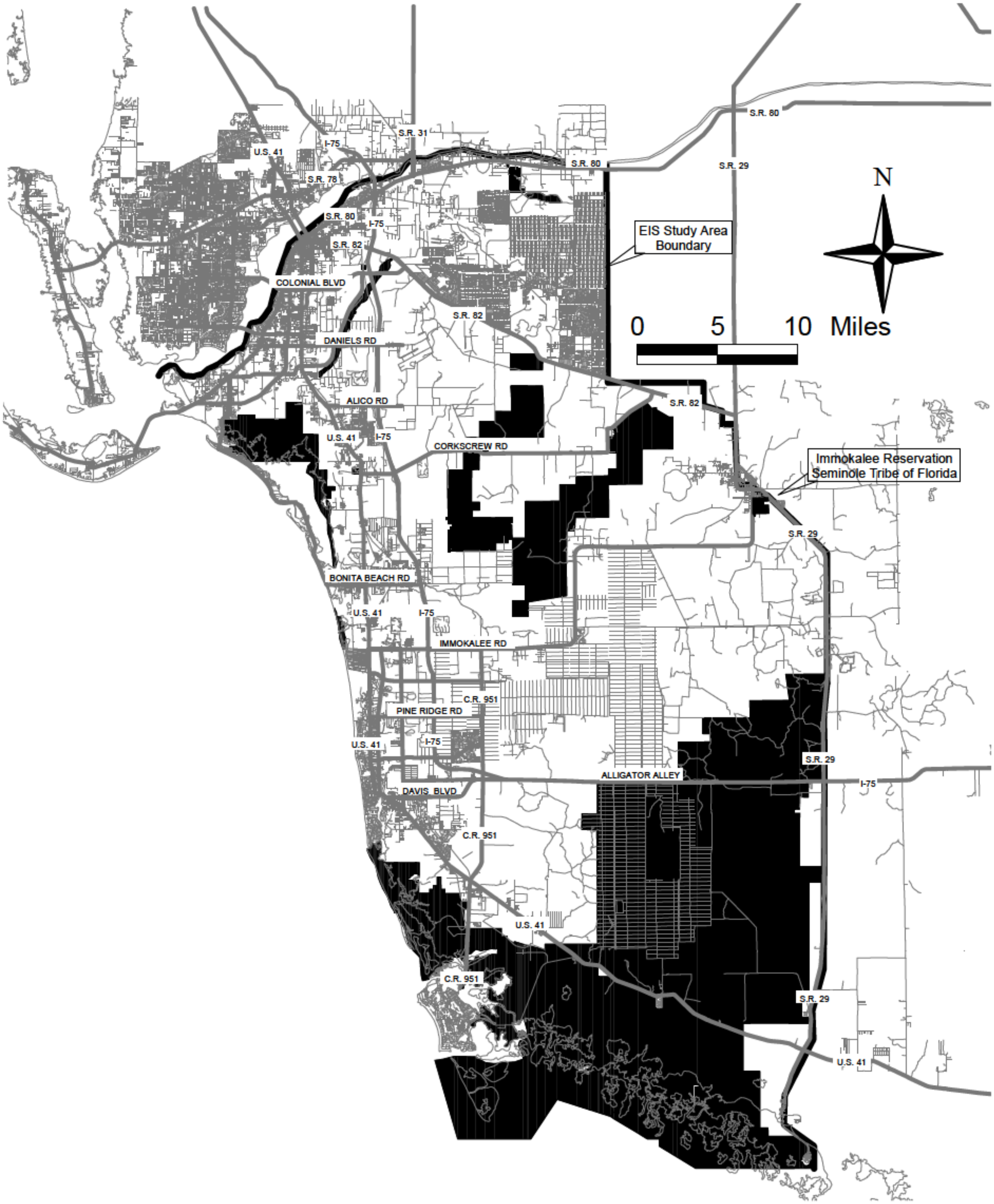
Assessment of Effect. If the proposed project is located as described above, describe why there is not a practicable alternative that would avoid the location of or minimize the quantity of fill placed in the wetland. As described by 40CFR 230.10(a)(2), an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If unavoidable, describe practicability of locating project in a different basin. If project cannot be located in a different basin, describe practicability of treating the stormwater to achieve 95% reduction of the average annual load of pollutants See also the ideas for Enhanced Stormwater BMP Development special permit conditions in EIS Section 4.10.2.8.2.2.



