APPENDIX D

LAKEBELT WILDLIFE STUDY

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DADE COUNTY LAKE BELT PLAN

WILDLIFE STUDY - FINAL REPORT

Submitted to

DADE COUNTY

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

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EXECUTIVE SUMMARY

The Lake Belt Study Area (LBSA) of northwestern Dade County covers 47,921 acres (EAS Engineering, Inc., 1995). The region includes approximately 7,500 acres of sawgrass marshes with little to no invasion by the exotic pest plant *Melaleuca quinquenervia* (melaleuca). The area also includes approximately 8,100 acres of moderate coverage by melaleuca (10% to 75% melaleuca) and 17,300 acres with greater than 75% coverage by melaleuca. The remainder of the area is composed of lakes, littoral zones, agricultural lands, canals, levees, correctional facilities, electrical power facilities, and power line right-of-way (EAS Engineering, Inc., 1995). In many areas, there is a high degree of interspersion of habitat, so that areas with high melaleuca coverage are adjacent to areas with low or no melaleuca coverage. This mosaic of habitats may increase the ability of animal populations to persist in areas with high melaleuca coverages. Further, the western boundary of the region is adjacent to Water Conservation Area (WCA) 3B. Species with high vagililty, such as wading birds, seasonally move between the LBSA and WCA 3B.

The Wildlife Studies portion of the Lake Belt Ecological Studies evaluated wildlife diversity and habitat use of melaleuca impacted wetlands. It required monthly sampling, using multiple techniques, in five cover types. The cover types were defined by the percent coverage of melaleuca. Other factors, which may effect wildlife distribution and abundance, such as hydrologic regime or surrounding habitat, were not controlled variables in the contracted sampling design.

Findings to date suggest:

1. Cumulative numbers of species were highest in areas with moderate melaleuca coverage (Marsh has less than 10% melaleuca coverage while DMM and SDM more than 75% melaleuca coverage). The number of species (species richness) is not, by itself, a good measure of the environmental value of a habitat. Numerous studies indicate that disturbed areas have higher diversity than natural areas. Which species are using a habitat is most important to final evaluation of habitat quality.

2. Species composition was evaluated based upon the "wetland association" of amphibians, reptiles, birds, and mammals. Areas with low melaleuca coverages had more species that were fully dependent or seasonally dependent upon wetlands (Fig. 36, 37). Areas with moderate levels of melaleuca retained a high number of wetland associated species, but also had additional species not typically associated with natural graminoid wetlands. Areas with high melaleuca coverages had similar number of species as areas with low melaleuca coverage, however, many of these species were not typical of natural graminoid wetlands.

3. Cumulative number of individuals was highest in areas with low to moderate melaleuca coverage. This was mainly the result of the higher abundance of Crayfish, Grass shrimp and fishes in these areas during the wet season. High abundance of

these animals is important in maintaining higher-level consumers (e.g., many reptiles, wading birds).

4. Fifteen non-native species of vertebrates were trapped in the five defined cover types for wildlife sampling (Tab. 14) during the 24 months of the study. The percentage of the 24 month cumulative numbers of species and individuals that were non-native was highest in dense mature melaleuca (DMM) and in dense sapling melaleuca (SDM). Overall, cichlid fishes were the most abundant group of non-native animals trapped. An additional five species of non-native vertebrates were observed along levees within the study area.

5. In summary of the above results, the data after 24 months of sampling indicated that as succession proceeded from 50-75% melaleuca coverage (P75) to 75-100% coverage (either mature or sapling state), the number of wetland associated species decreased, the number of non-native animals increased, and overall species abundance decreased.

6. Red imported fire ant mounds (RIFA) were absent in marshes with low levels of melaleuca and rare in mature dense melaleuca stands (Fig. 35). The highest numbers were found in areas with moderate levels of melaleuca (50%-75% melaleuca, P75 cover type). This cover type does not have as a high soil moisture content as the marshes nor the nearly complete canopy shading of mature dense melaleuca stands. As standing water levels increased, the number of ground active mounds decreased. It was noted that at least some of the mounds moved into the bark of melaleuca trees.

7. Eleven listed species were observed in the LBSA (Tab. 13). *Endangered Species.* The Wood stork was the only Endangered species observed in the LBSA. It is listed at both the State and Federal levels. Both adult and juvenile Wood storks were observed foraging in the study area. *Threatened Species.* The American alligator was the only species listed as Threatened (Similarity of Appearance) at the Federal level that was observed. The alligator is listed as a Species of Special Concern at the state level (see definition below). The Least tern is listed at the State level as Threatened, but does not have any designation at the Federal level. It was observed aerial foraging along canals. *Other State Listed Species: Species of Special Concern.* Seven species listed as SSC were observed in the LBSA. These species are: American alligator (see above), Gopher tortoise, Snowy egret, Tricolor heron, Little blue heron, White ibis, and Roseate spoonbill. A single Gopher tortoise was found along a levee. Suitable habitat for this species does not exist in the LBSA. The occurrence of this individual was anomalous. The remaining five species of wading birds seasonally foraged within the LBSA. *Other Federal Listed Species: Candidates (C1 and C2) and Under Review (UR).* Three species designated C2 has been observed. These species are: Gopher tortoise (see above), Island glass lizard, and Loggerhead shrike. The latter two species were trapped or observed numerous times. Neither the Island Glass lizard or the Loggerhead shrike have any designation at the state level.

8. While rainfall during the two years of this study was high, annual mean water levels at gages in the LBSA were within normal ranges (Fig. 4). The effect of well field pumping and other water management strategies may effect the relationship between rainfall and standing water levels in an unnatural manner. Results of this study cannot be seen as unusual for the area or as an artifact of periods of high rainfall. Moreover, the large number and the range of age classes of many of the wetland dependent animals trapped indicated normal, resident breeding populations.

9. There were two principal physical gradients in the Lake Belt Study Area environment: melaleuca density and water levels. Melaleuca density was a geographic gradient, with density varying primarily from east to west. Water level was primarily a temporal gradient, varying with seasonal rainfall. The dominant characteristic of the faunal shifts along the gradient of increasing melaleuca coverage was increased numbers of upland, arboreal, and, or forest species, not the loss of wetland species. The dominant characteristic of the faunal shifts along the gradient of water level was seasonal variation in abundance of wetland species.

10. Community composition of fishes and herptiles was most strongly related to gradients of water level. Community composition of birds and mammals was most strongly related to gradients of melaleuca density.

11. Lake designs that maximize mining potential appear to have minimal wildlife habitat value. Lake designs to promote wildlife habitat value would not realize full mining potential. Therefore, two types of lakes should be considered. Lake designs that maximize mining potential should be located east of the FPL R/W. Lake designs that promote wildlife habitat should be located between the FPL R/W and the Dade-Broward Levee. The area west of the Dade-Broward Levee should have no mining activity. This area, known as the Pennsuco wetlands, currently is a functioning marsh, and should be maintained with appropriate seasonal variation in depth and duration of flooding. These suggestions are consistent with the initial configurations being considered for hydrological modeling by the South Florida Water Management District.

TABLE OF CONTENTS

SCOPE OF REPORT vi
LIST OF TABLES vii
LIST OF FIGURES viii
LIST OF APPENDICES xii
INTRODUCTION 1
COVER TYPE TERMINOLOGY 1
SITE SELECTION 2
SAMPLING METHODS 4
Dip net sampling 5
Minnow trap sampling 5
Drift fence arrays 5
Faunal transects 6
Bird strip transects 6
Road surveys 7
Red imported fire ants (RIFA) 7
Live trapping for small mammals 8
Scent and bait stations 8
Seasonal variations in hydrology 8
RAINFALL AND STANDING WATER LEVELS 9
STATISTICAL METHODS 10
Perspective on testing 10
Data sets and analyses 10
Hierarchy of analyses 12
Dispersion and Goodness of Fit Tests 13
Rainfall and hydrological analyses 14
HABITAT QUALITY AND SPECIES COMPOSITION 14
RESULTS AND DISCUSSION OF RAINFALL AND STANDING WATER 15
1985 - 1995 Standing water levels in the LBSA 15
Correlations of rainfall and standing water level with trap rates 15
RESULTS AND DISCUSSION OF EACH FAUNAL GROUP 16
Relative value of sampling procedures 17
Macro-invertebrates 17
Fishes 18
Amphibians and Reptiles 20
Birds 23
Mammals 27
Red imported fire ants 29
TWENTY-FOUR MONTH CUMULATIVE RESULTS 29
State or Federal listed species 31
Numbers of native and non-native species 32
Habitat preference and species composition 33
Wading bird use of the LBSA 34
SUCCESSIONAL TRENDS 35
Successional changes in vegetative structure 35
Landscape effects 36
Changes in species composition 37
Percent similarity in species composition ..... **Error! Bookmark not defined.**
Multivariate analyses of changes in species composition 39
BIOLOGICAL CONSIDERATIONS IN DESIGNING A LAKE BELT PLAN 39

Lake basin morphology 40
Lake trophic status 42
Littoral zone development 42
Other perspectives on habitat characteristics beneficial to wetland animals 43
EVALUATION OF CURRENT DESIGNS 44
Lake depths 44
Littoral zone width 44
Shoreline development 44
Littoral zone depth and slope 45
Interface to shoreward habitat 45
ALTERNATIVES TO CURRENT CONDITIONS 46
LITERATURE CITED 49

SCOPE OF REPORT

This is a draft final report for the Wildlife Studies Portion of the Lake Belt Ecological Studies. All final deliverables as delineated in the contract between Metropolitan Dade County, Department of Environmental Resources Management and EVERGLADES RESEARCH GROUP, INC. are presented for the period January 1,1994 through December 31, 1995:

1. A list and map that show the approximate positions of all sampling sites for all portions of the contracted work (Tab. 1; Fig. 2).

2. A species list for all taxonomic groups listed in the award, by cover types (Tab. 3).

3. Rarefaction curves and analyses for taxonomic groups listed in the award. The curves show the plot of cumulative species vs. cumulative individuals sampled. The analyses predict the cumulative number of species expected by cover type (Figs. 11, 18, and 25).

4. Data were analyzed in terms of relative abundances, habitat preferences, and dispersion patterns by cover type.

5. A matrix of the relative abundance of each species, by cover type, for each sampling method (Tabs. 4-11). A second matrix codes species simply by presence or absence (Tab. 3).

6. Matrices of relative abundance by cover type were analyzed by cluster analyses, principal component analyses, and factor analyses, as appropriate for the data set (Figs. 14, 19, 22, 23, 26, 34).

7. Table of endangered and threatened species as listed by U.S. Fish and Wildlife Service, the Florida Game and Fish Commission, and the Florida Committee on Rare and Endangered Species (Tab. 13).

8. Figure showing the percentage of taxonomic groups that were similar between each cover type and the cover type with the lowest melaleuca coverage (Figs. 40, 41).

9. Data on fire ant mounds density by cover type were analyzed and discussed (Fig. 35).

10. A discussion of predicted habitat shifts, habitat use, species diversity, and population viability for based upon the impacts of the conversion of much of the study area to deep lakes and littoral zones. Discussion includes a brief overview of natural Florida lakes. Proper scaling of littoral zone to lake area is discussed.

11. Earlier sources of data were reviewed. Results of this study were compared, when possible. A complete bibliography of sources is included.

LIST OF TABLES

TABLE 1. List of sites used in sampling for 5 cover types (CT1 - CT5) as shown in Figure 1.

TABLE 2. Summary of sampling frequency and requirements of each sampling procedure.

TABLE 3. Presence/absence of species by cover type.

TABLE 4. Fish and macro invertebrate dip net sampling by cover type.

TABLE 5. Results of minnow trap sampling by cover types.

TABLE 6. Results of drift fence trapping, by replicate, in 5 cover types.

TABLE 7. Results of drift fence trapping, summarized by cover type.

TABLE 8. Results of faunal strip transects.

TABLE 9. Results of bird strip transects.

TABLE 10. Results of road surveys.

TABLE 11. Scent and bait stations and small mammal live trapping results by cover type.

TABLE 12. The number of active red imported fire ant mounds in the 5 cover types.

TABLE 13. Species listed by either Florida Committee on Rare and Endangered Animals, State of Florida, or the United States Fish and Wildlife Service.

TABLE 14. Percentage of native and non-native species of fishes, amphibians, reptiles, birds, and mammals in each cover type based upon cumulative totals.

TABLE 15. Habitat association and species composition in each Cover Type based upon the cumulative totals of number of species and number of individuals of amphibians, reptiles, birds, and mammals.

TABLE 16. Average fish biomass in littoral and limnetic zones from nine Florida lakes. Data were obtained from Florida Game and Fresh Water Fish Commission Annual Reports. (Kg/ha x 0.89 = lbs/ac). Table was taken in its entirety from William et al. (1985), page 57.

LIST OF FIGURES

FIGURE 1. Major habitat types in southern Florida based upon dominant vegetation. From Dalrymple and Bass, In press.

FIGURE 2. Study area with approximate locations of sampling sites. All sites were part of the random sampling protocol (see Methods section); sites followed by an asterisk (*) were systematically sampled using permanent drift fences and funnel traps. The approximate locations of the two United States Geological Survey gages from which data were analyzed are also indicated.

FIGURE 3. Results of cluster analyses of drift fence data based on three different representations of the data. The first graph was based upon raw data, the second on data standardized as percent composition, and the third on data represented as presence or absence.

FIGURE 4. Plot of annual mean water level at USGS Gage 972 and G975 for the period 1985 through 1995. If error bars do not overlap, then the means were significantly different (Tukey's Honest Significant Difference tests).

FIGURE 5A. Plot of the monthly rainfall at Miami International Airport. 5B. Plot of monthly average water level at G-972 for the period 1985-1995. 5C. Plot of the monthly average water level at G-975 for the period 1985-1995.

FIGURE 6. Plot of the number of individuals of macroinvertebrates trapped in each replicate of drift fencing for the 24 months of the study period (1994-1995). Also plotted is the average monthly water level at USGS gage G-972 for the same period. The horizontal line represents the estimated ground surface elevation.

FIGURE 7A. Plot of the number of individuals of fishes trapped in each replicate of drift fencing for the 24 months of the study period (1994-1995). Also plotted is the average monthly water level at USGS gage G-972 for the same period. 7B. Plot of the number of individuals of herptiles trapped in each replicate of drift fencing for the 24 months of the study period (1994-1995). In both graphs, the average monthly water level at USGS gage G-972 is also plotted for the same period. The horizontal line represents the estimated ground surface elevation. The horizontal line represents the estimated ground surface elevation. individuals trapped by dip netting and drift fencing. 24 month cumulative data collection.

FIGURE 8. Comparison of the number of species and individuals of fishes trapped by dip netting, minnow trapping, and drift fencing.

FIGURE 9. Abundance, species richness, and diversity of macroinvertebrates trapped by drift fencing in the five defined cover types.

FIGURE 10. Cluster analyses by individual replicates and by taxa for macroinvertebrates. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 11. Rarefaction curves for fishes trapped in each cover type. Curves based upon 24 month cumulative data from drift fencing.

FIGURE 12. Abundance, species richness, and diversity of fishes trapped by drift fencing in the five defined cover types.

FIGURE 13. Average number of individuals and species of exotic fishes trapped in each cover type. Averages calculated from cumulative numbers trapped in each replicate during 24 months of drift fencing. If error bars do not overlap, then the means were significantly different.

FIGURE 14. Cluster analyses by individual replicates and by taxa for fishes. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 15. Distributions of selected native fishes in each of the 15 replicates. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 16. Distributions of selected non-native fishes in each of the 15 replicates. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 17. Abundance, species richness, and diversity of herptiles trapped by drift fencing in the five defined cover types.

FIGURE 18. Rarefaction curves (number of species versus number of individuals sampled) for herptiles based upon drift fence data for each cover type; 24 month cumulative data collection.

FIGURE 19. Cluster analyses by individual replicates and by taxa for herptiles. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 20. Distributions of selected native herptiles in each of the 15 replicates. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 21. Distributions of selected native herptiles in each of the 15 replicates. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 22. Factor analyses of herptiles based upon raw data and data standardized as percent composition. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 23. Plot of the first two factor loadings for herptiles. Based upon 24 month cumulative drift fence data from the 15 replicates (3 replicates per cover type).

FIGURE 24. Abundance, species richness, and diversity of birds observed during strip transects in the five defined cover types.

FIGURE 25. Rarefaction curves (number of species versus number of individuals sampled) for birds based upon strip transect data for each cover type; 24 month cumulative data collection.

FIGURE 26. Cluster analyses by cover type and by taxa for the strip transect data for birds. Based upon 24 month cumulative strip transect data from the five cover types (data from the three replicates per cover type combined).

FIGURE 27. Distributions of selected birds in each of the cover types. Based upon 24 month cumulative strip transect data from the five cover types (data from the three replicates per cover type combined).

FIGURE 28. Plot of the percentage of individuals and species of resident and wintering bird species. Based upon 24 month cumulative strip transect data from the five cover types (data from the three replicates per cover type combined).

FIGURE 29. Plot of the number of wading birds observed during monthly road surveys for the northern and southern portions of the FPL R/W. Pennsuco Canal divided northern and southern.

FIGURE 30. Approximate locations of wading bird rookeries in Water Conservation Area 3. Adapted from Runde et al., (1991).

FIGURE 31. Carolina wren nest in the peeling outer bark of a mature melaleuca tree in a DMM site. Ground dove nest in a clump of muhly grass (*Muhlenbergia capillaris*) in a P50 site. Woodpecker cavities in a melaleuca snag.

FIGURE 32. Occurrence of each mammal species by cover type.

FIGURE 33. Plot of average number of individuals of mammals by cover type.

FIGURE 34. Cluster analyses by cover type and by taxa for mammals. Based upon 24 month cumulative values for all observations of mammals (data from the three replicates per cover type combined).

FIGURE 35. Quarterly number of active red imported fire ant (RIFA) mounds by cover type. Data from the three replicates per cover type combined.

FIGURE 36A. Number of individuals of wetland associated amphibians, reptiles, birds and mammals by cover type. 36B. Number of individuals of non-wetland (upland) associated amphibians, reptiles, birds, and mammals by cover type. Based upon 24 month cumulative data, all methods combined.

FIGURE 37. Trends in wetland and non-wetland associated species as melaleuca invasion progresses. Based upon 24 month cumulative data, all methods combined.

FIGURE 38. Abundance of resident bird species breeding during the 1994 and the 1995 breeding seasons. Based upon 24 month cumulative data from bird transects. Data from Apr-Sep bird transects in all cover types combined.

FIGURE 39. Summary of changes in vegetation structural diversity and wildlife diversity in native wetland habitats with increasing coverage by melaleuca.

FIGURE 40. Percent of species in common between Marsh and each other cover type for fishes, herptiles, birds, and mammals.

FIGURE 41. Total taxa for each faunal group and percent of taxa found in all of the five defined cover types.

FIGURE 42. Cluster analyses of the five defined cover types based upon presence/absence data for 133 taxa of macroinvertebrates, fishes, amphibians, reptiles, birds, and mammals.

FIGURE 43. Plot of factor loadings for each cover type of the first two taxa based upon presence/absence data for 133 taxa of macroinvertebrates, fishes, amphibians, reptiles, birds, and mammals.

FIGURE 44. A schematic drawing of habitat use by some typical wetland birds. From Weller (1982).

FIGURE 45. Schematic of lake and littoral zones with enhancements for wildlife.

FIGURE 46. Schematic diagram of a three region Lake Belt Plan.

LIST OF APPENDICES

Appendix I. Photographs of representative sites for each cover type.

Appendix II. Random sites sampled each month.

Appendix III. Statistical formulas and outputs.

Appendix IV. Glossary of the common and latin names of each species found during the 24 months of the study in the Lake Belt Study Area. Glossary also indicates whether a species is considered "exotic" in southern Florida, is listed by either the State of Florida of the U.S. Fish and Wildlife Service. For Amphibians, Reptiles, Birds, and Mammals, each species is also categorized by degree of wetland association, based upon life history traits. For Birds only, it is also indicated whether the species is resident, wintering, summering, or transient in southern Florida.

Appendix V. Clarifications of species identifications or designation.

INTRODUCTION

The Lake Belt Study Area (LBSA) of northwestern Dade County covers 47,921 acres (EAS Engineering, Inc., 1995). The region includes approximately 7,500 acres of sawgrass marshes with little to no invasion by the exotic pest plant *Melaleuca quinquenervia* (melaleuca). The area also includes approximately 8,100 acres of moderate coverage by melaleuca (10% to 75% melaleuca) and 17,300 acres with greater than 75% coverage by melaleuca. The remainder of the area is composed of lakes, littoral zones, agricultural lands, canals, levees, correctional facilities, electrical power facilities, and power line right-of-way (EAS Engineering, Inc., 1995).

The region's hydrology, water storage and water quality, as well as wildlife resources, and general environmental values must be evaluated before a thorough plan for land use may be developed. Previous studies on wildlife use of melaleuca have focused on either a few species (Mazzotti et al., 1981; Sowder and Woodall, 1985) or surveyed only dense melaleuca stands (Schortemeyer et al., 1981; Repenning, 1986). The objective of the Wildlife Studies portion of the Lake Belt Ecological Studies was a thorough evaluation of wildlife species diversity and habitat use of areas described as marsh, exotic plant invaded marsh, dense melaleuca, and other natural and man-made habitats. Wildlife was broadly defined to include selected macroinvertebrates (Crayfish, Grass shrimp), as well as fishes, amphibians, reptiles, birds, and mammals.

The study required a series of regular samplings of wildlife in a variety of cover types for a two year period. This report analyzes the data collected during the two years.

COVER TYPE TERMINOLOGY

Previous descriptions of the natural wetlands of the study area, especially the area called the Pennsuco wetlands or Pennsuco Everglades located west of the Dade-Broward Levee, have described them as prairies and, or short hydroperiod wetlands (Larsen, 1992; EAS Engineering, 1995). The classic vegetation survey by Davis (1943) characterized most of the area as "saw-grass marshes (medium dense to sparse)", with the southeastern corner characterized as "saw-grass marshes (with wax myrtle thickets)". Davis mapped a "wet prairie" cover type, but it occurs to the east of the LBSA. Reconstruction of pre-drainage conditions by Everglades National Park (ENP), the Army Corps of Engineers (COE), and the South Florida Water Management District (SFWMD), all include these wetlands as part of the long hydroperiod marsh of northeastern Shark River Slough (Fig. 1; also so Fennema et al., 1994). Recent hydrological records demonstrate that the Pennsuco wetlands are still flooded for more than six months a year under "normal rainfall" (1986; Davis et al., 1994). Soils are classified as muck or peat soils, with depths up to 1 meter (EAS Engineering, 1995). The existing dominant vegetation is dense sawgrass, one to two meters tall. Finally, the data on the wildlife of the region presented below clearly indicate a wetland community typical of long-hydroperiod marshes.

Therefore, based upon both historical and existing conditions, these wetlands should be characterized as "marsh", not "prairie". We have used the term marsh, as opposed to prairie, throughout this report to make this designation clear. Continued use of the term prairie or short hydroperiod wetland for these marshes, could lead to a serious error in evaluating their current values as well as their future role in the implementation of a Lake Belt Plan, the Lower East Coast Buffer Zone, and restoration efforts for the Northeast Shark River Slough.

Five cover types were designated for sampling of Wildlife by the Lake Belt Studies Environmental Review Committee. Cover types were defined by the committee based upon percent coverage by melaleuca. The following abbreviations for the five cover types defined for wildlife sampling were used in the text, tables, and figures.

Note: Previous reports on the Wildlife Studies portion have used the cover type abbreviations listed in the original RFP. The new abbreviations are as follows, with the previous abbreviation given in parentheses:

DMM **75 - 100% mature dense melaleuca coverage (CT 1)**
DBH of trees > 3 inches; moderate stem density
SDM **75 - 100% sapling dense melaleuca coverage (CT 2)**
DBH of trees < 3 inches; very high stem density
P75 **50 - 75% melaleuca coverage (CT 3)**
P50 **10 - 50% melaleuca coverage (CT 4)**
Marsh **0 - 10% melaleuca coverage (CT 5)**

A detailed vegetation map of the area was not available when site selection for the Wildlife Studies began. Potential study sites were identified from the vegetation map in Larsen (1992) and 1992 aerial photographs. Actual site selection was determined by ground-truthing. Several site visits were made with DERM staff and vegetation experts from EAS Engineering, Inc., in an effort to assure consensus of cover type designation.

Photographs of representative sites of each cover type can be found in Appendix I of this report.

SITE SELECTION

Each site selected for repeated sampling had to be accessible on foot from an existing grade (e.g. levee, or right of way), and cover a minimum of one acre (based upon the scale of vegetation mapping).

Based upon the original specifications of the contracted work, three locations (replicates) of each of the five cover types were selected (15 sites total). Scouting of the area during early December 1993 indicated a general hydrological gradient along a north-south axis in the study area. Further, most of the P50 and P75 cover types mapped were located north of the Pennsuco Canal. Since we were limited to three

replicates per cover type and the contract required that data analyses include one-way Analysis of Variance to test for difference between melaleuca cover types, sites were chosen to minimize hydrological variation. During the site selection process in December 1993 and January 1994, ERG staff escorted vegetation experts from EAS Engineering and DERM staff to potential sites. A cover type designation was agreed upon in field for 13 of the 15 selected sites. At this point, EAS and DERM staff decided that field visits to remaining sites were not necessary. When the location of the sites was presented to the full Environmental Review Committee in February 1994, concern was expressed that the sampling did not cover a broad enough area. Therefore, the sampling procedure was modified. The existing three replicates per cover type continued to be sampled on a monthly basis by drift fencing only. An additional seven sites for each cover type were to be selected, to bring the total to ten replicates for each cover type. Three of these ten replicates would be randomly selected each month for sampling by all methods other than drift fencing. Some of the additional sites were identified solely from recent aerial photographs and the vegetation map in Larsen (1992). Complete ground truthing of all sites was completed over a period of months, as the sites were randomly selected for sampling. If, upon ground truthing, the cover type designation differed from that initially identified from aerials, the cover type designation from ground truthing was given preference. Depending on the circumstances, the site was included using the ground-truthed designation, or a new location was selected after ground-truthing. Any discrepancies between earlier maps and the current map of approximate site locations are primarily the result of further ground-truthing.

As stated earlier, the intensive site preparation required for some sampling techniques (e.g. drift fencing) required that three sites for each cover type were repeatedly sampled each month (indicated by an asterisk in Tab.1 and Fig. 2). Repeated sampling of the same sites over time would allow for statistical tests not permitted by sampling of random sites over time. The locations of the repeatedly sampled sites were selected to minimize hydrological variation for statistical rigor in a one-way Analysis of Variance. Other sampling techniques required little site preparation, and therefore, allowed sampling to occur in a random subset of three of the ten sites in each cover type on either a monthly (dip netting, minnow trapping, faunal transects, bird transect) or quarterly basis (red-imported fire ant surveys and mammal surveys). This procedure permitted a wider range of sites to be sampled. However, since the replicates within cover types were not from identical locations each sampling period, this data could not be analyzed by ANOVA as cumulative samples from the same place over time (see Statistical Procedures below). Nevertheless, these data could still be analyzed as pooled samples for chi square tests, Index of Dispersion assessment, cluster and principal component analyses.

As a general rule, hydropattern is a strong determinant of wetland species diversity and abundance (Mitsch and Gosselink, 1986; Campbell and Christman, 1982; Dalrymple, 1988). Drift fencing required the same 15 sites to be visited at least 5 times per month for each of the 24 months. This regular, repeated sampling of the same site over time allowed an understanding of the range of field hydrological conditions

experienced by a site through time. Most other methods required a random selection of sites each month. Random sampling of sites only gave a point estimate of field hydrological conditions on the day of sampling. Since hydrological conditions of a site are determined by a combination of rainfall, surface elevation, microtopographic variation, and water management practices, actual standing water levels cannot be predicted from one variable alone (e.g. rainfall or topography). While empirical measurements of standing water levels at each site during sampling were made, a more thorough history of water levels at drift fence sampling sites aided our biological interpretations.

SAMPLING METHODS

The Everglades region presents some unique sampling problems. The shallow freshwater habitats can be difficult to sample for aquatic organisms (Kushlan, 1974), and likewise the seasonal flooding of habitat makes sampling for semi-aquatic and terrestrial animals difficult (Dalrymple, 1988). There may be too little water to get a sample of fish at one time, and yet the standing water may flood traps and kill semi-aquatic and terrestrial animals at other times. For this reason some cover types can only be sampled effectively by some methods during certain seasons of the year, and multiple sampling methods may be required to obtain representative samples of all the fauna (Kushlan, 1974).

While drift fencing was performed at the same sites each month, the other methods were performed at a random subset of three sites. Random selection of the three sites in each cover type was done prior to data collection, using a random number generator. Dip netting, minnow trapping, faunal transects, bird transects, and RIFA surveys were performed as feasible at the these sites. Additional sites were not chosen if one or more of the three randomly selected sites did not have the appropriate hydrological conditions for sampling by a particular method. Sampling the next month was done at a different subset of randomly selected sites. A similar method for site selection was followed for small mammal live trapping and scent and bait stations with the following exception. Since only one replicate per cover type was performed, if the first randomly selected site was not feasible for sampling, then two other sites were randomly selected. Sampling was deemed "not feasible" only if each of these sites were too wet for sampling. A listing of which sites were sampled each month is available in Appendix II. Where sampling procedures could not be performed due to water conditions (e.g. too wet for small mammal live trapping, or too dry for minnow traps), the summary indicates no sampling with the use of the symbol x. The dash symbol (-) indicates that sampling was performed, however no animals were collected in the sample. The end result is the same, i.e. zero data, but the distinction is made to make it thoroughly clear when a sampling method was not feasible. In all statistical tests (see next section), the sums of x's are treated as 0's (zeros) for testing purposes.

For each sampling technique, the methodology, frequency of survey, number of replicates, the types of animals sampled, and sampling limitations are described in detail below and summarized in Tab. 2.

Dip net sampling

Monthly sampling of three randomly selected sites in each cover type (15 sites total). Both dip netting and minnow trapping provide a relative abundance of fishes, Odonate larva, snails, grass shrimp, and crayfish. Occasionally, aquatic amphibians and reptiles were also captured.

Dip netting was performed using a fixed area/fixed time method. Five sweeps of the dip net were taken at approximately 5 minute intervals (the time required to sort the contents of the net into a sampling jar). Dip netting requires at least one square meter of one inch of water.

Minnow trap sampling

Monthly sampling of three randomly selected sites in each cover types (15 sites total). here were 15 traps per sites, checked 24 hours after deployment. When water levels were high enough, half of the traps were allowed to float at the surface, while the other half were weighted to rest at the bottom of the water column. Minnow trapping required at least 12 inches of standing water.

Drift fence arrays

Monthly sampling of three permanent sites in each cover type (15 sites total). Drift fence trapping in this study was used as a sampling method for all aquatic, semi-aquatic and terrestrial macroinvertebrates and vertebrate animals.

A drift fence array is simply a vertical barrier along which traps are placed. The design and placement of the traps depends upon the target species. Drift fence trapping has been a traditional method for sampling amphibians and reptiles in mesic and xeric habitats (c.f. Heyer et al., 1994). The use of a vertical barrier with associated traps has also been used to sample fishes and macroinvertebrates (McIvor and Odum, 1986, 1988; also see USFWS Commercial Fisheries Circular 48). In studies of the amphibians and reptiles of the Long Pine Key region of Everglades National Park, the Pa-hay-okee marshes of Everglades National Park, and the Big Cypress National Preserve, drift fences designed to trap amphibians and reptiles also regularly trapped high numbers of Crayfish, Grass Shrimp and fishes (Dalrymple, 1988; G.H. Dalrymple and F.S. Bernardino, unpublished data; Dalrymple, G.H., 1995).

Drift fence arrays were constructed using shade cloth. The array had four 15 m long by 1 m high arms, arranged as a cross [+]. Traps were constructed of 1/8" gauge galvanized hardware cloth, with two funnels at one end of the trap. One trap was placed at the end of each arm of the array, so that one funnel rested on each side of

the fence (as done by Dalrymple, 1988). Pit fall traps were not feasible since the soil was saturated. Under these conditions, traps will not stay in the ground.

Drift fence arrays were checked four days per month, generally, every other day over a eight day period. Arrays were maintained so that the fencing remained upright and no gaps developed between the fencing material and the ground. Funnel traps were repaired or replaced as needed. When the traps were not being checked, they were removed from the end of the fence and the funnels were blocked to prevent an animal from entering the trap.

The number of amphibians, reptiles, fishes, small mammals, and macroinvertebrates were listed and analyzed from drift fence arrays. The numbers of each species were evaluated as animals per array day (number of days array traps were open) for comparison to other studies using this technique.

Standing water depth during drift fence trapping does not preclude trapping. The time period between trap check days was modified when traps were underwater to minimize mortality of amphibians and reptiles. The number of check days remained the same. Trap rates were calculated using the number of days the arrays were operated, not the number of times the traps were checked.

Faunal transects

Monthly sampling of three randomly selected sites in each cover type (15 sites total). Transects, 100 meters long and 10 meters wide, were searched for mammal tracks and scats, amphibians and reptiles, as water levels permitted. Data are presented as presence or absence only. One mammal could imprint a series of tracks or leave multiple scats. Amphibians were identified by sight or by vocalization. It was not possible to accurately determine the number of individuals in a breeding chorus of frogs.

Faunal transects required that standing water levels were less than six inches, since mammalian sign is not evident under these conditions.

Bird strip transects

Monthly sampling of three randomly selected sites in each cover type (15 sites total). Bird strip transects were a fixed length of 100 meters. The width of each transect was determined by the furthest distance to a bird observed during the transect. If the bird was flying overhead or could not be positively identified, it was not recorded. All data were collected between sunrise and 11 a.m. The order in which cover type sites were sampled was randomly chosen each month.

Strip transects for birds in this study were designed to focus on the birds that have limited daily cruising radii and, therefore, were most likely to identify habitat preferences based on vegetative cover, rather than hydrology. Perching birds

(blackbirds, shrikes, warblers, cardinals), other land birds (doves, kingfishers, woodpeckers), some smaller wading birds (snipe, and rails), and some birds of prey are usually studied to evaluate between habitat differences in vegetative cover (Stauffer and Best, 1980). Such surveys also allow assessment of habitat use by migratory and/or transient birds versus resident breeders (Keller et al, 1993).

Information on wading bird and water bird use of the study area was most commonly collected in road/levee surveys, see below). Wading birds have daily cruising radii from roosting to foraging sites of up to 35 km (Frederick and Collopy, 1988). The wading birds move about looking for any source of standing water that is currently at the proper depth to allow them to forage. For that reason, they will fly in and out of most cover types, including forested wetland swamps, to use the standing water. Likewise the duck-like birds, cormorants, anhinga, and some birds of prey are not good indicators of how subtle shifts in tree coverage affect habitat use by birds. The latter groups of birds are best studied on a much broader habitat scale, and one that focuses on hydrology of wetlands, lakes, and littoral zones, and gives flock counts, and or relative abundance data.

Road surveys

Monthly sampling of the FPL right-of-way, Well field Canal levee, and Krome Avenue. Monthly estimates of habitat use, and relative abundance of small mammals, amphibians and reptiles, and birds were made from road cruising surveys. Relative abundance of turtles and alligators using the Well field Canal were also collected during these surveys. Preliminary surveys indicated a difference in the distribution of wading birds along the Well field Canal and the FPL right-of-way. Therefore, each of these two roadways were subdivided for data recording. The levee associated with the Well field Canal is divided into two sections: a north-south section and an east-west section. The north-south section is referred to as the improved portion of the Dade-Broward Levee (D-B Levee in tables). The Well field canal runs along the east side of the Dade-Broward Levee. Along the west side of the levee are three shallow mitigation areas. Each mitigation area is approximately 0.25 miles long and retains water year round. The FPL right-of-way(R/W) was divided into a "north" and "south" section, with the boundary being the Pennsuco Canal.

Surveys of Krome Avenue (western border of study area) focus on animals physically on the road, usually dead. These surveys are limited, since Krome Avenue is a high-speed traffic road. Birds can not be surveyed along Krome Avenue.

Red imported fire ants (RIFA)

Quarterly sampling of three randomly selected sites in each cover type (15 sites total). Estimates of red imported fire ant (RIFA) density by cover type used three 1/10 ha circular sample plots done in triplicate in each cover type on a quarterly basis(Allen, 1993 and manuscripts). The diameter and height of each mound was categorized as small, medium or large. Each mound was probed with a stick to determine whether it

was active or inactive. Active mounds always had great numbers of ants emerge within seconds of testing. Since the meaning of inactive mounds is unclear at this time, the data is reported but not analyzed further (Allen, 1993, and manuscripts).

Live trapping for small mammals

Quarterly sampling of one randomly selected site per cover type (5 sites total). Small mammal live trapping was done quarterly in the 5 cover types. One randomly selected site in each cover type was sampled using a set of 15 Sherman live traps for rat-sized mammals, paired with 15 Sherman live traps for mouse sized mammals. The traps were laid out in pairs along a transect through each sampling site. The trap pairs were placed 10 m apart, and baited with oats. Traps were checked for 3 consecutive mornings. The numbers of each species of small mammal trapped in live trap sampling arrays were listed and analyzed. Live trapping required no standing water.

Scent and bait stations for medium to large mammals

Quarterly sampling of one randomly selected sites in each cover type (one of each station per cover type; 5 sites total). Stations consisted of an attractant elevated on a post 0.5 m above the ground. The post was surrounded by a one meter square area that was cleared of vegetation, covered with two to three inches of fine sand, with the surface troweled smooth. The sand must be fine grained so that tracks of animals weighing one to twenty pounds will clearly imprint. The attractant in the center of the scent stations was a strap of rug covered with animal feces or urine, and at the bait station, an aluminum pan filled with an oily, tuna flavored pet food. On three consecutive mornings, the sand around the stations was examined for tracks, cleaned, and smoothed out. Scent stations and bait stations required no standing water.

Species lists (presence/absence during a sampling period) were generated. The same individual could visit a station over consecutive nights (i.e., the same raccoon could visit the station each night). Further, any animal visiting a station was likely to leave multiple tracks.

Seasonal variations in hydrology, sampling technique applicability to hydrology, and quarterly results

Some variation in species occurrence within and between cover types is a function of water levels. Each time a site was selected for sampling, standing water depth was estimated using a meter stick. These estimates of surface water depths were intended as a preliminary aid to understanding biological issues, not as a final statement regarding hydrological issues within the study area.

During the first quarter all cover types were showing progressive drying, while during the second quarter they were showing very unpredictable short term flooding, due to episodic rainfall. During the third quarter, Marsh cover types had continuous standing water levels varying in depth between 15 and 30 cm. Each of the other four

Cover types experienced recurring episodes of intense, localized rainfall resulting in short term flooding. A site could have no standing water one day, the next day have at least 5 cm of standing water, and two days later have no standing water. Cover types P75, SDM and DMM experienced more fluctuations in standing water levels during the third quarter than did P50. Such variations are normal and reflect the seasonal shifts in habitat use by wildlife and fishes.

During the fourth quarter, DMM and SDM both had periods of no standing water while P75 and P50 had continuous minimum standing water levels of 8 cm. Maximum standing water levels at all sites in DMM, SDM, P75 and P50 were approximately 50 cm, following Tropical Storm Gordon (November 14 thru November 16, 1994). Marsh had continuous minimum standing water levels of 35 cm and maximum levels of 70 cm following Tropical Storm Gordon.

During the fifth quarter, monthly rainfall still exceeded averages expected for each month. Still, all areas experienced decreasing standing water levels. All sites in Marsh (0% to 10% melaleuca) still had some standing water toward the end of March. At least some of the sites in the other cover types had completely dried out at some point during the quarter. The heavy rains experienced in mid-March resulted in some sites which had previously dried re-flooding.

During the sixth quarter, sites were generally dry during April. Heavy, sporadic rainfall began in early May. All sites had fluctuating water levels throughout May and June.

During the seventh quarter, most sites had continuous standing water. Only a few sites had a brief interval (3 to 7 days) without standing water in mid to late September.

During the eighth quarter, most sites had continuous standing water. Southern Florida experienced unusually heavy rainfall October 16 through October 19. It is estimated that the Lake Belt Study Area received 12 cm to 18 cm of rainfall during these three days. By mid-December, some sites in the northern portion of the study area were either dry or had scattered puddles of water while some sites in the southern portion of the study area still had 15 cm to 30 cm of standing water.

RAINFALL AND STANDING WATER LEVELS

The South Florida Water Management District (SFWMD) has described the 1994-1995 period of rainfall and hydropattern as a "25-year" high water event throughout Dade County (add lit cite). But in individual basins of water management, such as Water Conservation Area 3B, the Bird Drive Basin, or the Pennsuco-Lake Belt Study Area, the relationship of standing water to rainfall may be dramatically effected by regional patterns of water management and use. Pumpage for drinking water well fields, and, or water releases from basin to basin may affect the actual standing water levels in an unnatural manner.

As a preliminary assessment of the relationship between the regional high rainfall event and the actual water levels in the LBSA, two data sets were gathered through the Water Resources Section of DERM. The first data set was monthly rainfall at Miami International Airport for the two year period of sampling. MIA recording station was chosen because of its proximity to the LBSA. The second data set was the eleven year period (1985 to 1995) of water levels measured at two permanent USGS wells in the LBSA. Two gages were selected. One gage was located west of the Dade-Broward Levee (G-975) and the other east of the Dade-Broward Levee (G-972; see Fig. 2).

We recognize that a full and thorough assessment of water management issues is being performed by the SFWMD. However, the results of this study are not available at this time. Our analyses were simply intended to aide in biological interpretation of the results. Ultimately, the biological assessment would be greatly enhanced by the addition of: 1) the final vegetation map and analyses; and 2) a final agreement on ground surface elevation at USGS wells within the LBSA to permit assessment of actual standing water levels.

STATISTICAL METHODS

Perspective on testing

The current study was designed to address questions of wildlife use of habitat that varied in the degree of melaleuca cover. It could not address more fine-scale resolution of variation within a cover type. It is well known that in the ecological sciences, field studies do not lend themselves to simple significance testing - there are too many uncontrollable variables involved. In ecological field studies, we cannot control for microtopographic effects, rainfall, water management, water depth, flooding duration, soil variations, and autocorrelations caused by spatial patterns. The goals of field data analyses should be to identify gross patterns of habitat use, and to identify the specific ecological requirements of the species found in the area. Our goal in this study was to identify groups of species that indicate the quality of habitat types along the single gradient of the degree of melaleuca coverage, without presuming to explain the degree of variability associated with all the other uncontrollable variables.

Data sets and analyses

Cumulative two year data sets for macroinvertebrates, fishes, and amphibians and reptiles (herptiles) collected by site specific repeated samplings over time, from drift fence data sets, were analyzed by ANOVA, with 3 replicates per cover type. These data sets were analyzed by parametric ANOVAs of the raw data, and of the log transformations of the raw data (to adjust for deviations from normal distribution). The data were also ranked, and analyzed by non-parametric Kruskal-Wallis ANOVA as a check on distribution effects. In all cases, neither log transformation or ranking altered the results of hypothesis testing of the raw data (only the exact probability values

differed). If had been differences in results from the use of multiple tests, it would have been reported. Therefore, we reported only the resultant test statistics, and p values for the raw data sets.

The Environmental Review Committee required that some sampling procedures (bird transects, mammal traps, faunal transects, Red Imported Fire Ants (RIFA), minnow traps, and dip nets) be based on random site selections per sampling event. Cumulative data generated by this sampling protocol could not be analyzed by ANOVA, because site-specific repeated measures were not available. No parametric or non-parametric test of means or medians is available for these data. Such statistical tests require independent replicates (repeated measures) of the same sites, at the same time.

The above limitations are not critical to statistical analyses in ecological sciences. Simple statistical tests for average differences between cover types in numbers of individuals, or numbers of species reveal a limited amount about the ecological nature of cover type differences. They are useful for recognizing gross differences in species richness, or diversity, but say little about the species composition of the cover types. Therefore, **multivariate techniques**, which permit evaluation of the individual species' contributions to cover type differences (and vice versa) were used.

Data sets collected at standard sites, such as drift fence data for fishes, herptiles, or macroinvertebrates, were analyzed using the multivariate techniques of cluster analysis, factor analysis and, or multidmensional scaling. These analyses have the same three replicates for each cover type sampled each month, and allow us to see more of the variation among sites within the same cover type. The plots of these analyses will have three replicates for the five cover types, entered separately and plotted separately. These data sets had enough replicates to permit factor analyses as well as cluster analyses and multidimensional scaling. For example, the herptile drift fence data has a matrix of 36 rows (species) by 15 columns (locations), i.e. a 36 x 15 matrix.

Cluster analyses were done using the unweighted pair-group average (UPGMA) amalgamation method of joining groups. The joining was done on a distance matrix generated as the subtraction of each Pearson's product moment correlation coefficient from unity (1.0 , i.e. 1-r), to generate the distances. If for example two cover type sites or species had a correlation coefficient of 0.91, then their distance is 1.0 - 0.91, or 0.09 (i.e. they cluster close together). The **factor analysis** method used was the unrotated matrix of **principal components** based on the same matrices of correlation coefficients. These methods are standard procedures, and incorporate the least manipulation of the original data (unlike, e.g. varimax rotations, etc.). Additionally, **Multidimensional Scaling** was used to corroborate the results of the factor analyses.

Multivariate matrices were derived from both the raw data and from transformations of the raw data as percentage occurrence per species (to remove absolute sample size effects). Transformations neither changed, nor enhanced results

(two example of results by raw vs. transformations is given in Figs. 3 and 22). Therefore, to include the effects of differences in absolute sample sizes, multivariate matrices derived from the raw data sets were given preference over matrices derived from transformed data.

Additionally, in factor analyses, a variety of methods and rotations of data were applied. Again, they neither changed, nor enhanced results from analyses of raw data sets (such methods include principal component analysis, Communality analysis, Principal axis methods, and Maximum likelihood analysis; as well as Varimax and Equimax rotations). Therefore, we reported only the results of multivariate analyses for the raw data sets.

The one exception to the above preference for raw data, was with the application of multivariate techniques to a qualitative (presence/absence) data set for 133 taxa. This qualitative data set included all species of macroinvertebrates, fishes, herptiles, birds, and mammals that occurred in at least one of the five defined cover types (133 taxa total). It was impossible to obtain a clear pattern from the raw data for all these groups simultaneously, because of the wide variation in capture rates (e.g. over a thousand for some invertebrates, several hundred for some fishes, but ten or less for many herptiles, birds, or mammals). n such cases, standardization, either as normal deviates or percent composition, did not remove this variation. Scoring species as present (= 1) or absent (= 0) simplified the matrix to generate an overall pattern of species richness that was easily interpreted.

Data sets that were collected using randomly located sites do not have the same physical replicates between samplings, and in these cases the data for each cover type was lumped together to represent the overall pattern for the cover type. For example the bird transect data had a matrix of 46 rows (species) by 5 columns (cover types), i.e. a 46 x 5 matrix. With only five columns, these matrices were analyzable by cluster analysis, but not by factor analysis.

Hierarchy of analyses and transformations of data sets

Given the fact that some methods collected larger data sets than others (i.e. drift fences compared to dip nets and minnow traps), the statistical usefulness of a sampling method was defined as the total amount of information that the method contributed to species richness (measured as number of species per cover type), and relative abundance (measured as total raw sample sizes). In all cases the results (see below) identified the drift fence as yielding the most information on species richness and relative abundance.

For the above reasons, the results of the statistical analyses (including parametric and multivariate methods) applied to the drift fence data are presented in detail (with tables and figures). The tests done to identify the most robust data set are presented as a preliminary to detailed results in each taxonomic group assessed.

In the same context, both bivariate, parametric, and multivariate analyses of presence/absence data and data sets transformed as percent composition, added no information, i.e. clarified no patterns identified using the raw data. While all contractually required analyses of transformed data (both presence/ absence, and percent composition) were performed, each separate analysis was not included in this report. Since the analyses generated similar results, inclusion of each would simply add to the bulk of the report, without enhancing the interpretation (examples are included in Fig. 3). The results of these transformation analyses were presented to the Technical Committee's staff and are available as print-outs, and matrices for analyses as required.

In addition, log transformations of raw data sets were also analyzed for all ANOVAs that were performed, but in no case did the interpretation of statistical testing change by such transformation. Therefore, as done above for multivariate analyses, only the result of raw data testing are presented.

Tests for patterns of Dispersion and Goodness of Fit Tests

Species may show three fundamental patterns of dispersion, or distribution, among habitat or cover types: uniform, random or clumped (also called contagious or aggregated). Both the **dispersion index** and **contingency table (observed vs. expected results)** method of evaluating patterns of dispersion were used in the present study.

The Index of Dispersion (I) was calculated as the variance divided by the mean, of a sample of locations, where a species was recorded (Krebs, 1988; I = variance/mean). The test statistic for this index was chi square (X^2), where df (degrees of freedom) = number of locations minus 1. Interpretations were based upon a two way test, in which the null hypothesis that the distribution was random was accepted if:

$$X^2_{0.975} < \text{Observed } X^2 > X^2_{0.025}.$$

Significant differences less than 0.025 were interpreted as **clumped**, and greater than 0.975 were **uniform**.

An alternative "goodness of fit" approach to the testing of distributions was a **two by *n* table** (where *n* is the number of cover types, and the two alternatives were: observed numbers vs. expected numbers). As in the case of the dispersion index, the test statistics was chi square, X^2. The results of both methods are presented below.

Rainfall and hydrological analyses used in final report

Hydrological data were obtained through Dade County's Water Resources Section of DERM. Pearson product moment correlation coefficients (r) were calculated for each taxa group with water levels measured at USGS gages G972 and G975. In graphical analyses, the height of the water column and the number of individuals or species were plotted for each month. The estimated ground surface elevation is delineated as a straight line in the figures (Figs. 4-6).

Additionally, rainfall data from Miami International Airport was used for correlation analyses of numbers of individuals and species of taxa groups on a monthly basis.

HABITAT QUALITY AND SPECIES COMPOSITION

Disturbance of natural communities typically results in an increase in species diversity as "weed" species, non-native, migratory and/or species uncommon to the natural community increase in numbers (Odum, 1983). The number of species (species richness) and the number of individuals (species abundance) are not, by themselves, a good measure of the environmental value of a habitat (Van Horne, 1983). Which species are using a habitat and the manner in which they use the habitat (foraging, breeding) are more important to final evaluation of habitat quality (Stauffer and Best, 1980; Keller et al, 1993). A fair analysis of habitat quality would evaluate the types of species (e.g. wetland versus upland animals, native versus non-native), as well as their abundances.

Habitat requirements for all life history stages of each species were determined based on the literature and personal experience. Each species was then assigned to one of three categories based upon these life history traits. For the purpose of the analysis, species whose respiration, feeding mechanisms, reproduction or larval development require 9 to 12 months of standing water each year were termed **"wetland dependent"**. Species whose respiration, feeding mechanisms, reproduction or larval development require 1 to 9 months of standing water each year were termed **"seasonal wetland"**. Species whose respiration, feeding mechanism, reproduction or larval development are independent of standing water were termed **"wetland independent"**. Animals described as "wetland dependent" or "seasonal wetland" use upland habitats, but a population could not persist without suitable wetland habitat. Conversely, animals described as "wetland independent" use wetland habitats, but their life history traits allow them to survive and successfully breed outside of wetlands.

Species assigned to the same category may have different preferences with regard to timing, depth and duration of flooding. Fredrickson and Laubhan state (p. 645): **"No single wetland or wetland type will provide all the resources needed by a single vertebrate during all of its life-history stages or for all vertebrates adapted to wetlands. Thus, wetland complexes are essential for successful management".**

Some species designations were difficult due to insufficient information and therefore, future modifications are possible. The current assigned wetland association of each species of amphibian, reptile, bird and mammal is listed in Appendix IV. This categorization was restricted to amphibians, reptiles, birds, and mammals. **Fishes were excluded because they are all, obviously wetland dependent, and were trapped in very high numbers. Therefore, they would artificially bias the results toward the wetland dependent categorization.**

RESULTS AND DISCUSSION OF RAINFALL AND STANDING WATER LEVELS

1985 - 1995 Standing water levels in the LBSA

ANOVA of water levels at G972 and G975 for the eleven year period showed significant differences in hydropattern among groups of years (G972: $F = 10.586$, $df = 10, 114$, $p < 0.0001$; G975: $F = 9.891$, $df = 10, 115$, $p < 0.0001$). This eleven year period included "low" rainfall years (1989-1991), "normal" rainfall (1985-1988), and "high" rainfall years (1994-1995). Tukey's Honest Significant Difference Tests were done to determine which years were significantly lower than 1994 and 1995 at both wells. At G972, the average monthly water level in 1994 was only significantly higher than the three drought years of 1989 -1991. In 1995 at G972, was higher than the three drought years, plus 1985 (Tukey's Honest Significant Difference Tests; Fig. 4). At G975, the average monthly water level in 1994 was only significantly higher than for the two drought years of 1989 -1990, and 1985. In 1995 at G975 was only significantly higher than the three drought years, and 1985 (Tukey's Honest Significant Difference Tests; Fig. 4). G 972 and G 975 water levels during 1994 and 1995 were not significantly higher than the three "normal" water years of 1986 - 1988.

High rainfall cannot be used to argue that the results of this study were biased toward high standing water levels. **The actual average monthly standing water levels measured at USGS gages in the LBSA were not significantly higher than during periods of normal rainfall.** Water management strategies and well field pumping are the most likely explanations. Moreover, in 1994, it was not as wet as in 1995 (Fig. 5). Yet more species and individuals were trapped in 1994 (147 species and 12,904 individuals) than in 1995 (123 species and 10,621 individuals) in the five defined cover types.

Correlations of rainfall and standing water level with trap rates

Major peaks in capture of aquatic macroinvertebrates, fishes, and herptiles were generally associated with changing water levels (either rising or falling). As a general rule, animals tended to move more when conditions were changing. Further, when standing water existed over large areas, aquatic and semi-aquatic animals were more dispersed, and capture rates were generally lower (Figs. 6,7). USGS well G972 was used as an example of the relationships in the accompanying figures. The L.S.D

elevation (4.87 NGVD) was used as a conservative estimate of ground surface elevation for this well. Actual ground surface is likely to be even lower.

Correlation analyses were restricted to the faunal groups for which data were collected at standard locations by drift fence, namely macroinvertebrates, fishes, and herptiles. Monthly rainfall (MIA data), and the monthly average water levels at USGS G972 were used to calculate correlation coefficients with species and individuals. Statistical outputs for the following analyses can be found in Appendix III.

For macroinvertebrates, four replicates showed positive correlations between rainfall and number of species of macroinvertebrates, and seven replicates showed correlations between rainfall and number of individuals. For fishes, there were no significant correlations between rainfall and numbers of species of fishes and only two replicates had significant correlations between rainfall and the number of individuals of fishes. There were no correlations between rainfall and numbers of species or individuals for herptiles.

When correlation coefficients were calculated for water level at USGS G972 and the number of species, there were significant positive correlations for macroinvertebrates at eleven of the fifteen replicates (73%); for fishes at ten sites (66%); and for herptiles at only one of fifteen replicates (7%; a P75 site).

Finally, drift fence catch rates of amphibians and reptiles from this study in the LBSA were compared to average trap rates from a three year study (1984-1986) of wetlands in Everglades National Park (Dalrymple, 1988). The ENP study used the same design of drift fences, and occurred during a period of "normal" rainfall and hydropattern. Trap rates in the LBSA ranged from 0.34 to 0.69 herptiles per day, while trap rates in ENP were 1.04 herptiles per day. These trap rates indicated that if hydrological conditions were affecting yields, the result was to lower yields, not increase yields.

RESULTS AND DISCUSSION OF EACH FAUNAL GROUP

Common names of species were used in text and figures. The latin name of each species can be found in Appendix IV. Any clarifications of species taxonomy or identifications from quarterly reports were listed in Appendix V.

The overall information on species presence or absence from cover types (CT) is summarized in Table 3 and below. In this section, each major faunal group was discussed (macroinvertebrates, fishes, herptiles, birds, and mammals). Then, overall species composition and abundance across all faunal groups was compared between cover types. The presence of Endangered, Threatened, State of Florida Species of Special Concern, and USFWS Candidate species was noted by cover type. The habitats they were observed in was also noted. Species composition and abundance was evaluated by native versus non-native species and by habitat association (wetland versus upland species).

Relative value of sampling procedures

Some sampling methods collected less data than others did. The best example of this came from comparison of fishes trapped by dip netting, minnow trapping, and drift fencing. Drift fencing collected more individuals than either dip netting or minnow trapping ($F = 51.248$, $df = 2,12$, $p < 0.0001$ (Fig. 8). Even when the drift fence data was divided by four (because the drift fences were checked four times per month vs. one for the other methods), the minnow trap data were still significantly lower than the drift fence and dip methods. Similar results were obtained when capture rates of other faunal groups were compared by method. Statistical analyses improved in robustness and clarity, when both species lists, and relative abundance data (number of individuals per sample) increase. While the discussions below considered all data collected, regardless of method, in-depth quantitative analyses were restricted to the single, most robust data set.

Macro-invertebrates

Macro-invertebrates were identified or trapped in the five defined cover types by four standard methods (dip netting, minnow trapping, drift fencing, and faunal transects; Tab. 4, 5, 6-7, and 8, respectively). The first three methods trapped semi-aquatic and aquatic species (e.g. Crayfish, Grass shrimp). Butterflies and adult dragonflies and damselflies were identified during faunal transects. During the two year study period, 31 species and 10,461 individuals were trapped or identified in the five defined cover types. The cumulative number of species found in each cover type ranged from 19 (DMM) to 27 (P75). The cumulative number of individuals in each cover type ranged from 895 (DMM) to 3,718 (P50).

The most abundant invertebrates trapped were the Crayfish (5,963 individuals trapped) and the Grass shrimp (2,924 individuals trapped). **Crayfish were most abundant in P50 (2,722 individuals) and least abundant in Marsh (212 individuals). Grass shrimp were most abundant in Marsh (1,830 individuals) and least abundant in P75 (46 individuals).** These animals are preyed upon by a wide range of fishes, herptiles, wading birds, and some mammals.

Quantitative analyses presented in this report were based on the two year cumulative results from drift fencing, since this data set permitted the most robust statistical analyses (including ANOVA with triplicates per cover type). Eleven species were included in these analyses (Tab. 6).

There were no significant differences in the number of individuals ($F = 1.704$, $df = 4, 10$, $p = 0.225$), number of species ($F = 0.595$, $df = 4, 10$, $p = 0.68$), or diversity indexes ($F = 0.89$, $df = 4,10$, $p = 0.1$) of macroinvertebrates between cover types (Fig. 9).

In tests of dispersion using the Index of Dispersion, all macroinvertebrates showed random distributions among cover types (statistical outputs included in Appendix III). **This indicates that cover type, defined by melaleuca cover, was not as important in the dispersion of the species as were other variables, including standing water.**

Cluster analyses revealed two main groupings of macroinvertebrates by cover types: Grass shrimp, Apple snails, Lubber grasshoppers, dragonfly larvae, and Papershell snails were predominantly found in Marshes and some of the intermediate cover type sites (P50, P75; Fig. 10). Crayfish, Dytiscid beetles, Gyrinid beetles, Ram's horn snails, and Giant water bugs, Lethocerus, were predominant in DMM, SDM and other intermediate sites.

Fishes

Fishes were trapped in the five defined cover types by three standard methods (dip netting, minnow trapping, and drift fencing; Tabs. 3, 4, and 5-6, respectively). During the two year study period, 27 species and 10,708 individuals were trapped or identified in the five defined cover types. he cumulative number of species found in the five cover types ranged from 18 (SDM) to 22 (Marsh). The cumulative number of individuals in each cover type ranged from 1,142 (DMM) to 3,250 (P50). An additional three species of fishes were observed in the study area, at sites other than the defined cover types (e.g. canals, pools along FPL R/W). These species were: Bowfin, Striped mullet, Peacock bass. It is unlikely that any of these species would survive in the seasonal wetland habitats of the five defined cover types.

The Mosquitofish was the most abundant species trapped (5,384), followed by Marsh killifish (1,092), Jewelfish (1,083) and Black acara (686).

Eight species of non-native fishes were trapped or observed in the LBSA. These species were the Jewelfish (1,083 individuals), Black acara (686 individuals), Pike killifish (111 individuals), Nicaraguan cichlid (62 individuals), Spotted tilapia (27 individuals), Oscar (23 individuals), Walking catfish (13 individuals), and Peacock bass (1 individual). We list the Peacock bass an a non-native species, yet this species is recognized by the Florida Game and Fresh Water Fish Commission as a game species and is regulated. Juveniles of five species were trapped (Jewelfish, Black acara, Oscar, Nicaraguan cichlid, Spotted tilapia). The Pike killifish, Nicaraguan cichlid, and Jewelfish are predaceous on small forage size fishes. The impact of these small to moderate size predators may have an impact on the natural recruitment of many forage fish species in the area. However, it is likely that they are preyed upon by higher level consumers.

Statistical analyses of fishes by each of the individual methods (dip, minnow, drift fencing) were done. However, not all of these methods yielded data that was as easily analyzed. Dip netting captured 2,020 individuals of 16 species of fishes (Tab. 4), minnow trapping captured 221 individuals of 11 species of fishes (Tab. 5), and drift fencing captured 8,428 individuals of 27 species of fishes (Tab. 6-7). Analyses

improved in robustness and clarity, when both species lists, and relative abundance data (number of individuals per sample) increased. The raw data for fishes from minnow traps and dip nets does not yield as much information on richness and abundance as does the drift fence method. In comparison of the three methods for fishes, drift fencing collected more individuals than both dip and minnow trapping ($F = 51.248$, $df = 2,12$, $p < 0.0001$ (Fig. 8). Even when the drift fence data was divided by four (because the drift fences were checked four times per month vs. one for the other methods), the minnow trap data was still significantly lower than the drift fence and dip methods. Therefore, drift fencing provided the most robust data set for the in-depth quantitative analyses presented below.

Rarefaction curves for fishes indicated that, after 24 months, sampling was approaching maximum species richness in some cover types (curves were flattening out; Fig. 11); i.e. a large number of fishes would need to be trapped before a new species would be trapped for most cover types. The rarefaction curves for Marsh and DMM indicated that new species could be expected. Marsh had the highest species richness, with the greatest number of species trapped even though a higher number of individuals were trapped in other cover types. During the last quarter of trapping, two new species of fishes were trapped in DMM (Oscar and Spotted tilapia, both exotic cichlids), SDM (Spotted sunfish and Walking catfish), and P50 (Spotted sunfish and Spotted tilapia). No new species were trapped in P75 or Marsh.

Twenty seven species and 8,428 individuals of fishes were captured in drift fences. ANOVA was used to compare the average number of species and the average number of individuals trapped between cover types (Tab. 6). **There were no differences between cover types in the average number of species trapped** ($F = 1.389$, $df = 4,10$, $p = 0.306$). **However, there were higher average numbers of individuals captured in Marshes, P50, and P75, than in SDM, and DMM** ($F = 6.269$, $df = 4, 10$, $p = 0.008$; Fig. 12). This pattern of abundance of fishes may help to explain why the intermediate cover types were commonly used by foraging wading birds, and many fish-eating herptiles. The Shannon Diversity Index was not significantly different between cover types ($F = 0.438$, $df = 4,10$, $p = 0.779$, Fig. 12). There were no significant differences in the number of individuals, or species of exotic fishes found among the cover types (p's > 0.05; Fig. 13).

Sixteen of the 27 species of fishes showed clumped distributions. However, only seven species showed this clumping within a single cover type (statistical outputs included in Appendix III). The Bluefin killifish, Spotted sunfish and Oscar clumped in Marshes, the Florida gar and Spotted tilapia in P75, and the Pike killifish and Swamp darter in SDM. Each of the other taxa that showed clumped distributions, 9 of 16 (or 56%), were clumped in locations in more than one cover type. **Since only 7 of 27 species (26%) showed clumped distribution within a single cover type, variables other than melaleuca density were equally important in determining species abundance. These variables include variations in historical patterns of distribution, hydropattern, and access to deep water refugia.**

Cluster analyses of the data for fishes showed the three Marsh replicates tightly grouped together, but joined by a range of replicates from intermediate cover types, and even DMM. Four of the six dense melaleuca sites (DMM and SDM) clustered together with one P75 site (Fig. 14). This result demonstrated the wide overlap in fish community structure among the melaleuca gradient. In other words, most species of fish were found wherever there was standing water. For example, in Figures 15 and 16, six of the eight species distribution patterns shown, reveal common use of many cover types. However, two of the species show a cover type preference. Distribution of the Bluespotted sunfish was clumped in Marsh, and that of the Pike killifish was clumped in SDM.

As was the case for the macroinvertebrates, fishes, as a group, followed gradients of water more strongly than gradients of melaleuca coverage, at least through P75. **It is important to note that there was a lower abundance of fishes in dense melaleuca coverages. This translates into a lower forage base for many higher-level consumers** (e.g. many herptiles, wading birds, some mammals).

Amphibians and Reptiles

Amphibians and reptiles were trapped or observed in the five defined cover types by four standard methods (dip netting, minnow trapping, drift fencing, and faunal transects; Tabs. 3, 4, 5-6, and 7, respectively) plus serendipitous incidental observations. During the two year study period, 38 species and 1,547 individuals were trapped or identified in the five defined cover types. The cumulative number of species found in each cover type ranged from 27 (SDM and Marsh) to 31 (P50). The cumulative number of individuals in each cover type ranged from 208 (Marsh) to 380 (SDM). An additional five species of reptiles were observed in the study area along levees, but were not trapped in any of the five defined cover types. These five species were: Gopher tortoise, Chicken turtle, Peninsula cooter, Brown water snake, and Rough green snake. These species will be discussed in further detail at the end of this section.

The most abundant amphibians found in the LBSA were the Southern leopard frog (256 individuals), Greenhouse frog (174 individuals), Oak toad (134 individuals), Pig frog (108 individuals), and the Greater siren (64 individuals). The most abundant reptiles were the Brown anole (180 individuals), Black racer (104 individuals), Florida green water snake (70 individuals), Florida water snake (70 individuals), and the American alligator (67 individuals).

Two species of non-native amphibians and one species of non-native reptile were trapped. All three species are typical of drier, ruderal or edificarian habitats (Duellman and Schwartz, 1957; Dalrymple, 1988). The Cuban treefrog (13 individuals) was trapped in P75, DMM and SDM. The Cuban treefrog requires standing water for its egg/tadpole stage, yet these stages are of short duration (two months). The Greenhouse frog (174 frogs) was trapped in 11 separate sites representing DMM, SDM, and P75 habitats. However, 87% of these frogs were trapped at just two sites (109

frogs at a SDM site and 42 frogs at a DMM site). The Greenhouse frog has no aquatic egg/tadpole stage. The Brown anole is highly tolerant of disturbed settings (Wilson and Porras, 1983). It was most abundant in DMM (83 lizards from 5 sites) and SDM (38 lizards from 4 sites), although it was trapped in all cover types (180 lizards total across all habitats).

Thirty-four species and 1,265 individuals of herptiles were captured in drift fences. ANOVA was used to compare the average number of species and the average number of individuals trapped between cover types (Tab. 6). **There were no significant differences between cover type in the average number of species** ($F = 2.08$, $df = 4,10$, $p = 0.16$), **average number of individuals** ($F = 1.40$, $df = 4, 10$, $p = 0.30$), **or Shannon diversity** ($F= 0.710$, $df = 4, 10$, $p = 0.603$; Fig. 17).

Rarefaction indicated that the number of species trapped was at expected levels (all Cover types have current values that exceed the expected value from rarefaction from Everglades National Park prairies, Dalrymple, 1988). Furthermore, all cover types yielded very similar curves when their rarefaction curves were calculated (Fig. 18). During the last quarter of trapping, no new species of herptiles were trapped in any of the cover types. It is predicted that new species would be trapped at a very low rate.

Eighteen of the 34 species of herptiles (54%) showed clumped distributions. However, only six species showed this clumping within a single cover type (statistical outputs in Appendix III). The Striped mud turtle and the Southern toad clumped in Marshes. The Eastern garter snake and the Southeastern five-lined skink clumped in P75. The Brown anole and Green treefrog clumped in DMM. The other 12 taxa that showed clumped distributions, clumped in locations in more than one cover type. In other words, a species clumped in a marsh site, as well as a site representing any one of the other four cover types. **Since only 6 of 34 species (18%) showed clumped distribution within a single cover type, this indicated that variables other than melaleuca density were also important in determining species abundance. These variables include variations in historical patterns of distribution, hydropattern, and access to either deep water refugia or high ground refugia.**

When the numbers of individuals of each species were placed in a correlation matrix by cover types for multivariate analyses, the sites that shared similar species composition were easily identified. In the cluster analysis by cover types, Marsh separated out with one of the P50. The other two P50 grouped with the P75. The SDM and DMM separated as a third distinct group (Fig. 19). When the same matrix was analyzed by species composition, the Pig frog, Striped mud turtle, Florida green water snake, Striped crayfish snake, and Cricket frog all clustered together as good indicators of Marsh conditions. The majority of snakes, lizards, frogs, toads and lizards used the wide range of intermediate cover types (P50 and P75). This included fully aquatic species such as the Mud snake, Two-toed amphiuma, Southern leopard frog, and Florida banded water snake. The non-native Cuban treefrog, Greenhouse frog, and Brown anole, together with the native Eastern narrow-mouth toad, Oak toad, and Greater siren grouped together in DMM and DMS. As was the case for fishes, many

herptiles demonstrated overlap in community structure along the melaleuca gradient. For example, in Figures 20 and 21, five of the eight species distribution patterns shown, reveal common use of many cover types. However, three of the species show a cover type preference. Distribution of the Striped mud turtle was clumped in Marsh. The Striped crayfish snake showed preference for Marsh and P50. The Greenhouse frog very abundant at two sites (a SDM and a DMM), yet absent from most sites.

The presence of so many Greater sirens in DMM and DMS habitats was unexpected. This salamander is fully aquatic, and, is unable to feed out of the water. It would quickly die from desiccation on dry land. It was trapped at 11 of the 15 drift fence sites. Twenty-two of the 60 Greater sirens trapped by drift fencing were trapped in one DMM site (Tab. 6). This site was located along the northern edge of the LBSA, isolated from areas of lower melaleuca density. This animal has a rather limited home range and individuals were trapped as soon as standing water levels existed. Four individuals were trapped at this site two days after heavy rain resulted in flooding of this site. A fifth, large individual was trapped on the third day following flooding. This indicated some unidentified subterranean refugia near the trapping sites. Another 11 Greater sirens were trapped at one SDM site (Tab. 6). Refugia for this species are known to be subterranean moist soils, where they aestivate in a mucus covering (Bishop, 1962).

Factor analyses (of raw data and data transformed as percent composition; Fig. 22) also identified the same separation of species by habitat preference. Both the cluster and factor analyses of the cover types revealed the same pattern. Marsh factored out as a distinct group at one extreme, with a gradient extending from P50 to SDM and DMM (Figs. 19, 22). The same matrix was analyzed for the loadings of the taxon on the first two principal components (Fig. 23). The loadings showed a broad scattering. Taxa at one extreme (left side of graph) were typical of Marsh and P50. Taxa at the other extreme (right side of graph) were typical of DMM and SDM. The taxa with significant clumped distributions were outlined (Fig. 23; I index p's < 0.025).

In addition to the 34 species of herptiles trapped by drift fencing, an additional 4 species were noted in at least one of the five defined cover types by other methods (total of 38 species in defined cover types). Three species of herptiles were observed only during faunal transects (American alligator, Florida softshell turtle, Florida redbelly turtle, Tab. 8). The size of these species made it very unlikely that they would be trapped by drift fencing. A fourth species, the Yellow rat snake, was noted in DMM as an incidental observation. The individual was seen in the branches of a melaleuca tree, approximately three meters above the ground. The Yellow rat snake is highly arboreal, hence rarely traps. Each of the four species noted above were also observed during road surveys (Tab. 10).

In addition to the 38 species of herptiles observed in the five defined cover types, five other species were seen only along levees during road surveys in the LBSA (Tab. 10). Three of these five species would be likely to survive in the seasonal wetland habitats of the LBSA, yet their life histories would make them difficult to trap. The Chicken turtle and the Peninsula cooter are large aquatic turtles that are rarely trapped

by drift fencing. The Rough green snake is highly arboreal and therefore, also unlikely to be trapped by drift fencing. The Gopher tortoise, a Species of Special Concern, was observed once along a levee at the southern end of the study area. The shell of this individual was marked with blue paint, suggesting the animal was at one time held in captivity. The historical distribution of the Gopher tortoise in southern Florida would have included sandy pinelands in the eastern portion of Dade County. However, the LBSA does not include habitats suitable for maintaining a population of Gopher tortoises. A Brown water snake was observed along a levee adjacent to a canal. This species prefers deeper riverine waters (e.g. canals). It is probable that it would at least seasonally use wetland habitats in the study area.

Four species that were expected to occur in the LBSA were never observed. Two of these, the Eastern indigo snake (*Drymarchon corais*) and the Eastern diamondback rattlesnake (*Crotalus adamanteus*) are large, upland species. Their absence indicated that not enough continuously dry land exists in the area to support populations. Two other species, the Dusky pygmy rattlesnake (*Sistrurus miliarus*) and the Florida brown snake (*Storeria dekayii*) are both smaller snakes. These species are typical of seasonal wetlands and are commonly seen over most of rural Dade County. The Dusky pygmy rattlesnake, when present, is normally very abundant and commonly seen. Its absence indicated that the area may have too little dry land to support populations.

Birds

Birds were observed in the five defined cover types by two standard methods (faunal transect and fixed length strip transects; Tabs. 8 and 9, respectively) plus serendipitous incidental observations. During the two year study period, 48 species and 614 individuals were identified in the five defined cover types. The cumulative number of species found in each cover type ranged from 17 (Marsh and DMM) to 30 (P75). The cumulative number of individuals in each cover type ranged from 39 (DMM) to 163 (P75). An additional 44 species were observed along roadways and levees in the study area. These will be discussed in further detail below.

The most abundant species observed in the LBSA were the Great egret (593 birds), Little blue heron (348 birds), Meadowlark (174 birds), Great blue heron (173 birds), and the Red-winged blackbird (166 birds).

ANOVA could not be performed to test for significant differences in the average numbers of species and individuals between cover types since the data were collected from randomly selected sites.

When the strip transect data was analyzed as twenty-four month cumulative data, 518 individuals of 46 species were observed across all five cover types (Tab. 9). P75 had the highest number of species (29) and the highest number of individuals (146; Fig. 24). DMM had the lowest number of species (9) and individuals (39). Marsh had the second highest number of individuals (137) yet had a lower number of species (15)

than SDM, P75 and P50 (22, 29, and 27 species, respectively). Shannon Diversity was highest in SDM and lowest in Marsh (Fig. 24). Lower diversity indicates that a lower number of species accounted for most of the individuals. Evenness was also highest in SDM. It was lowest in P75. Lower evenness indicates that some species were abundant, while others were rare (Odum, 1983).

Species in P75 were a peculiar mix of typical wetland/prairie species and upland species. Species observed in DMM were characteristic forest/edge species. Species observed in Marsh were typical of Everglades wetlands (herons, egrets, Red-winged blackbird, Eastern meadowlark, and Common yellowthroat; Robertson and Kushlan, 1984).

The rarefaction curves of all cover types still showed an upward trend, indicating that maximum species richness was not sampled after 24 months (Fig. 25). The numbers of new species recorded in each Cover type during the eighth quarter were: DMM, 0 species; SDM, 1 species; P75, 1 species; P50, 1 species; Marsh, 1 species.

Fifteen of 46 species of birds observed during transects showed clumped distributions. Unlike the patterns seen in macroinvertebrates, fishes and herptiles, most species (11 of 15 or 73%) clumped in a single cover type (statistical outputs available in Appendix III). The Common yellowthroat, Common snipe and Red-winged blackbird clumped in Marsh. The Eastern phoebe and Boat-tailed grackle clumped in P50. The Northern flicker, Northern mockingbird, Yellow-rumped warbler, and Prairie warbler clumped in P75. The American redstart and Rufous-sided towhee clumped in SDM. The remaining species clumped in adjacent seral stages. The fifteen species (33% of total species) that had clumped distributions accounted for 76% of all individuals observed in transects (395 of 518). Many species did not show a clumped distribution simply because they occurred only a few times (e.g. House wren, Swamp sparrow). **For 11 of the 15 species that showed a clumped distribution, clumping occurred within a single cover type. This indicated that cover type, defined by degree of melaleuca density, was important in the distribution of the many bird species.**

Since the data were collected from three randomly selected sites in each cover type for each month, the data was combined for each cover type. The resultant matrix for multivariate analyses was a 46 (species) x 5 (cover type) matrix.

Cluster analysis demonstrated that the species composition of the cover types was dramatically different (Fig. 26). **Common yellowthroats (57 individuals), and Red-winged blackbirds (47) were characteristic of Marsh.** These two species are resident breeding species, typical of marsh habitats. They accounted for 76% of all individuals seen in Marsh habitats during transects. **The DMM sites were characterized by the presence of Carolina wren and Bluejay.** The plots of numbers of individuals of Common Yellowthroat and Carolina Wren by cover type were essentially the opposite of one another (Fig. 27). **The majority of herons, egrets, perching birds, loggerhead shrikes, raptors, and woodpeckers used P50, P75,**

and SDM. These cover types had the most species represented, but no more individuals than the marshes.

Of the 46 species observed during transects, 29 were resident species and 17 were wintering species (see Appendix IV for listing of resident versus wintering species). **The percentage of individuals that were resident species was highest in Marsh (93%) and lowest in SDM (49%; Fig. 28).** Most migratory species were warblers, which favor forested areas (Morse, 1985).

The strip transect method used in this study targeted bird species with small daily cruising radii, which selected habitat based primarily upon vegetative cover (e.g. passerines, some raptors), not standing water conditions (e.g. many wading birds). Yet wading birds are frequently given high profile in wetland assessments in southern Florida. Again, sampling methods in this study were intended to provide gross information on all species. Wading birds observed during transects were generally solitary, foraging individuals. Wading bird use of the habitats other than the five defined cover types will be discussed below.

In addition to strip transects, bird abundances (especially wading birds) along levees in the LBSA were evaluated during road surveys. Overall, 2,780 individuals of 72 species of birds were observed during monthly road surveys (Tab. 10). Forty-four of these species were not observed in any one of the five defined cover types. Several factors contributed to higher species counts during road surveys versus strip transects. Road surveys covered a much longer distance, and crossed a variety of cover types as well as edges of cover types. Many raptors and warblers prefer edge habitats. Additionally, secretive species were detectable from a distance along the roadway. This included King rails, Pied-bill grebe, and American coots. These species would be expected to use marsh habitats, but their behavior of quietly moving away rather than flushing makes them difficult to detect on foot in dense vegetation. Wading and shore birds were frequently observed along the Dade-Broward Levee and the FPL R/W.

During some months, mixed flocks of 50-240 wading birds were observed foraging in the shallow water impoundments along the FPL R/W, particularly south of the Pennsuco Canal (Fig. 29). While a number of juvenile wading birds (White ibis, Little blue heron, Wood stork) were observed foraging in the area, their presence was not considered to indicate breeding populations in the LBSA for two reasons. Firstly, there were no direct observations of nesting. Nesting typically occurs in large tree islands. While these habitats occurred in the study area, they were located such that either an airboat or aircraft would be necessary to survey them. This was beyond the scope of the project. Secondly, there are several traditional breeding rookeries for wading birds in the eastern portion of Water Conservation Area (WCA) 3B (1987, 1988, 1989 aerial surveys), approximately 8 km east of the western boundary of the LBSA (Fig. 30; modified from Runde et al., 1991). Wading birds have daily cruising radii from roosting to foraging sites of up to 35 km (Frederick and Collopy, 1988).

Four species of non-native birds were observed along levees or canals in the study area. Each of these species is considered to have established a self-sustaining breeding population (Robertson and Woolfenden, 1992). All are more common in suburban and ruderal settings than in natural habitats (Robertson and Woolfenden, 1992). The European starling was observed both summers, nesting in electric poles along the FPL R/W. Muscovy ducks were observed along canals. A single Budgie was observed along Dade-Broward Levee. The Eurasian collared-dove was observed along levees.

Serendipitous observations of nesting occurred during the two years. Two Carolina wren nests were found. One nest was located in the peeling outer bark of a mature melaleuca tree in DMM cover type (Fig. 31). The second nest was located in a pile of minnow traps stored in the fork of a sapling melaleuca tree in a SDM cover type. A Ground dove nest was located in a clump of muhly grass (*Muhlenbergia capillaris*) in P50 (Fig. 31). A single Red-winged blackbird nest was found constructed in the fork of a melaleuca tree in P50. A Killdeer nest and a Common nighthawk nest were located along gravel levees. Both species nest on the ground, frequently in areas with sparse vegetation. Additionally, juveniles of several known breeding species were seen in the company of adults. This indicated that these species were also breeding in the area, since groups of juveniles and adults would not be seen far from the nesting site. These species included Northern cardinal, White-eye vireo, Red-winged blackbird (many juveniles seen), and King rail. This summary of birds breeding within the study was not intended to be a complete list of breeding species. It included only those species directly observed nesting or with juveniles.

Numerous melaleuca trees with woodpecker cavities were located. Cavities are used year-round for roosting, not solely for nesting. The Red-bellied woodpecker was most frequently observed in DMM, DMS, and P75 while the Northern flicker was observed in P75, P50, and along levees. It was never observed in DMM or DMS. Flickers are known to prefer open areas, since, unlike most woodpeckers, they will forage on the ground (Erhlich et al., 1988). In Long Pine Key, Everglades National Park, five flicker nest cavities were located in pine trees within 150 meters of short-hydroperiod finger glades (Lewis, 1994). Melaleuca snags frequently had several excavations, stacked one on top of the other (Fig. 31). Generally, the upper cavities were only partially excavated. A number of cavities were located within 1.5 meters of the ground surface.

Raptors, especially Red-shouldered hawks, were commonly seen perched on the edges of dense melaleuca stands along levees and the FPL R/W. On several occasions, Red-shouldered hawks were observed eating a snake. Ospreys were commonly seen foraging along canals and the shallow water impoundments along the southern portion of the FPL R/W. American kestrels were abundant during the winter. They were most frequently seen along the FPL R/W, perched on a wire.

Loggerhead shrikes were common along the DB Levee, but were also observed perched in melaleuca trees in Marsh, P50, P75, and SDM. Loggerhead shrikes were abundant

Mammals

Mammals or mammalian sign (track/scat) were trapped or observed in the five defined cover types by three standard methods (faunal transects, bait and scent stations for medium to large mammals, live-trapping for small mammals; Tabs. 7 and 10, respectively). During the two year study period, 16 species and 195 individuals were trapped or identified in the five defined cover types. The cumulative number of species found in each cover type ranged from 7 (Marsh) to 14 (DMM). The cumulative number of individuals in each cover type ranged from 24 (Marsh) to 45 (P50 and DMM). Additional observations of mammals were made along levees in the study area. While no additional species were noted along levees, they were the most common place to see medium (Raccoon, Gray fox) and large mammals (White-tailed deer).

Five species of non-native or domesticated mammals were observed. Dogs were the most common domesticated mammal seen (26 occasions), and were observed throughout the study area. Domestic cats were seen along a levee, approximately one mile from a residential area. Two non-native rodents (Black rat and House mouse) were trapped in a DMM site that was located between agricultural and residential areas along Krome Avenue. These two species are uncommon in natural habitats isolated from developments. Nine-banded armadillo was common during the first year in DMM and SDM sites. This species is well-established throughout Florida (Layne, 1976).

The only mammal to show a significantly clumped distribution was the Nine-banded armadillo, which was most common in DMM (Fig. 32; statistical outputs in Appendix III). For all other mammals, the data sets were either too small (e.g. many of the small rodents, and shrew) or the species did not showed a clumped distribution. White-tailed deer, Raccoon, Virginia opossum, and Bobcat ranged throughout the study area, regardless of melaleuca density. **This indicates that cover type was not as important in the dispersion of the species as were other variables, including standing water.** The River otter was strongly associated with marsh, but the sample size was too small to yield a significant clumped distribution. This was the only mammal species observed in the LBSA which is fully dependent upon wetland habitats.

Dry ground refugia, including trees, were especially important to many of the mammal species in the area. This is critical in terms of future planning. **Retention of the mammalian fauna of the area requires planning for dry ground refugia and water-dry land interfaces of sufficient acreage to permit persistence of mammal populations.**

Continuous high standing water levels limited the use of bait and scent stations and searches for sign (tracks or scat). At most, species list by cover type can be generated.

Nine-banded armadillo sign was common in DMM. Individuals were frequently seen along levees. Virginia opossum and Raccoon tracks were noted in all cover types. Raccoons were the most frequently seen mammal. Each of these species are abundant and common throughout their ranges.

Marsh rabbit tracks and scats were observed in all cover types. On two separate occasions, scat was found on top of a drift fence funnel trap when sites had standing water. Bobcat tracks were noted in P50, P75, SDM and DMM. On one occasion in February 1995, a Bobcat was seen walking along the FPL R/W. Gray fox tracks were observed in P75, SDM and DMM. Additionally, a Gray fox was seen on a levee, in the same general area, three separate times during one week in December 1994. On each occasion, the fox disappeared into sites with dense sapling melaleuca. A Gray fox was also seen along a trail in a DMM site. Gray Fox prefer habitats with dense vegetative cover and are known to seek refuge in trees.

In 1994, a River otter was seen on two occasions along the east-west portion of the Wellfield Canal and once along the Dade-Broward Levee. In both sightings along the Wellfield Canal, the River otter was seen crossing from an area with approximately 50% melaleuca coverage into the Wellfield Canal. River otter tracks were noted in Marsh, and scat were occasionally found along the Dade-Broward Levee.

White-tailed deer were seen on several occasions along the FPL R/W and the Dade-Broward Levee. Tracks were seen in each of the five cover types during the dry season. Two does were once seen in the Pennsuco wetlands. Both bucks and does have been seen. It is estimated that the area could support a maximum of 12 to 15 deer. The most recent deer sighting occurred during October 1995, when two does were seen three separate times during one week.

The Hispid cotton rat was trapped in P50, P75, and SDM, the Marsh rice rat was trapped in all cover types, and the Cotton mouse in SDM and DMM (Tab. 11). The cover type/habitat preferences of these three rodents observed in this study are similar to trapping results in mature dense melaleuca versus "mixed melaleuca-graminoid" (Mazzotti et al., 1981) and tree islands surrounded by sawgrass marsh (Smith and Vriese, 1979).