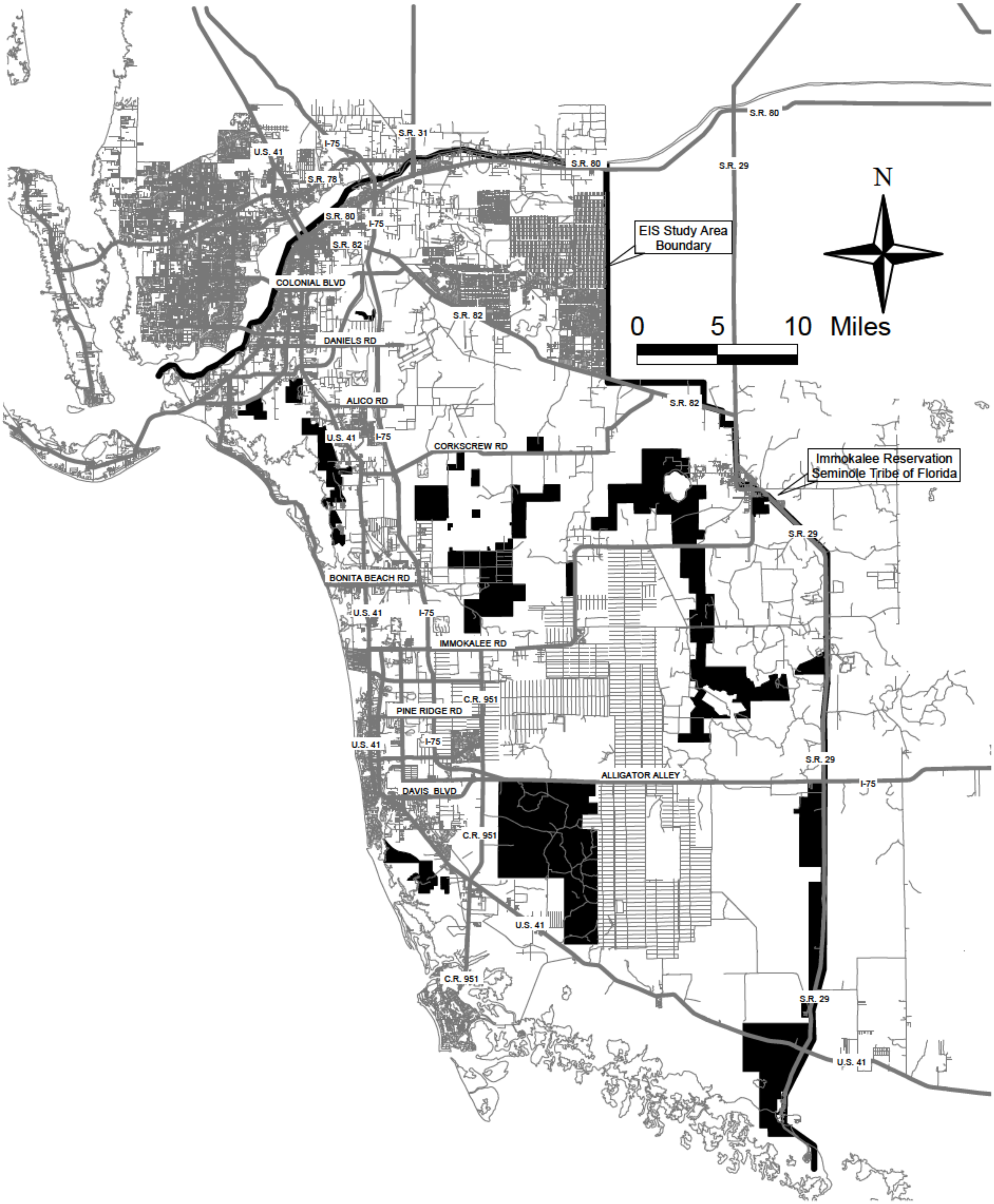
10. Audubon's Caracara



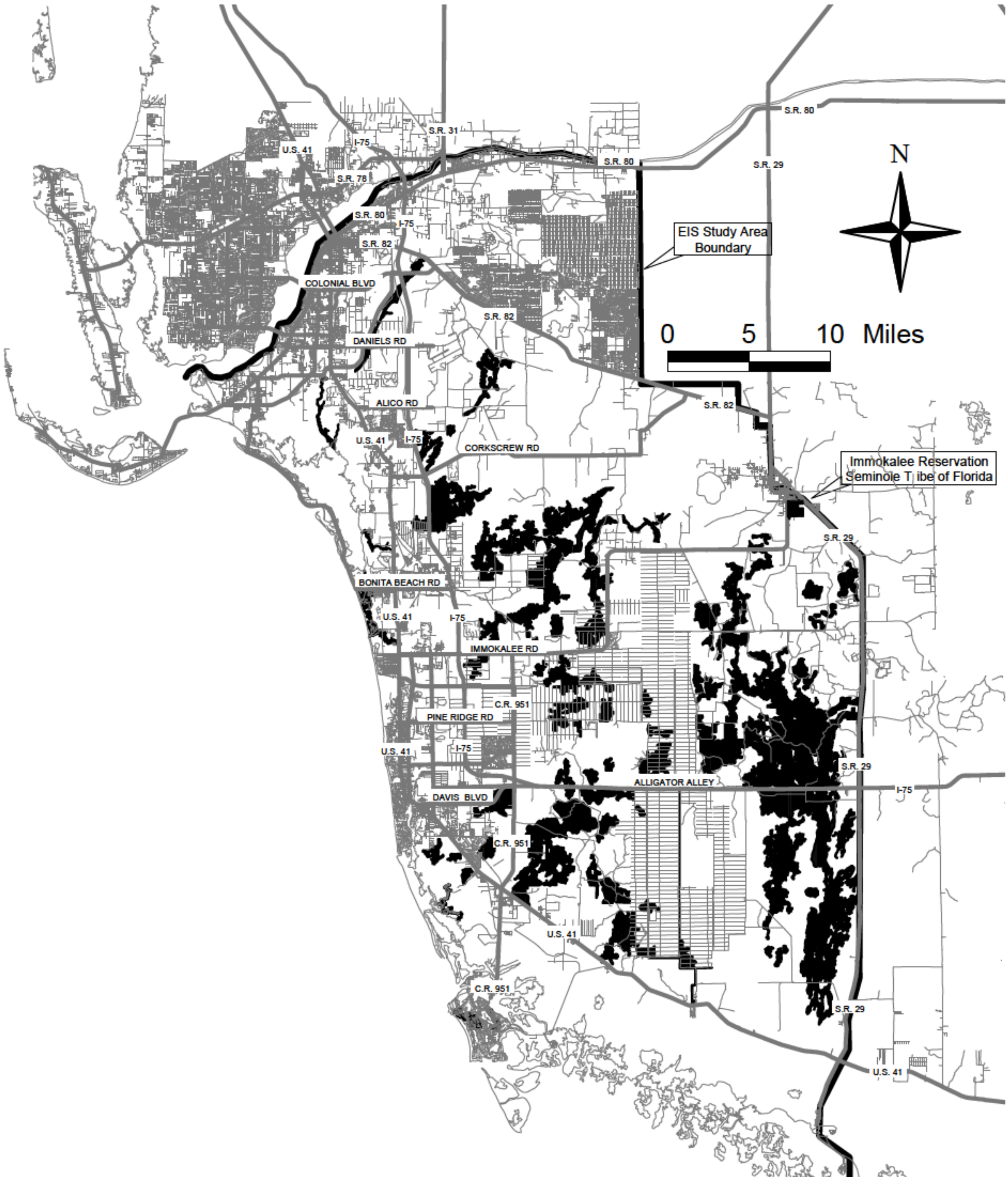
11. Bald Eagle



12. Management of Preserves



13. Public Acquisition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U.S. 41
I-75
S.R. 78
S.R. 80
S.R. 29
I-75
S.R. 82
EIS Study Area
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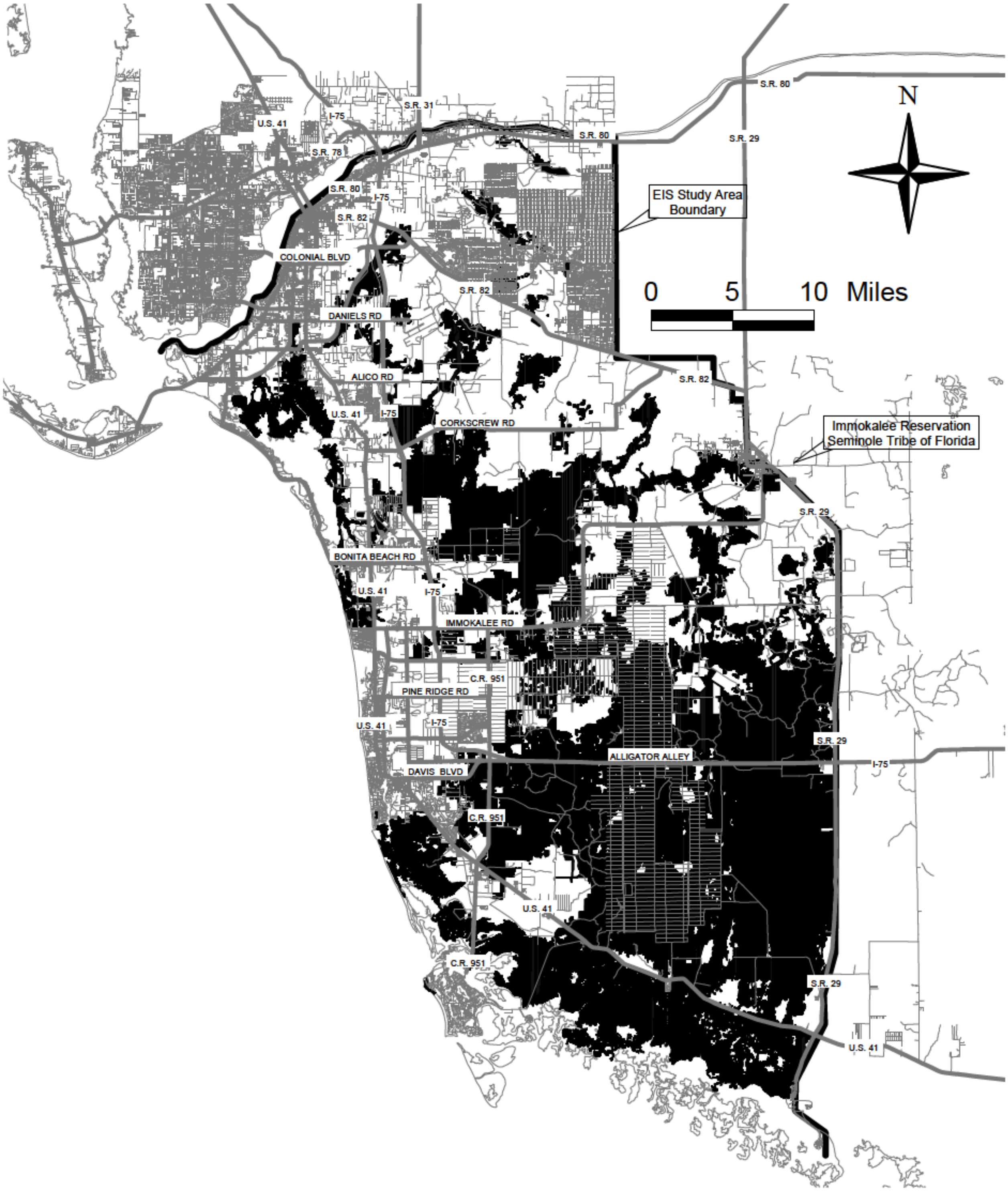
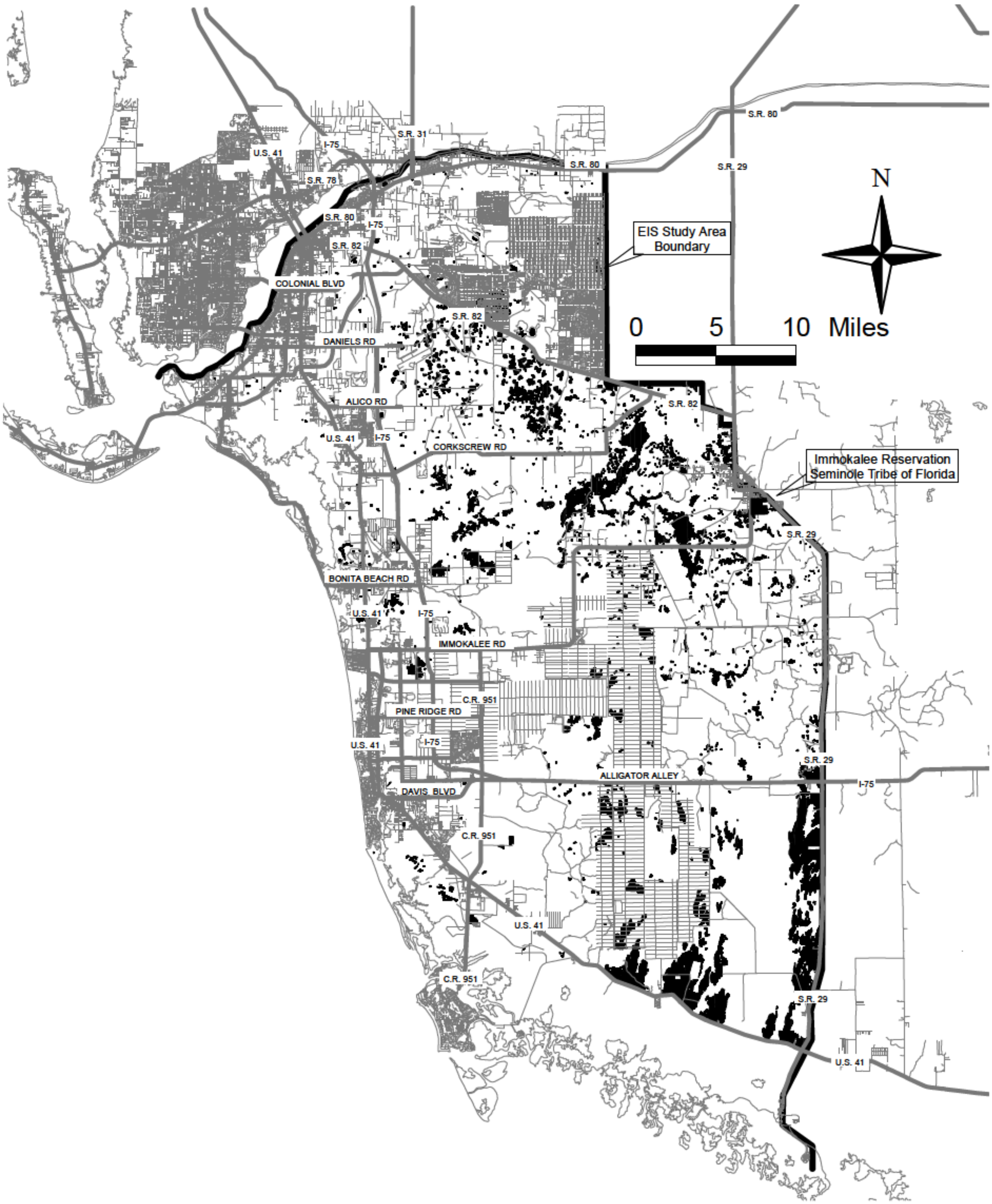
S.R. 82
ALICO RD
U.S. 41
I-75
CORKSCREW RD
Immokalee Reservation
Seminole Tribe of Florida
S.R. 29
BONITA BEACH RD
U.S. 41
I-75
IMMOKALEE RD
C.R. 951
PINE RIDGE RD
U.S. 41
I-75
S.R. 29
ALLIGATOR ALLEY
I-75
DAVIS BLVD
C.R. 951
U.S. 41
C.R. 951
S.R. 29
U.S. 41