Red imported fire ants (RIFA)

The abundance of RIFA mounds was quantified on a quarterly basis (Tab. 12). The highest number of ground active mounds was found in P75, followed by P50 (Fig. 35). Ground active mounds were rare in DMM (1) and absent in Marsh. Fire ants avoid shaded conditions (such as close-canopy DMM cover type) as well as areas of high soil moisture content (such as the Marsh covertype). During five of the eight quarters, each of the randomly selected Marsh sites had standing water. During periods of standing water in the P50, P75 and SDM cover types, it was noted that at least some of the mounds moved into the bark of melaleuca trees.

Ground active fire ant mounds are known to have a detrimental effect on ground dwelling birds, such as Bobwhite quail, indirectly by affecting insect populations (Allen et al., 1993 and 1994). The effect of RIFA on other ground dwelling animals has not been well documented. However, on several occasions, we noted small herptiles (Oak toad, Southeastern five-lined skink, Red rat snake) devoured by RIFA. We also observed that RIFA mounds relocated into the bark of the melaleuca trees during periods of standing water. Of 83 trees surveyed in three separate P50 and P75 sites with standing water, 31 of the trees had active RIFA mounds in the bark. During this survey, we also observed a Southeastern five-lined skink, a Green anole, a Green treefrog and a Squirrel treefrog in the peeling bark of melaleuca trees. The fact that both RIFA and small herptiles seek refuge in melaleuca bark during periods of high water may diminish the ability of small herptiles to survive periods of high water.

TWENTY-FOUR MONTH CUMULATIVE RESULTS

When all sampling methods and incidental observations were considered, a cumulative number of 23,525 individuals of 160 species of **invertebrates and vertebrates** were trapped or observed in the five defined cover types during the 24 months of the study. Fishes accounted for 46% of all individuals (10,708 individuals of fishes). For the cumulative data set by cover types, the number of species and individuals, respectively, were:

Cover type	Species	Individuals
Marsh	94	4,936
P50	109	7,421
P75	115	5,121
SDM	103	3,555
DMM	98	2,492

Vertebrates have been the traditional classes of animals used in evaluating wildlife habitat value. Across all five cover types, 13,064 individuals of 129 species of vertebrates were trapped or observed during the 24 months of the study. For the cumulative data set by cover types, the number of species and individuals, respectively, of **vertebrate animals only** were:

Cover type	Species	Individuals
Marsh	73	2,664
P50	86	3,703
P75	88	3,259
SDM	84	1,841
DMM	79	1,597

The cumulative numbers of species and individuals of each vertebrate class are indicative of the species diversity of the study area relative to the southern Florida region. The cumulative numbers of species and individuals observed in all five defined cover types during the first 24 months of sampling were:

Class	Species	Individuals
Fishes	27	10,708
Amphibians	16	881
Reptiles	22	666
Birds	48	614
Mammals	16	195

The roadways, particularly the FPL right-of-way, levees and canals were frequently used by wading birds and larger aquatic vertebrates (turtles, alligators) that are less frequently trapped. Therefore the cumulative numbers of vertebrates observed or captured in the study area, including the defined cover types, roadways, levees and miscellaneous habitats, were pertinent:

Class	Species	Individuals
Fishes	30	10,737
Amphibians	16	942
Reptiles	27	983
Birds	92	3,678
Mammals	16	272

The FPL right-of-way, the mitigation areas along the Well field Canal, and the canals appeared to be focal points for birds, especially the duck-like swimmers, wading, and shore birds, using the region. Duck-like swimmers (coots and gallinules) use natural areas, but, since they quietly swim away rather than flush, it was difficult to detect the presence of these species on foot in dense vegetation. Furthermore, many smaller perching birds were detected using edges of DMM and SDM only during road surveys. Many of these species prefer thickets or edges.

State or Federal listed species

Species listed under either state or federal guidelines may require consideration in developing land use plans. The following species designations are current as of February 14, 1994 (Wood, 1994). Eleven listed species were observed in the LBSA (Tab. 13).

Endangered Species. The Wood stork is the only Endangered species observed in the LBSA. It is listed at both the State and Federal levels. Both adult and juvenile Wood storks were observed foraging in the shallow water impoundments along the FPL R/W, mitigation areas along the Dade-Broward Levee, and in P75. The highest number of individuals observed in one day was 53. These individuals were in a mixed species of flock of more than 300 wading birds foraging along the FPL R/W in April, 1995. The closest breeding rookery (1989 data) is located approximately 15 km to the west of the Lake Belt Study Area, on the eastern border (L67) of WCA 3A (Bancroft et al., 1990; Runde et al., 1991). This colony supported 125 nesting pairs of Wood storks. It also supported Great egrets, Snowy egrets, Tricolored herons, Little blue herons, and White ibis. Total number of active nests was estimated to be more than 2,000 (Bancroft et al., 1990).

Threatened Species. The American alligator was the only species listed as Threatened (Similarity of Appearance) at the Federal level that was observed. The alligator is listed as a Species of Special Concern at the state level (see definition below). It is listed at the federal level due to similarity of appearance to declining populations in the northern part of its range. The alligator was regularly observed in canals. Trails were frequently seen in P50 and Marsh. Four individuals that had been killed by gunshot were found. One of the animals had its tail removed. The Least tern is listed at the State level, but does not have any designation at the Federal level was seen on several occasions, foraging above a canal.

Other State Listed Species: Species of Special Concern. The State of Florida designates populations that are not currently Threatened or Endangered within the state yet have shown long term population declines and are considered either vulnerable to exploitation or environmental changes as Species of Special Concern (SSC).

Seven species listed as SSC have been observed in the LBSA. These species are: American alligator, Gopher tortoise, Snowy egret, Tricolor heron, Little blue heron, White ibis, and Roseate spoonbill. The American alligator was discussed above under Threatened Species. A single Gopher tortoise was found along a levee. The individual had been marked with paint, suggesting that it had been held in captivity. Suitable habitat for this species does not exist in the LBSA. The occurrence of this individual is anomalous. The remaining five species of wading birds seasonally forage within the LBSA. Traditional breeding rookeries are located to the west of the LBSA in Water Conservation Area 3A and 3B.

Other Federal Listed Species: Candidates (C1 and C2) and Under Review (UR). The US Fish and Wildlife Service designates species that are considered vulnerable as candidate species. Species for which there is sufficient evidence to warrant either Endangered or Threatened status are designated as C1. Species considered vulnerable yet requiring additional evidence to determine population status are designated as C2. Candidate species are not protected under the US Endangered Species Act. However, the USFWS "encourages their consideration in environmental planning" (US FR Vol 55, No. 35, pp. 6184-6229).

Three species designated C2 have been observed. These species are: Gopher tortoise, Island glass lizard, and Loggerhead shrike. The Gopher tortoise was discussed above as a State of Florida Species of Special Concern. The Island glass lizard was trapped on nine separate occasions in P50 and P75. This species does not have any designation at the State level. The Loggerhead shrike is a winter resident bird. It was observed in Marsh, P50, P75, SDM and along levees. This species does not have any designation at the state level.

Numbers of native and non-native species

During the 24 months of the study, 2,452 individuals of 20 species of non-native vertebrates were trapped or observed within the study area, including areas other than the five defined cover types. Eight of these 20 vertebrates were fishes (Black acara, Jewelfish, Pike killifish, Spotted tilapia, Oscar, Nicaraguan cichlid, Walking catfish, Peacock bass). We list the Peacock bass an a non-native species, yet this species is recognized by the Florida Game and Fresh Water Fish Commission as a game species and is a regulated species. Of the remaining 12 species, 5 were mammals (Black rat, Domestic cat, Domestic dog, House mouse, and Nine-banded armadillo), 4 were birds (Budgie, Muscovy duck, Eurasian collared-dove, European starling), 1 was a reptile (Brown anole), and 2 were amphibians (Cuban tree frog and Greenhouse frog). All but one of these non-native species are "Wetland Independent". The Cuban treefrog is the only non-native species which is "Seasonal Wetland" and has been trapped in DMM, SDM and P75.

When only the five defined cover types were considered, 2,377 individuals of 15 species of non-native fishes, amphibians, reptiles, birds, and mammals. The five species found only along levees were Peacock bass, Budgie, Muscovy duck, Eurasian collared-dove, and European starling. **The percentage of the 24 month cumulative numbers of species and individuals that are non-native was highest in DMM and SDM (Tab. 14).** The most abundant non-native animal was the Jewelfish (cichlid fish, 1,083 individuals), followed by the Black acara (cichlid fish, 686 individuals), Greenhouse frog (174 individuals), Brown anole (170 individuals) and the Pike killifish (111 individuals).

Habitat preference and species composition

Gross comparisons of the numbers of species or numbers of individuals found in each cover type did not yield significant differences among the cover types. However, multivariate analyses, which considered the contribution of each species to overall community composition, demonstrated differences between cover types. Indices of dispersion indicated that many faunal groups were distributed along a gradient other than melaleuca density. To assist in evaluating community composition in terms of hydrology, each species was categorized based upon their requirement for a particular, gross hydrologic pattern.

Macro-invertebrates and fishes were excluded from the wetland association analyses for two reasons. Firstly, most taxa in these groups are wetland dependent. Since large numbers of macro-invertebrates and fishes were trapped relative to all other faunal groups, their inclusion would swamp the analyses. Secondly, macro-invertebrates and fishes usually showed a positive correlation between the number of species and water levels. The objective of these analyses was to determine the relative quality of habitat based on the degree of melaleuca invasion, not water levels. Therefore, species groups that showed significant positive correlations with rising water level were more likely to confound the effects of melaleuca invasion and current hydrological patterns. In other words, it could be said that high numbers of species and, or individuals were related more to water levels than melaleuca density.

For the purpose of the analysis, species whose respiration, feeding mechanisms, reproduction or larval development require 9 to 12 months of standing water each year were termed **"wetland dependent"**. Species whose respiration, feeding mechanisms, reproduction or larval development require 1 to 9 months of standing water each year were termed **"seasonal wetland"**. Species whose respiration, feeding mechanism, reproduction or larval development are independent of standing water were termed **"wetland independent"**. Animals described as "wetland dependent" or "seasonal wetland" use upland habitats, but a population could not persist without suitable wetland habitat. Conversely, animals described as "wetland independent" use wetland habitats, but their life history traits allow them to survive and successfully breed outside of wetlands. The current assigned wetland association of each species of amphibian, reptile, bird and mammal is listed in Appendix IV. **Macro-invertebrates and fishes were excluded from the analyses.**

When the 24 month cumulative data for all sampling methods were considered, the occurrence of "wetland dependent" and "seasonal wetland" species of amphibians, reptiles, birds, and mammals was highest in Marsh (0% to 10% melaleuca) and lowest in SDM and DMM (75% to 100% melaleuca, either sapling or mature). In Marsh, wetland associated species accounted for 76% of the species and 91% of the individuals trapped or observed (Tab. 15). SDM and DMM had the lowest percentage of wetland associated species (42% and 41%, respectively) and individuals (44% and 44%, respectively). Observed vs. expected numbers for wetland and non-wetland individuals and species per cover type both showed significant differences. **There**

were fewer wetland and more non-wetland species occurring in the SDM and DMM cover types (chi squares = 75.23 and 245.17, df = 4 and 4, p's < 0.0001, respectively; Fig. 36).

The numbers of wetland dependent and seasonal (y-axis) versus numbers of non-wetland animals (x-axis) were plotted for each cover type (Fig. 37). Regardless of whether the graphical analysis considered numbers of species or individuals of wetland versus non-wetland taxa, the patterns were the same. As succession moved from Marsh to P50 and P75, there was a curvilinear (negative exponential) trend for increased numbers of non-wetland species without a decrease in numbers of wetland species. Once melaleuca density went above P75, wetland associated taxa decreased in both number and abundance. This indicated that the loss of wetland species habitat value did not occur until melaleuca density caused canopy closure (e.g. above 75% melaleuca coverage). The point at which the number of species or individuals of terrestrial taxa was equal to the number of wetland taxa was demarcated on the figures as straight lines from the origin of the graphs. This point was reached at or near P75, i.e. melaleuca densities of 75%. The trend of increased species diversity was typical of intermediate stages in disturbed or degraded ecosystems (Odum, 1983).

It is important to recognize that species categorized as "wetland dependent" or "wetland seasonal" may require dry areas or have a preference for water depth. In fact, most wetland-associated vertebrate animals are adapted to using water depths of less than 25 cm (Fredrickson and Laubhan, 1994). Breeding densities of typical marsh bird species have been correlated with standing water levels in other areas of the birds' ranges. Both the Common yellowthroat and the Eastern meadowlark generally have higher breeding densities when climatic conditions indicate low standing water levels during the breeding season (Cody, 1985). Similar information regarding Red-winged blackbird breeding density and water levels was not available. However, since it commonly forages on the ground, it would follow a similar trend. Summer peaks of breeding Common yellowthroats, Red-winged blackbirds or Eastern meadowlarks were less obvious in 1995 compared to 1994 (Fig. 38).

Wading bird use of the LBSA

Wading birds were most frequently seen during road surveys. Several wading bird rookeries exist in the eastern portion of Water Conservation Area 3 (Fig. 30). Wading birds appear to locate appropriate areas for foraging quickly, even at distances from roosting sites (Fredrickson and Laubhan, 1994). Average distance traveled daily from a rookery to suitable foraging habitat is approximately 10 km, but may range up to 35 km (Frederick and Collopy, 1988). Water depth appears to be one of the critical determinants for selecting foraging habitat. Smaller egrets and herons (Snowy, Little Blue) most effectively forage in water depths less than 15 cm; larger waders (Great Blue Heron, Great Egret) selectively forage in 15 to 30 cm of water (Fredrickson and Reid, 1986). Species breeding in these rookeries included the Great egret, Green heron, Great blue heron, and Anhinga (Runde et al., 1991).

With the exception of the Great blue heron, herons and egrets preferentially nest in willows. Additionally, most rookeries are surrounded by water, which apparently reduces nest predation by terrestrial mammals and snakes (Frederick and Collopy, 1988). There were only a few suitable willow heads in the LBSA large enough for a breeding colony. One of these was located at the junction of the Pennsuco Canal and the Dade-Broward Levee. Congregations of Black-crowned night herons were noted during the spring at this site. However it was not clear if a breeding rookery was established.

Great blue herons tend to nest alone or in groups of a few pairs. This species has been reported to nest in melaleuca trees (Frederick and Collopy, 1988). Anhingas have also been reported to nest in melaleuca heads surrounded by sawgrass marshes (Schortemeyer et al., 1981). Nesting attempts in melaleuca trees by Great blue herons or Anhingas were not observed in the LBSA.

SUCCESSIONAL TRENDS

Successional changes in vegetative structure and faunal implications

Melaleuca invasion of native prairies changes the vegetational structure of the landscape. It is unclear to what extent melaleuca invasion also changes the hydrological characteristics of an area. This study was designed to address only the impact of melaleuca coverage on wildlife diversity and abundance. Prior to the current study, the only information available was based upon either dense melaleuca stands only (Schortemeyer et al., 1981) or were short-term studies that considered only a few species (Mazzotti et al., 1981; Sowder and Woodall, 1985 Repenning, 1986).

As melaleuca coverage increases, a graminoid prairie with low structural diversity becomes a savannah (mix of open prairie and trees) with increased structural diversity. As melaleuca coverage continues to increase, the savannah becomes a closed canopy forest with sparse understory. Since little understory persists in the forest and most of the trees are of similar size, structural diversity of the forest is lower than existed in the savannah stage of melaleuca invasion. Some animals (e.g. many birds, c.f. Cody, 1985) select habitat based upon subtle differences in vegetational structure. However, other animals (e.g. amphibians and reptiles) are less sensitive to vegetative structure but select habitats based upon other characteristics (e.g. soil or hydrological characteristics; Campbell and Christman, 1982).

The results of this study demonstrated a higher diversity and abundance of birds in the cover types that have moderate levels of melaleuca coverage. As discussed above, these were the cover types with the greatest structural diversity. Notably absent from these areas, though, were resident bird species which are specific about the types of trees they use (e.g. Pine warbler). Many of the transient and winter-resident birds occurred at much lower abundances than in cypress swamps of the Big Cypress National Preserve or the uplands of Long Pine Key, Everglades National Park (GHD, personal observations).

In contrast to the birds, a similar diversity of amphibians and reptiles was found across all cover types. However, their abundances generally decreased in the closed-canopy melaleuca forest (DMM cover type). The lower abundances indicated poorer habitat quality. This was probably the result of the closed-canopy of the forest limiting the amount of sunlight reaching the water surface. With reduced sunlight, the algae forming the structure of the periphyton mat does not develop. Many species of amphibians and reptiles consume Crayfish, Grass shrimp, and smaller forage fishes, which depend upon a well-developed periphyton mat. However, complex patterns of hydrology, and gapping in forest canopy due to wind storms and fires permits light penetration and the persistence of productive pockets of aquatic life even within dense stands of melaleuca. Changes in both structural and wildlife diversity are summarized in Fig. 39.

Landscape effects

Melaleuca invasion of a graminoid marsh increases the patchiness of the habitat. An aerial view of the LBSA reflects the high degree of interspersion of vegetative cover types, particularly north of the Pennsuco Canal and along the southern border (C4 (Tamiami) Canal) *[In the final version of this report, Fig. 2 will be replaced by color plate of vegetation map produced by EAS Engineering and will be referenced at this point. Vegetation map was not available for inclusion in this report].* Cover types for wildlife sampling and vegetation mapping were defined by percent coverage by melaleuca. The spatial scale on which melaleuca coverage is defined is critical. Shifts in abundance of many plant and wildlife populations relate to the degree of canopy closure as well as hydrology. The impact of seedling or sapling melaleuca, which has little or no canopy, differs from that of mature melaleuca trees with the same percent coverage. It was for this reason that the original cover types were modified to include two coverages of 75% to 100% melaleuca (sapling versus mature).

The mosaic of prairies with low to moderate infestations of melaleuca surrounding mature dense melaleuca stands may allow higher numbers of individuals and species to persist in, or seasonally use, mature dense melaleuca stands. However, this factor was not explicitly considered in sampling. The only variable considered was melaleuca coverage. Random sampling of three replicates of each cover type per month did not permit testing of any variable other than melaleuca coverage. Further studies should address the effect of site location on animal abundance.

While the mosaic of habitats may contribute to the abundance of animals (particularly fishes and semi-aquatic herptiles) in dense melaleuca sites, it is unlikely that the Pennsuco marshes on the western edge of the area were the sole source of fishes and some fully aquatic herptiles (e.g. Greater siren, Two-toed amphiuma). Levees subdivide the LBSA along both north-south and east-west axis. These levees are dispersion barriers to fishes, and some fully aquatic herptiles. Therefore, some species are confined to isolated sub-basins, which sustain local populations. Abundance of Greater siren in a DMM site isolated from areas with lower melaleuca

coverages was a good example of this. The rapid rate at which fully aquatic herptiles and fishes exploited standing water in many sites indicated that deep water or subterranean refugia were available within each of the sub-basins.

Changes in species composition

The number of species (species richness) and the number of individuals (species abundance) are not, by themselves, a good measure of the environmental value of a habitat. Disturbance of natural communities typically results in an increase in species diversity as non-native, migratory and/or species uncommon to the natural community increase in numbers. A typical example of this was increased species diversity in areas with moderate levels of melaleuca coverage. This resulted primarily from native bird species atypical of graminoid prairies using the unnatural habitat created by melaleuca invasion. Which species are using a habitat and the manner is which they use the habitat (foraging, breeding) are more important to final evaluation of habitat quality (Stauffer and Best, 1980; Keller et al, 1993). A fair analysis of habitat quality would evaluate the types of species (e.g. wetland versus upland animals, native versus non-native), as well as their abundances.

As discussed earlier, the loss of wetland species habitat value did not occur until melaleuca density caused canopy closure (e.g. above 75% melaleuca coverage; Fig. 36, 37). The point at which the number of species or individuals of non-wetland taxa was equal to the number of wetland taxa was reached at or near P75, i.e. melaleuca densities of 75%. These graphs also demonstrated the non-linear rate of transition.

It is important to recognize that species categorized as "wetland dependent" or "wetland seasonal" may require dry areas or have a preference for water depth. In fact, most wetland-associated vertebrate animals are adapted to using water depths of less than 25 cm (Fredrickson and Laubhan, 1994). Species assigned to the same category may have different preferences with regard to timing, depth and duration of flooding. Fredrickson and Laubhan state (p. 645): **"No single wetland or wetland type will provide all the resources needed by a single vertebrate during all of its life-history stages or for all vertebrates adapted to wetlands. Thus, wetland complexes are essential for successful management.".**

There were two principal physical gradients in the Lake Belt Study Area environment: tree density and water levels. Tree density was a geographic gradient, with density varying primarily from east to west. Water level was primarily a temporal gradient, varying with seasonal rainfall.

The dominant characteristic of the faunal shifts along the gradient of increasing melaleuca coverage was increased numbers of upland, arboreal, and, or forest species, not the loss of wetland species. Analysis of the species that are most strongly tied to this gradient, indicated that degree of melaleuca cover causes original wetland habitat to become progressively suitable to non-wetland species at a faster rate, than it becomes unsuitable to wetland species. The result is a pattern of

increasing species diversity and abundance through the intermediate cover types. Increasing use of areas by savannah and forest birds, and mammals plays a significant role in creating this gradient.

The dominant characteristic of the faunal shifts along the gradient of water level was seasonal variation in abundance of wetland species. The majority of fully aquatic species (the aquatic macro invertebrates, all the fishes, and some herptiles, birds, and mammals) did use habitat with increased canopy cover, primarily as an effect of standing water. The existence of this prey base (invertebrates and forage sized fishes, in particular) permitted higher consumers to use these habitats.

Canopy closure occurred when melaleuca cover increased beyond 75%. This reduced sunlight penetration to the understory, and therefore reduced primary productivity of the periphyton and submerged macrophytes. This had a dramatic effect on the primary consumers and detritovore macroinvertebrates (e.g. apple snails, crayfish), resulting in overall lower abundance and productivity in the understory. However, complex patterns of hydrology, and gapping in forest canopy due to wind storms and fires permits light penetration and the persistence of productive pockets of aquatic life even within dense stands of melaleuca.

While it has been anecdotally noted in the literature that melaleuca invasion causes secondary increase in ground surface elevation, we observed little evidence of this in the study area. As the previous brief hydrological assessment has pointed out, most sites in the study area were flooded regularly according to existing patterns of rainfall, topography, and water management. Therefore, we have no evidence at this time that the gradients identified in species patterns were due to a ground surface elevation gradient. The wide variety of upland animals found in the area appeared to regularly use levees, embankments, roadways, naturally elevated spots, and trees as high water refugia.

Percent similarity in species composition

Using the species composition of the Marsh cover type as a standard for comparison for the other designated cover types, the percent of the species for each faunal group in each cover type that was the same as the species found in Marsh was calculated. For fishes and herptiles the four cover types shared between 50 and 70 percent of the Marsh species in common. The mammals showed similarities in species overlap with Marsh from 40 to 65 percent. The birds showed the greatest difference in species composition among cover types, with between 20 and 30 percent overlap in species composition to Marsh (Fig. 40).

In general, as melaleuca invasion progressed the fishes and herptiles retained a high degree of constancy in community composition. The fishes and herptiles moved along a gradient primarily dictated by standing water levels. Since the area had a very limited variation in topography, these faunal groups appeared to move in and out of local areas as water levels shift due to variation in topography, regardless of melaleuca

density. The birds showed the most dramatic shift from typical marsh inhabitants to progressively greater numbers of forest dwelling species. The mammals showed a progressive change from wetland to upland species as forest cover increased.

The percent of taxa that were found in each of the five cover types varied widely between faunal groups (Fig. 41). Eighty percent of the 10 invertebrate taxa trapped by drift fencing were found in each cover type. Only 2 of the 46 birds observed in strip transects were found in each cover type (Common yellowthroat and Palm warbler).

Multivariate analyses of changes in species composition

In order to clarify patterns of species use of the region, a large data set was developed based on the raw data sets. This large data set was constructed as a qualitative data set, i.e. presence/absence data entries (see methods section) of 133 taxa of macroinvertebrates, fishes, herptiles, birds, and mammals. The data set was empirically derived, i.e. it relied on actual recorded observations using standard methods rather than a subjective list of what should or might occur in a cover type. The data set was analyzed by cluster analysis, factor analysis and multidimensional scaling in order to determine what subsets of species best characterized cover types. These subsets drew species from all the taxonomic groups.

Cluster analysis of the 133 taxa's presence or absence in the five cover types using percent disagreement resulted in a tree diagram in which Marsh was first joined by an intermediate grouping of P50 and P75, and secondarily by the more distant grouping of SDM and DMM (Fig. 42).

The same pattern was seen in the plot of the first two principal components of the factor analysis (Fig. 43): a curvilinear pattern or gradient from Marsh through P50 and P75 to the dense coverages. Overall then, the gradients in community composition that were identified when each faunal group was analyzed separately were also seen when all faunal groups were analyzed simultaneously.

BIOLOGICAL CONSIDERATIONS IN DESIGNING A LAKE BELT PLAN

Natural lakes are absent from southern Florida below Lake Okeechobee, with the exception of Lake Traford, near Immokalee, in Collier County. Of the 3,191 named, natural Florida lakes, 88.6% are less than 200 acres, 8.2% are between 200 and 100 acres, and 3.2% are greater than 1,000 acres (Dickinson et al., 1982). Many of the existing rock-mined lakes are 200 to 300 acres in size, with the largest lake approximately 580 acres (data obtained through DERM). Most of the lakes proposed in the South Florida Limestone Mining Coalition (SFLMC) Lake Belt Plan are greater than 1,000 acres (data from map of plan presented July 1995). This makes it difficult to readily compare the community composition and dynamics of natural Florida lakes and lakes created by rock-mining.

The characteristics of the *existing* lakes and littoral zones are addressed in this and following sections. It is important to recognize that the major issues identified herein address the "Lake Belt Plan" proposed by the SFLMC at the Lake Belt Implementation Committee's Public Meeting in July 1995. This plan is a "working document" being evaluated by various government, public institutions, and the rock-mining industry. However, much of the substantive analysis and recommendations offered here deal with the scale of design important for maintaining biological values.

Many institutions evaluating the plan must be primarily concerned with how many acres of land become lakes, or how lakes affect water management. The following biological assessment is concerned with questions such as, "How does the size, shape, depth, and placement of lakes affect biological processes in and outside of the study area?" and, "To what degree can lakes and littoral zones replace or enhance local and regional biological communities and dynamics?". The evaluation and recommendations herein are intended to offer substantive information for a final study design that benefits the biological system.

The analyses and review of the literature are intended to identify features of a littoral and lake design that could enhance overall wetland value. The present situation should be interpreted as transitional to an improved long range design with improved ecotones between upland, shore and shallow habitat, and lakes. Comparison of the rock mined lakes and littoral system to natural systems is based on the review of Florida lakes by Williams et al (1985). Comparisons of the wetland characteristics of littoral and lake complexes draw heavily from reviews by Canfield and Hoyer (1992), Williams et al (1985), Fredrickson and Laubhan (1994), and the classic review by Weller (1982). (Bold face, italics, or underling were added to stress specific facts in the quotes used below).

In reviewing the dynamics and productivity of fisheries in Florida lakes, Williams et al (1985:56) state that **"In lakes, the principal habitat variables influencing fish populations are *basin morphology, lake trophic status, and development of rooted aquatic plant communities."* Numerous authors have identified this series of limnetic and littoral characteristics that are important in overall evaluation of lake systems.** A brief summary of findings is given below.

Lake basin morphology

In reviews of basin morphology, **mean depth, shoreline development, littoral zone slope, and surface area** are the most important factors affecting habitat availability.

The effect of **mean depth** of a lake was succinctly summarized by Williams et al (1985:57). "As shown in Table 3 [*included herein as Table 16*], the biomass of all groups of fish, especially sport fish, is higher in littoral areas than in open water. Most Florida lakes with mean depths of less than 30 feet (10 m) have abundant acreage of

littoral habitat for fish production. Florida lakes with mean depths greater than 30 feet (10 m) are generally unproductive sinkhole lakes."

Shoreline development, littoral zone slope and littoral zone area are interrelated. Williams et al (1985:57-58) defined and discussed shoreline development as follows: "The technical term "shoreline development", as used here, refers to the extent to which lake shoreline departs from the shape of a circle. Lakes which are more nearly circular when viewed from above have low shoreline development, whereas lakes which are elongate or have numerous coves, peninsulas, and islands have high shoreline development. As shoreline development increases, the amount of ecotonal area increases. Ecotone occur where two habitats types, such as vegetated littoral zone and open water, meet. They are characterized by a higher diversity of organisms resulting from the greater number of habitat types available in close proximity to each other. It has been demonstrated that shoreline development (the ratio of lake shoreline to surface area) is positively correlated with total standing crop of fish and sport fish harvest in reservoirs. **Lake surface area influences fish populations by simply increasing the quantity of available habitat, thereby increasing the total standing crop and potential harvest of fish. However, as surface area increases, the standing crop of fish per unit of surface area typically decreases. This is due to a proportionally greater increase in limnetic [*open water*] versus littoral zone habitat."**

Williams et al (1985:76) discussed the question of impacts from actual physical land area lost or altered during human activities, emphasizing the impacts of dredge and fill operations in wetland setting. "First, dredging and filling in wetlands along lake shorelines permanently destroys habitat vital to biological productivity and fishery resources. Shallow vegetated areas of lake systems are extremely important to the production of sport and forage fishes by serving as breeding, nursery, and refuge habitat. For example in Lake Tohopekaliga, water depths less than 15 centimeters supported a standing crop of small forage fishes and centrarchids in excess of 115 kg/ha with numbers exceeding 44,000,000 fish/ha [Wegener et al, 1973]. Similarly, Moyer and Williams [1982] have shown that emergent littoral zone vegetation supports a standing crop of 677 fish food organisms/m^3 as compared with 2 organisms/m^3 in nearby littoral areas dredged for small boat navigation channels. Since fish and invertebrate populations are reduced in proportion to the amount of habitat lost, the standing crop of fish and fish food organisms in a lake will decline in numbers similar to those reported above. Because these numbers represent standing crop only, the loss in terms of annual productivity per unit of lake area can be expected to be considerably higher."

Comparison of estimates of standing crop of forage fish per unit area for open marsh systems vs. small constant depth littoral zones can be misleading. Moreover, the estimates vary widely, and are significantly affected by sampling methods, and hydrological conditions (see Loftus and Eklund, 1994). Part of the problem with simplistic comparison of forage fish standing crops is that they do not include information on the actual availability to consumers, e.g. foraging wading birds. Wading

birds normally exploit forage fishes during periods of dry down, when the fishes are trapped in small puddles and pools of water at extremely high density. Such drying down currently does not exist for the rock mined lakes' littoral zones, which have a constant depth, and for which the adjoining deeper water of the lake can act as a temporary refuge from wading bird foraging. Canfield and Hoyer (1992:565-566) discussed lake characteristics with regard to wading bird use and state: "Because these birds can not wade in limnetic portions of a lake system, it is not surprising that mean depth values were not significantly related to bird abundance, and species richness. The width of the immediate shoreline that can be used by many wading birds, however, is potentially important. This width would be related to the slope of a lake system, out from the shoreline, which would determine the maximum depth at which many bird species could wade and forage for food. **The slope of a lake has also been related to patterns in aquatic macrophyte biomass and coverage (Canfield and Duarte 1988), *thus slope rather than shoreline development or mean depth may be the most important factor influencing bird abundance and species richness after the effects of trophic status are accounted for."*** They go on to say (p.580)... **"We also believe that near-shore terrestrial vegetation may be very important to bird populations using lakes because we observe the majority of birds near shoreline areas".**

Lake trophic status

William et al. (1985) state (p. 58): "Trophic status refers to the fertility of a lake and is a direct function of nutrient loading. Oligotrophic, nutrient-poor lakes, generally have littoral zone plant communities that provide habitat for sport and forage fish, but lack of nutrients inhibits production so that total biomass and potential harvest of fish is low. The low nutrient supply also inhibits phytoplankton production in open water areas, so that limnetic fish populations are severely limited."

Littoral zone development of rooted aquatic plant community

Williams et al (1985) point out that early in the eutrophication process there are benefits to fish populations and habitat conditions, but a point is reached where the system becomes degraded. Increasing nutrient loading eventually can lead to hypereutrophic conditions, with increased density of littoral plants (phytoplankton, and floating macrophyte, e.g. water hyacinth), decreased dissolved oxygen, increased phytoplankton turnover and development of mucky sediments, declines in sport and forage fish populations, increase in "rough fish" populations.

William et al give extensive details and reviews of habitat characteristic of lakes that are beneficial to forage fish, sport fish, and overall lake quality. They also emphasize the role of periodic "drawdowns", as have Weller (1982) and Fredrickson and Laubhan (1994) in improving overall quality of littoral zones for vegetative interspersion, habitat quality, forage fish populations, and habitat for sport fish nesting.

In discussing what they consider to be possibly the "most highly prized freshwater game fish in Florida", the largemouth bass, Williams et al state (p.62) that "Florida bass are largely oriented to the littoral zone, preferring shallow, highly vegetated areas. Blocknet samples taken from lake Kissimmee showed a littoral/limnetic population density ratio of 10:1 for harvestable sized bass (greater than 25 cm TL), while the littoral/limnetic density ratio for lake Tohopekaliga was 16:1 in 1977. Similar ratios for Lake Dora and Griffin were respectively 33:1 and 38:1 by number and 29:1 and 30:1 by weight."

Other perspectives on habitat characteristics beneficial to wetland animals

As pointed out by Weller (1982:943) in his classic paper on the management of freshwater marshes for wildlife, his two main objectives were "the preservation of marshes in a natural and esthetically pleasing state (with or without manipulation" and "to maintain high productivity of characteristic flora and fauna in marsh units."

Weller recognized the importance of the wide diversity of semi-aquatic and upland species that seasonally use and contribute to the productivity and diversity of wetland settings, especially water birds. He noted (p. 943) that "Commonly, marshes are viewed as basins that can be changed to a unit more productive of a single species or complex of species other than those found there at a given time." And he considered it important in both natural and artificial wetlands to maintain species diversity for overall health of the system.

He reviewed the literature on nesting by wetland birds and noted:

1. There was a positive correlation between the number of bird nests with the number of plant communities in marshes.

2. Many marsh birds nest near water-cover interfaces or the meeting of two cover type.

3. Most species favor marshes in a "hemimarsh" stage with a ratio of 1:1 cover-water interspersion.

4. The greatest species richness and greatest density of nests occurred where there was high interspersion of open water within the vegetated portions of marshes (ranging form 1:1 to 1:2 cover-water interspersion).

5. Marshes with a complex plant zonation also have several layers of vegetation (Fig. 44).

6. To preserve a typical marsh avifauna, it is best to have several wetland types, as well as upland areas present.

He also reviewed the importance of aquatic invertebrates and mammals in overall wetland function and concluded that **a healthy marsh is part of a wetland -**

upland complex that includes fully aquatic, semi-aquatic and upland species (e.g. herbivores such as nutria, deer, muskrat). He stated that (p. 945) "Stability seems deadly to marsh systems, at least where terrestrial or semiaquatic faunas are preferred to open marsh or lake faunas."

EVALUATION OF CURRENT DESIGNS FOR LAKES AND LITTORAL ZONES

The factors reviewed above were used to evaluate the current pattern of lakes in the study area as well as the SFLMC's proposed Lake Belt Plan. Several problem areas were identified. Each problem will be discussed, along with potential solutions to be considered in future designs.

Lake depths

Problem: The lakes are too deep (they are all greater than 30 feet (10 m) in depth (more often greater than 60 feet (20 m) in depth). Deep lakes are generally poor habitat for fishes in this region. Digging shallower lakes will have a negative overall impact, because more lakes will have to be dug to meet rock mined materials demand.

Solution: Little can be done on this variable if all future lakes must meet a single design plan. Therefore, development of two mining zones with different lake characteristics is recommended. This is discussed in further detail below.

Littoral zone width

Problem: Existing littoral zones are too narrow relative to lake surface area. Estimates of littoral area surrounding existing Florida lakes range widely, but the portion of a lake-littoral complex that is commonly littoral zone is between 10 and 30%. For a one square mile area, that is equivalent to 64 to 192 acres of littoral zone. The more area available to littoral zones, the more forage and sport fish will be available.

Solution: Littoral zones, of at least some lakes should be made wider, and approach 10 - 30% of the areal extent of the total lake littoral complex (see below).

Shoreline development

Problem: The current littoral zones have minimal shoreline development. They are a straight edge. As pointed out above, the greater the shoreline development the more productive the zone is.

Solution: The edges of at least some lakes should be designed to include greater variation in edge structure, such as coves and peninsulas.

Littoral zone depth and slope

Problem: The littoral zones lack zonation in depth and therefore vegetation. As pointed out above, littoral zones should make a gentle gradual transition form dry land to deep water. This permits seasonal changes in water depth, and seasonal changes in the percentage of area inundated.

Solution: The littoral zones should be dug to have a sloping gradient from waters edge to approximately about three feet (one meter). The degree of the slope will be determined by the width of the littoral zone. Littoral zone width would be determine by the size of the lake.

A preliminary estimate of littoral zone width is based on the following generalizations for healthy, natural systems. Firstly, a unit of marsh has about one-tenth the productivity of a unit of littoral zone (see Williams et al, 1985; Canfield and Hoyer, 1992; and information herein for some of the available estimates). Therefore, loss of a square mile (640 acres) of marsh requires a minimum of 64 acres of littoral productivity to compensate. This acreage could be distributed equally among all sides of the lake, unequally among some sides, or solely along one side of the lake. For simplicity of calculation, considered the 64 acres distributed along only one side of the lake. The littoral zone would then need to be one mile long and 1/10th mile wide (530 foot). Secondly, a natural and healthy littoral zone should have depths ranging from zero to three feet along a gentle slope. This would allow it to sustain an invertebrate and forage fish assemblage, a sport fish (large mouth bass) breeding and nursery habitat, depths suitable for wading bird and shorebird foraging habitat, and zonation of submerged and emergent macrophytes. Without depths suitable to wading bird foraging, productivity of macro-invertebrates and fishes would not be available to these consumers. Now take, for example, a square mile lake-littoral zone complex, with the littoral zone restricted to one edge of the lake. For a minimal littoral zone design of 10% of the lake-littoral area, the littoral zone would be a minimum of 1/10 th mile wide (530 feet or 175 m). To generate maximum depths of three feet, the slope of the littoral zone would be approximately one degree.

Interface to shoreward habitat

Problem : The littoral zones currently have little or no interface to upland habitat required by wetland seasonal, semi-aquatic, and upland species that normally use wetland edges. Currently, the littoral zones interface to either narrow roadway/levees or melaleuca invaded areas. The littoral zones should have some interface to upland habitat required by wetland seasonal, semi-aquatic, and upland species that normally use wetland edges. Future development of relatively narrow strips of land from what where originally haul roads, may be of use as greenways, and even as corridors for movement, but would be so limited in areal extent as to preclude maintenance of

populations of many species including white-tailed deer, bobcat, gray fox. There is almost no place for semi-aquatic and upland species to reside, bask, or lay eggs.

Solution: Plan to include sufficient acreage of land adjacent to lakes that can function as marsh and seasonally dry areas. Addition of native trees in these areas would benefit many bird species and semi-arboreal herptiles (treefrogs, some snakes). These areas will be especially critical to maintaining mammalian populations in the area.

ALTERNATIVES TO CURRENT CONDITIONS

With no action there will be continuing spread of melaleuca and decrease in habitat quality. Without changes to the exiting pattern of rock mining, there will continue to be a patchwork of varying formats or configurations of lakes with narrow, single depth littoral zones that will have limited mitigation value. Therefore, the "No Action" alternative will result in a continuing loss of wildlife habitat value.

The best alternative should include compartmentalization of mining activities. Within a region, mining should occur first in areas with the highest melaleuca density. In areas where little mining should occur (Pennsuco wetlands), melaleuca should be removed in order to prevent habitat degradation.

A three subregion alternative along an east-west gradient is suggested. The degree of rock-mining would differ between the regions. More importantly, lake configurations in the different regions would be determined by different criteria (e.g. maximize recovery of rock versus promote wildlife habitat). This approach is consistent with initial configurations being considered by SFWMD for hydrological modeling.

The region east of the existing FPL R/W would be an area of intensive rock mining. Lake configuration would be designed to maximize mining potential. Therefore, lakes would be dug to maximum depths, with minimal littoral zone designs, and, or on-site mitigations. Zone wide water management would be least harmful to habitat heterogeneity in this eastern "intense" management area. In the future, portions of this zone could be modified and opened to intense public recreational activities (such as sail and power boating activities) as agencies are inclined. The haul roads could be developed as a greenway that could serve public recreational needs (e.g. biking, hiking), and also serve as minimal wildlife corridors connecting to the western two thirds of the region.

The region between the existing FPL right of way and the Dade-Broward Levee would be a transition zone. Lake configuration would be designed to promote wildlife habitat. This would include shallower lake depths and maximum littoral zone development in terms of area, width, slope, and zonation. Areas with the greater than 75% melaleuca coverage should be preferentially mined. Mining should be minimized in areas with low to moderate melaleuca coverages. The results of this study have

demonstrated that they retain a full complement of native wetland species. Therefore, they would serve as a nearby-source of animals to populate the littoral zones. Provisions should also be made for maintaining or enhancing east-west corridors. The Dade-Broward levee or an equivalent area would serve as a north-south wildlife corridor, and would be of use by semi-aquatic species from both the Pennsuco Everglades and the central zone. Variations in water levels due to human management, could be localized on a year to year basis to increase variation in drawdown and or flooding, and therefore promote lake to lake heterogeneity (which is beneficial to lake system management for wildlife, see above).

The western region would be west of the Dade-Broward Levee (the Pennsuco Everglades). It would be maintained as a functional marsh with appropriate seasonal and annual variations in depth and duration of flooding. This region will act as a significant area of wetland for use by resident species, and as peripheral wetlands for wide ranging users, such as wading birds.

Since management goals are likely to change through time, the design should allow for flexibility in management approaches. The suggested plan would make it possible to implement a variety of management techniques. The following list of suggested management practices and, or principals should be considered (see Weller, 1982: 949-954):

1. System management, rather than species by species management, results in widespread benefits to all wildlife and plants.

2. Management to produce early plant successional stages results in longer lasting benefits, and creates diverse habitat niches.

3. For improved habitat heterogeneity in wetland complexes, all units in an area should not be managed in the same manner at the same time.

4. Wetland:upland ratios that preserve natural patterns and diversity should be used.

5. Natural or artificial simulation of drawdown, especially within subregions of the system will benefit productivity in marshes, littoral and limnetic zones (also see Kadlec, 1962; Meeks, 1969; Williams et al, 1985; and Fredrickson and Laubhan, 1994).

In addition, artificial habitat enhancements could be included. Numerous authors have discussed and recommended a variety of techniques to improve habitat value. Artificial **fish attractors** to improve sport fishing by anglers are currently popular in many Florida lakes and are managed by the Florida Game and Fresh water Fish Commission. But Williams et al (1985:102) emphasize that **"Their primary purpose is to concentrate existing fish populations to provide increased angler success and sportfish harvest, rather than increasing the biological productivity of a lake system."**

A number of additional actions that can be considered for wildlife habitat improvement include **native tree islands and littoral edge stands of willow, cypress, or pond apple** to improve ecotones between open water shoreline and marsh habitat. **Isolated island systems in lakes** with native macrophytes and trees to promote water and wading bird roosting, and breeding habitat that is isolated from human disturbance and mammalian predators (also see Hammond and Mann, 1956; Sargeant, 1982). **Points of land, isthmuses, or spits** of land along shorelines will be beneficial to overall productivity, habitat diversity, and maintenance of upland-wetland species requirements (cf. e.g. Newman and Griffin, 1994).