14. Flowways



15. Habitat Fragmentation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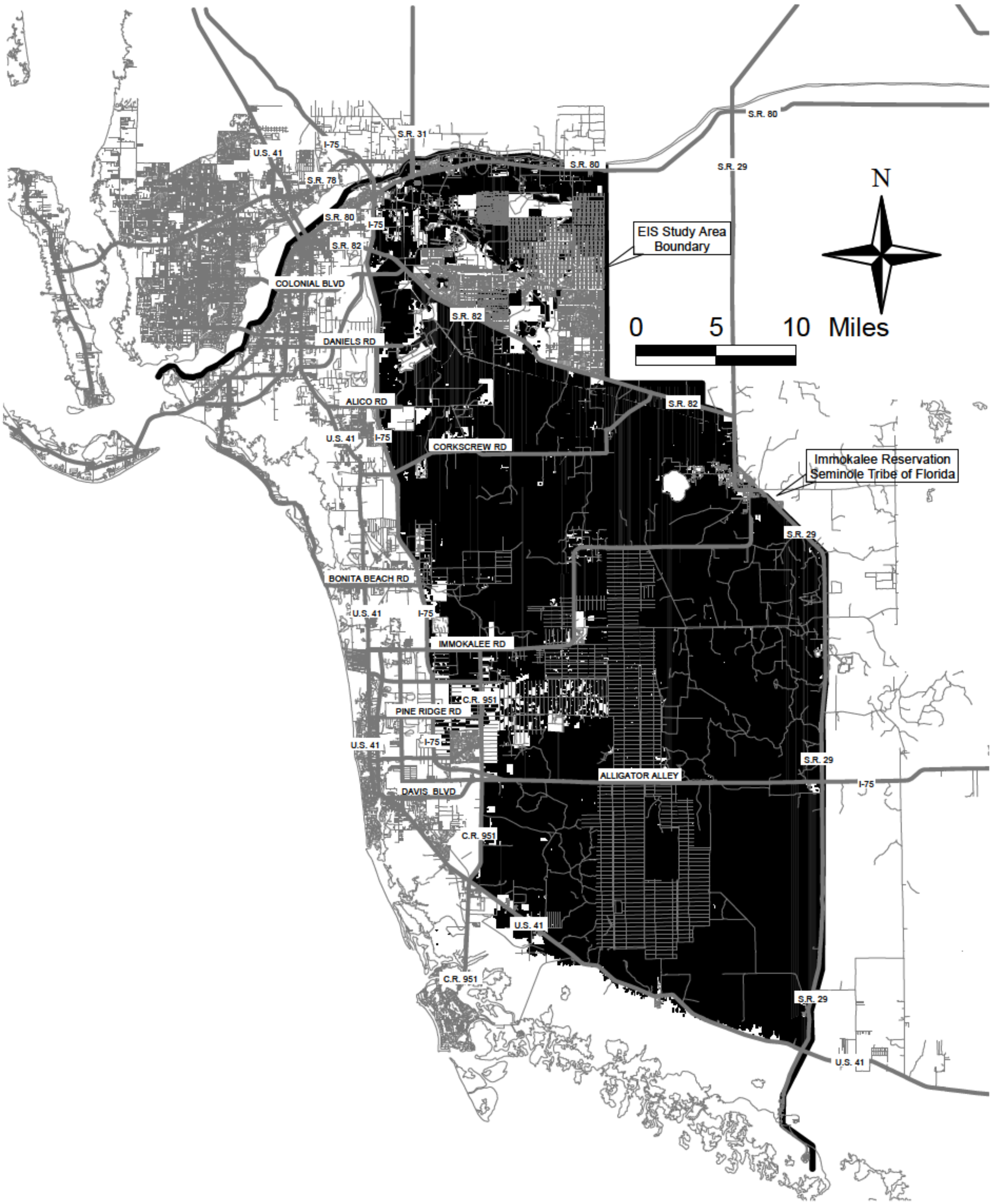
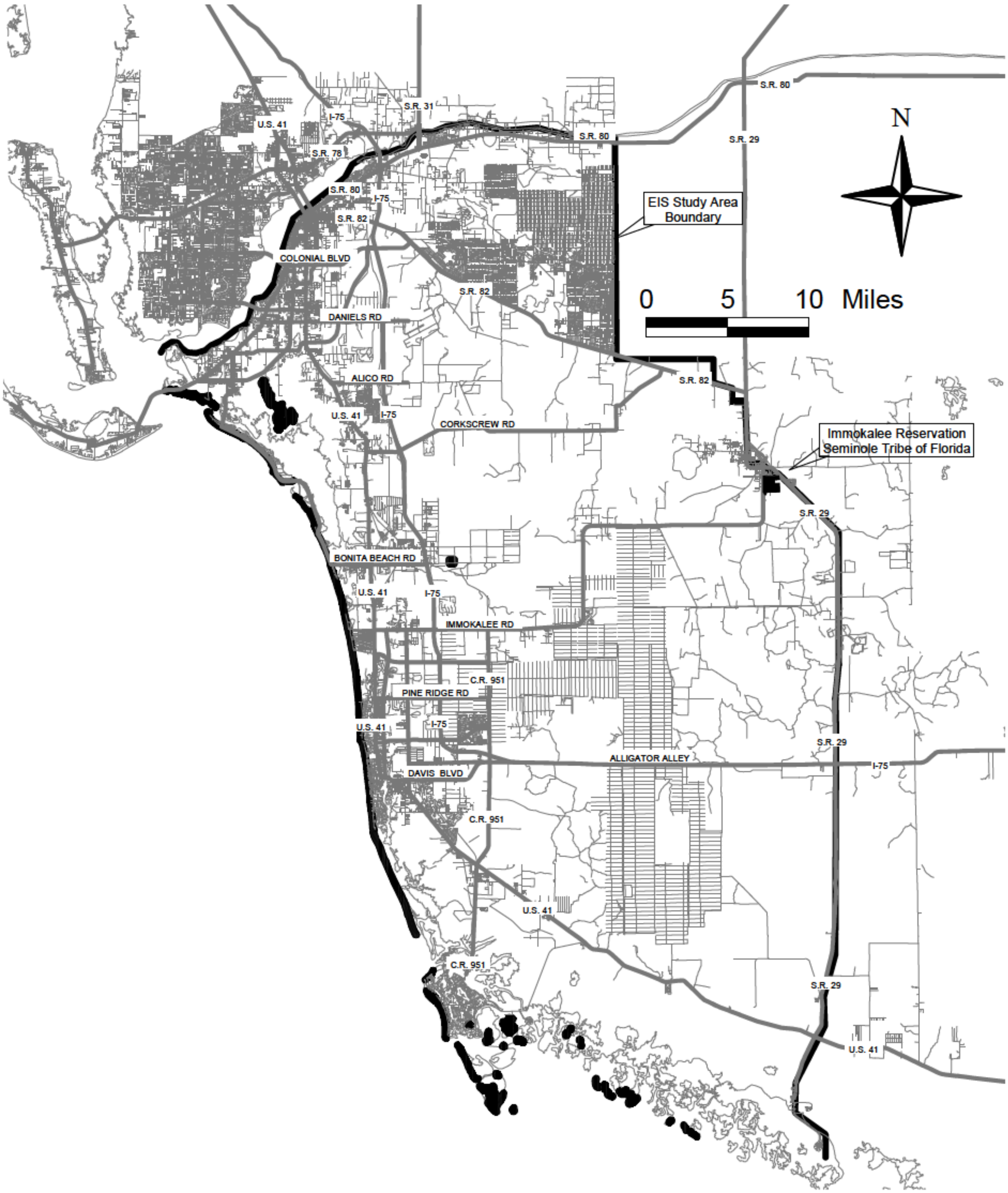
C.R. 951
S.R. 29
U.S. 41

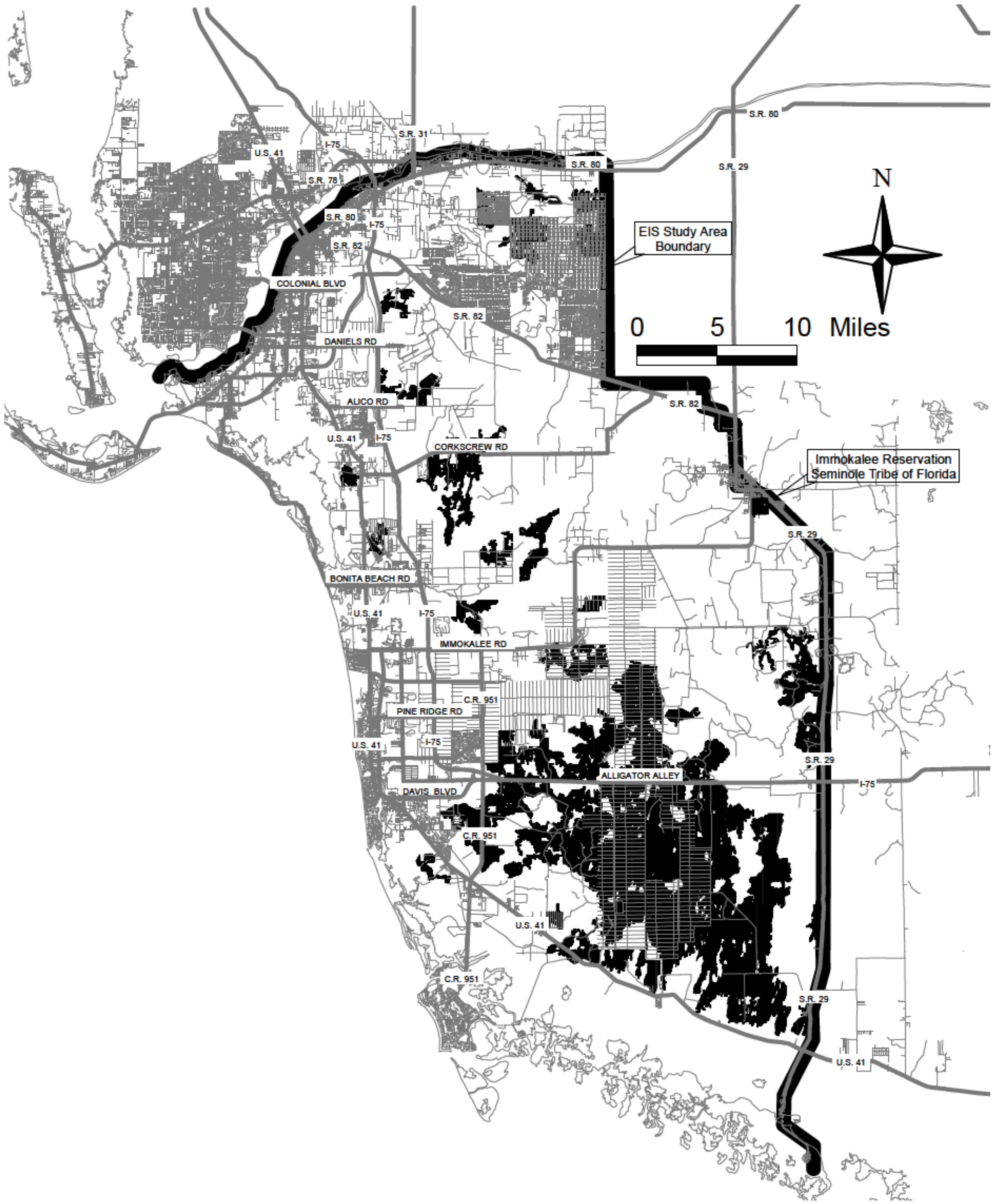
16. Marshes



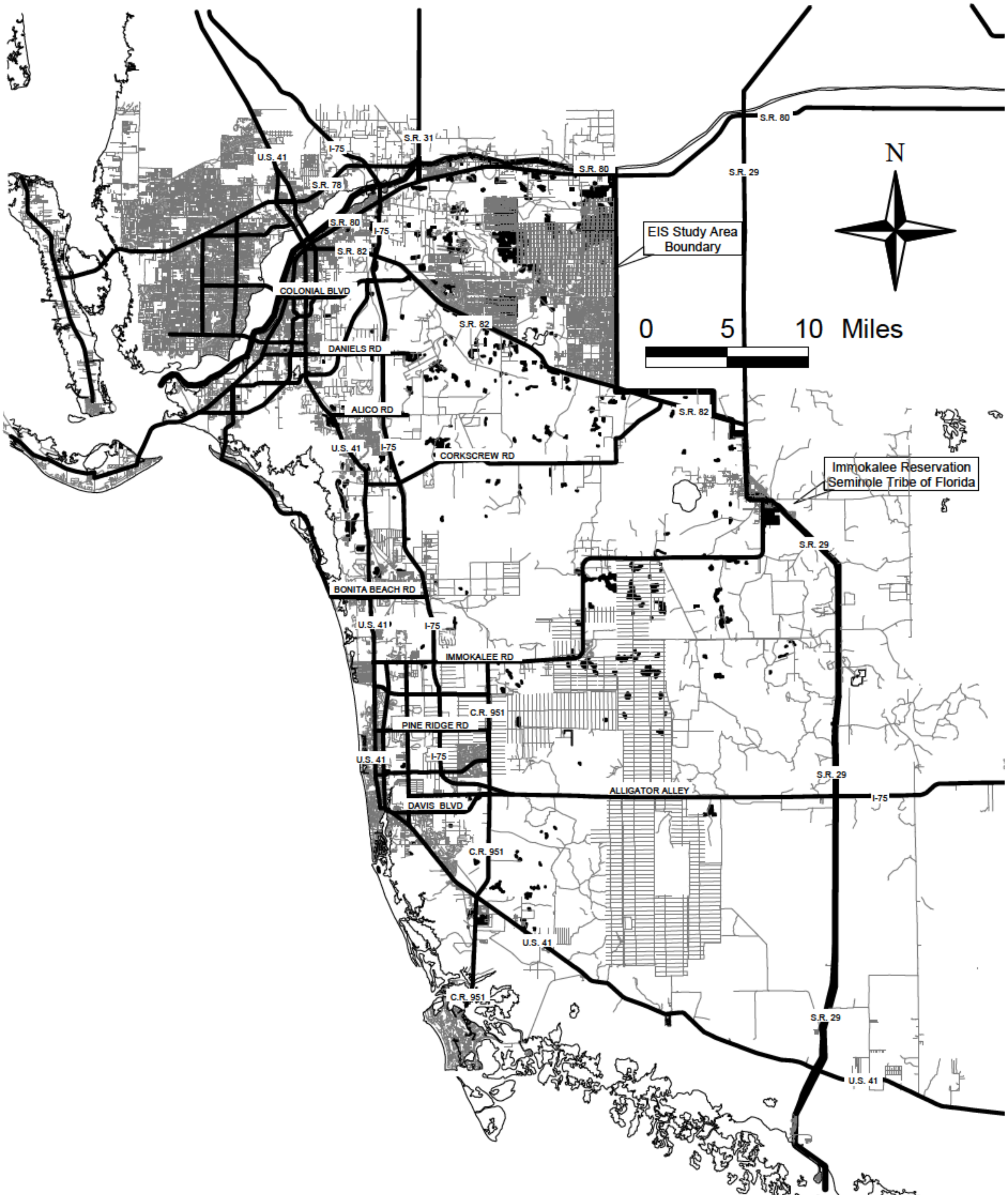
17. Florida Panther



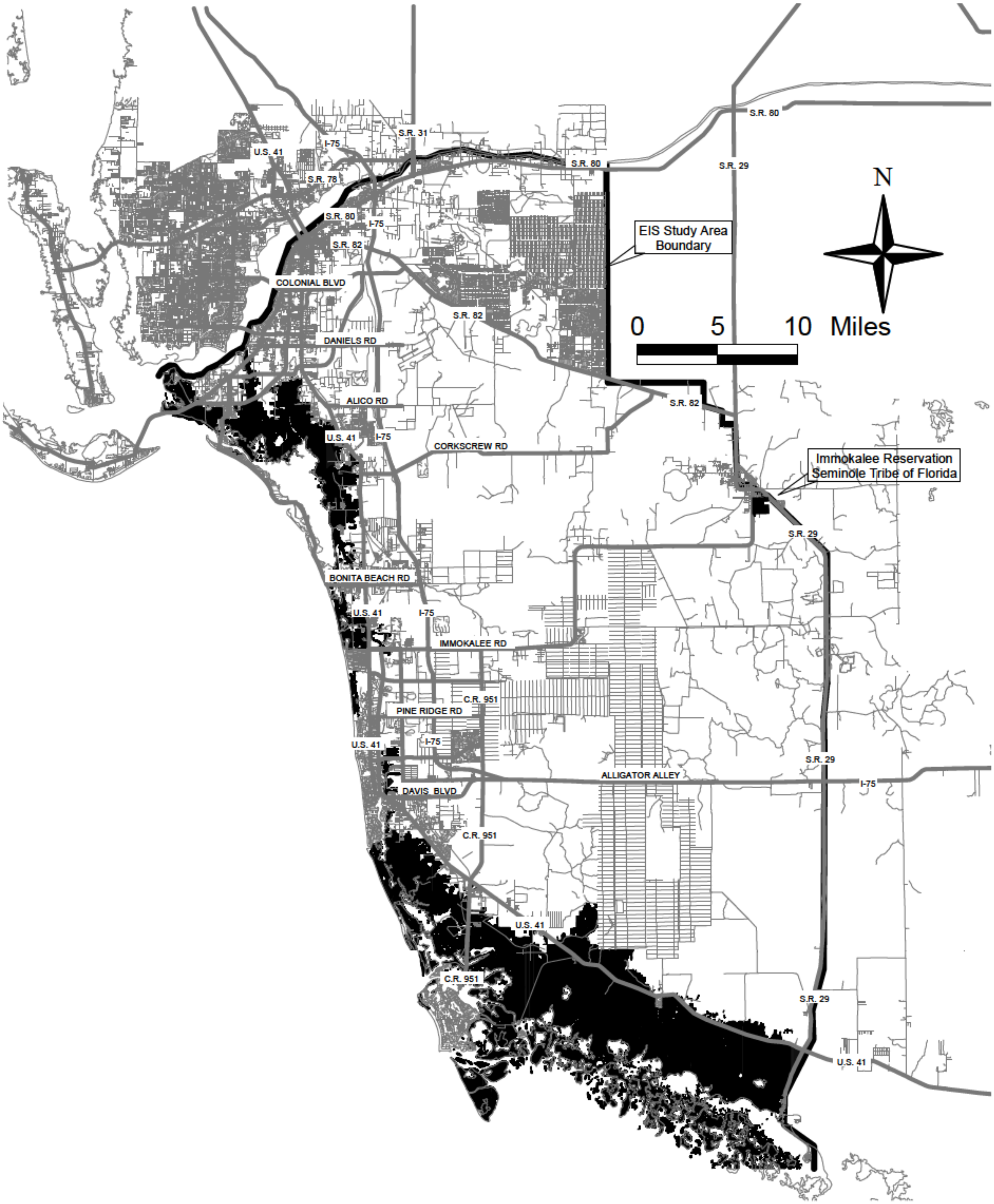