Once the regional implications of the various options for this region are interpreted in terms of private and public needs, many of the above suggestions could be integrated into the final configuration of the lake and littoral complex. The options listed above are only a preliminary list. They are readily attainable and should be recognized as opportunities to "fine tune" the ultimate lake and littoral designs. Hopefully, after the hydrological, economic, and social issues have been integrated into the analyses, the final plan developed for the Lake Belt Study Area will recognize and recommend that the existing biological resources of the area can be preserved and even enhanced.

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TABLES

TABLE 1. Wildlife study site descriptions. Approximate locations of all study sites have been located on the vegetation map of the Lake Belt produced by EAS Engineering.

COVER TYPE **DMM** 75% to 100% MATURE

DM-1. T52S-R39E Section 10*
DM-2. T52S-R39E Section 15*
DM-3. T52S-R39E Section 28*
DM-4. T52S-R39E Section 27
DM-5. T52S-R39E Section 33 north
DM-6. T52S-R39E Section 33 south
DM-7. T53S-R39E Section 12
DM-8. T53S-R39E Section 28 north
DM-9. T53S-R39E Section 28 south
DM-10. T54S-R39E Section 6

COVER TYPE **SDM** 75% to 100% SAPLING

DMS-1. T52S-R39E Section 10*
DMS-2. T52S-R39E Section 15* north
DMS-3. T52S-R39E Section 15* south
DMS-4. T52S-R39E Section 27
DMS-5. T53S-R39E Section 9
DMS-6. T53S-R39E Section 11
DMS-7. T53S-R39E Section 16
DMS-8. T53S-R39E Section 15
DMS-9. T54S-R39E Section 5 west
DMS-10. T54S-R39E Section 5 east

COVER TYPE **P75** 50% - 75% MELALEUCA

P75-1. T52S-R39E Section 22*
P75-2. T52S-R39E Section 28*
P75-3. T52S-R39E Section 27* south
P75-4. T52S-R39E Section 27 north
P75-5. T52S-R39E Section 34
P75-6. T53S-R39E Section 9
P75-7. T53S-R39E Section 16
P75-8. T53S-R39E Section 28
P75-9. Government Lot 6
P75-10. T54S-R39E Section 4

COVER TYPE **P50** 10% - 50% MELALEUCA

P50-1. T52S-R39E Section 29*
P50-2. T52S-R39E Section 28* west
P50-3. T52S-R39E Section 28* east
P50-4. T52S-R39E Section 27
P50-5. T52S-R39E Section 30
P50-6. T52S-R39E Section 34
P50-7. T53S-R39E Section 15
P50-8. T53S-R39E Section 31 north
P50-9. T53S-R39E Section 31 south
P50-10. T54S-R39E Section 4

COVER TYPE **MARSH** < 10% MELALEUCA

P-1. T52S-R39E Section 20*
P-2. T52S-R39E Section 20*
P-3. T52S-R39E Section 20*
P-4. T52S-R39E Section 17
P-5. T53S-R39E Section 7
P-6. T53S-R39E Section 18 north
P-7. T53S-R39E Section 18 south
P-8. T53S-R39E Section 19
P-9. T53S-R39E Section 30 north
P-10. T53S-R39E Section 30 south

Abbreviations correspond to cover type abbreviations on vegetation map.

* Indicates permanent trapping array at site.

TABLE 2. Summary of sampling frequency and requirements of each sampling procedure.

Method	Groups Sampled	Frequency	# Replicates
Dip nets	Invertebrates, Fishes, Amphibian tadpoles	monthly	3
Minnow traps	Invertebrates, Fishes, Amphibian tadpoles	monthly	1
Drift fences	Fishes, Amphibians, Reptiles, Small Mammals Macroinvertebrates	monthly	3
Faunal strip transects	Macroinvertebrates, Amphibians, Reptiles, Birds, Mammals (primarily by sign)	monthly	3
Strip transects	Birds	monthly	3
Road surveys	Amphibians, Reptiles, Birds, Mammals	monthly	1
RIFA	Red Imported Fire Ants mound counts	quarterly	3
Live trapping	Small size Mammals	quarterly	1
Bait and Scent stations	Medium to large size Mammals	quarterly	1

Method	Requirements
Dip nets	Five dips/site At least 1 sq. m of 1 inch standing water
Minnow traps	Fifteen traps/site ; sampled after 24 hrs in water At least 1 sq. m of 12 inches standing water
Drift fences	Four traps/site; checked four days/month
Faunal strip transects	100 m strip transect; fixed width of 10 m Less than 6 inches of standing water
Strip Transects	100 m transect; width varies with sighting distance
RIFA	0.10 hectare plots; three per site; cover types done in triplicate Requires no standing water
Live trapping	30 traps/site; sampled three consecutive nights Requires no standing water
Bait and Scent stations	One of each station/site; sampled three consecutive nights Requires no standing water

TABLE 3. Cumulative species list (presence/absence only) for the five cover types defined for wildlife sampling.

	MARSH	SERAL STAGE >>>>>	>>>>>	SAPLING	MATURE
	Marsh	P50	P75	MELALEUCA SDM	MELALEUCA DMM
Invertebrates					
Dragonflies					
Twilight darner					■
Halloween pennant	■	■	■	■	■
Eastern pondhawk	■	■	■	■	■
Golden-winged skimmer	■	■	■	■	■
Blue dasher	■	■	■	■	
Eastern amberwing		■	■		
Four-spotted pennant		■	■		
Corporal skimmer			■		■
Dragonfly nymphs	■	■	■	■	■
Damselfly nymphs	■		■	■	■
Butterflies					
Black swallowtail		■	■		
Buckeye	■		■		
Giant swallowtail		■	■		
Gulf fritillary	■	■	■	■	■
Little metalmark			■		
Orange julia long wing	■		■	■	■
Oval satyr		■			
Viceroy	■		■		
White peacock	■	■	■	■	
Zebra long wing			■	■	■
Snails					
Ram's horn snail	■	■	■	■	■
Common pond snail	■	■			
Paper shell snail	■	■	■	■	■
Columbian ram's horn snail*		■			
Apple snail	■	■	■	■	■
Other invertebrates					
Grass shrimp	■	■	■	■	■
Crayfish	■	■	■	■	■
Lethocerus (Hemiptera)	■	■	■	■	■
Dytiscid beetle	■	■	■	■	■
Gyrinid beetles	■	■	■	■	■
Lubber grasshopper	■	■	■	■	■
% MELALEUCA COVERAG	0% - 10%	10% - 50%	50% - 75%	75% - 100% SAPLING	75% - 100% MATURE

*Indicates exotic or domesticated species

TABLE 3. Cumulative species list (presence/absence only) for the five cover types defined for wildlife sampling.

	MARSH	SERAL STAGE >>>>>	>>>>>	SAPLING	MATURE
	Marsh	P50	P75	MELALEUCA SDM	MELALEUCA DMM
Fishes					
Gar	■		■		
Brown bullhead catfish			■		■
Yellow bullhead catfish					■
Walking catfish*		■	■	■	■
Sheepshead minnow	■				■
Golden topminnow	■	■	■	■	■
Marsh killifish	■	■	■	■	■
Flagfish	■	■	■	■	■
Bluefin killifish	■	■	■	■	■
Pike killifish*		■	■	■	■
Mosquito fish	■	■	■	■	■
Least killifish	■	■	■	■	■
Sailfin molly	■	■	■	■	■
Brook silverside	■				
Bluespotted sunfish	■	■			
Bluegill	■		■	■	
Dollar sunfish	■	■			
Redear sunfish	■	■	■	■	■
Spotted sunfish	■	■		■	■
Large-mouth bass	■	■			
Swamp darter	■		■	■	
Warmouth	■	■	■	■	■
Spotted tilapia*		■	■		■
Oscar*	■			■	■
Jewelfish*	■	■	■	■	■
Black acara*	■	■	■	■	■
Nicaraguan cichlid*	■	■	■	■	■
% MELALEUCA COVERAG	0% - 10%	10% - 50%	50% - 75%	75% - 100% SAPLING	75% - 100% MATURE

*Indicates exotic or domesticated species

TABLE 3. Cumulative species list (presence/absence only) for the five cover types defined for wildlife sampling.

	MARSH	SERAL STAGE >>>>>	>>>>>	SAPLING MELALEUCA	MATURE MELALEUCA
	Marsh	P50	P75	SDM	DMM
Amphibians					
Greater siren	■	■	■	■	■
Dwarf siren		■			
Amphiuma	■	■	■	■	■
Peninsula newt	■		■	■	■
Southern toad	■			■	■
Oak toad	■	■	■	■	■
Eastern narrowmouth toad		■	■	■	■
Greenhouse frog*			■	■	■
Florida chorus frog		■			
Little grass frog	■	■			
Southern cricket frog	■	■	■		■
Green treefrog	■	■	■	■	■
Squirrel treefrog	■	■	■	■	■
Cuban treefrog*			■	■	■
Southern leopard frog	■	■	■	■	■
Pig frog	■	■	■	■	■
Reptiles					
Alligator	■	■			
Striped mud turtle	■	■	■	■	■
Florida redbelly turtle	■	■			
Snapping turtle	■	■	■		
Florida box turtle			■	■	■
Florida softshell turtle	■	■		■	
Brown anole*	■	■	■	■	■
Green anole	■	■	■	■	■
Island glass lizard		■	■		
Five-lined skink		■	■	■	■
Florida water snake	■	■	■	■	■
Florida green water snake		■	■	■	■
Striped crayfish snake	■	■	■	■	■
Eastern garter snake	■	■	■	■	■
Peninsula ribbon snake	■	■	■	■	■
Ringneck snake	■			■	■
Mud snake		■	■		
Black racer	■	■	■	■	■
Red rat snake		■	■	■	■
Yellow rat snake					■
Florida kingsnake		■	■		
Cottonmouth	■	■	■	■	■

*Indicates exotic or domesticated species

TABLE 3. Cumulative species list (presence/absence only) for the five cover types defined for wildlife sampling.

	MARSH	SERAL STAGE >>>>> >>>>>		SAPLING	MATURE
	Marsh	P50	P75	MELALEUCA SDM	MELALEUCA DMM
Birds					
Double-crested cormorant					
Mottled duck	■				
Great blue heron	■	■	■	■	
Little blue heron		■	■		
Tricolor heron		■	■		
Great egret	■	■			
Green heron	■	■	■	■	■
Wood stork			■		
Common moorhen	■				
Common snipe	■	■	■		
Marsh hawk	■		■		
Red-shouldered hawk			■	■	■
American kestrel				■	
Common nighthawk	■		■	■	■
Belted kingfisher		■	■		
Red-bellied woodpecker		■	■	■	■
Yellow bellied sapsucker					■
Downy woodpecker		■	■	■	
Yellowshafted flicker		■	■		
Ground dove		■			
Mourning dove		■			
Great crested flycatcher				■	
Eastern phoebe		■	■		
Western kingbird		■			
Bluejay		■	■	■	■
House wren			■		
Blue-gray gnatcatcher		■	■	■	■
Carolina wren			■	■	■
Gray catbird			■	■	■
Mockingbird	■	■	■	■	■
Loggerhead shrike	■	■	■	■	
White eye vireo				■	
Northern parula warbler			■	■	■
Yellow rumped warbler		■	■	■	
Prairie warbler			■	■	
Palm warbler	■	■	■	■	■
Black&white warbler				■	■
American redstart				■	■
Common yellowthroat	■	■	■	■	■

TABLE 3. Cumulative species list (presence/absence only) for the five cover types defined for wildlife sampling.

	MARSH	SERAL STAGE >>>>>	>>>>>	SAPLING	MATURE
	Marsh	P50	P75	MELALEUCA SDM	MELALEUCA DMM
Birds					
Yellow-breasted chat		■	■		
Swamp sparrow	■				
Red-winged blackbird	■	■		■	
Boat-tailed grackle	■	■	■	■	
Common grackle		■		■	
Meadowlark	■	■	■		
Summer tanager					■
Cardinal		■	■	■	■
Rufous-sided towhee		■	■	■	
Mammals					
Virginia opossum	■	■	■	■	■
Southern short-tailed shrew				■	
Hispid cotton rat		■	■	■	■
Marsh rice rat	■	■	■	■	■
Cotton mouse				■	■
House mouse*					■
Black rat*					■
Raccoon	■	■	■	■	■
Nine-banded armadillo*				■	■
Marsh rabbit	■	■	■	■	■
Gray fox			■	■	■
Domestic dog*	■	■	■	■	■
Bobcat		■	■	■	■
Domestic cat*					■
River otter	■				
White-tailed deer	■	■	■	■	■

*Indicates exotic or domesticated species

% MELALEUCA COVERAG	0% - 10%	10% - 50%	50% - 75%	75% - 100% SAPLING	75% - 100% MATURE

TABLE 4. Dip net results by cover type. Twenty-four month cumulative results.

*Indicates exotic species

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Invertebrates					
Damselfly nymph	2	-	5	6	2
Dragonfly nymph	5	2	2	2	3
Giant water bug	4	3	5	-	-
Dytiscid beetles	3	5	2	-	1
Ram's horn	3	-	2	2	5
Papershell snail	-	-	-	5	-
Apple snail	1	1	1	-	-
Grass shrimp	91	35	24	23	2
Crayfish	13	41	60	16	14
Fishes					
Golden topminnow	5	11	18	2	-
Marsh killifish	5	2	12	5	1
Flagfish	35	15	7	10	-
Bluefin killifish	39	15	4	17	1
Pike killifish*	-	1	1	2	-
Mosquito fish	467	300	220	290	179
Least killifish	115	38	8	5	-
Sailfin molly	51	27	34	24	7
Bluespotted sunfish	-	1	-	-	-
Warmouth	2	-	-	-	-
Redear sunfish	1	-	4	8	-
Swamp darter	1	-	-	-	-
Oscar*	-	-	-	1	-
Jewelfish*	3	-	1	-	1
Black acara*	2	1	14	4	1
Spotted tilapia*	-	-	2	-	-
Amphibians & Reptiles					
Southern leopard frog	-	-	-	-	1
Pig frog	-	-	1	-	-
Striped crayfish snake	-	1	-	-	-
Number of species	20	17	21	17	13
Number of individuals	848	499	427	422	218

	Across all five cover types ## Species	## Individuals
Invertebrates	9	391
Fishes	16	2020
Amphibians & Reptiles	3	3
Total	28	2414

TABLE 5. Minnow trap results by cover type. Twenty-four month cumulative results.

*Indicates exotic species	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Invertebrates					
Dragonfly nymph	1	-	-	-	-
Giant water bug	6	-	3	4	1
Dytiscid beetles	4	5	1	10	3
Ram's horn	-	-	-	2	-
Papershell snail	-	-	-	5	-
Apple snail	3	-	-	-	2
Grass shrimp	5	-	2	5	3
Crayfish	13	42	53	20	30
Fishes					
Golden topminnow	9	6	2	2	2
Marsh killifish	-	11	9	7	2
Flagfish	16	5	4	6	-
Pike killifish	-	-	-	1	-
Mosquito fish	19	17	32	19	13
Least killifish	3	1	-	-	-
Sailfin molly	1	1	3	4	1
Bluegill	-	-	-	2	-
Redear sunfish	-	2	2	-	-
Jewelfish*	-	2	8	-	4
Black acara*	1	-	-	2	2
Amphibians & Reptiles					
Greater siren	-	1	-	2	1
Two-toed amphiuma	-	-	-	-	1
Peninsula newt	-	-	1	1	-
Squirrel treefrog	-	-	-	-	2
Southern leopard frog	-	2	1	2	2
Pig frog	-	2	-	-	5
Florida water snake	1	-	-	-	1
Peninsula ribbon snake	-	-	-	1	-
Black racer	-	-	-	1	-
Number of species	13	13	13	19	17
Number of individuals	82	97	121	96	75

	Across all five cover types ## Species	## Individuals
Invertebrates	8	223
Fishes	11	221
Amphibians & Reptiles	9	27
Total	28	471

TABLE 6. Drift fence trapping results by each replicate. Twenty-four month cumulative results.

	Marsh 0% - 10% 24 month cum.			P50 10% - 50% 24 month cum.			P75 50% -75% 24 month cum.			SDM >75% Sapling 24 month cum.			DMM >75% Mature 24 month cum.		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Invertebrates															
Dragonfly nymph	12	6	2	—	1	8	—	—	—	1	3	—	1	—	1
Lubber	4	14	1	3	—	—	—	1	—	15	3	5	4	4	4
Giant water bug	6	9	15	1	66	87	66	40	39	9	17	39	4	1	17
Dytiscid beetles	7	25	7	7	84	86	78	68	52	17	12	45	5	5	14
Gyrinid beetles	—	—	—	—	—	—	—	4	—	2	—	1	—	1	1
Ram's horn	—	1	5	—	4	14	3	1	6	—	—	1	—	—	1
Papershell snail	—	6	—	—	1	1	1	1	3	1	—	1	5	—	1
Apple snail	2	11	4	1	—	1	3	—	2	1	—	—	1	6	6
Grass shrimp	295	748	690	459	3	19	4	5	10	319	9	17	130	19	1
Crayfish	68	67	50	104	626	1896	763	352	94	136	243	669	124	292	153
Fishes															
Gar	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
Yellow bullhead catfish	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Brown bullhead catfish	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—
Walking catfish	—	—	—	1	—	3	1	—	1	—	1	—	—	2	3
Sheepshead minnow	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Golden topminnow	30	29	34	76	29	35	33	16	14	4	—	34	—	—	3
Marsh killifish	32	43	16	99	62	80	85	164	132	37	118	121	26	11	12
Flagfish	79	43	40	99	55	53	6	17	75	1	7	11	25	—	13
Bluefin killifish	18	11	10	7	4	2	1	—	12	1	1	2	1	7	9
Pike killifish	—	—	—	—	—	—	—	12	—	43	3	31	10	—	—
Mosquito fish	296	264	281	264	598	556	344	130	429	35	17	98	81	10	400
Least killifish	3	12	2	4	2	—	—	5	10	—	—	—	—	3	—
Sailfin molly	16	46	50	39	82	62	38	24	113	1	1	—	2	1	30
Brook silverside	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Bluespotted sunfish	1	2	2	3	1	—	—	—	—	—	—	—	—	—	—
Warmouth	1	1	—	1	2	5	—	2	2	1	1	5	—	2	2
Bluegill	2	1	1	—	—	—	1	—	1	1	—	1	—	—	—
Dollar sunfish	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Redear sunfish	11	3	10	11	6	5	33	3	5	—	1	8	1	4	6
Spotted sunfish	3	5	1	3	—	—	—	—	—	—	—	1	—	1	—
Large mouth bass	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—
Swamp darter	1	—	—	—	—	—	—	1	—	3	—	—	—	—	—
Oscar	—	19	—	—	—	—	—	—	—	—	—	—	—	2	—

DOC#614

TABLE 6. Drift fence trapping results by each replicate. Twenty-four month cumulative results.

	Marsh 0% - 10% 24 month cum.			P50 10% - 50% 24 month cum.			P75 50% -75% 24 month cum.			SDM >75% Sapling 24 month cum.			DMM >75% Mature 24 month cum.		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Jewelfish*	6	19	7	15	132	148	150	234	96	18	18	133	7	35	41
Black acara*	5	5	13	12	135	80	41	42	36	10	5	105	42	102	23
Nicaraguan cichlid*	8	2	2	—	2	2	1	—	3	1	2	34	3	1	1
Spotted tilapia*	—	—	—	—	1	—	—	—	3	—	—	—	—	1	—
Amphibians															
Dwarf siren	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Greater siren	2	1	2	5	—	2	3	—	3	2	7	11	—	22	—
Two-toed amphiuma	2	—	1	1	4	10	4	3	3	3	6	8	—	1	4
Peninsula newt	—	2	1	—	—	—	—	—	1	—	—	—	—	3	—
Southern toad	7	2	—	—	—	—	—	—	—	—	1	3	—	—	4
Oak toad	2	—	—	—	6	9	6	24	5	15	10	12	2	—	3
Eastern narrowmouth toad	1	1	—	—	3	—	—	5	6	14	—	3	8	1	—
Greenhouse frog*	—	—	—	—	—	—	1	2	1	109	—	1	41	10	2
Florida chorus frog	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Little grass frog	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Southern cricket frog	—	4	1	—	2	2	1	3	—	—	—	—	—	1	—
Green treefrog	—	1	—	1	—	—	—	—	—	2	—	—	—	2	5
Squirrel treefrog	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—
Cuban treefrog	—	—	—	—	—	—	2	—	—	2	1	—	—	2	3
Southern leopard frog	13	9	3	15	16	15	34	15	15	9	6	19	17	13	19
Pig frog	5	4	2	12	8	7	14	2	7	—	1	6	—	—	7
Reptiles															—
Striped mud turtle	7	5	8	2	1	4	1	1	3	—	—	—	1	1	1
Florida box turtle	—	—	—	—	—	—	1	—	1	—	1	—	—	1	1
Florida snapping turtle	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—
Brown anole*	1	—	—	6	—	—	1	7	—	6	4	6	25	10	17
Green anole	5	1	—	5	—	—	—	2	3	—	—	1	—	—	—
Island glass lizard	—	—	—	1	4	2	1	1	—	—	—	—	—	—	—
Five-lined skink	—	—	—	—	—	1	—	12	—	—	3	—	—	1	—
Florida water snake	6	2	4	2	1	3	3	8	4	2	2	5	1	1	2
Florida green water snake	19	8	7	15	4	11	2	1	6	1	5	7	—	3	—
Striped crayfish snake	10	4	—	2	4	9	1	1	2	—	1	2	—	1	—
Eastern garter snake	2	—	—	—	5	3	8	6	3	4	2	3	—	6	1
Peninsula ribbon snake	—	1	1	1	1	2	3	5	3	3	4	2	4	2	1
Southern ringneck snake	1	—	—	—	—	—	—	—	—	1	—	—	—	1	—

DOC#614

TABLE 6. Drift fence trapping results by each replicate. Twenty-four month cumulative results.

	Marsh 0% - 10% 24 month cum.			P50 10% - 50% 24 month cum.			P75 50% -75% 24 month cum.			SDM >75% Sapling 24 month cum.			DMM >75% Mature 24 month cum.		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Mud snake	—	—	—	—	—	3	1	1	2	—	—	—	—	—	—
Black racer	—	—	1	2	1	—	4	6	1	1	4	7	1	2	1
Red rat snake	—	—	—	—	2	—	—	2	—	—	—	1	—	1	—
Florida kingsnake	—	—	—	—	2	—	2	—	1	—	—	—	—	—	—
Cottonmouth	—	1	—	1	1	3	2	2	8	—	—	3	—	—	4
Mammals															
Southern short-tailed shrew	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Hispid cotton rat	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
Marsh rice rat	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
All animals															
Number of species	40	40	37	39	39	36	41	42	45	38	35	40	28	45	39
Number of individuals	991	1,438	1,278	1,284	1,962	3,229	1,748	1,232	1,220	832	521	1,463	573	598	818
Trap rate	6.19	8.99	7.99	8.03	12.26	20.18	10.93	7.70	7.63	5.20	3.26	9.14	3.58	3.74	5.11
Amphibians & Reptiles only															
Number of species	15	15	13	17	18	16	22	22	20	16	16	18	10	21	16
Number of individuals	83	46	33	73	66	86	96	110	78	175	58	100	101	85	75
Trap rate	0.52	0.29	0.21	0.46	0.41	0.54	0.60	0.69	0.49	1.09	0.36	0.63	0.63	0.53	0.47

Trap rate = (Number of individuals)/(Number of days array opened)
Over the two year period, each array was open for 160 days.

DOC#614

TABLE 7. Drift fence trapping results by cover type, with triplicates per cover type. Twenty-four month cumulative results

*Indicates an exotic species	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Invertebrates					
Dragonfly nymph	20	9	-	4	2
Lubber	19	3	1	23	12
Giant water bug	30	154	145	65	22
Dytiscid beetles	39	177	198	74	24
Gyrinid beetles	-	-	4	3	2
Ram's horn	6	18	10	1	1
Papershell snail	6	2	5	2	6
Apple snail	17	2	5	1	13
Grass shrimp	1733	481	19	345	150
Crayfish	185	2626	1209	1048	569
Fishes					
Gar	-	-	2	-	-
Yellow bullhead catfish	-	-	-	-	1
Brown bullhead catfish	-	-	1	-	1
Walking catfish	-	4	2	1	5
Sheepshead minnow	1	-	-	-	1
Golden topminnow	93	140	63	38	3
Marsh killifish	91	241	381	276	49
Flagfish	162	207	98	19	38
Bluefin killifish	39	13	13	4	10
Pike killifish	-	-	12	77	17
Mosquito fish	841	1418	903	150	491
Least killifish	17	6	15	-	3
Sailfin molly	112	183	175	2	33
Brook silverside	1	-	-	-	-
Bluespotted sunfish	5	4	-	-	-
Warmouth	2	8	4	7	4
Bluegill	4	-	2	2	-
Dollar sunfish	1	1	-	-	-
Redear sunfish	24	22	41	9	11
Spotted sunfish	9	3	-	1	1
Large mouth bass	1	1	-	-	-
Swamp darter	1	-	1	3	-
Oscar	19	-	-	-	2
Jewelfish*	32	295	480	169	83
Black acara*	23	227	119	150	167
Nicaraguan cichlid*	12	4	4	7	5
Spotted tilapia*	-	1	3	-	1
Amphibians					
Dwarf siren	-	1	-	-	-
Greater siren	5	7	6	20	22
Two-toed amphiuma	3	15	10	17	5
Peninsula newt	3	-	1	-	3
Southern toad	9	-	-	4	4
Oak toad	2	15	35	37	5
Eastern narrowmouth toad	2	3	11	17	9
Greenhouse frog*	-	-	4	110	53
Florida chorus frog	-	1	-	-	-
Little grass frog	1	-	-	-	-
Southern cricket frog	5	4	4	-	1

TABLE 7. Drift fence trapping results by cover type, with triplicates per cover type. Twenty-four month cumulative results

*Indicates an exotic species	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Green treefrog	1	1	-	2	7
Squirrel treefrog	-	-	1	1	1
Cuban treefrog	-	-	2	3	5
Southern leopard frog	25	46	64	34	49
Pig frog	11	27	23	7	7
Reptiles					
Striped mud turtle	20	7	5	-	3
Florida box turtle	-	-	2	1	2
Florida snapping turtle	1	1	1	-	-
Brown anole*	1	6	8	16	52
Green anole	6	5	5	1	-
Island glass lizard	-	7	2	-	-
Five-lined skink	-	1	12	3	1
Florida water snake	12	6	15	9	4
Florida green water snake	34	30	9	13	3
Striped crayfish snake	14	15	4	3	1
Eastern garter snake	2	8	17	9	7
Peninsula ribbon snake	2	4	11	9	7
Southern ringneck snake	1	-	-	1	1
Mud snake	-	3	4	-	-
Black racer	1	3	11	12	4
Red rat snake	-	2	2	1	1
Florida kingsnake	-	2	3	-	-
Cottonmouth	1	5	12	3	4
Mammals					
Southern short-tailed shrew	-	-	-	1	-
Hispid cotton rat	-	-	1	-	1
Marsh rice rat	-	-	-	1	-
All animals					
Number of species	53	53	57	52	57
Number of individuals	3,707	6,475	4,200	2,816	1,989
Trap rate	7.72	13.49	8.75	5.87	4.14
Amphibians and Reptiles only					
Number of species	23	26	28	24	26
Number of individuals	162	225	284	333	261
Trap rate	0.34	0.47	0.59	0.69	0.54

	Across all cover types ## Species	## Individuals
Invertebrates	10	9,490
Fishes	27	8,428
Amphibians	16	771
Reptiles	18	494
Mammals	3	4
Total	74	19,187

TABLE 8. Faunal transects for observations of invertebrates, herptiles, and mammal sign (track and/or scat) by cover types. Twenty-four month cumulative results **Data is presence (+) or absence (-) only.**

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Butterflies & Dragonflies					
Black swallowtail	-	+	+	-	-
Blue dasher	+	+	+	+	-
Buckeye	+	-	+	-	-
Corporal skimmer	-	-	+	-	+
Eastern amberwing	-	+	+	-	-
Eastern pondhawk	+	+	+	+	+
Fourspotted pennant	-	+	+	-	-
Giant swallowtail	-	+	+	-	-
Golden-winged skimmer	+	+	+	+	+
Gulf fritillary	+	+	+	+	+
Halloween pennant	+	+	+	+	+
Little metalmark	-	-	+	-	-
Orange julia long wing	+	-	+	+	+
Oval satyr	-	+	-	-	-
Twilight darner	-	-	-	-	+
Viceroy	+	-	+	-	-
White peacock	+	+	+	+	-
Zebra long wing	-	-	+	+	+
Other Invertebrates					
Lubber	-	+	+	-	+
Giant water bug	+	+	+	-	-
Dytiscid beetles	+	+	-	+	-
Gyrinid beetles	+	+	+	+	+
Ram's horn	+	+	+	+	-
Common pond snail	+	+	-	-	-
Columbian ram's horn	-	+	-	-	-
Apple snail	+	+	+	+	-
Grass shrimp	+	+	+	-	-
Crayfish	+	+	+	+	+
Fishes					
Mosquito fish	-	+	-	-	-
Amphibians					
Oak toad	-	+	+	+	+
Greenhouse frog	-	-	+	+	+
Little grass frog	+	+	-	-	-
Southern cricket frog	+	+	-	-	-
Green treefrog	+	+	+	+	+
Squirrel treefrog	+	+	+	-	+
Cuban treefrog	-	-	-	-	+
Southern leopard frog	+	+	+	+	-
Pig frog	+	+	+	-	+
Reptiles					
American alligator	+	+	-	-	-
Striped mud turtle	+	+	+	+	-
Florida box turtle	-	-	+	+	+
Florida redbelly turtle	+	+	-	-	-

TABLE 8. Faunal transects for observations of invertebrates, herptiles, and mammal sign (track and/or scat) by cover types. Twenty-four month cumulative results **Data is presence (+) or absence (-) only.**

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Florida snapping turtle	+	+	-	-	-
Florida softshell turtle	+	+	-	+	-
Brown anole	+	+	+	+	+
Green anole	+	+	+	-	+
Florida water snake	+	+	+	-	-
Black racer	+	+	+	+	+
Florida kingsnake	-	-	+	-	-
Cottonmouth	+	+	+	-	-
Birds					
Great blue heron	+	-	-	+	-
Green heron	+	-	-	-	+
Mottled duck	+	-	-	-	-
Red-shouldered hawk	-	-	+	+	+
Common snipe	-	+	+	-	-
Common nighthawk	-	-	+	+	+
Red-bellied woodpecker	-	-	+	-	+
Downy woodpecker	-	-	-	+	-
Bluejay	-	-	-	+	+
Mockingbird	+	-	+	+	+
Blue-gray gnatcatcher	-	-	-	+	-
Palm warbler	-	-	-	+	-
Common yellowthroat	+	+	-	-	-
American redstart	-	-	-	-	+
Meadowlark	-	+	+	-	-
Red-winged blackbird	+	+	-	+	-
Boat tailed grackle	+	-	+	+	-
Mammals					
Nine-banded armadillo	-	-	-	+	+
Marsh rabbit	+	+	+	+	+
Raccoon	+	+	+	+	+
River otter	+	-	-	-	-
Gray fox	-	-	+	+	+
Domestic dog	+	+	+	+	+
Bobcat	-	+	+	+	+
Domestic cat	-	-	-	-	+
White-tailed deer	+	+	+	+	+

TABLE 8. Faunal transects for observations of invertebrates, herptiles, and mammal sign (track and/or scat) by cover types. Twenty-four month cumulative results **Data is presence (+) or absence (-) only.**

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Number of species					
Invertebrates	17	21	23	13	11
Fishes	-	1	-	-	-
Amphibians	6	7	6	4	6
Reptiles	10	10	8	5	4
Birds	7	4	7	10	7
Mammals	5	5	6	7	8
Total	45	48	50	39	36

	Across all five cover types
Number of species	
Invertebrates	28
Fishes	1
Amphibians	9
Reptiles	12
Birds	17
Mammals	9
Total	76

TABLE 9. Bird strip transect results by cover type, with triplicates per cover type. Twenty-four month cumulative results. Transects were fixed length of 100 meters, variable width.

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Double crested cormorant	1	-	-	-	-
Great blue heron	1	1	2	-	-
Green heron	3	1	1	1	-
Little blue heron	-	2	1	-	-
Great egret	3	6	-	-	-
Tricolor heron	-	1	1	-	-
Wood stork	-	-	1	-	-
Red-shouldered hawk	-	-	2	-	-
Marsh hawk	1	-	-	-	-
American kestrel	-	-	-	1	-
Common moorhen	1	-	-	-	-
Common snipe	5	1	1	-	-
Mourning dove	-	1	-	-	-
Ground dove	-	1	-	-	-
Common nighthawk	2	-	1	-	-
Belted kingfisher	-	2	2	-	-
Yellowshafted flicker	-	-	4	-	-
Red-bellied woodpecker	-	1	3	1	3
Yellow-bellied sapsucker	-	-	-	-	2
Downy woodpecker	-	1	1	1	-
Western kingbird	-	1	-	-	-
Great crested flycatcher	-	-	-	2	-
Eastern phoebe	-	4	1	-	-
Bluejay	-	1	5	5	5
House wren	-	-	1	-	-
Carolina wren	-	-	1	4	13
Mockingbird	-	1	5	-	-
Gray catbird	-	-	2	3	-
Blue-gray gnatcatcher	-	3	7	7	2
Loggerhead shrike	1	3	6	1	-
White eye vireo	-	-	-	1	-
Black white warbler	-	-	-	1	2
Northern parula warbler	-	-	1	2	-
Yellow rumped warbler	-	2	18	4	-
Prairie warbler	-	-	10	4	-
Palm warbler	2	11	22	13	9
Common yellowthroat	57	20	12	4	2
Yellowbreasted chat	-	1	1	-	-
American redstart	-	-	-	3	-
Meadowlark	8	26	28	-	-
Red-winged blackbird	47	11	-	1	-
Boat tailed grackle	4	21	-	-	-
Common grackle	-	2	-	1	-
Cardinal	-	1	5	4	1
Rufous-sided towhee	-	1	1	5	-
Swamp sparrow	1	-	-	-	-
Number of species	15	27	29	22	9
Number of individuals	137	127	146	69	39

	Across all five cover types
Number of species	46
Number of indivduals	518

TABLE 10. Road survey results. Twenty-four month cumulative results.
Road surveys for Birds were not done along Krome Avenue.

	Krome 24 month cum.	D-B Levee 24 month cum.	Wellfield 24 month cum.	FPL R/W north 24 month cum.	FPL R/W south 24 month cum.
Fishes					
Large mouth bass	-	-	-	-	1
Amphibians					
Southern toad	-	1	-	-	-
Oak toad	-	3	-	9	-
Southern cricket frog	-	-	-	-	3
Green treefrog	-	1	-	-	-
Squirrel treefrog	-	-	-	1	2
Cuban treefrog	-	-	-	1	-
Southern leopard frog	5	6	3	2	1
Pig frog	3	8	-	1	3
Reptiles					
American alligator	5	43	4	2	3
Striped mud turtle	2	-	-	5	-
Florida box turtle	3	2	1	2	-
Chicken turtle	-	1	-	-	-
Peninsula cooter	3	2	-	-	1
Florida redbelly turtle	3	15	-	1	-
Florida snapping turtle	2	-	-	1	-
Florida softshell turtle	2	21	1	1	-
Brown anole	-	9	-	1	-
Green anole	-	2	-	1	1
Florida water snake	2	-	-	2	6
Florida green water snake	3	1	-	-	3
Brown water snake	1	-	-	1	-
Eastern garter snake	-	1	1	2	-
Peninsula ribbon snake	-	1	-	2	-
Rough green snake	-	1	-	1	-
Black racer	2	11	1	9	6
Yellow rat snake	-	-	-	2	-
Florida kingsnake	-	1	-	2	2
Cottonmouth	-	3	-	4	-
Birds					
Pied billed grebe	x	3	1	3	25
Double crested cormorant	x	33	20	4	3
Anhinga	x	10	2	1	11
Great blue heron	x	46	10	34	75
Green heron	x	13	1	12	15
Cattle egret	x	-	2	1	-
Little blue heron	x	24	40	71	207
Great egret	x	32	29	190	322
Snowy egret	x	17	3	18	75
Tricolor heron	x	12	4	20	63
Black crowned night heron	x	3	-	-	1
Wood stork	x	2	-	7	55
White ibis	x	-	-	19	37
Roseate spoonbill	x	-	-	-	3
Mottled duck	x	-	-	-	1
Hooded merganser	x	-	-	-	2

TABLE 10. Road survey results. Twenty-four month cumulative results.
Road surveys for Birds were not done along Krome Avenue.

	Krome 24 month cum.	D-B Levee 24 month cum.	Wellfield 24 month cum.	FPL R/W north 24 month cum.	FPL R/W south 24 month cum.
Muscovy	x	1	-	-	-
Turkey vulture	x	33	3	1	4
Black vulture	x	20	32	1	2
Red-tailed hawk	x	-	-	-	1
Red-shouldered hawk	x	5	1	8	10
Swainson's hawk	x	-	-	1	1
Osprey	x	4	-	3	2
Merlin	x	-	-	1	-
American kestrel	x	6	-	44	28
King rail	x	-	-	-	6
Common moorhen	x	2	-	-	15
American coot	x	1	-	-	51
Killdeer	x	-	-	8	40
Common snipe	x	-	1	-	-
Greater yellowlegs	x	-	-	2	2
Lesser yellowlegs	x	-	-	-	2
Willet	x	-	-	-	1
Least tern	x	3	-	-	-
Mourning dove	x	-	-	5	-
Ringed turtle dove	x	1	-	3	-
Ground dove	x	19	6	23	-
Common nighthawk	x	-	-	1	2
Belted kingfisher	x	10	3	36	98
Yellowshafted flicker	x	-	-	2	1
Red-bellied woodpecker	x	-	-	4	-
Downy woodpecker	x	-	-	1	-
Eastern kingbird	x	1	-	-	-
Eastern phoebe	x	1	-	2	1
Barn swallow	x	-	-	15	-
Bluejay	x	11	-	12	4
House wren	x	-	-	-	1
Carolina wren	x	1	-	-	-
Marsh wren	x	1	-	-	-
Mockingbird	x	19	2	26	3
Gray catbird	x	1	2	4	2
Blue-gray gnatcatcher	x	2	4	6	-
Loggerhead shrike	x	16	1	24	21
European starling	x	-	-	13	11
White eye vireo	x	3	4	1	-
Black white warbler	x	-	-	5	-
Cape may warbler	x	-	-	2	-
Black throated blue warbler	x	-	-	2	-
Black throated green warbler	x	-	-	2	-
Blackpoll warbler	x	-	-	2	-
Prairie warbler	x	1	2	1	-
Palm warbler	x	26	8	6	6
Ovenbird	x	1	-	1	-
Common yellowthroat	x	19	-	4	-
American redstart	x	-	-	4	-

TABLE 10. Road survey results. Twenty-four month cumulative results.
Road surveys for Birds were not done along Krome Avenue.

	Krome 24 month cum.	D-B Levee 24 month cum.	Wellfield 24 month cum.	FPL R/W north 24 month cum.	FPL R/W south 24 month cum.
Meadowlark	x	2	-	83	18
Red-winged blackbird	x	89	1	2	11
Boat tailed grackle	x	3	-	1	26
Common grackle	x	4	-	69	-
Cardinal	x	5	5	2	1
Rufous-sided towhee	x	1	-	4	-
Savannah sparrow	x	3	-	-	-
Mammals					
Virginia opossum	2	2	-	1	1
Marsh rabbit	-	-	-	1	-
Raccoon	11	5	1	8	5
River otter	-	-	1	-	-
Gray fox	1	3	-	-	1
Domestic dog	1	2	-	1	-
Bobcat	-	-	-	6	2
White-tailed deer	-	5	-	-	1
Approximate distance surveyed	13 miles	2.5 miles	1.0 mile	4.5 miles	4.5 miles
Number of species	17	69	33	81	61
Number of individuals	51	660	200	887	1,308

Across all roads surveyed

	## Species	## Individuals
Fishes	1	1
Amphibians	8	53
Reptiles	20	211
Birds	72	2,780
Mammals	8	61
Total	109	3,106

TABLE 11. Mammal scent & bait stations and sherman live trapping results by cover type. Twenty-four month cumulative results. Data for scent & bait stations are presence (+) or abscence (-) only.

	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Bait stations					
Virginia opossum	+	+	+	+	+
Hispid cotton rat	-	-	-	+	-
Raccoon	+	+	+	+	+
Gray fox	-	-	-	+	+
Domestic dog	+	-	+	-	+
Bobcat	-	-	-	+	+
Number of species	3	2	3	5	5
Scent stations					
Virginia opossum	-	-	-	+	+
Hispid cotton rat	-	-	-	-	+
Raccoon	+	+	+	+	+
Domestic dog	-	+	+	-	+
Bobcat	-	-	-	+	+
White-tailed deer	+	-	+	-	-
Number of species	2	2	3	3	5
Sherman					
Crayfish	-	1	-	-	-
Gray catbird	-	-	-	-	2
Hispid cotton rat	-	7	4	1	-
Marsh rice rat	3	4	2	2	1
Cotton mouse	-	-	-	3	2
House mouse	-	-	-	-	1
Black rat	-	-	-	-	1
Number of species	1	3	2	3	5
Number of individual	3	12	6	6	7
All three methods combined: Mammals only					
Number of species	5	5	6	7	10

Across all five cover types

Number of species 11

TABLE 12. Red imported fire ant mounds by cover type. Twenty-four month cumulative results.
Triplicates per covertype, with three quadrats surveyed at each replicate.
The "-" indicates that sampling within a covertype was not possible due to standing water at each replicate site.

Quarter Yr	Marsh 0% - 10% 24 month cum.	P50 10% - 50% 24 month cum.	P75 50% -75% 24 month cum.	SDM >75% Sapling 24 month cum.	DMM >75% Mature 24 month cum.
Jan-Mar 94	0	25	94	6	1
Apr-Jun 94	0	6	5	7	0
Jul-Sep 94	-	0	0	2	0
Oct-Dec 94	-	-	-	-	-
Jan-Mar 95	-	0	3	0	0
Apr-Jun 95	0	4	0	2	0
Jul-Sep 95	-	0	0	0	0
Oct-Dec 95	-	0	0	0	0
Total number ACTIVE mounds	0	35	102	17	1

TABLE 13. Species listed by Florida Committee on Rare and Endangered Animals (FCREPA), Florida Game and Fresh Water Commission (GFC), or the US Fish and Wildlife Service (USFWS).

	FCREPA	GFC	USFWS	Cover types species observed in
American alligator	—	SSC	T (S/A)	Marsh, P50, FPL R/W, Canals
Gopher tortoise	T	SSC	C2	Levee
Island glass lizard	—	—	C2	P50, P75
Roseate spoonbill		SSC	—	FPL R/W
Little blue heron		SSC	—	P50, FPL R/W, Levees
Snowy egret		SSC	—	FPL R/W, Levees
Tricolored heron		SSC	—	FPL R/W, Levees
White ibis		SSC	—	FPL R/W, Levees
American kestrel		T	C2	FPL R/W, SDM
Loggerhead shrike		—	C2	Marsh, P50, P75, SDM, FPL R/W, Levees
Wood stork		E	E	FPL R/W, Levees
Least Tern		T	—	Canal

Abbreviations	Agency
E = Endangered	FCREPA, GFC, FWS
T = Threatened	FCREPA, GFC, FWS
SSC = Species of Special Concern	GFC
C2 = Candidate (insuffucient information)	FWS

DOC#614

TABLE 14. Percentage of native versus non-native fishes, amphibians, reptiles, birds and mammals, trapped or observed in CT 1 thru CT 5 based upon 24 month cumulative totals of number of species and number of individuals.

Cumulative totals of all Vertebrates

		# Spp	# Indiv
0% to 10% Melaleuca	Marsh	73	2664
10% to 50% Melaleuca	P50	86	3703
50% to 75% Melaleuca	P75	88	3259
>75% Melaleuca, Sapling	SDM	84	1841
>75% Melaleuca, Mature	DMM	79	1597

Cumulative totals of Native Species of Vertebrates

	# Spp	# Indiv	% Spp	% Indiv
Marsh	67	2563	92	96
P50	78	3149	91	85
P75	78	2563	89	79
SDM	73	1267	87	69
DMM	64	1145	81	72

% of Cumulative Total Numbers

Cumulative totals of Non-native species of Vertebrates

	# Spp	# Indiv	% Spp	% Indiv
Marsh	6	101	8	4
P50	8	554	9	15
P75	10	696	11	21
SDM	11	574	13	31
DMM	15	452	19	28

% of Cumulative Total Numbers

TABLE 15. Habitat association and species composition in each Cover Type based upon the 24 month cumulative totals of number of species and number of individuals of amphibians, reptiles, birds, and mammals.
Fishes were excluded from the analyses since all fishes are "wetland dependent" and their inclusion would bias interpretation toward a higher percentage of "wetland dependent" species.
Each species was categorized as : 1) Wetland Dependent; 2) Wetland Independent; or 3)Wetland Seasonal. Categorization was based upon available literature.

Wetland Dependent species require wetlands with a hydroperiod of nine to twelve months per year.
Wetland Seasonal species require wetlands with a hydroperiod of one to nine months per year, usually for breeding or larval development (such as tadpoles).
Wetland Independent species do not require wetlands during any season or life history stage.

Cumulative totals of all Amphibians, Reptiles, Birds, and Mammals

		# Spp	# Indiv
0% to 10% Melaleuca	Marsh	51	387
10% to 50% Melaleuca	P50	67	453
50% to 75% Melaleuca	P75	69	552
>75% Melaleuca, Sapling	SDM	66	509
>75% Melaleuca, Mature	DMM	59	455

Wetland Dependent Amphibians, Reptiles, Birds and Mammals

	# Spp	# Indiv	% Spp	% Indiv
Marsh	26	300	51	78
P50	25	258	37	57
P75	21	193	30	35
SDM	16	125	24	25
DMM	12	120	20	26

% of Cumulative Total Numbers

Seasonal Wetland and/or Wetland Tolerant Amphibians, Reptiles, Birds, and Mammals

	# Spp	# Indiv	% Spp	% Indiv
Marsh	13	53	25	14
P50	13	85	19	19
P75	15	147	22	27
SDM	12	100	18	20
DMM	12	78	20	17

% of Cumulative Total Numbers

Wetland Independent Amphibians, Reptiles, Birds, and Mammals

	# Spp	# Indiv	% Spp	% Indiv
Marsh	12	34	24	9
P50	29	110	43	24
P75	33	212	48	38
SDM	38	284	58	56
DMM	35	257	59	56

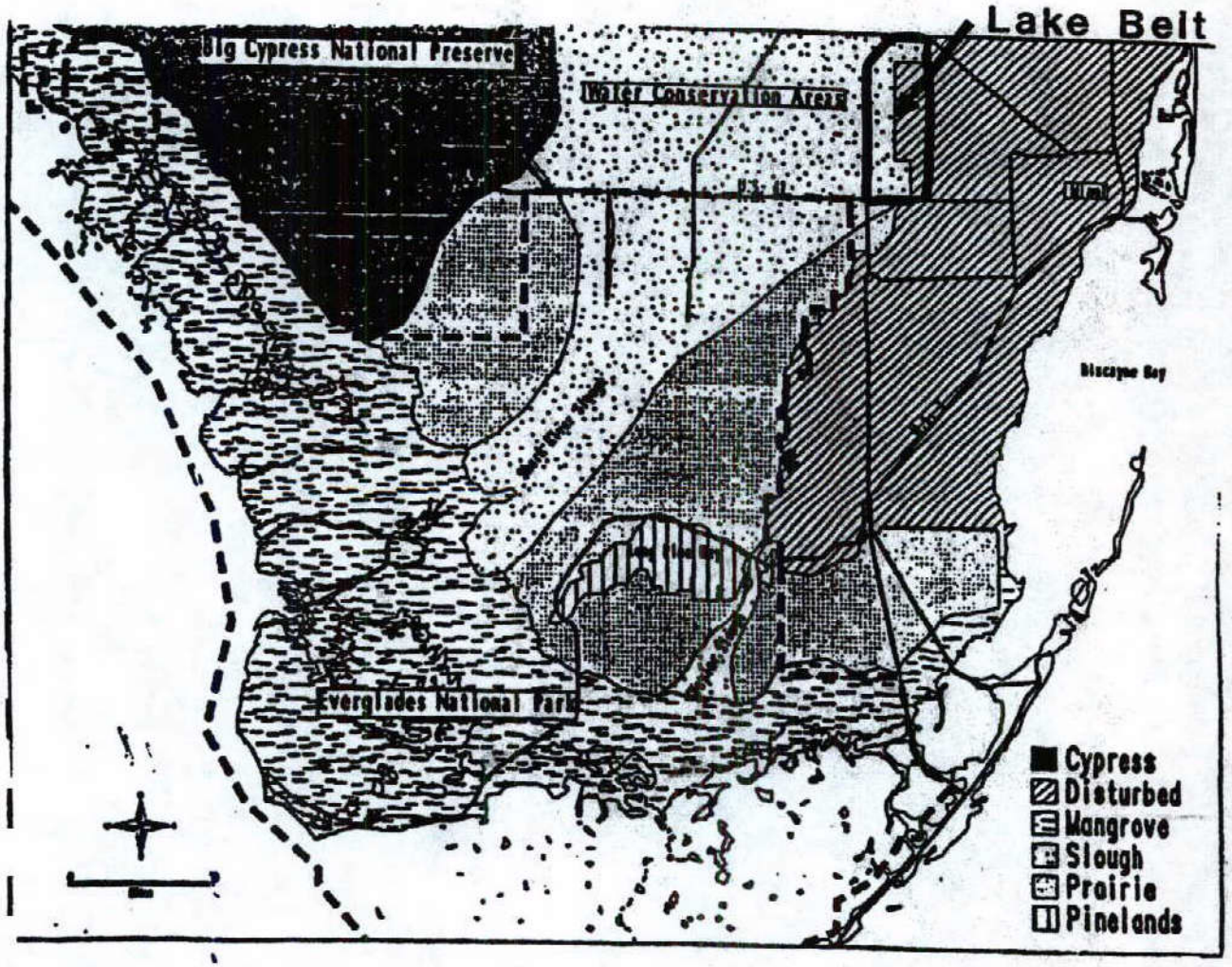
% of Cumulative Total Numbers

TABLE 16. Average fish biomass in littoral and limnetic zones from nine Florida lakes. Data were obtained from Florida Game and Fresh Water Fish Commission Annual Reports. (Kg/ha x 0.89 = lbs/ac.) *Table taken in its entirety from Williams et al., 1985, page 57.*

Fish Group	Littoral Biomass (kg/ha)	Limnetic Biomass (kg/ha)	Ratio
Sport fish	90.9	18.5	4.9/1
Commerical fish	9	6.8	1.3/1
Rough fish	46.6	35.8	1.3/1
Forage fish	26.4	7.3	3.6/1
TOTAL	172.9	68.4	2.5/1

FIGURES

FIGURE 1. Major habitat types in southern Florida based upon dominant vegetation. From Dairymple and Bass, In Press.



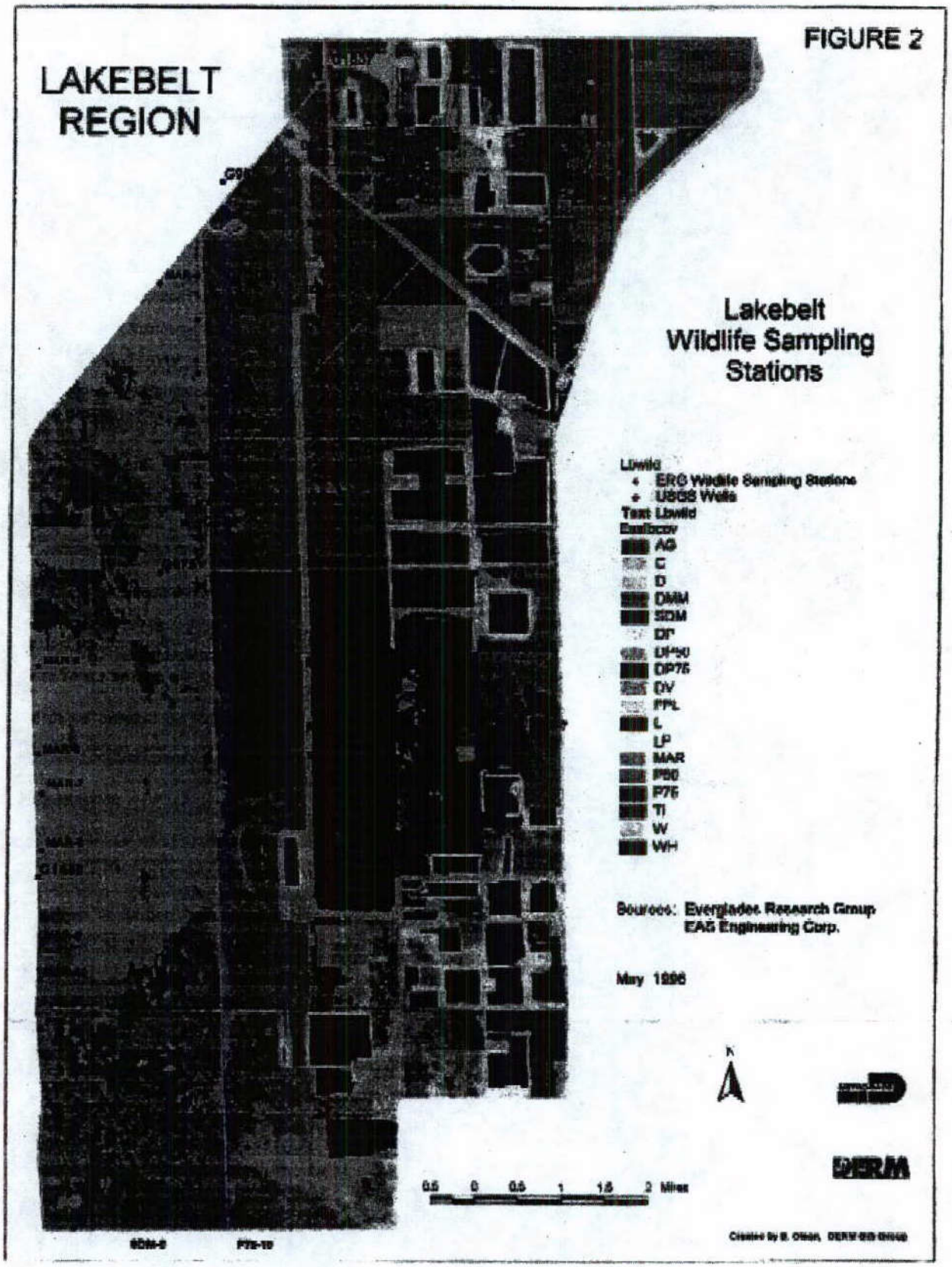
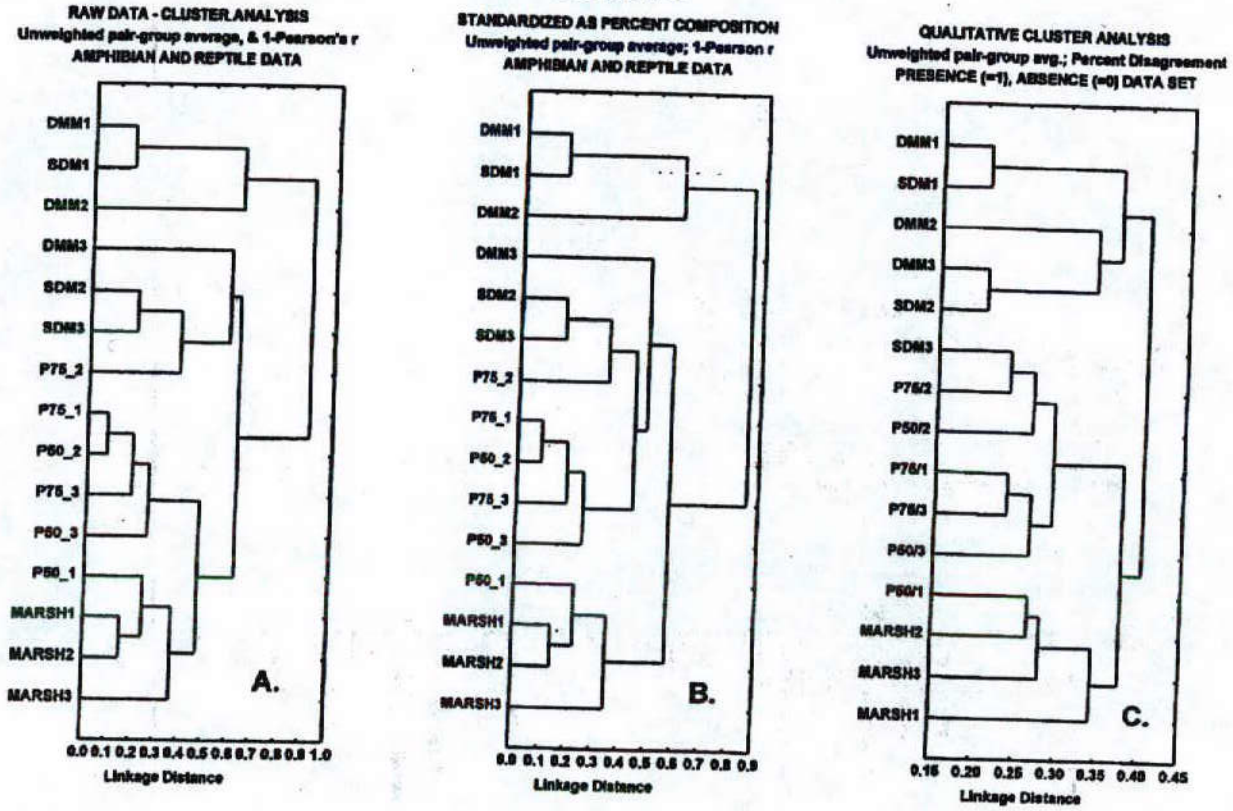


FIGURE 2
LAKEBELT REGION
Lakebelt Wildlife Sampling Stations
Lbwild
ERG Wildlife Sampling Stations
USGS Wells
Text Lbwild
Easibcov
AG
C
D
DMM
SDM
DP
DP50
DP75
DV
FPL
L
LP
MAR
P50
P75
TI
W
WH
Sources: Everglades Research Group
EAS Engineering Corp.
May 1996
0.5 0 0.5 1 1.5 2 Miles
DERM

DOC#614

FIGURE 3.

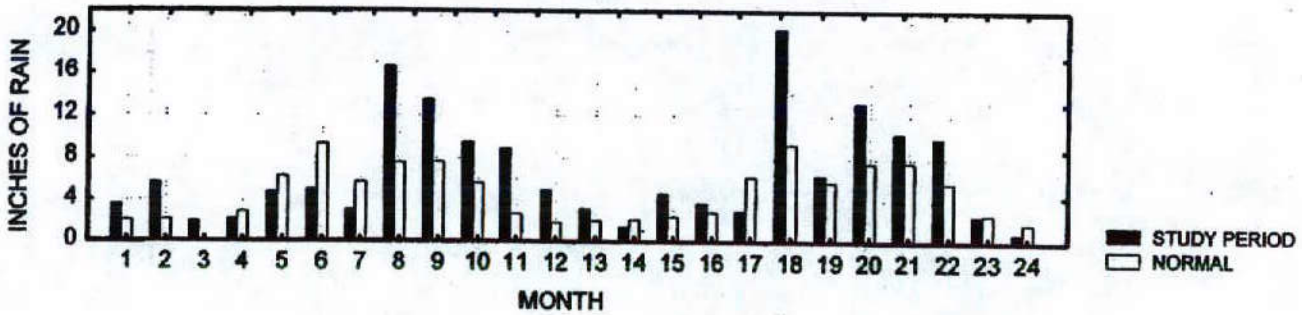


DOC#614

FIGURE 4.

A. RAINFALL DURING STUDY PERIOD - MIA RECORDINGS

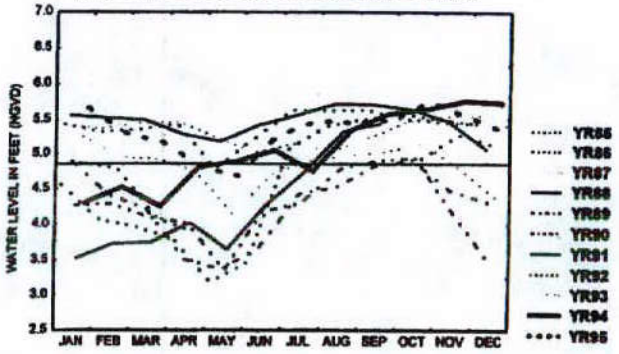
RAIN DURING STUDY VS. NORMAL (AVERAGE) VALUES



B.

USGS WELL G-872; JAN. 1985 - DEC. 1995

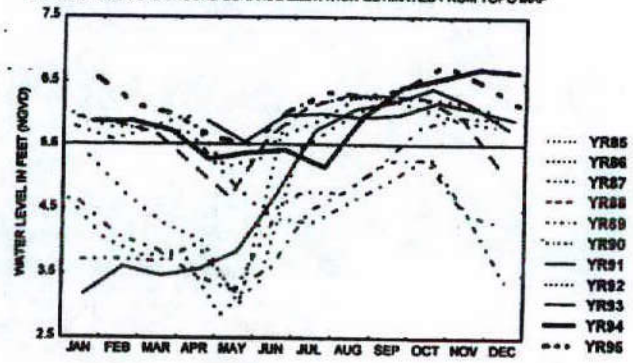
HORIZONTAL LINE IS GROUND SURFACE ELEVATION



C.

USGS WELL G-876; JAN. 1985 - DEC. 1995

HORIZONTAL LINE IS GROUND SURFACE ELEVATION ESTIMATED FROM TOPO MAP

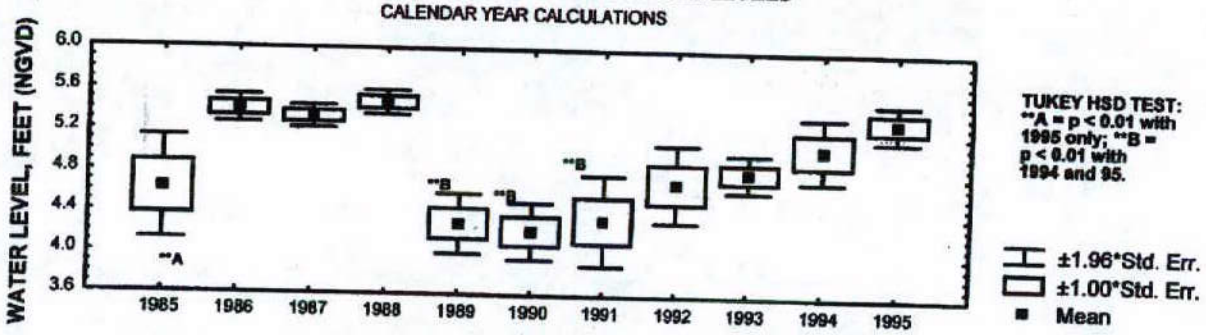


DOC#614

FIGURE 4D - E.

D. USGS WELL G-972 - ANNUAL MEAN WATER LEVELS

CALENDAR YEAR CALCULATIONS



E. USGS WELL G-975 - ANNUAL MEAN WATER LEVELS

CALENDAR YEAR CALCULATIONS

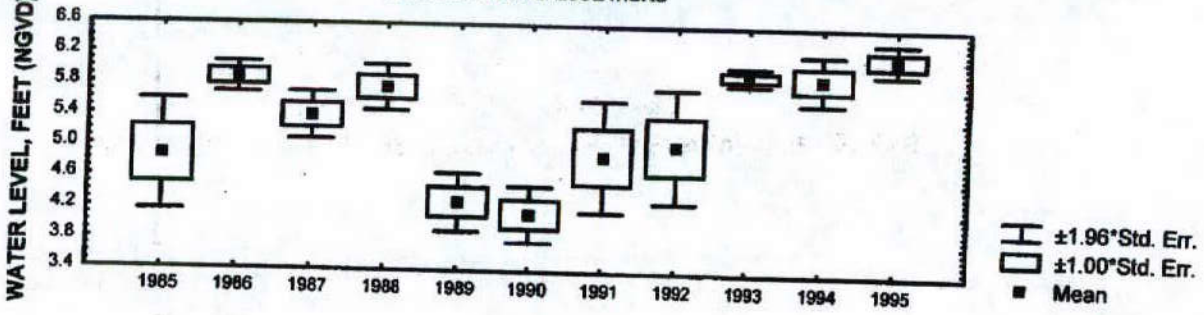


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FIGURE 5A. BOX AND WHISKER PLOTS OF MEAN WATER LEVELS FOR USGS WELLS 1994 -1995

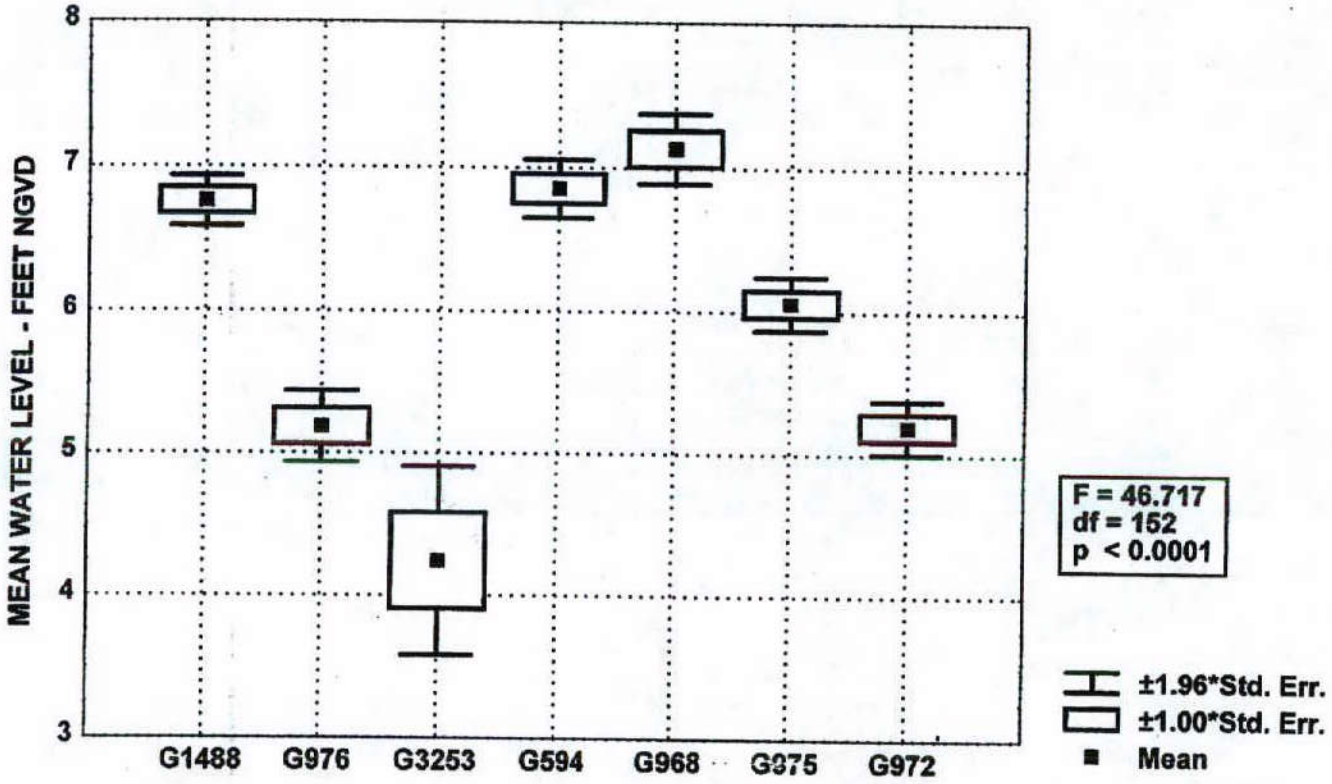
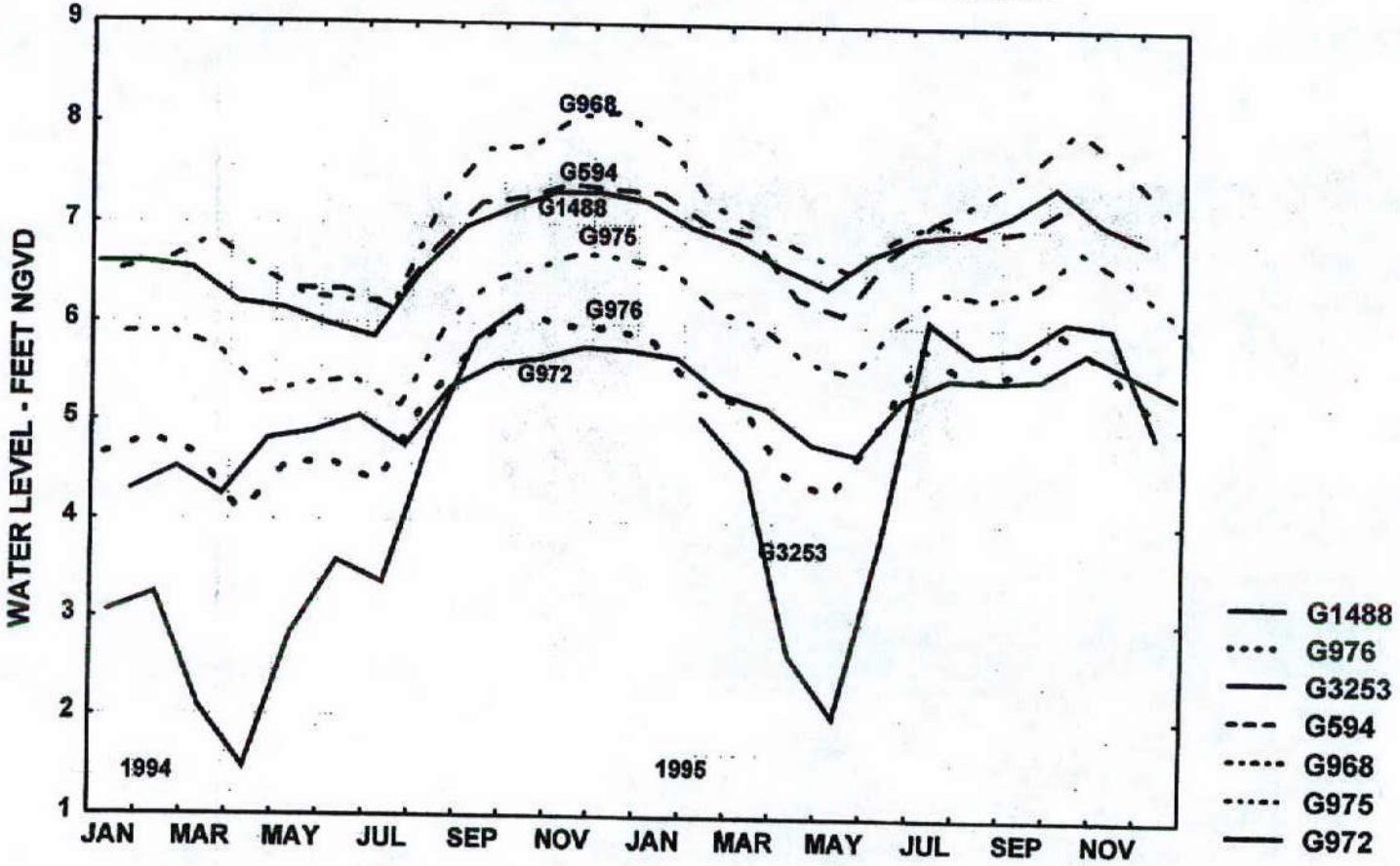


FIGURE 5B. 1994 & 1995 WATER LEVELS FOR USGS WELLS



DOC#614

FIGURE 5C. COEFFICIENTS OF VARIABILITY (CV) IN 1994 - 1995 USGS WELL DATA
CV = STANDARD DEVIATION / MEAN
CV IS A MEASURE OF RELATIVE VARIABILITY

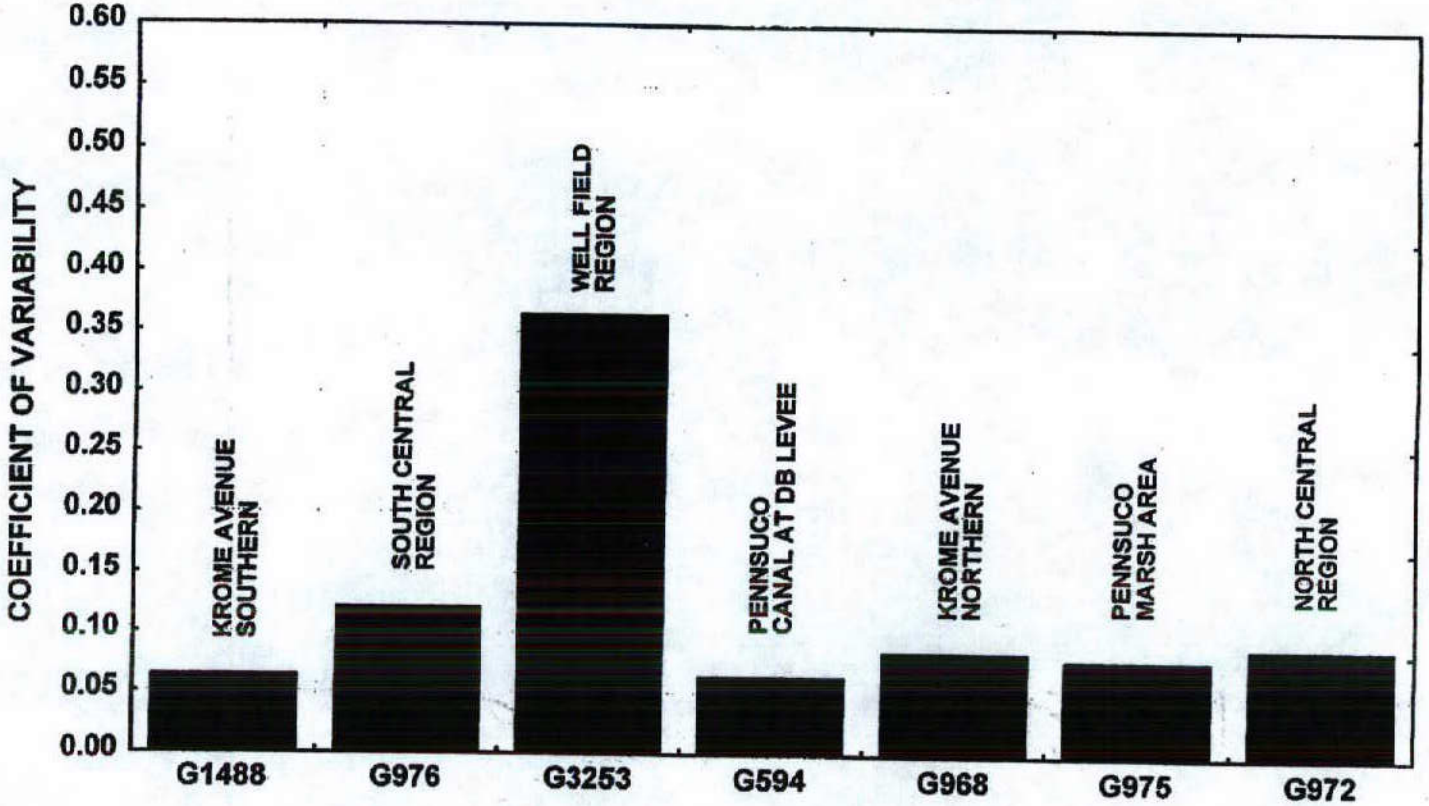


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FIGURE 6.
NO. INVERTEBRATES PER MONTH - DRIFT FENCE DATA & USGS WELL G972
JAN. 1994 - DEC. 1995

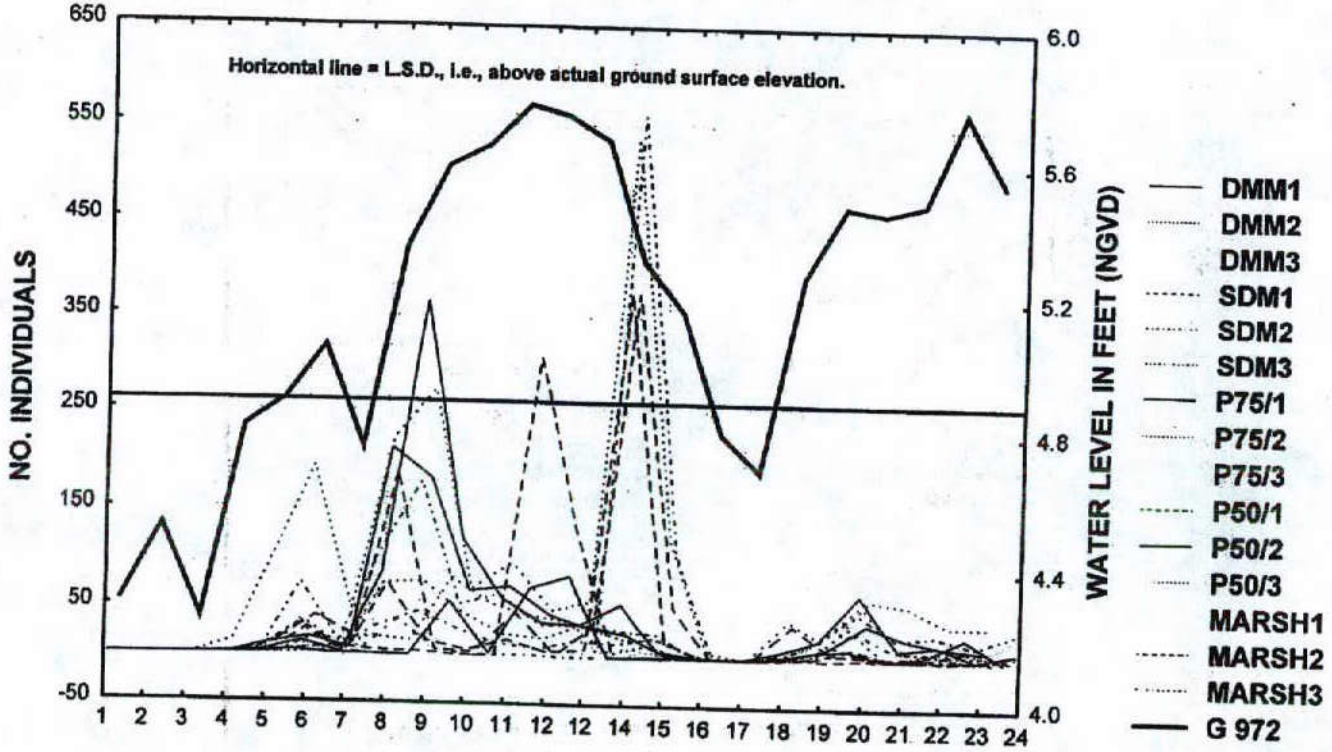

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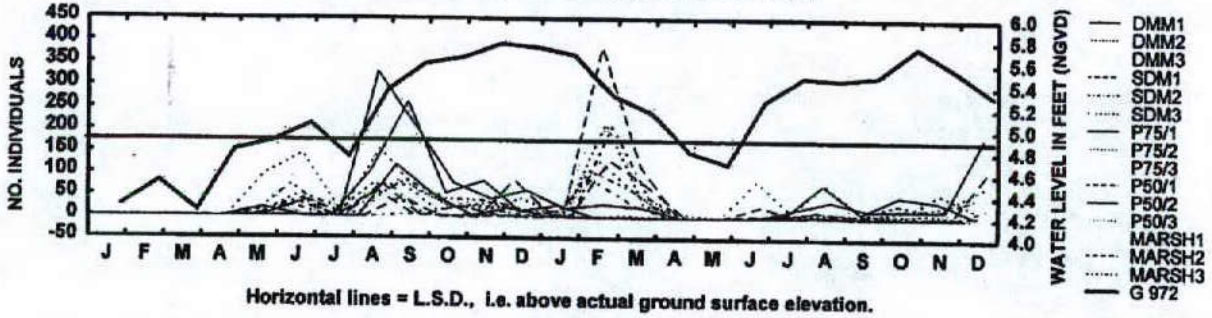
FIGURE 7.

A. NO. INDIVIDUALS OF FISHES PER MONTH - Jan. 1994 - Dec. 1995

DRIFT FENCE DATA (All replicates shown) & USGS WELL G-972



Horizontal lines = L.S.D., i.e. above actual ground surface elevation.

B. NO. INDIVIDUALS OF HERPTILES PER MONTH - Jan.1994 - Dec. 1985

DRIFT FENCE DATA (All replicates shown) & USGS WELL G-972

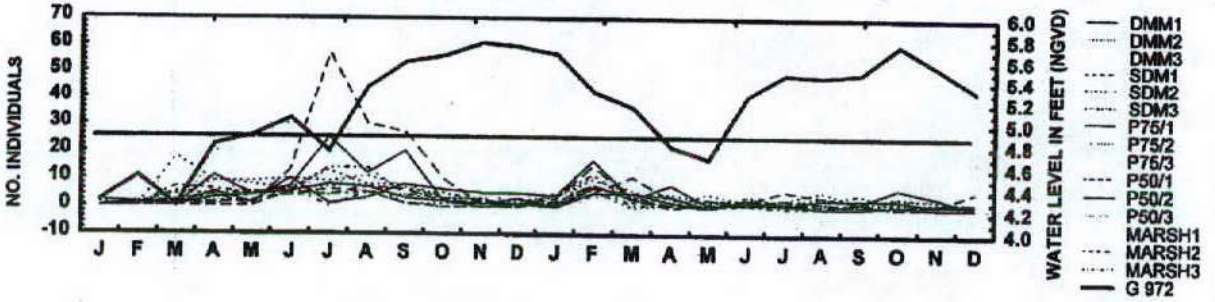


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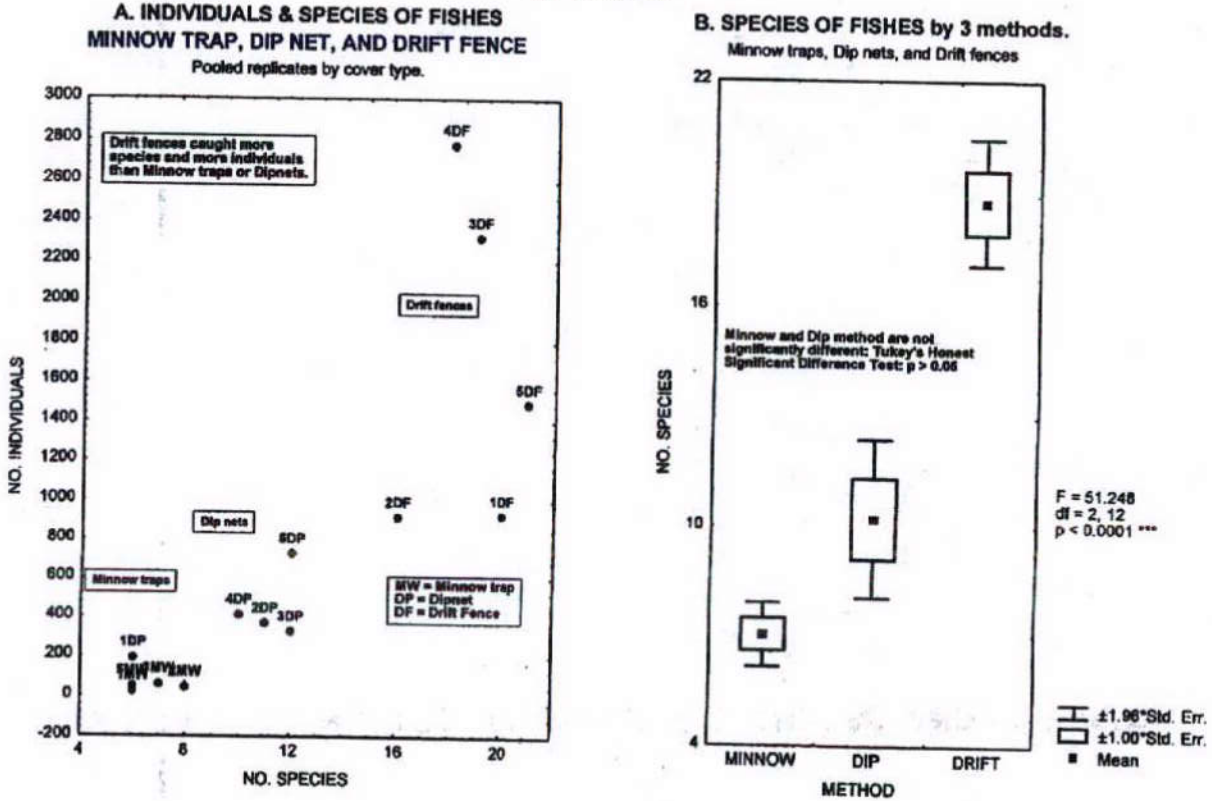
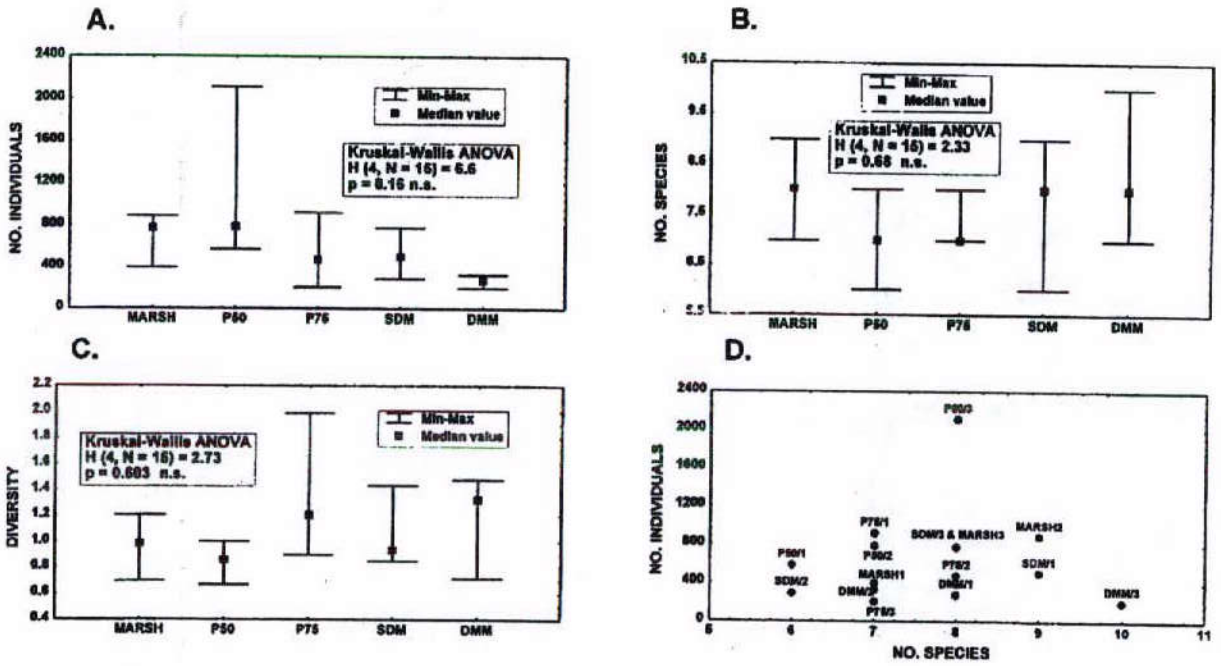
FIGURE 8.