18. Shorebirds



19. Red Cockaded Woodpecker



20. Florida Scrub Jay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C.R. 951
S.R. 29
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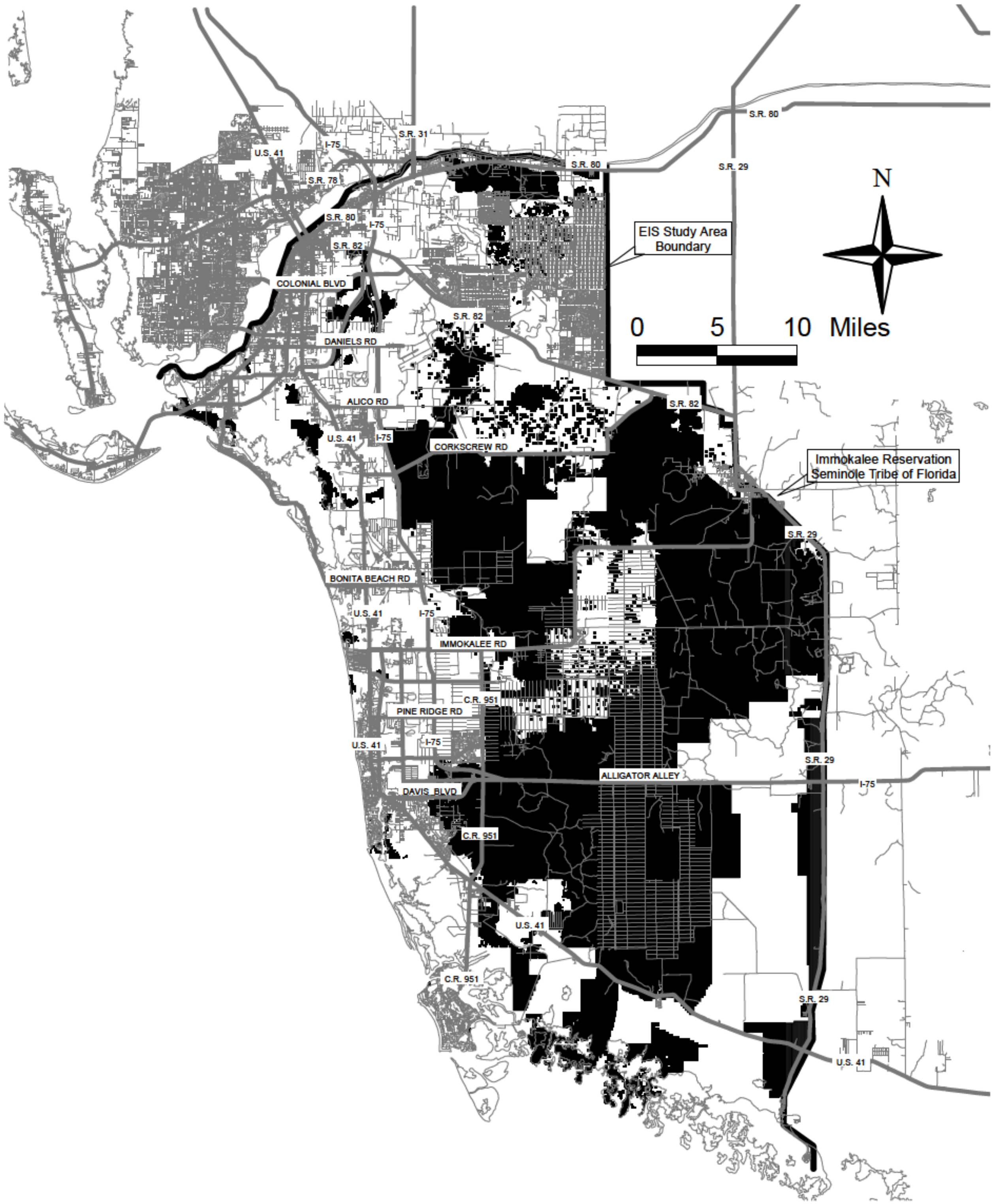
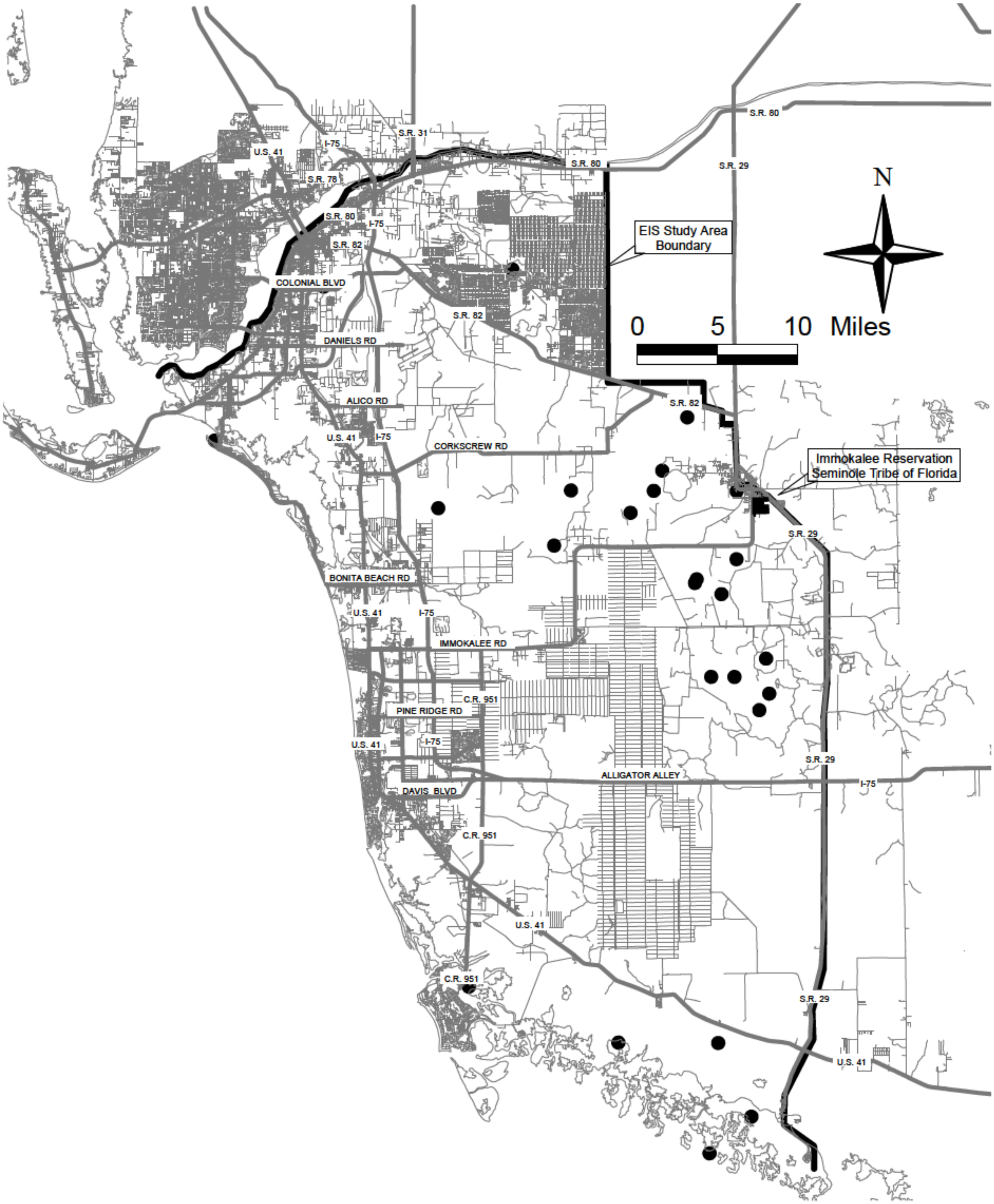
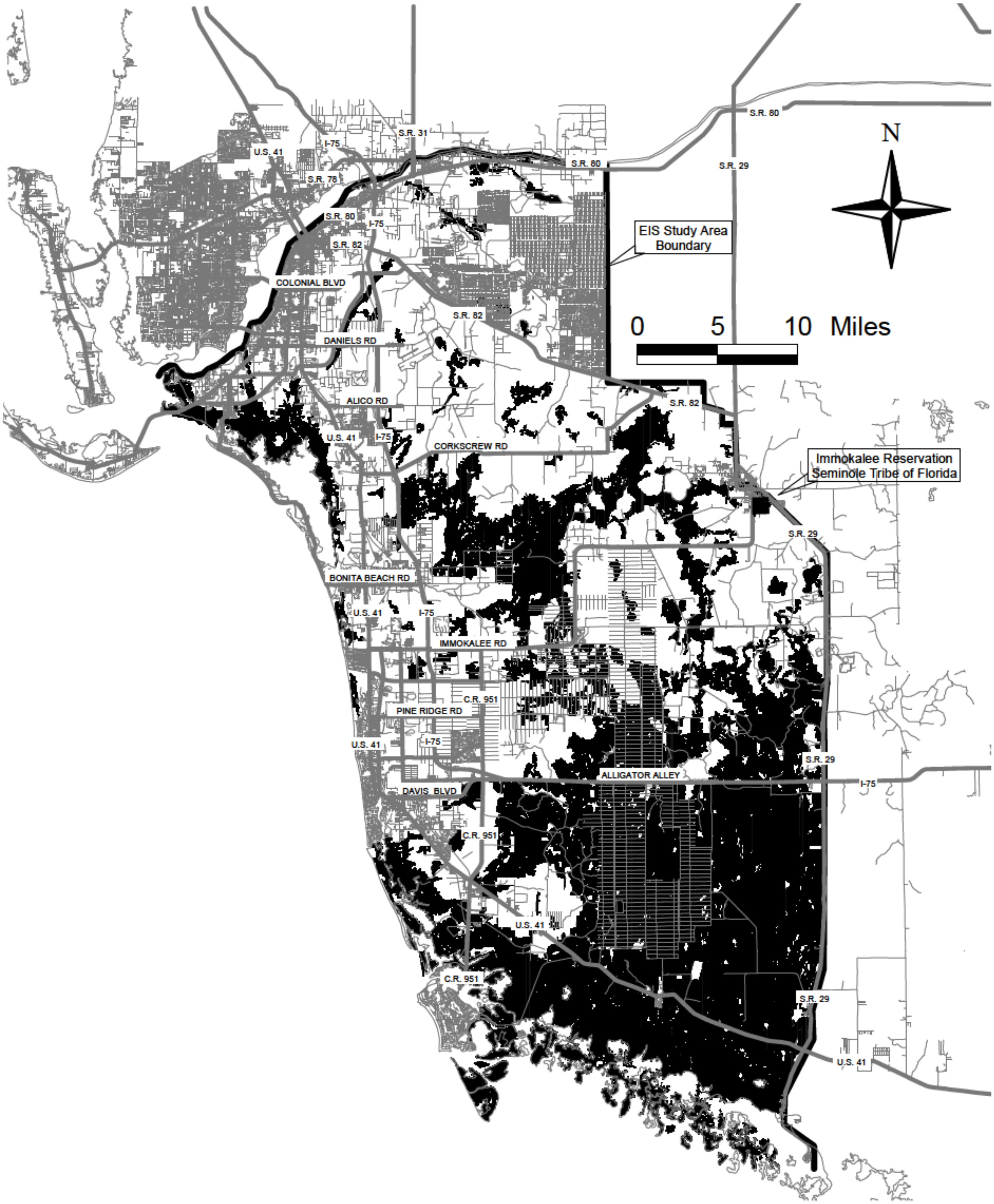
21. Coastal