DOC#614

FIGURE 9A. - D.
MACROINVERTEBRATES - ABUNDANCE, RICHNESS, AND DIVERSITY

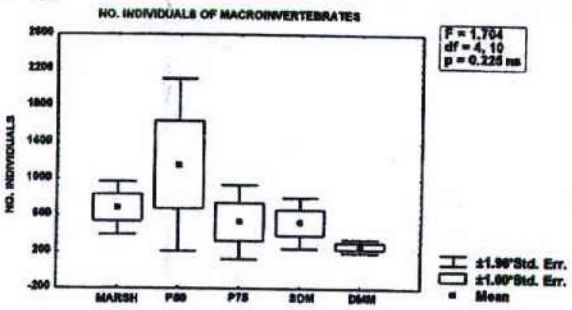


Drift fence data - 2 year cumulatives

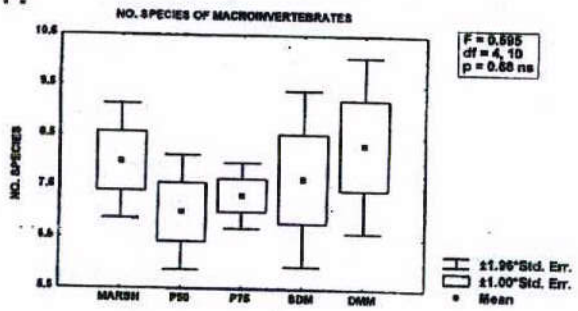
DOC#614

FIGURE 9E. - G.
MACROINVERTEBRATES - ABUNDANCE, RICHNESS, AND DIVERSITY

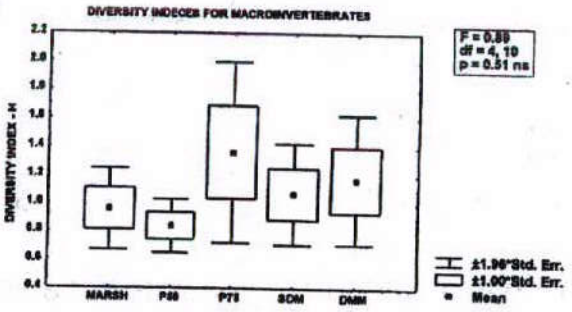
E.



F.



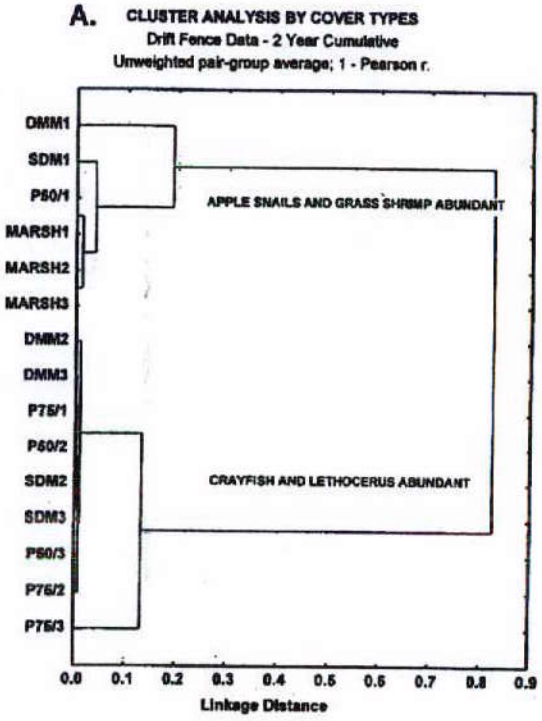
G.

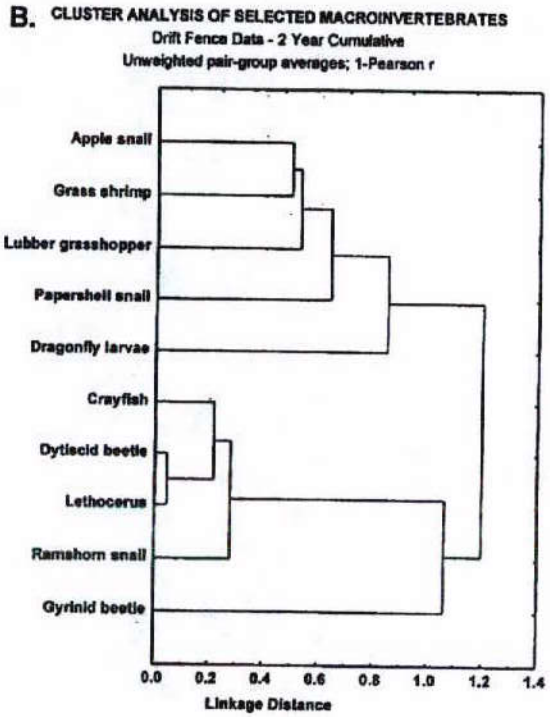


2 YEAR CUMULATIVES - DRIFT FENCE DATA

DOC#614

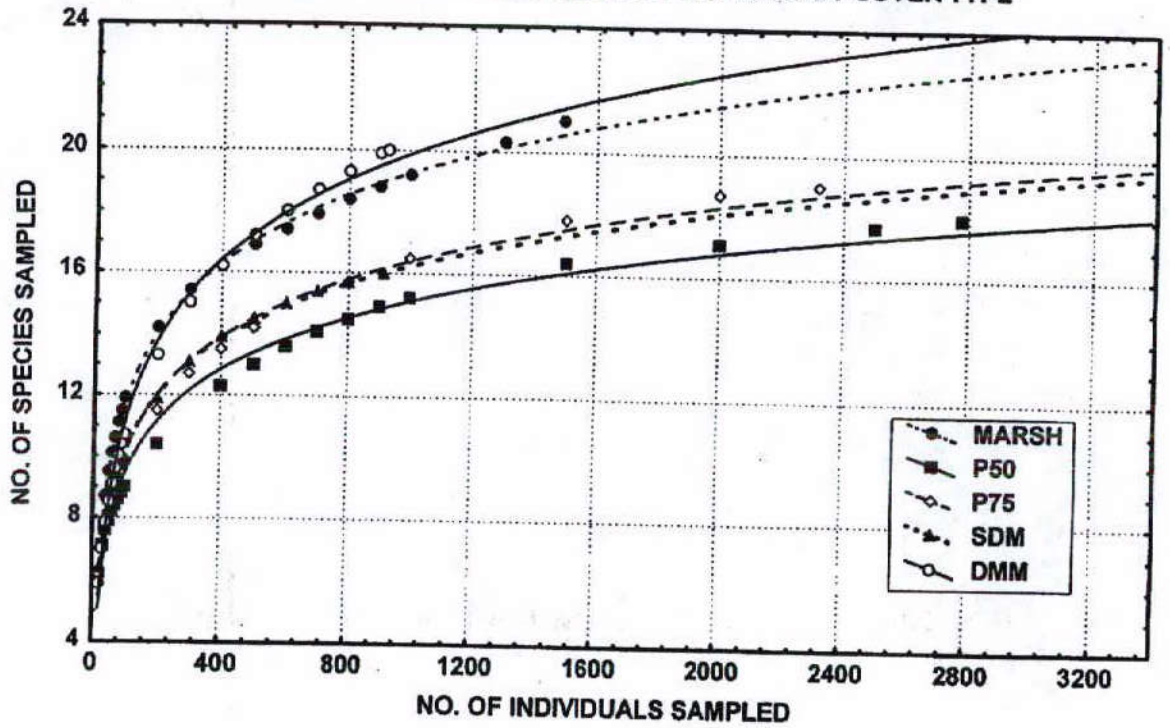
FIGURE 10.
MACROINVEREBRATES - CLUSTER ANALYSES





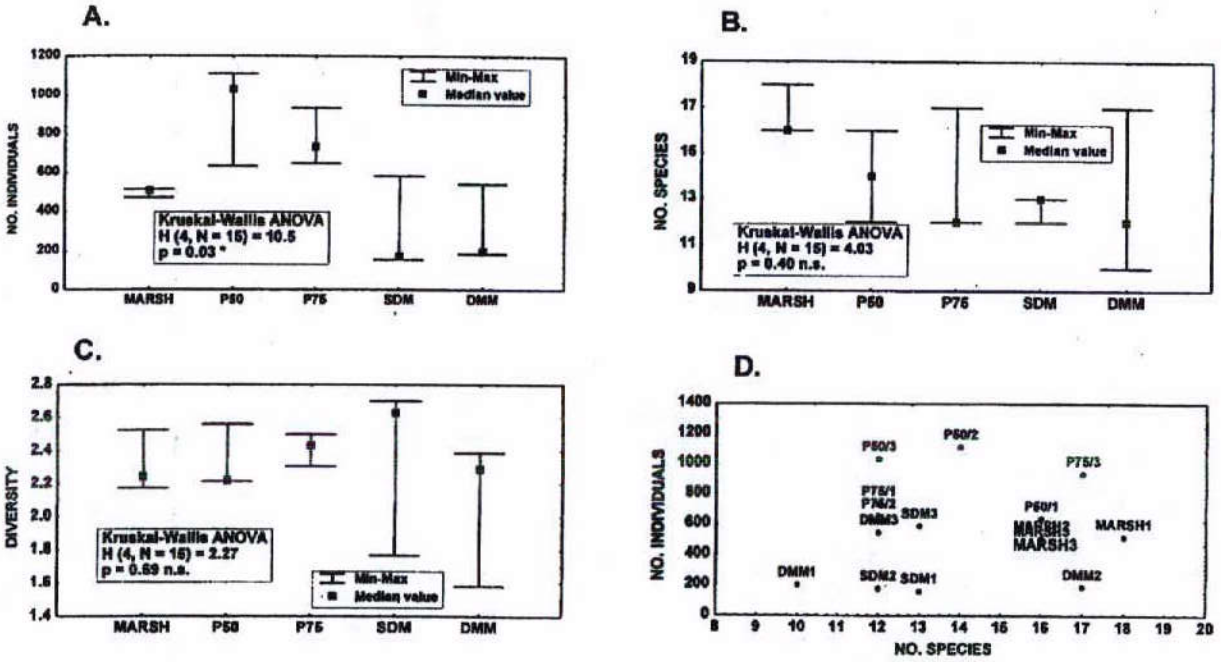
DOC#614

FIGURE 11. RAREFACTION CURVES FOR FISHES BY COVER TYPE



DOC#614

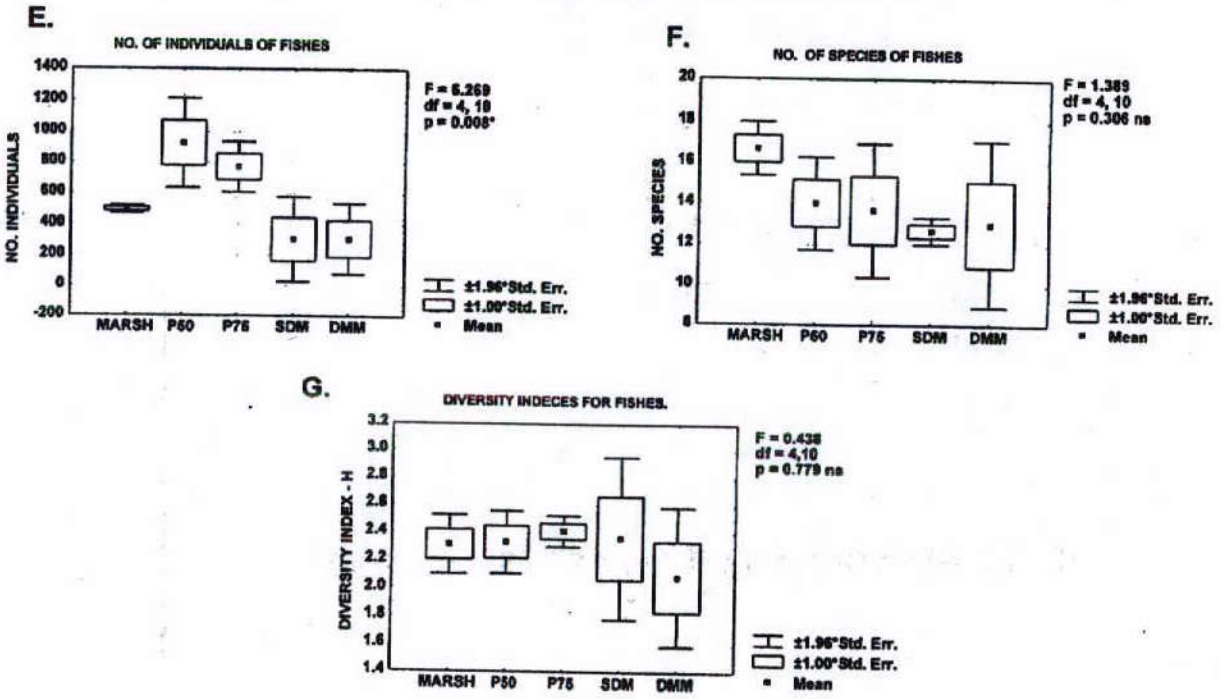
FIGURE 12A. - D.
FISHES - ABUNDANCE, RICHNESS, AND DIVERSITY



Drift fence data - 2 year cumulatives

DOC#614

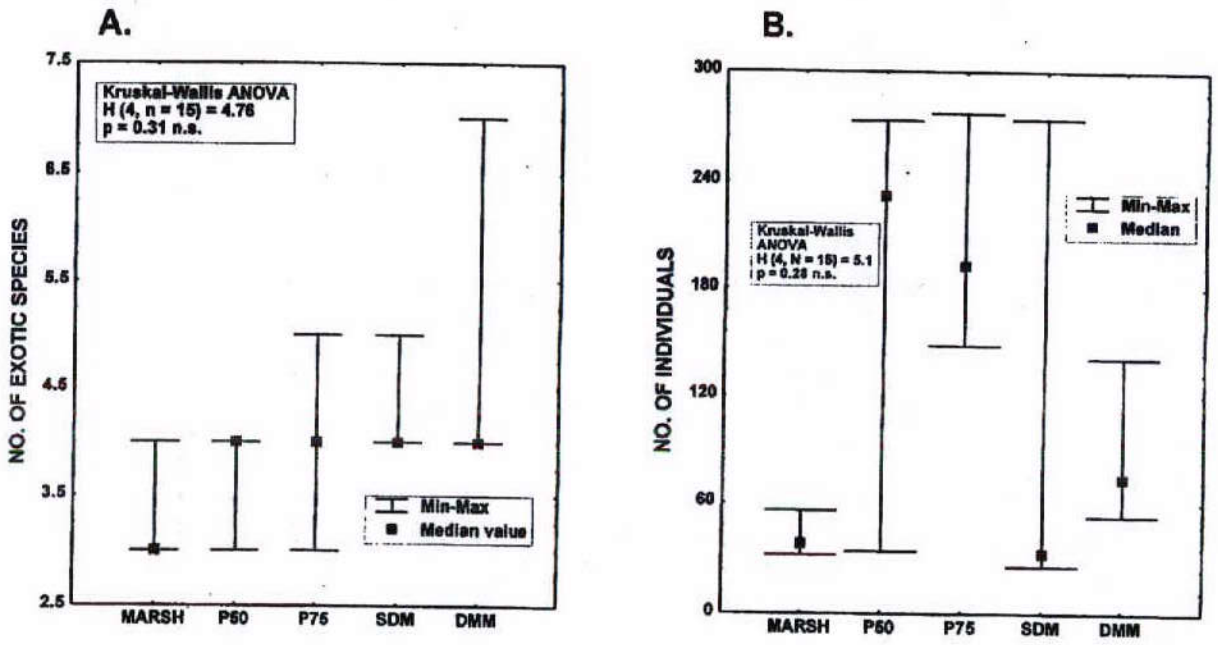
FIGURE 12E. - G.
FISHES - ABUNDANCE, RICHNESS, AND DIVERSITY



2 YEAR CUMULATIVES - DRFIT FENCE DATA

DOC#6 1 4

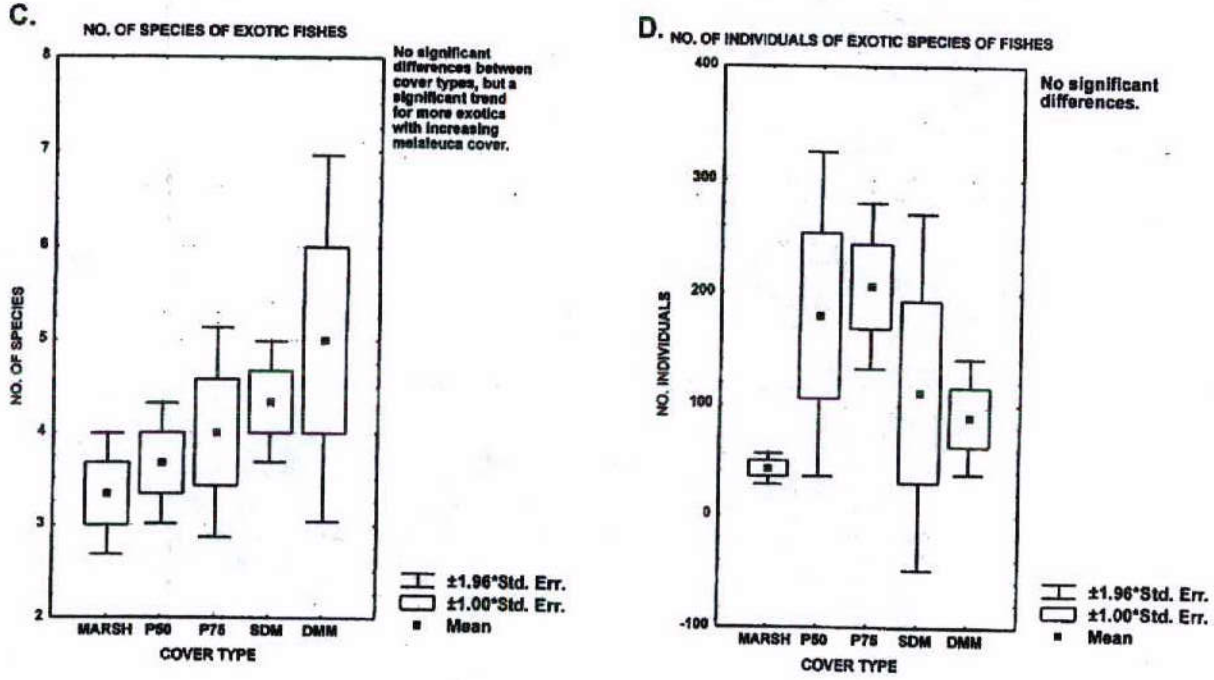
FIGURE 13A. - B.
EXOTIC SPECIES OF FISHES - RICHNESS AND ABUNDANCE



Drift fence data - 2 year cumulatives

DOC#614

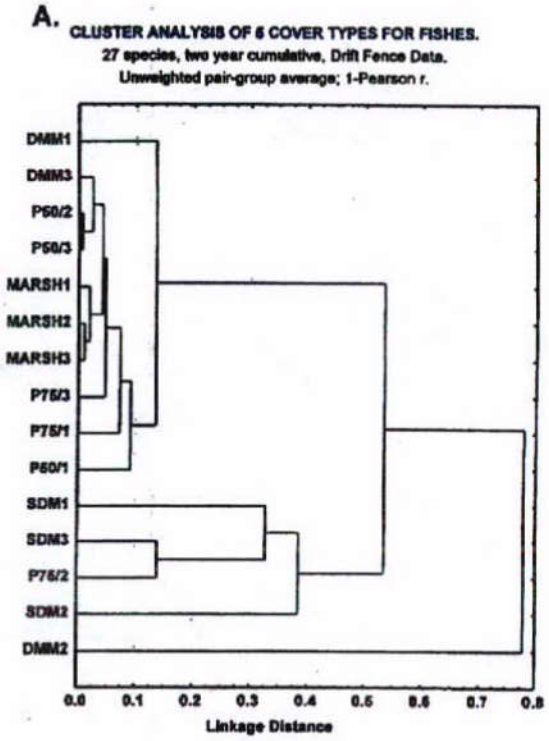
FIGURE 13C. - D.
EXOTIC SPECIES OF FISHES - RICHNESS AND ABUNDANCE

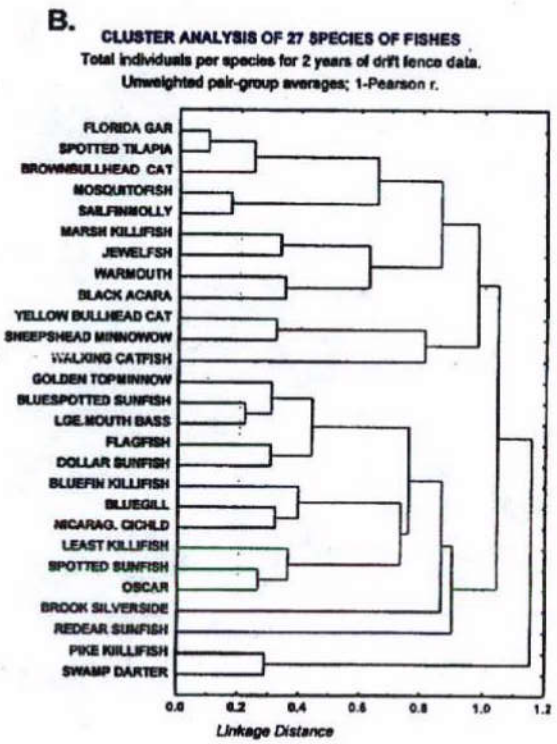


2 YEAR CUMULATIVES - DRFIT FENCE DATA

DOC#614

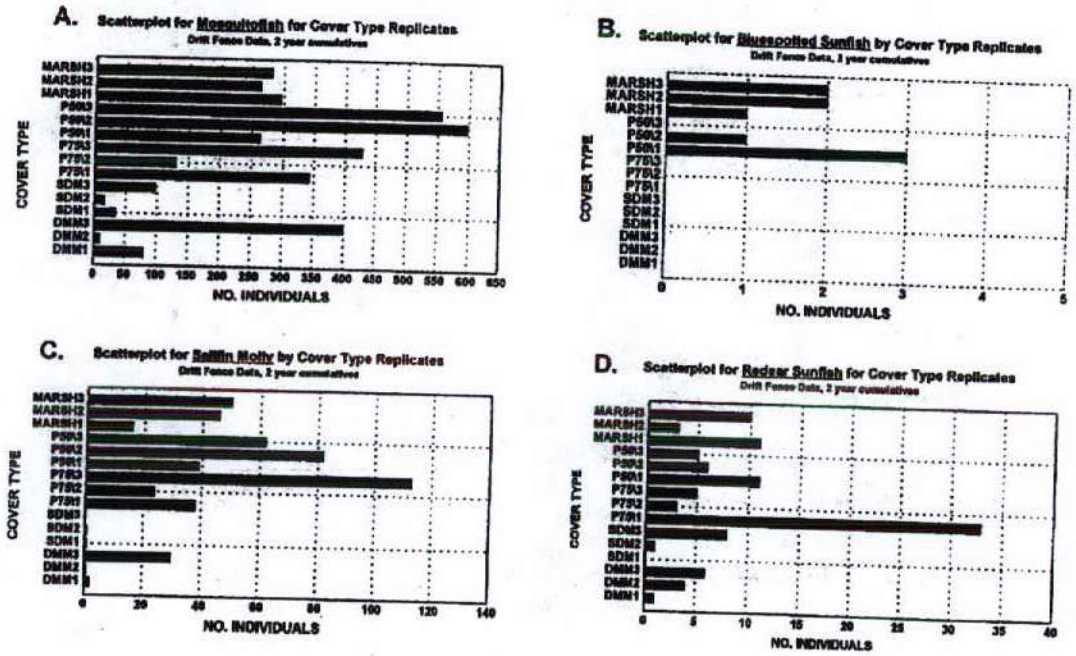
FIGURE 14. FISHES - CLUSTER ANALYSES





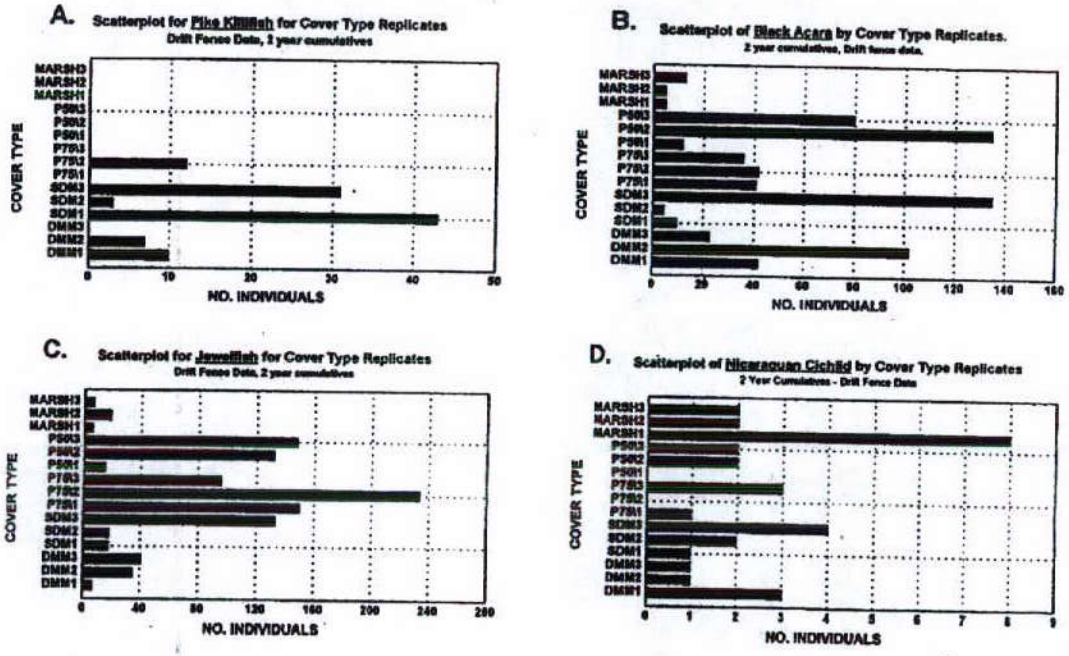
DOC#614

FIGURE 15. DISTRIBUTIONS OF SELECTED NATIVE FISHES BY COVER TYPE



DOC#614

FIGURE 16.
DISTRIBUTIONS OF SELECTED EXOTIC FISHES BY COVER TYPE



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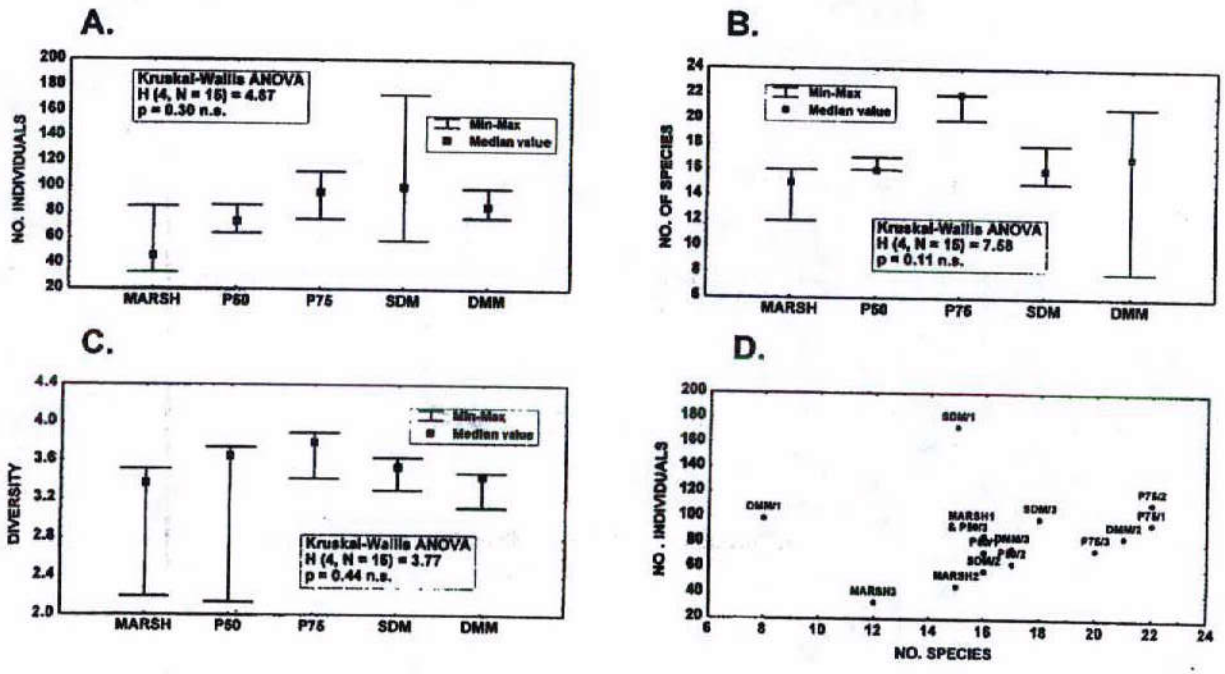
DOC#614

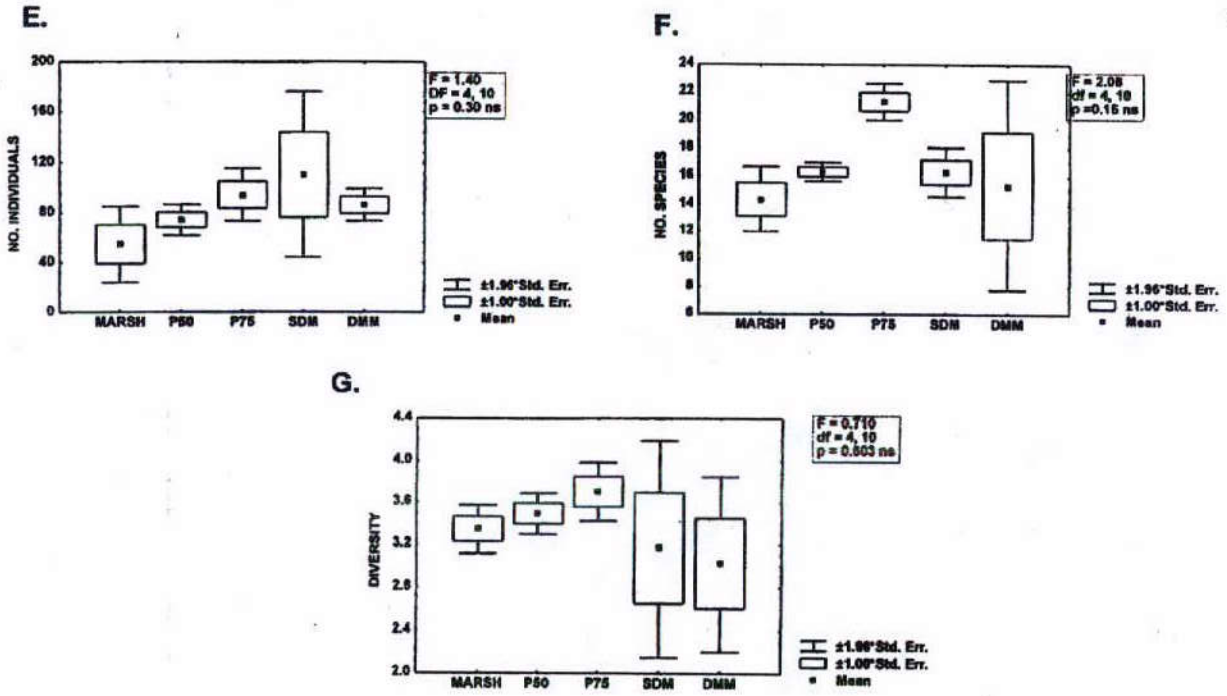
FIGURE 17A. - D.
AMPHIBIANS AND REPTILES - ABUNDANCE, RICHNESS, AND DIVERSITY



Drift fence data - 2 year cumulatives

DOC#614

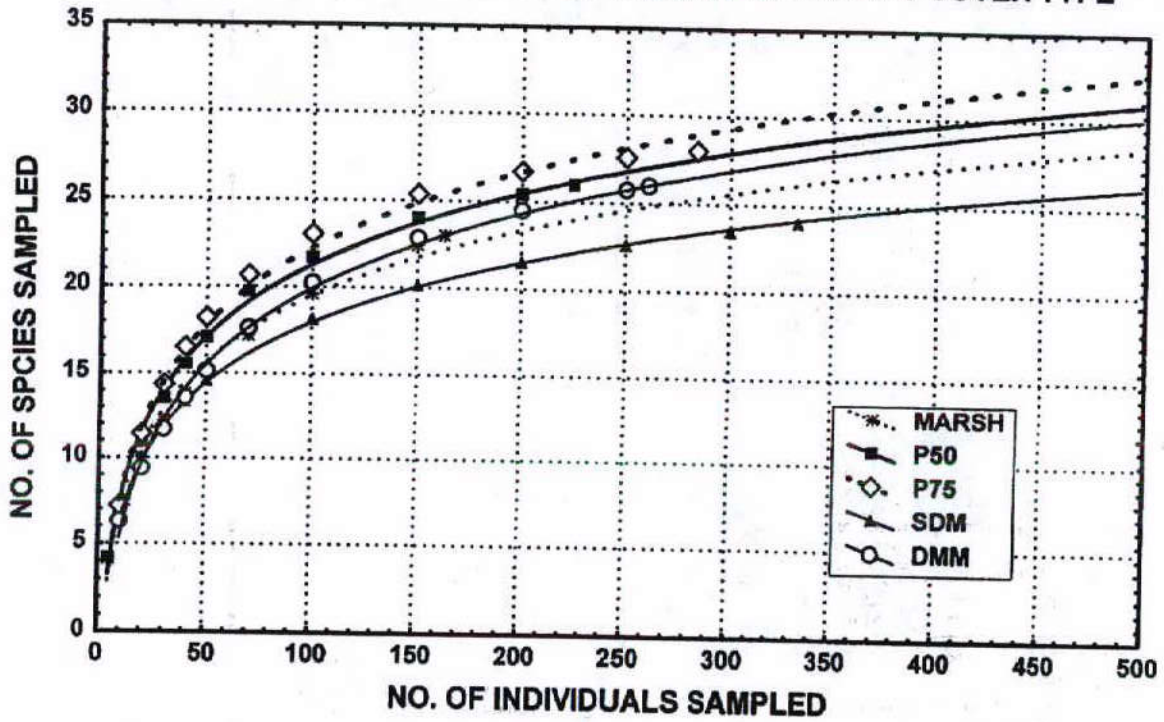
FIGURE 17E. - G.
AMPHIBIANS AND REPTILES



2 YEAR CUMULATIVES - DRIFT FENCE DATA

DOC#614

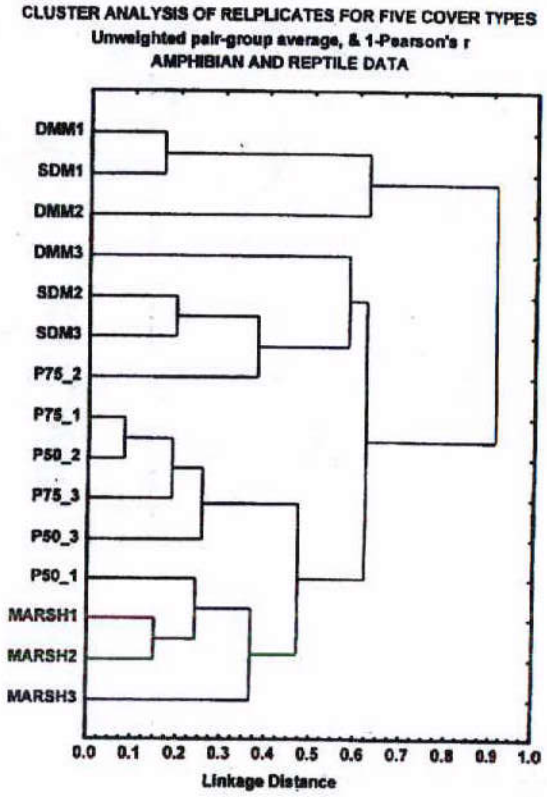
FIGURE 18. RAREFACTION CURVES FOR HERPTILES BY COVER TYPE



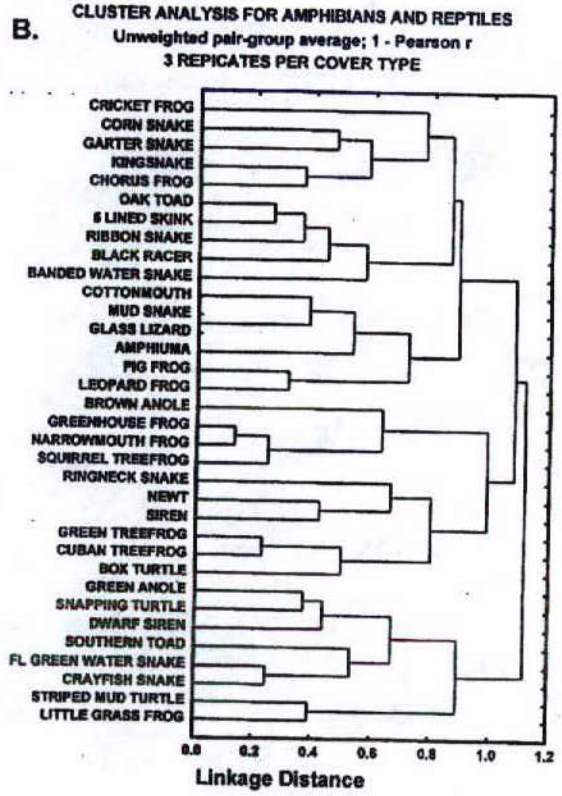
DOC#614

FIGURE 19.

A.

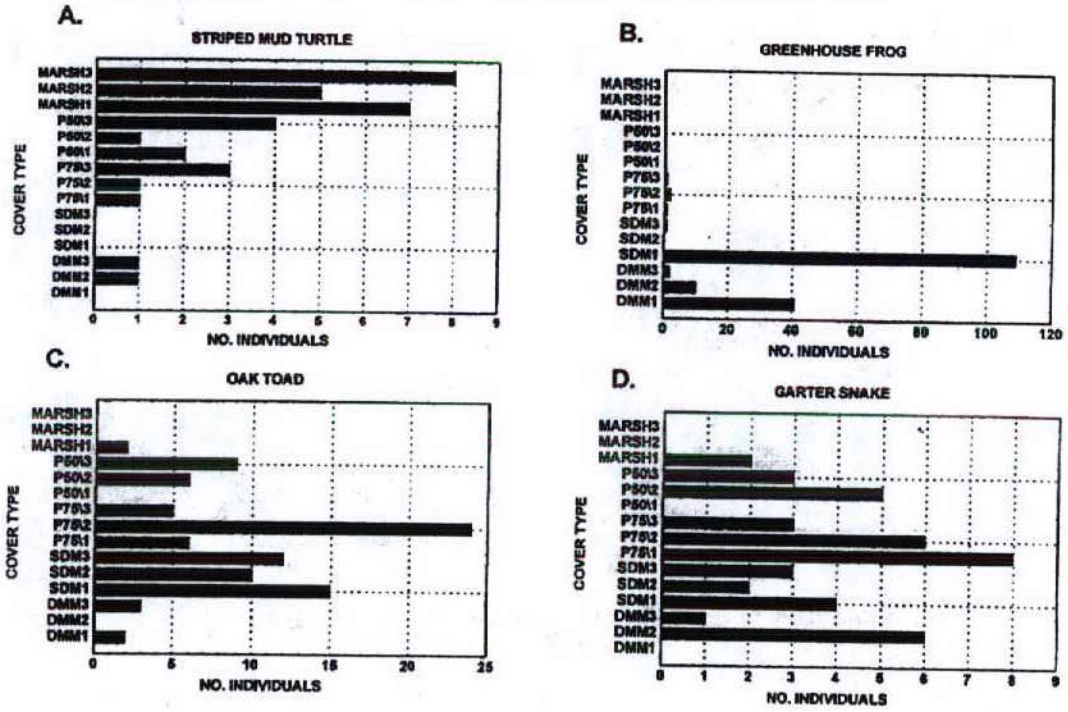


B.



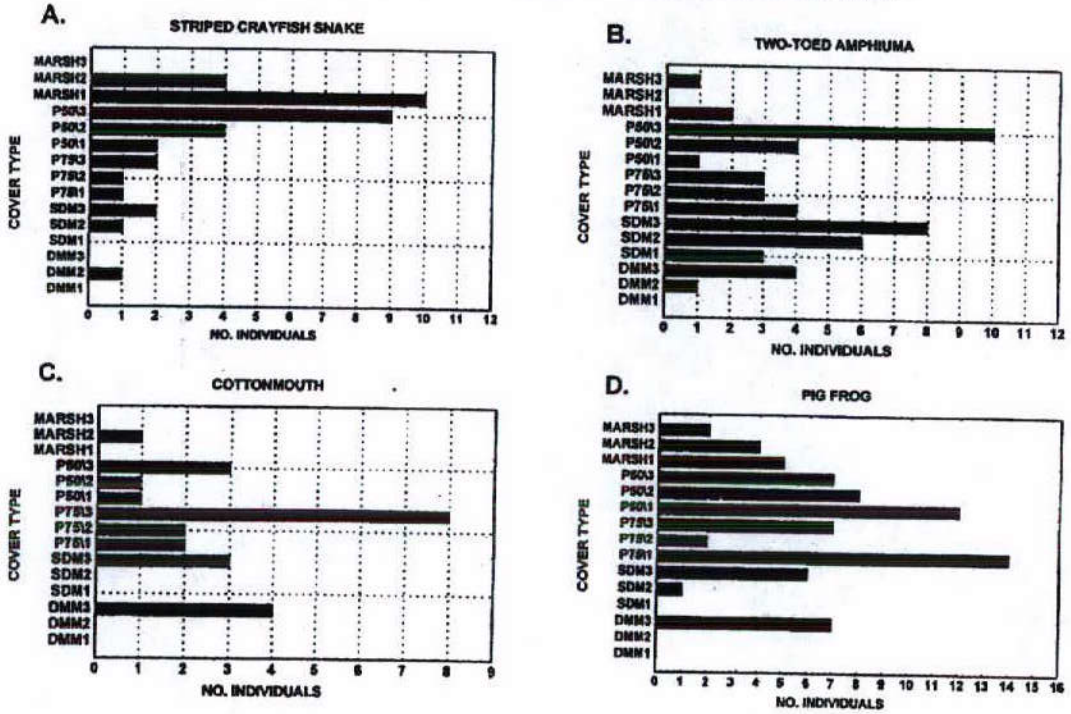
DOC#614

FIGURE 20.
DISTRIBUTIONS OF SELECTED HERPTILES BY COVER TYPE



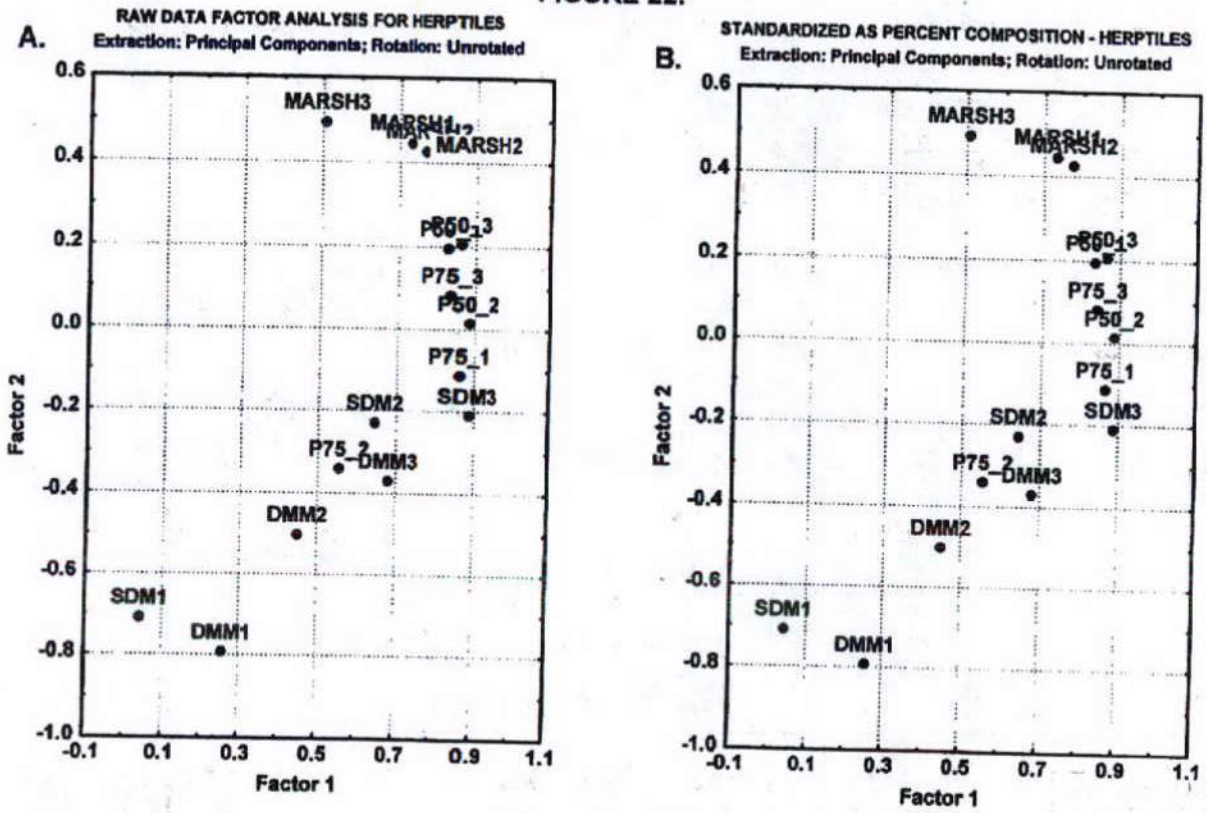
DOC#614

FIGURE 21.
DISTRIBUTIONS OF SELECTED HERPTILES BY COVER TYPE



DOC#614

FIGURE 22.



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[redacted]

FIGURE 23. HERPTILE FACTOR LOADINGS 1 & 2
Rotation: Unrotated; Extraction: Principal Components
By Cover Types (3 replicates each)

Taxa in clear boxes have clumped dispersion patterns in DMM and SDM.

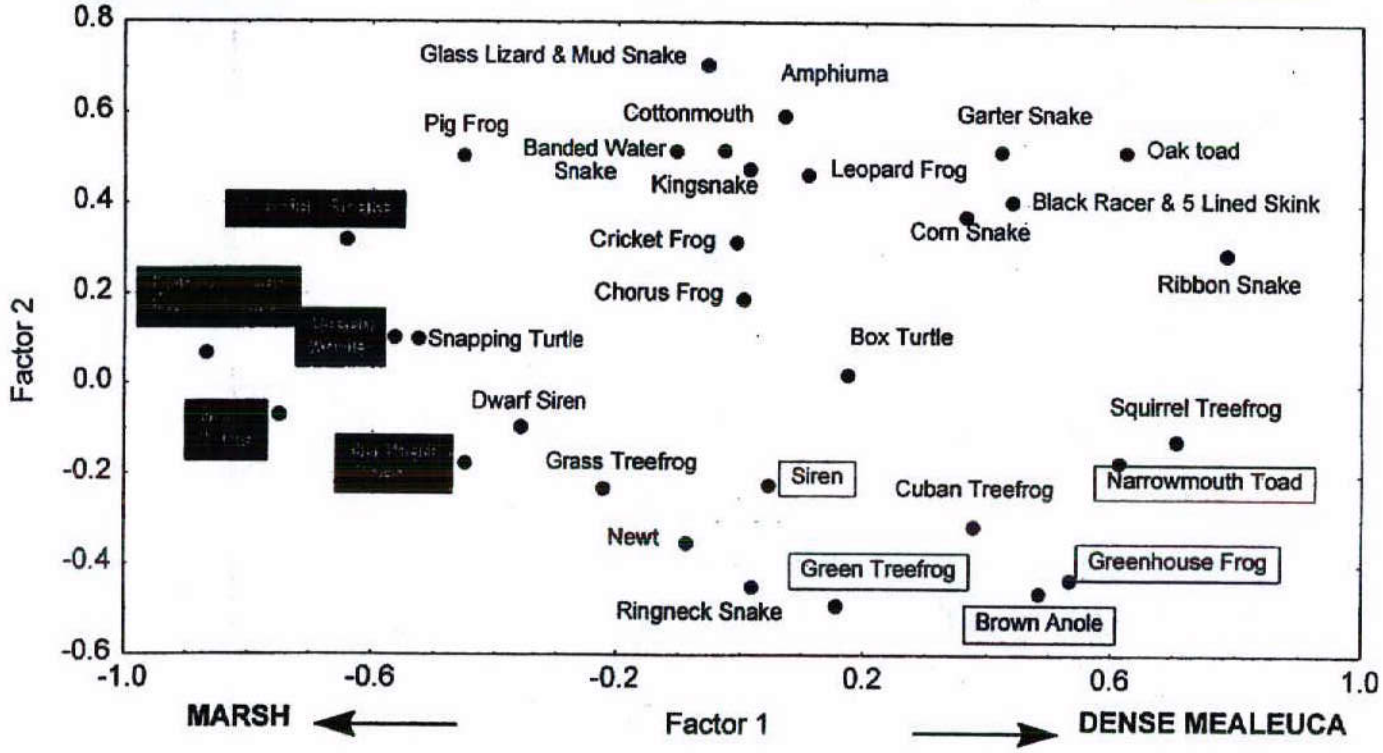

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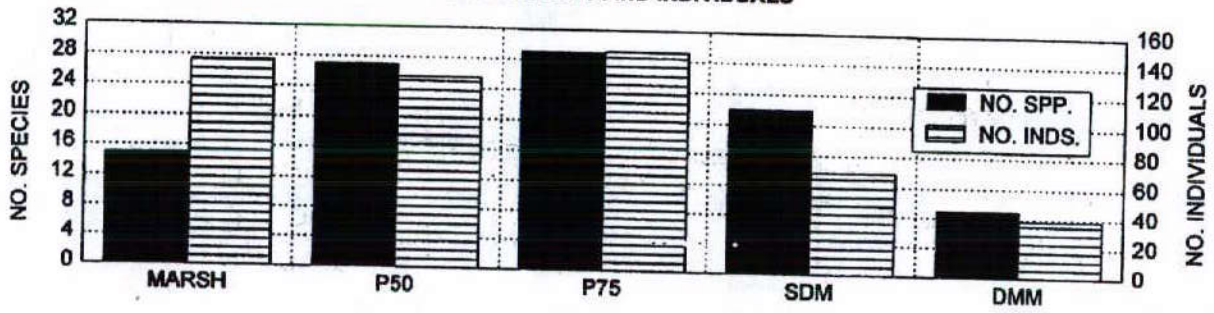
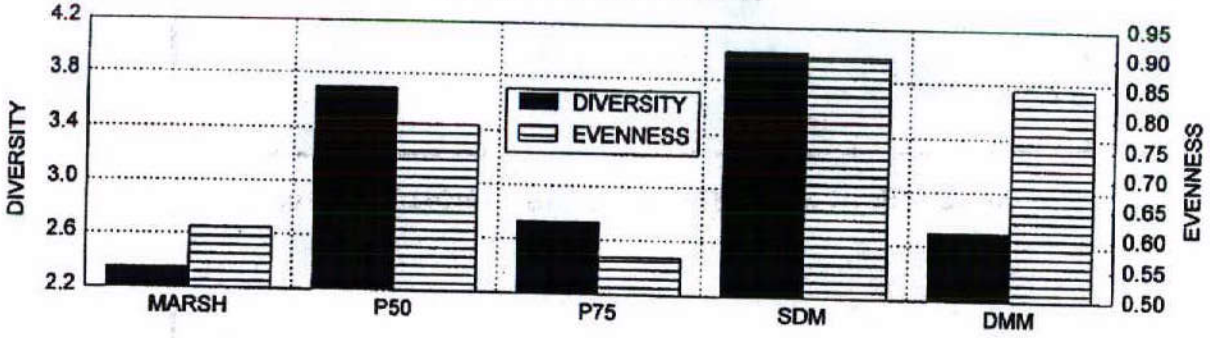
FIGURE 24. BIRD DATA FROM TRANSECTS FOR 5 COVER TYPES

TWO YEAR CUMULATIVES

A. NO. SPECIES AND INDIVIDUALS

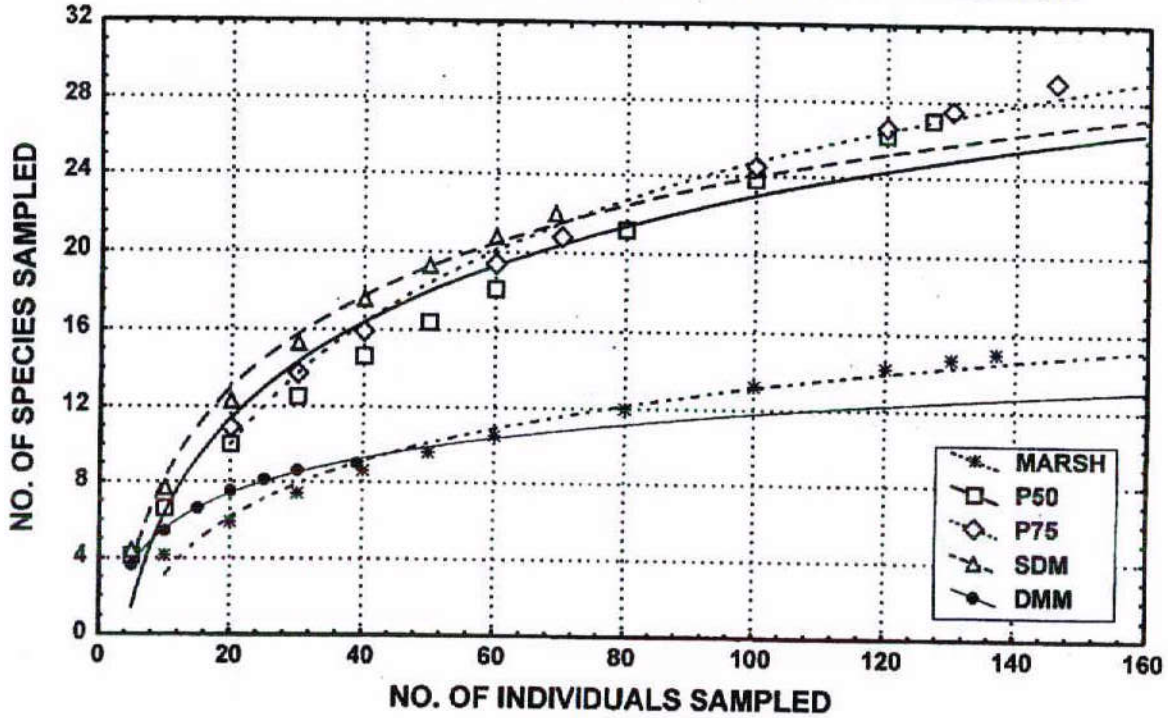


B. DIVERSITY AND EVENNESS



DOC#614

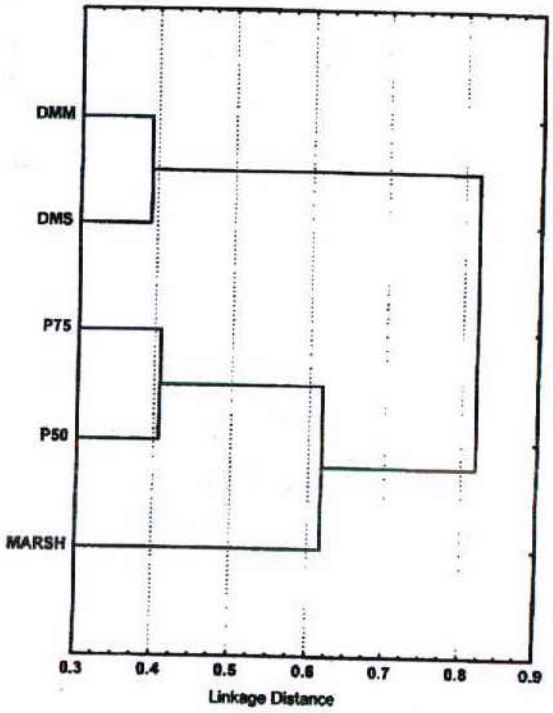
FIGURE 25. RAREFACTION CURVES FOR BIRDS BY COVER TYPE



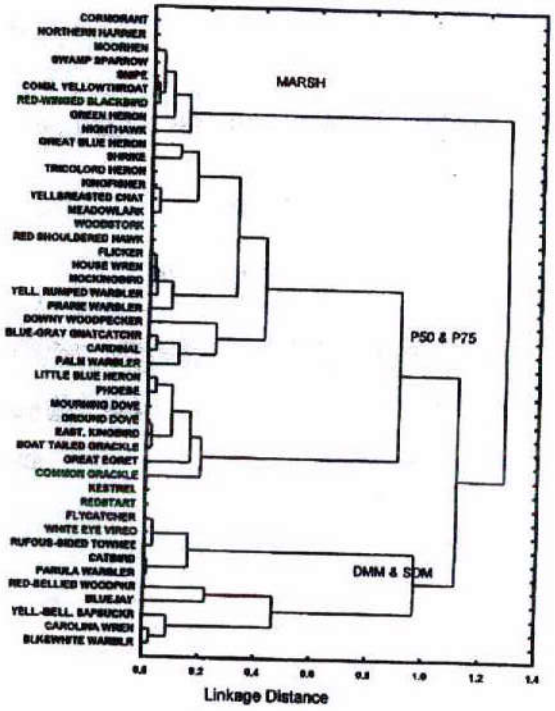
DOC#614

FIGURE 26.

A. CLUSTER ANALYSIS OF 46 BIRD SPECIES BY COVER TYPES
Unweighted pair-group average; 1-Pearson's r.
Based on bird transect data only, two year totals.

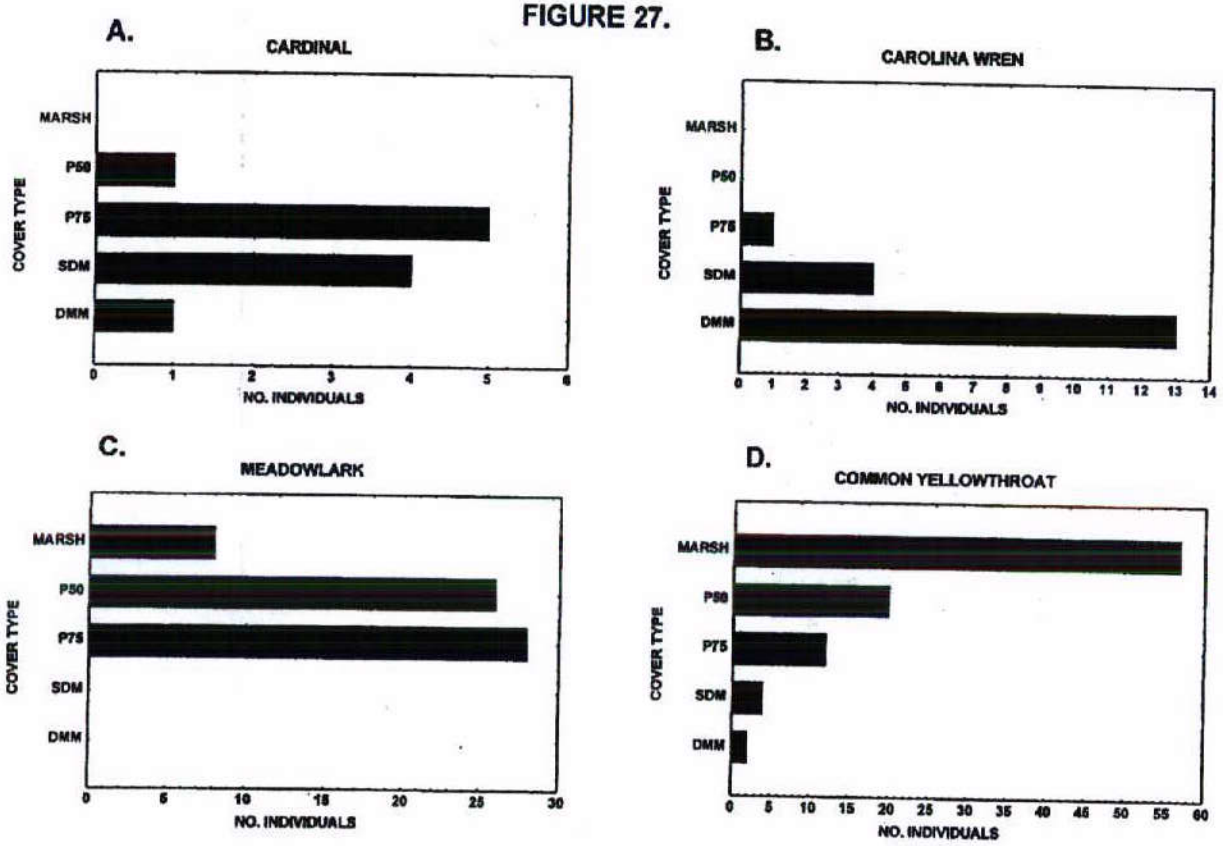


B. CLUSTER ANALYSIS FOR 46 BIRD SPECIES
TRANSECT DATA ONLY, IN 5 COVER TYPES
Unweighted pair-group averages; 1-Pearson r.



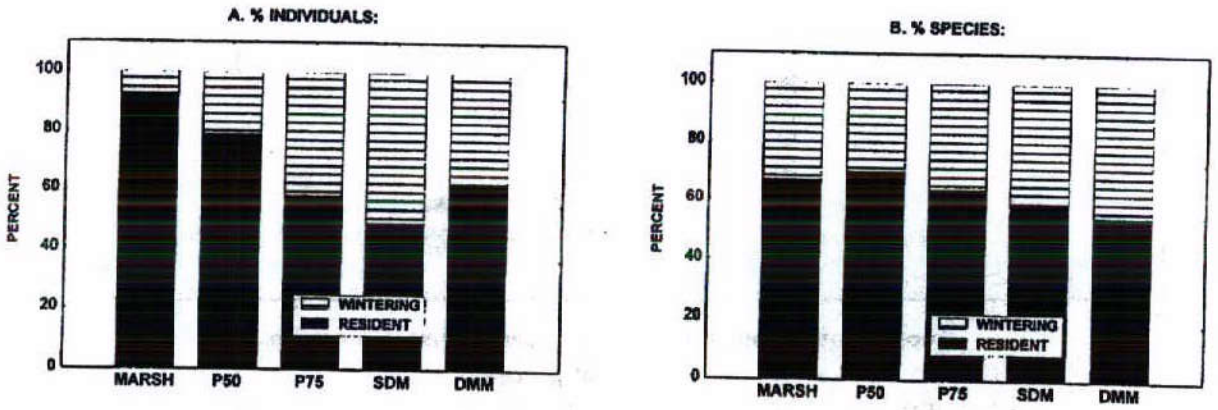
DOC#614

FIGURE 27.



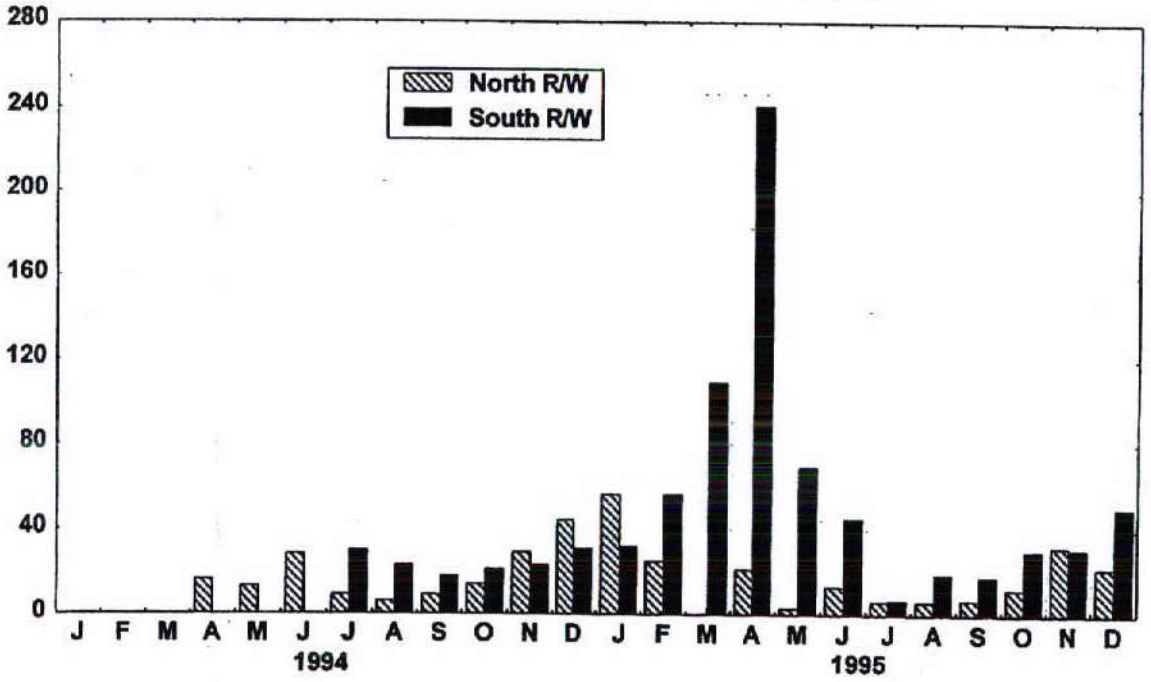
DOC#614

FIGURE 28. RESIDENT VS. WINTERING BIRDS IN 5 COVER TYPES.
PERCENT COMPOSITION BY INDIVIDUALS AND SPECIES.



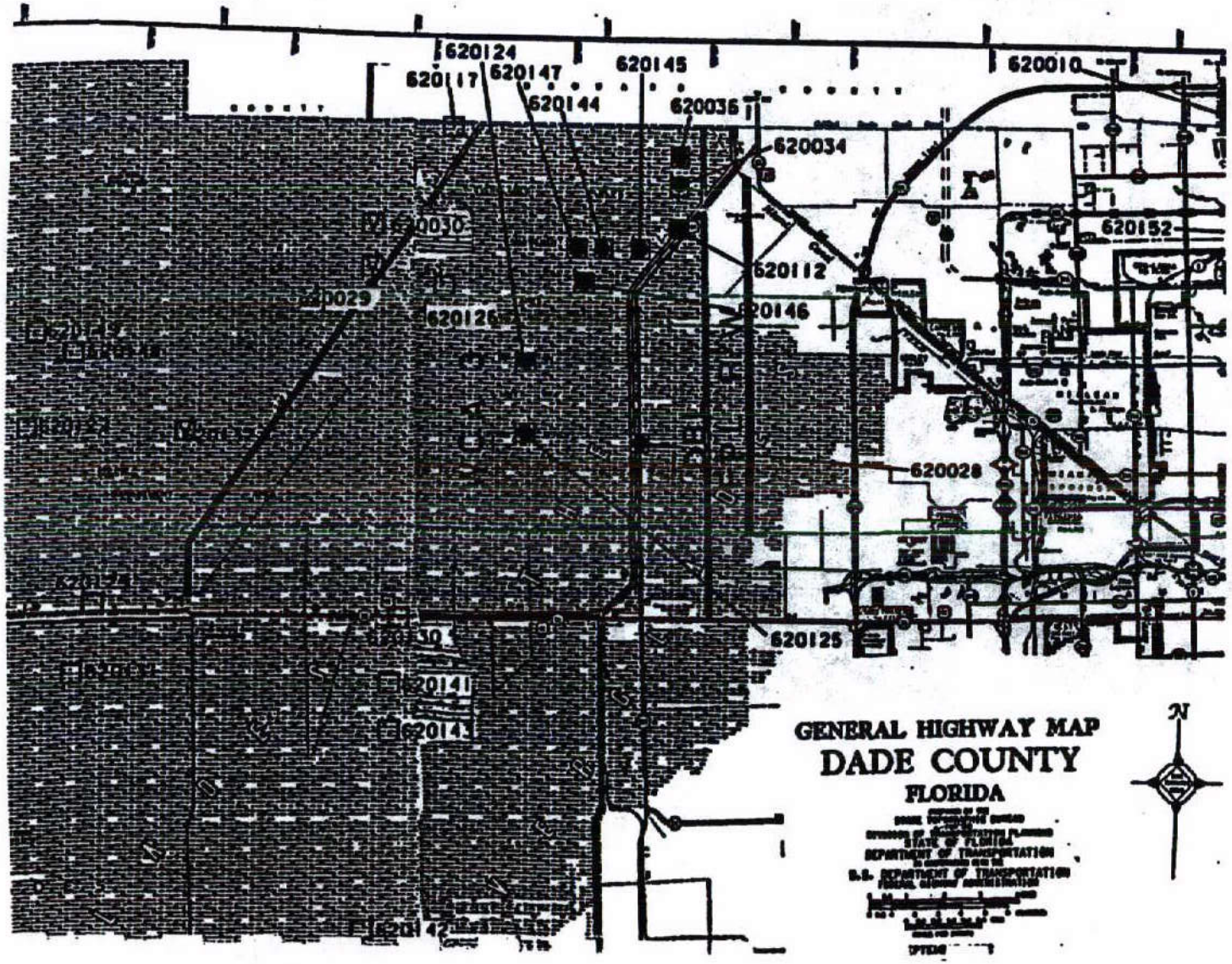
DOC#614

FIGURE 29. MONTHLY WADING BIRD COUNTS FROM ROAD SURVEYS
FPL RIGHT OF WAY
Pennsuco Canal divides R/W into North and South portions



DOC#614

Figure 30. Approximate locations of wading bird rookeries in Water Conservation Area (WCA) 3. Solid symbols represent rookeries within 10 km of the FPL Right-of-Way. Figure adapted from Runde et al., 1991.

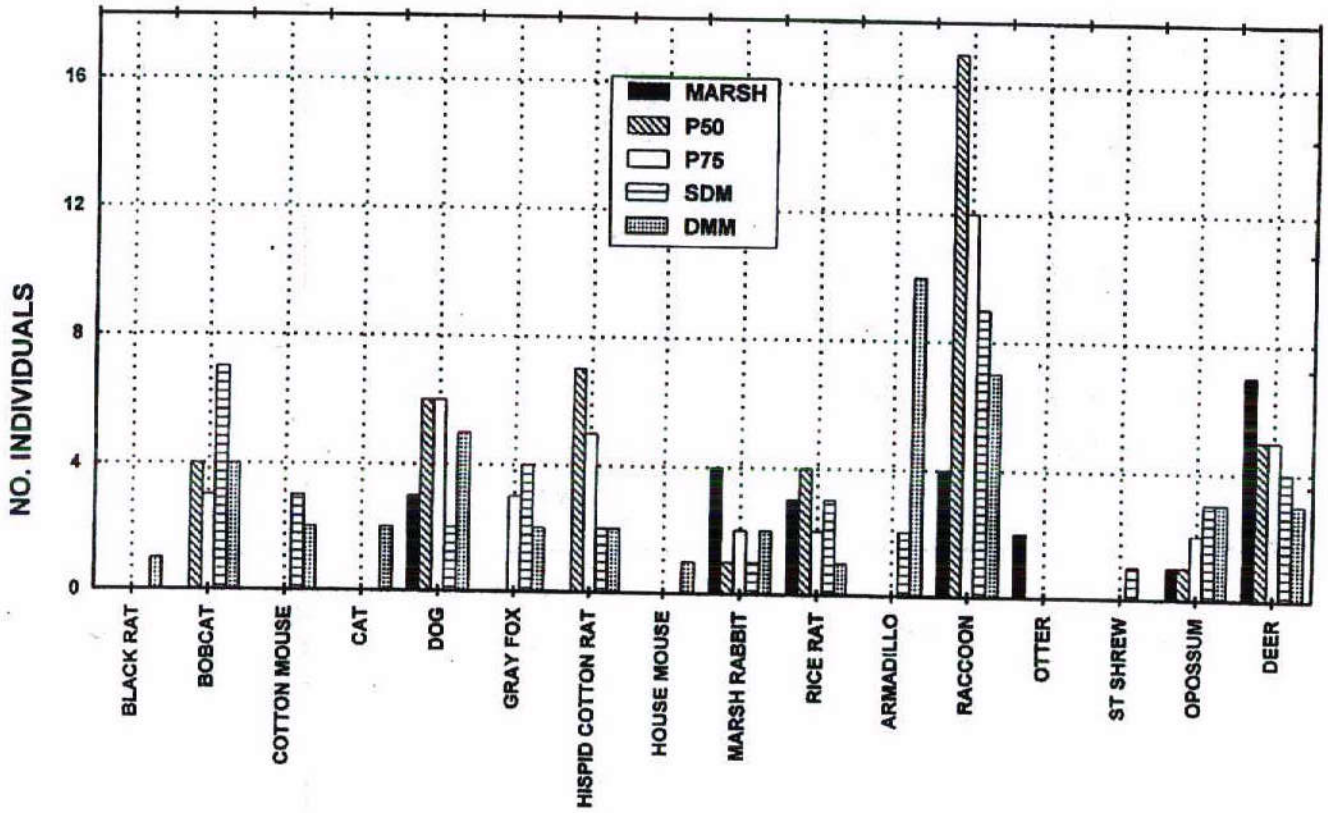


DOC#6614

Figure 31A. Carolina wren nest in the peeling outer bark of a mature melaleuca tree at DMM-6 site.

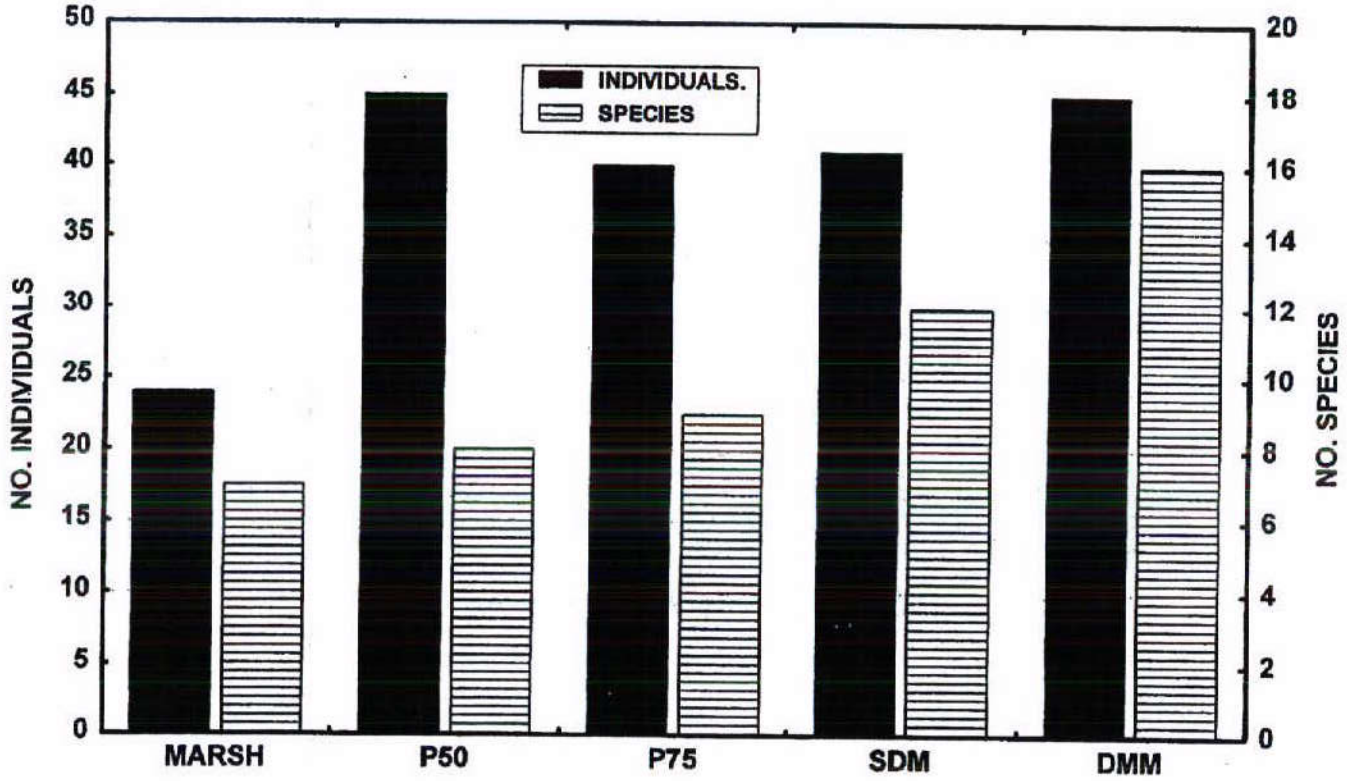
Figure 31B. Woodpecker cavities in a melaleuca snag. Photograph taken near site P50-3.

FIGURE 32. MAMMALS BY COVER TYPE



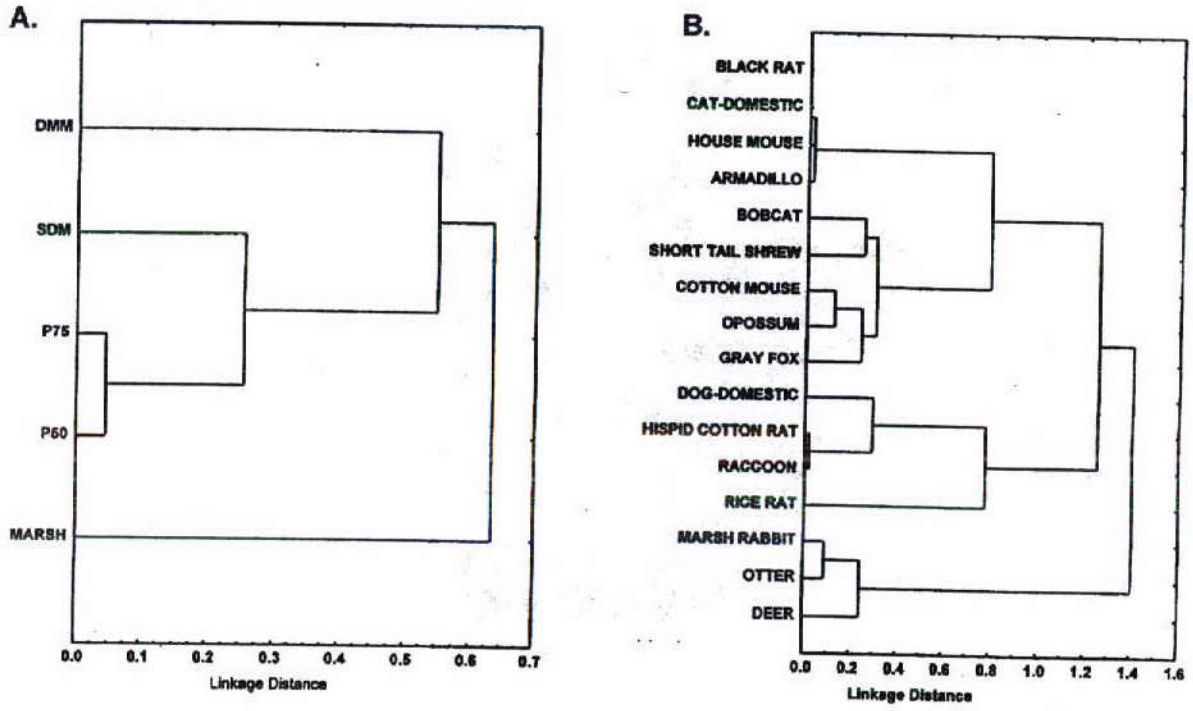
DOC#614

FIGURE 33. MAMMALS BY COVER TYPE
24 MONTHS - ALL METHODS



DOC#614

FIGURE 34. CLUSTER ANALYSES FOR MAMMALS IN 5 COVER TYPES
2 YEAR CUMULATIVE DATA SET - ALL METHODS
Unweighted pair-group method; 1 - Pearson r.



DOC#614

FIGURE 35 Number of active RIFA mounds by cover type for each quarter

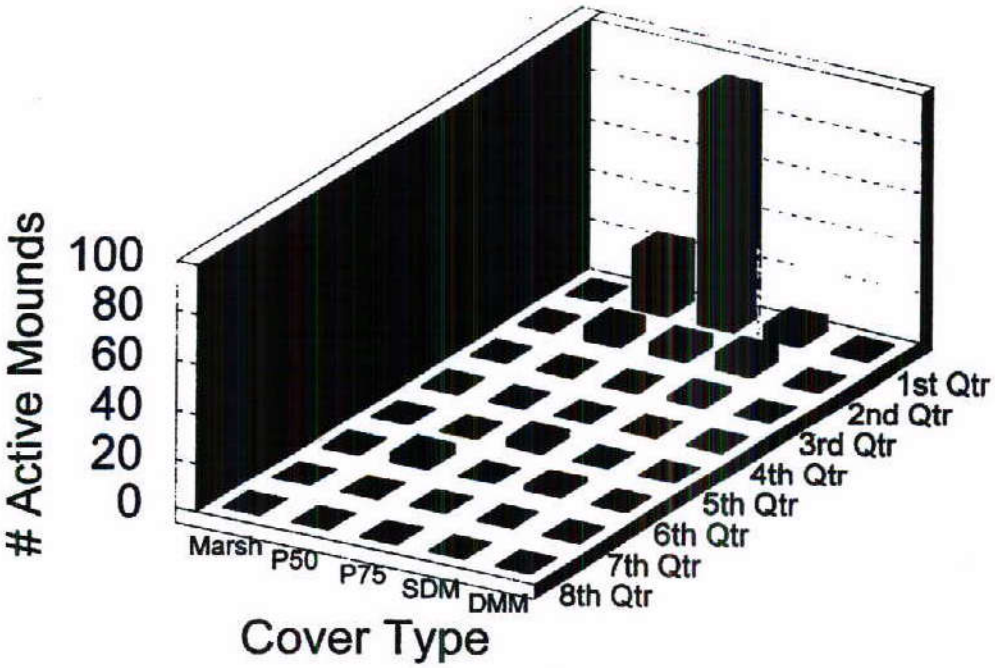
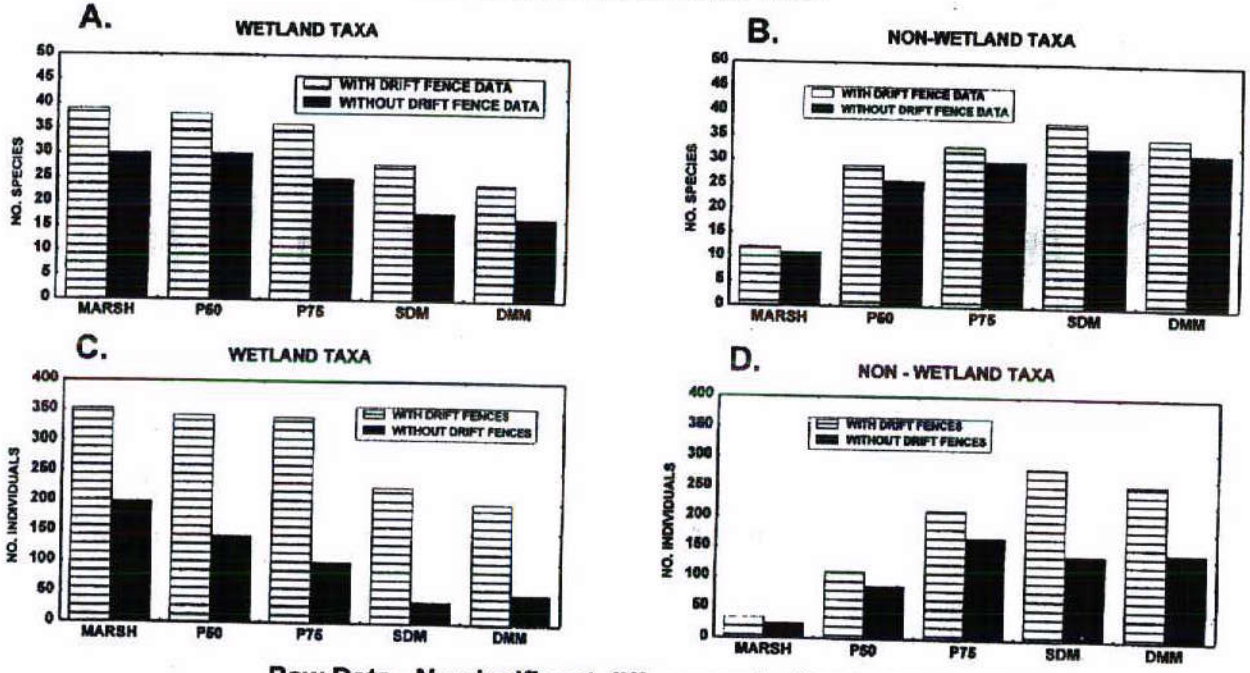


FIGURE 36A. - D. TRENDS IN WETLAND AND NON-WETLAND TAXA WITH AND WITHOUT DRIFT FENCE DATA INCLUDED

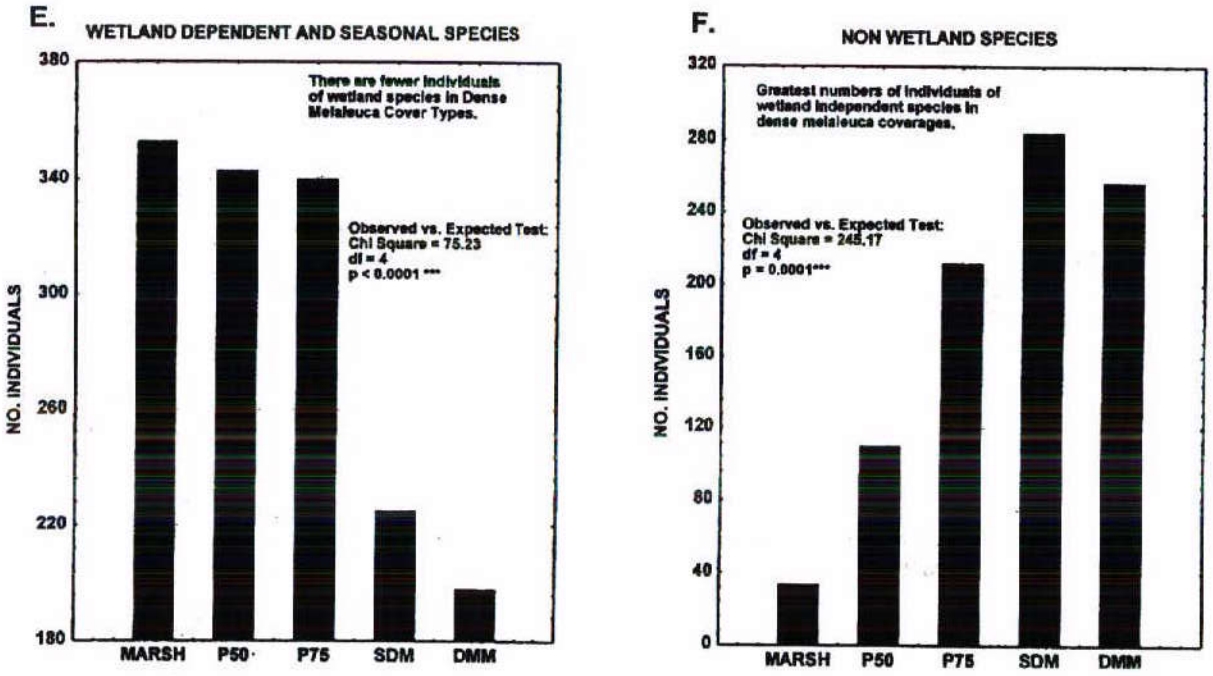
FISHES EXCLUDED IN ALL ANALYSES



Raw Data - No significant differences in distributions with & without drift fence data, Kolmogrov-Smirnov test p's > 0.05.