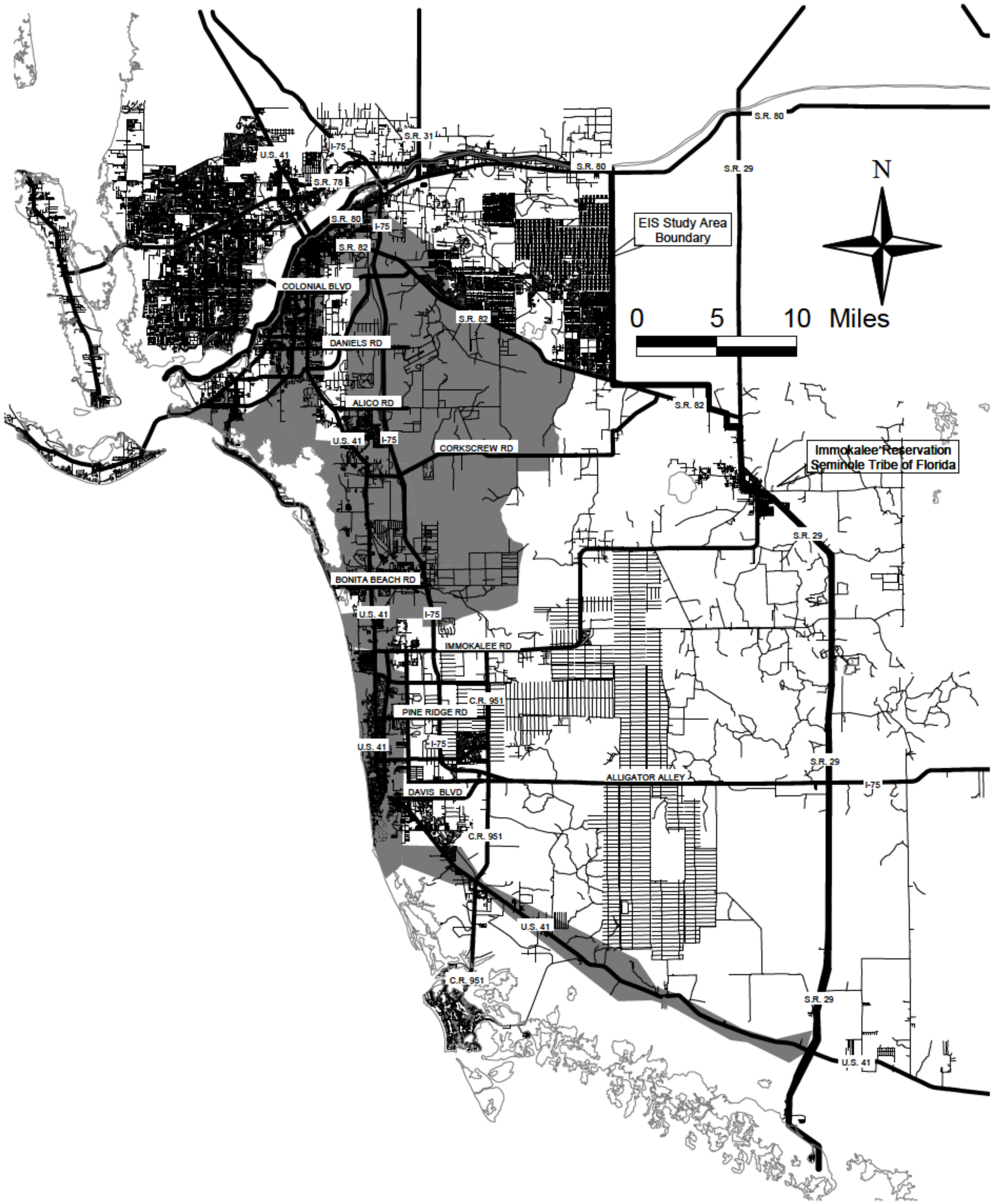
22. Strategic Habitat Conservation Areas



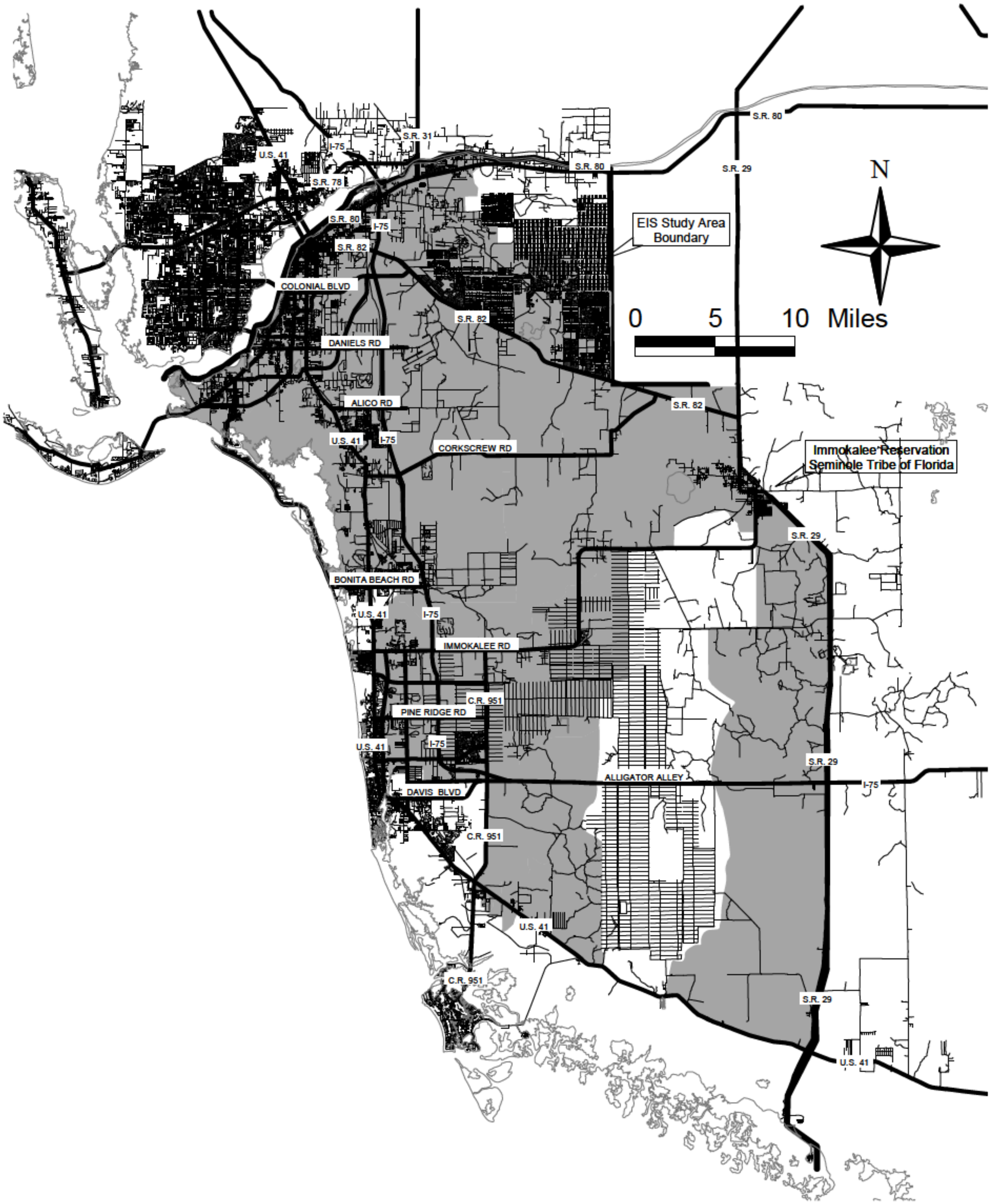
23. Wading Bird Rookeries



24. High Wetland Proportion



25A. Water Quality 303(d)



25B. Water Quality EIS Basins

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