DOC#614

FIGURE 36E. - F.
NO. OF INDIVIDUALS OF WETLAND DEPENENT & SEASONAL VS. NON WETLAND TAXA
AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS - ALL METHODS

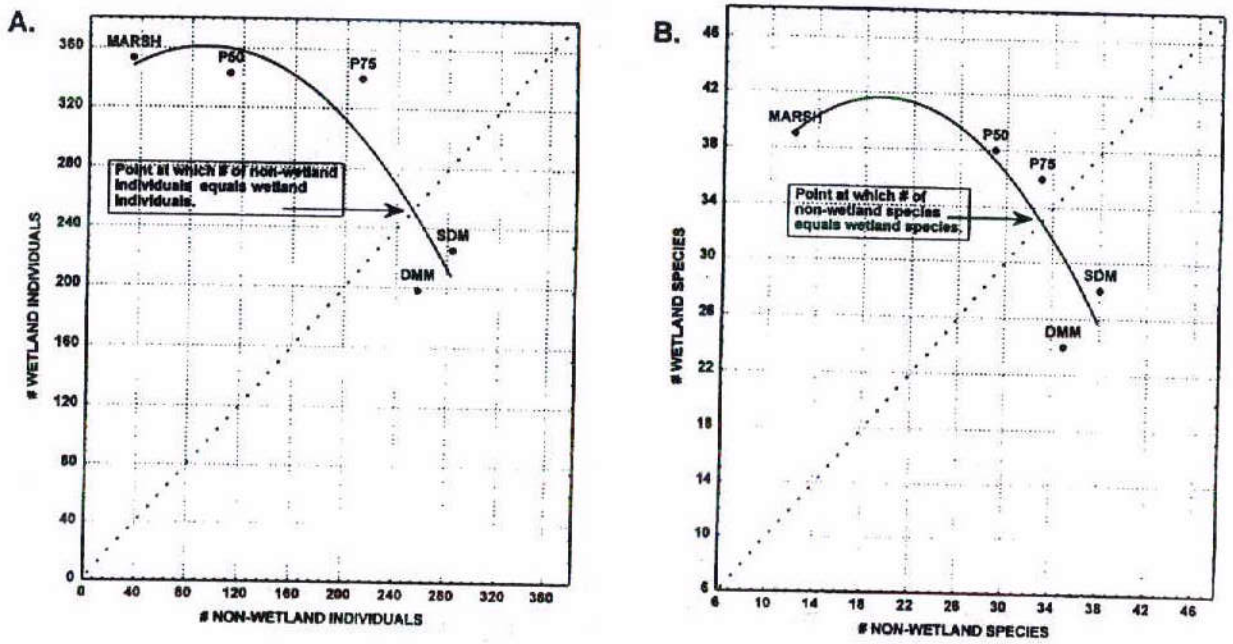


FISHES EXCLUDED FROM ANALYSES.

DOC#614

FIGURE 37. TRENDS IN WETLAND AND NON-WETLAND SPECIES AS MELALEUCA INVASION PROGRESSES.

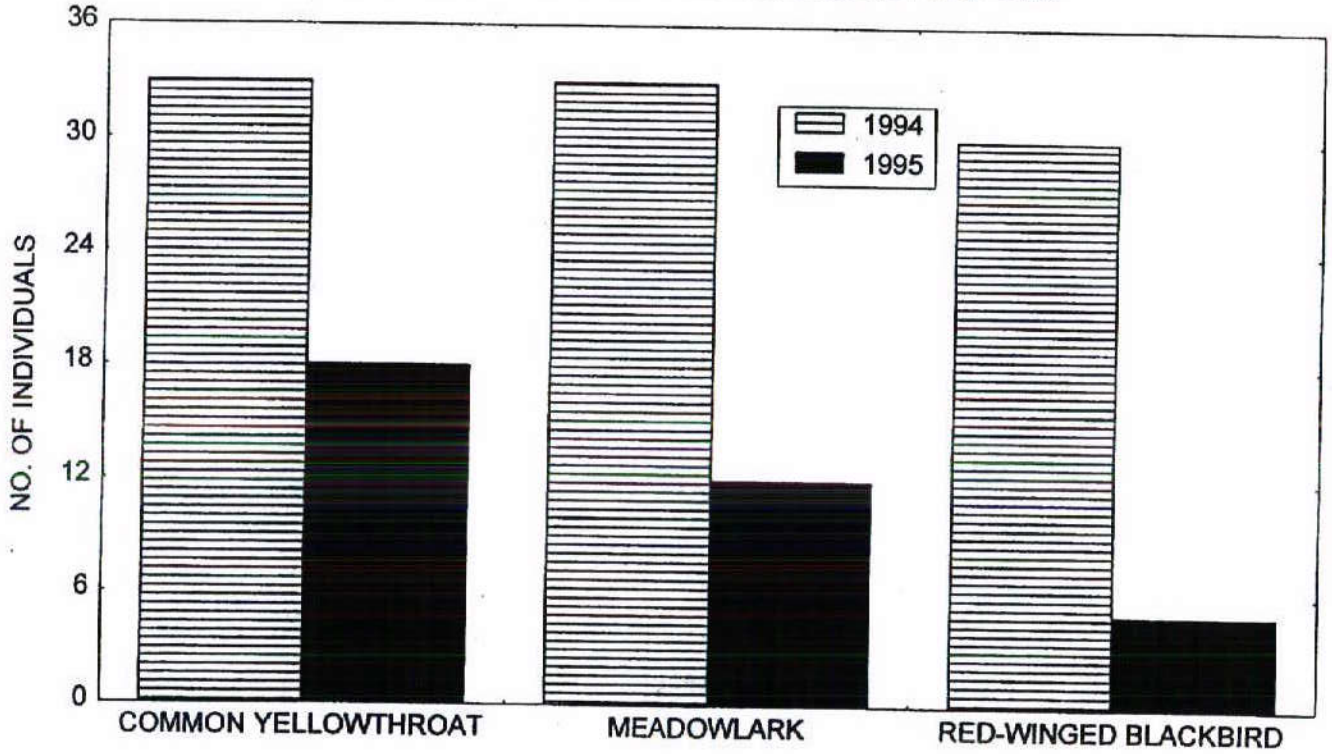
1. - Initially species richness and abundance increase as non-wetland species, especially birds, are added to the community.
2. - Finally, richness and abundance decline, as wetland species become more rare.



FISHES EXCLUDED FROM ANALYSIS. DATA INCLUDES AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS - ALL METHODS.

DOC#614

FIGURE 38.
ABUNDANCE OF THREE RESIDENT BREEDING BIRD SPECIES IN 1994 & 1995
STRIP TRANSECT DATA FOR APRIL - SEPTEMBER OF EACH YEAR.



DOC#614

FIGURE 39. Summary of changes in vegetation structural diversity and wildlife diveristy in native wetland habitats with increasing coverage by melaleuca.

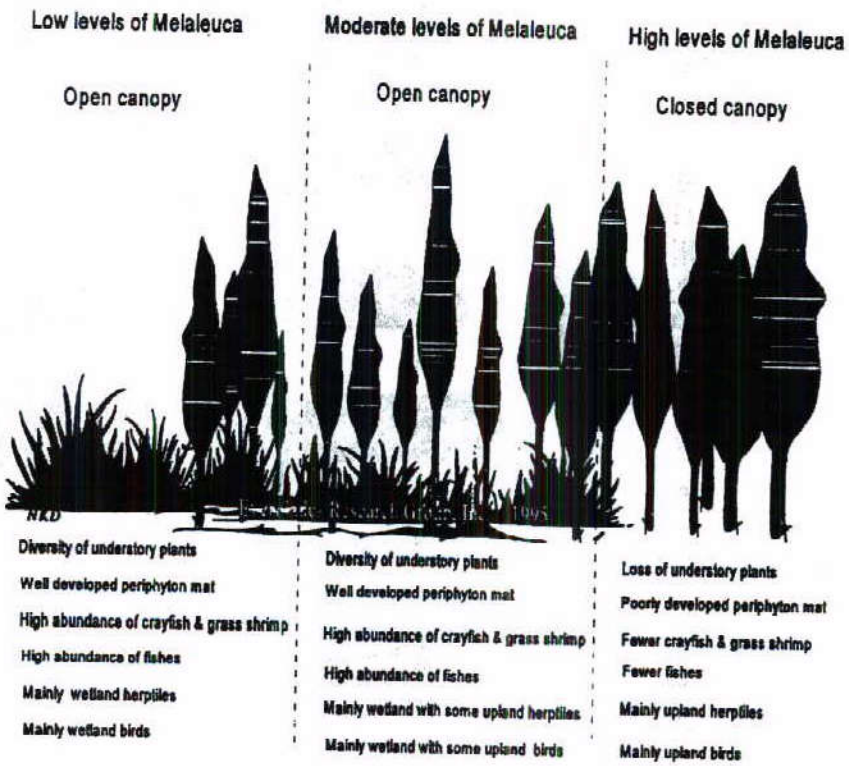
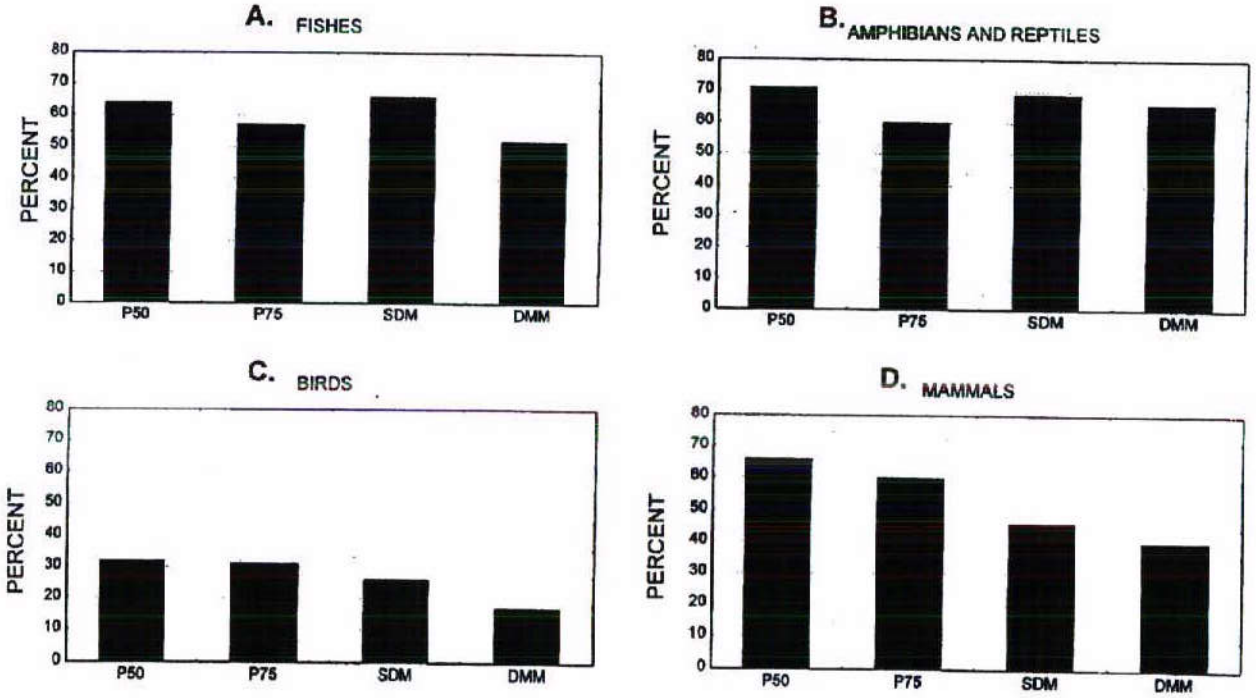
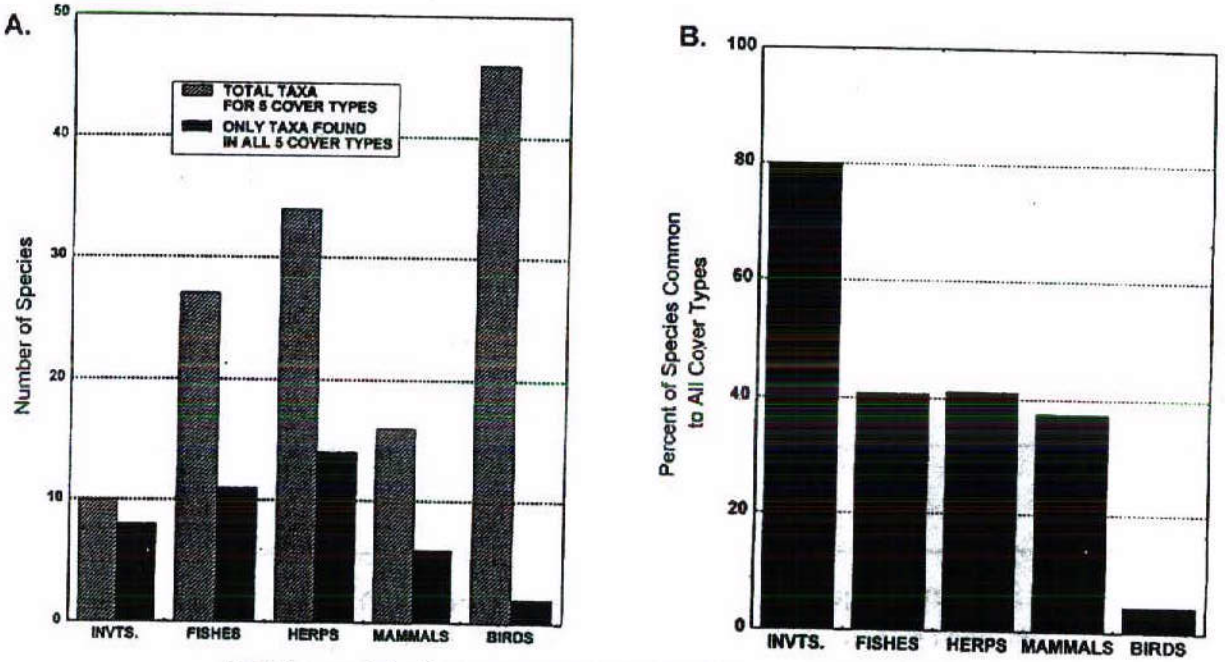


FIGURE 40.
PERCENT OF SPECIES IN MARSHES THAT OCCURED IN OTHER COVER TYPES



DOC#614

FIGURE 41. TOTAL TAXA AND TAXA COMMON TO ALL 5 COVER TYPES MARSHES - DENSE MELALEUCA.



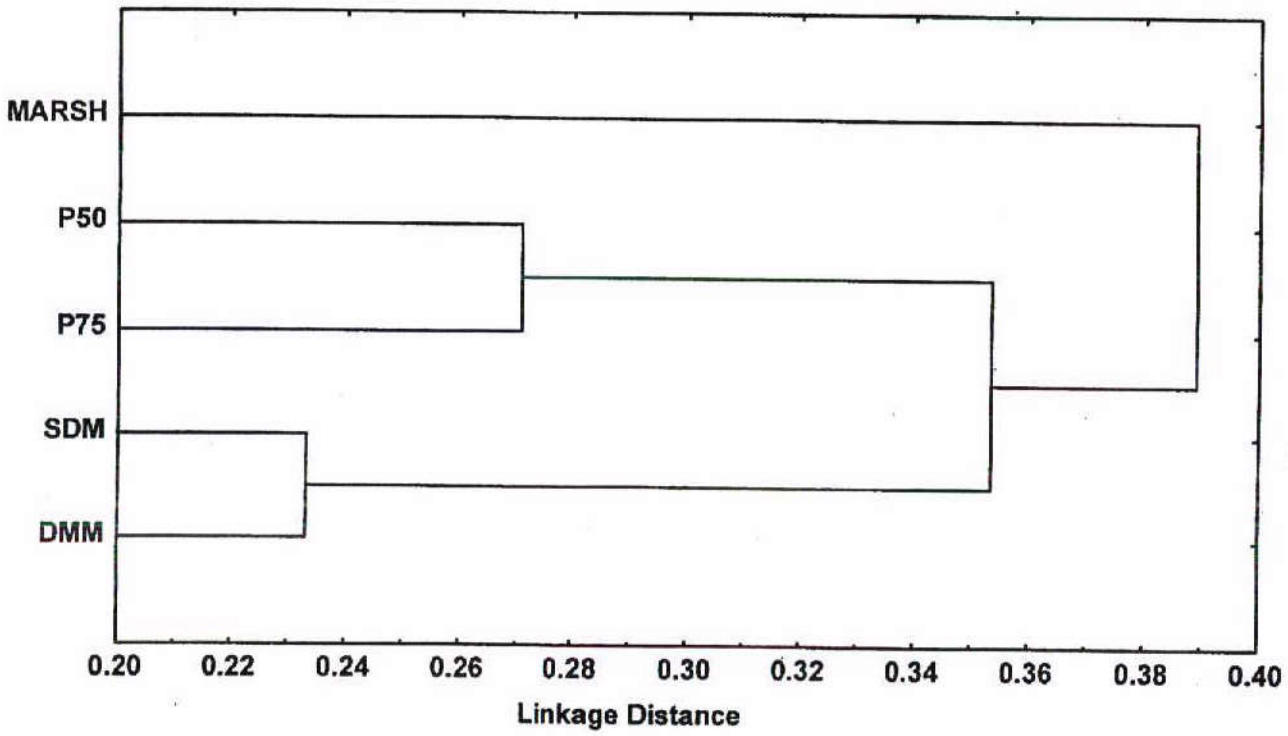
Drift fence data for macroinvertebrates, fishes and herptiles.
Transect, trap, and stations for mammals. Transects for birds.

DOC#614

FIGURE 42. CLUSTER ANALYSIS: PRESENCE (=1) or ABSENCE (=0) FOR 133 TAXA

Macroinvertebrates, Fishes, Herptiles, Birds, and Mammals.

Unweighted pair-group average; Percent disagreement.

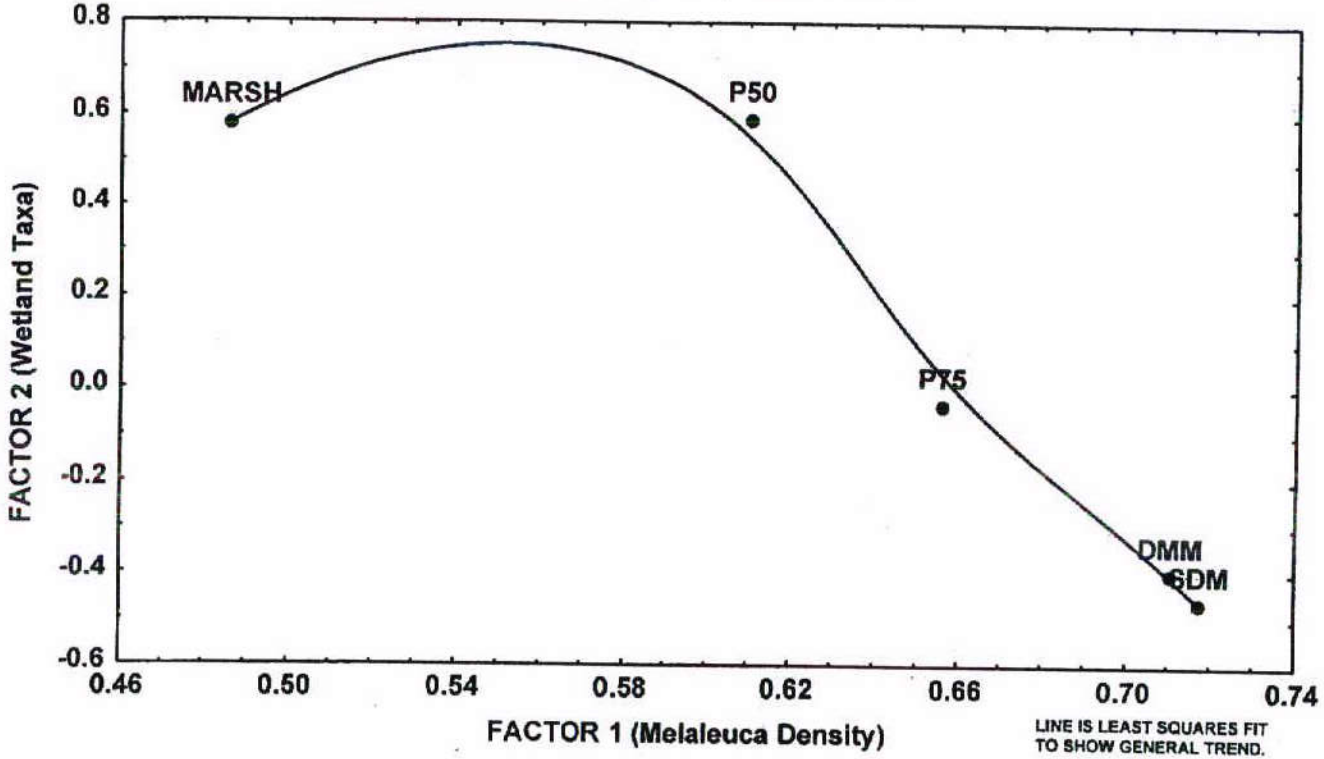


DOC#6 1 4

FIGURE 43. SCATTERPLOT OF FACTOR LOADINGS- PRESENCE/ABSENCE DATA FOR 133 TAXA

Macroinvertebrates, Fishes, Herptiles, Birds & Mammals; Present = 1; Absent = 0.

Extraction: Principal components; Unrotated



DOC#614

FIGURE 44. A schematic drawing of habitat use by some typical wetland birds. FROM WELLER (1982).

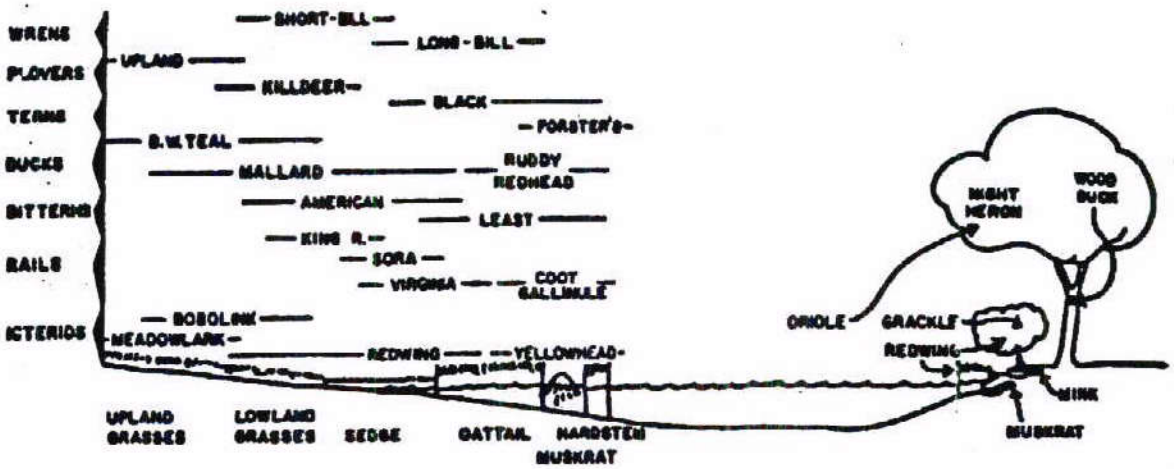
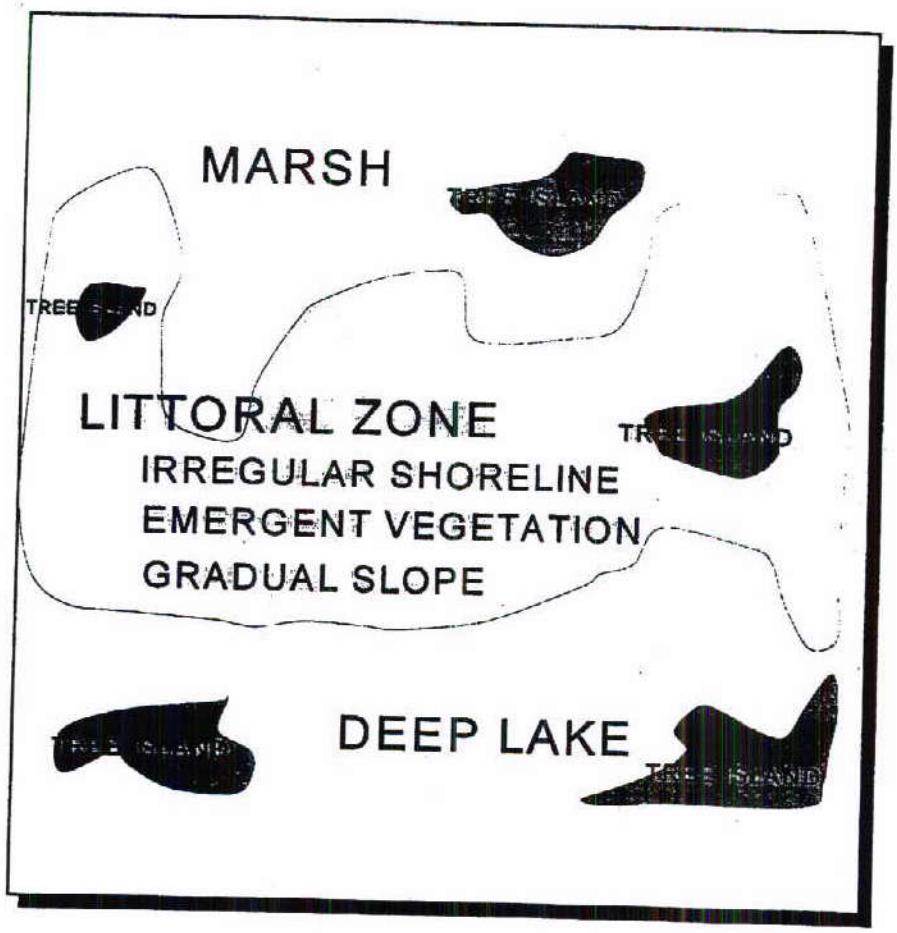
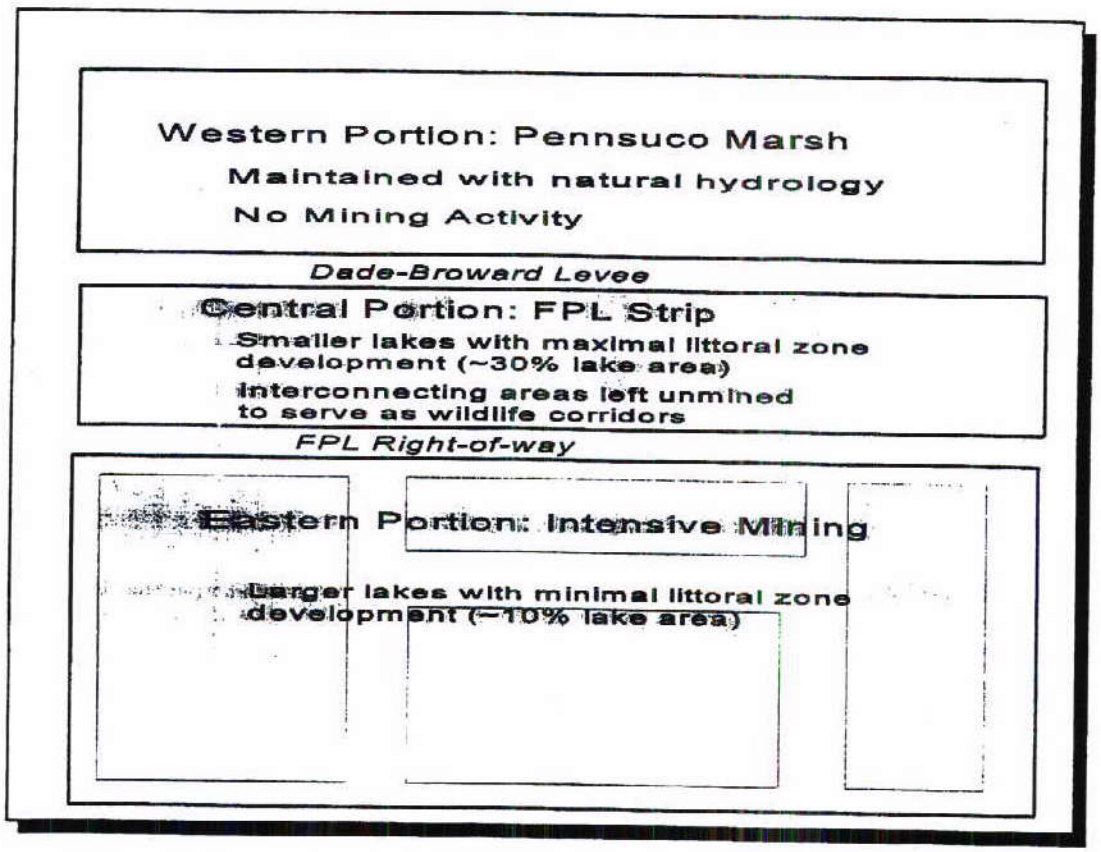


FIGURE 45. Schematic of lake and littoral zone with enhancements for wildlife.



Not to scale

Figure 46. Schematic diagram of a three region Lake Belt Plan.



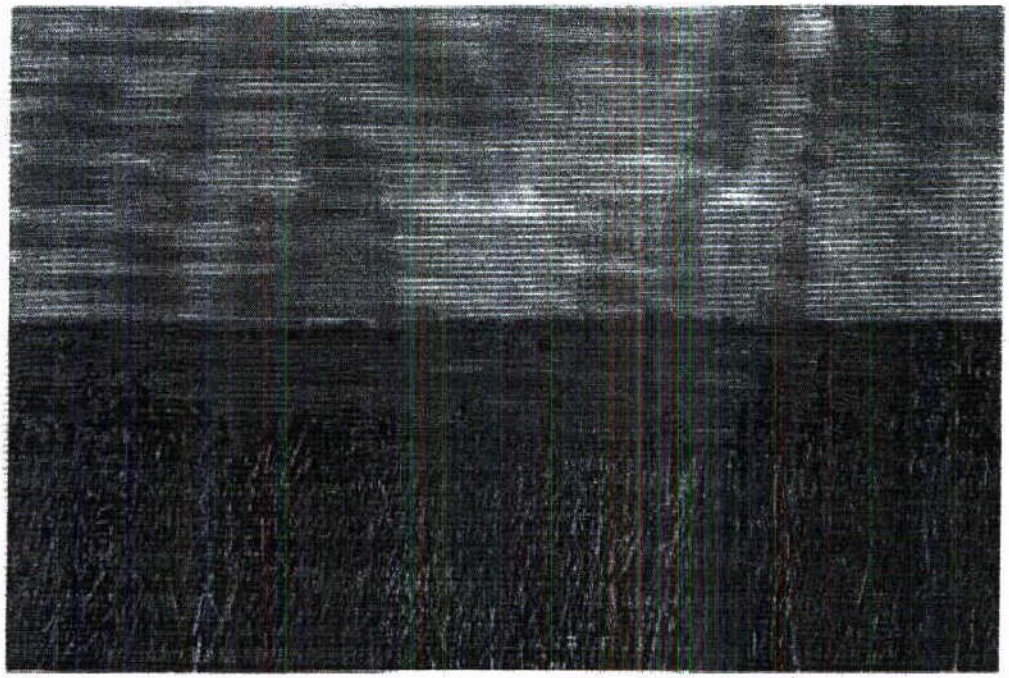
Not to scale

APPENDIX A

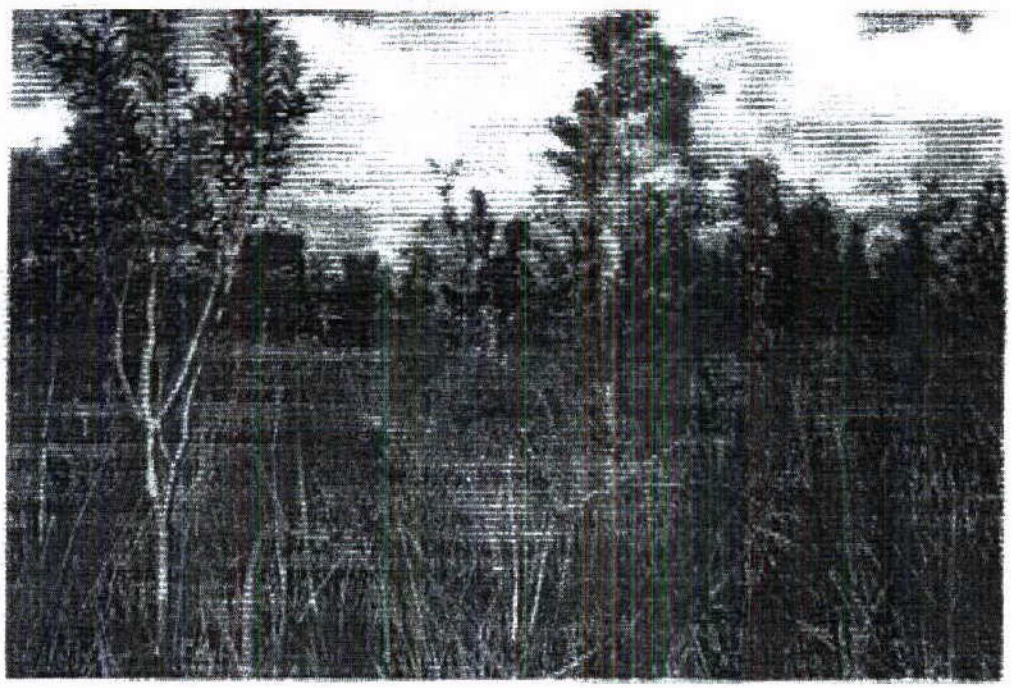
APPENDIX A

Photographs of representative sites for each cover type. For locations of the sites, refer to Figure 2. Cover types were assigned by ERG staff, in consultation with DERM staff and the vegetation expert from EAS Engineering. Cover type designation relied upon ground-truthing, since a vegetation map of the area was not available when site selection began. Twelve of the 50 sites were located by GPS by EAS Engineering. These sites were: MAR-1, MAR-2, MAR-3, P50-1, P50-2, P50-3, P75-1, P75-3, SDM-1, SDM-2, DMM-1, and DMM-3. Co-ordinates were used to locate the sites on the GIS map of the region. The remaining 38 sites were located on aerial photographs then entered into the GIS map.

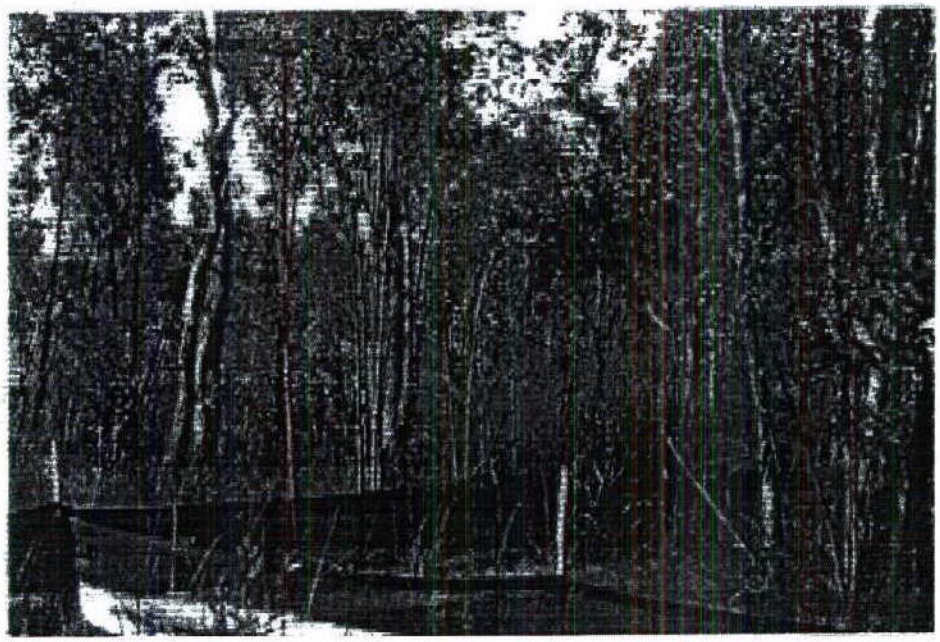
Marsh (0% to 10% melaleuca) cover type. Photograph taken from Dade-Broward Levee, looking west, in May 1996. Site MAR-2 was located in this area.



P50 (10% to 50% melaleuca) cover type. Photograph at site P50-1, in May 1996.



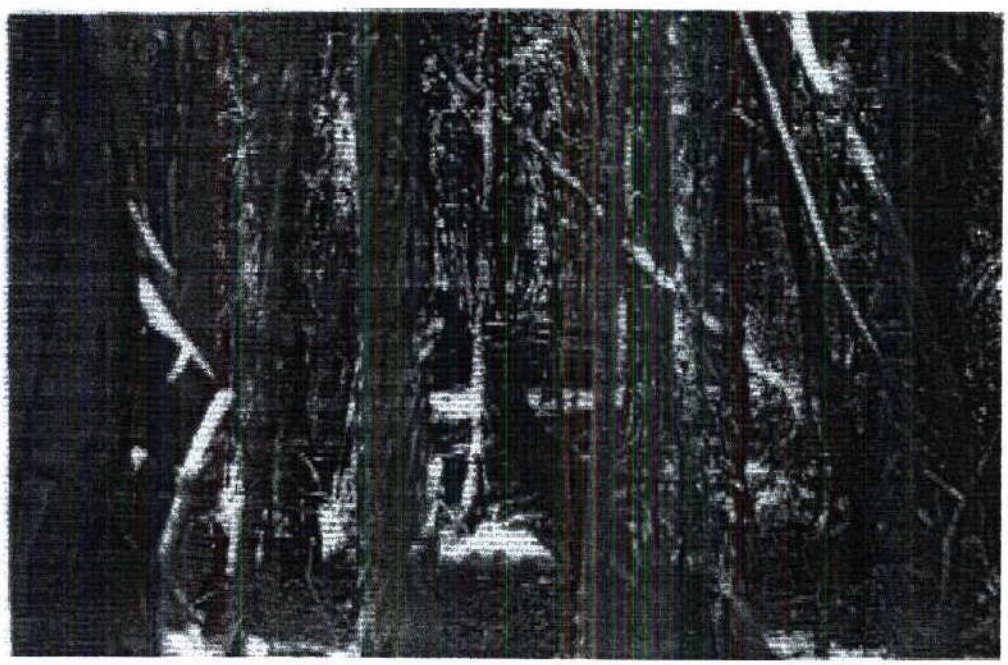
P75 (50% to 75% melaleuca) cover type. Photograph at site P75-1, in May 1996. Drift fence array (arrow) is partially visible.



SDM (75% to 100% melaleuca, sapling stage) cover type Photograph taken at site SDM-5, in May 1996.

SDM (75% to 100% melaleuca, sapling stage) cover type. Photograph taken at site SDM-2, in January 1994. Site was being cleared to place drift fence array.

DMM(75% to 100% melaleuca, mature stage) cover type. Photograph taken at site DMM-1, in January 1996. Drift fence array (arrow) is partially visible.



APPENDIX B

Listing of the three sites randomly selected each month for DIP NET SAMPLING. Shading indicates site conditions inappropriate for samplin
Asterisk (*) indicates sampling performed, but no animals were caught.
In the case of dip net sampling, inappropriate conditions were less than one meter square of standing water.
Sampling generally occurred during the first week of each month.
See Figure 2 for the approximate location of each site.

Within each cover type, site numbers are listed in numeric order.

		Marsh 0% - 10% Randomly selected sites			P50 10% - 50% Randomly selected sites			P75 50% -75% Randomly selected sites			SDM >75% Sapling Randomly selected sites			DMM >75% Mature Randomly selected sites		
Jan	94															
Feb	94															
Mar	94	3				6		7								
Apr	94			8								5				
May	94	2	4	6	3			7				3				
Jun	94	1	2	3	1									3		
Jul	94	1	2	3	1	2	3	1	2		2	5			3	
Aug	94	1	2	3	1	2	3	1	2	3		2	3			3
Sep	94	4	7	10	1	3	9	3	4	10	1	8	10	3	5	6
Oct	94	1	5	7	5	6	8	3	5	9	1	3	9	5*	7	10
Nov	94	1	6	8*	3*	4*	7	3	7*	10*	2	3*	7	1*	4*	8
Dec	94	2	8	10	2	4	8	4	6*	10	5	8	9	5*	6	7*
Jan	95	1	2	3	1	4	5	3	4	9*	5	6*	9*	1*	4	10
Feb	95	1	2	3	2	3	10	1	2	10	2	6	10	3	8*	10*
Mar	95	8	9	10	5	6		5*	7	8	2*	5	6*	1*	6	8
Apr	95					7		6	7		6		8			6*
May	95															
Jun	95	3*	5	6		3	5		4							
Jul	95	1	3	7	3	7	8	4	5	7	3	4	7	4*	5	6
Aug	95	1	4	6*	2*	4*	8	7*	9	10	6*	9	10	3*	4	10
Sep	95	2	3	8*	2	3	6	5	6	10*	4	5	8	4	8	10
Oct	95	4	9	10	1	5	7*	4	5*	7	1	7	9	7*	8	10
Nov	95	3	4	9	3*	7	8*	1	6*	8	5	7	8*	3*	8	9
Dec	95	2	4	6	1	5	6	6	7	9*	4	5	8	1*	2*	4

* Indicates sampling performed, yet no animals captured
Shading indicates too dry for sampling

DOC#614

Listing of the three sites randomly selected each month for MINNOW TRAPPING. Shading indicates site conditions inappropriate for sampling. Asterisk (*) indicates sampling performed, but no animals were caught. In the case of minnow trapping, inappropriate conditions were less than 10 cm of standing water. Sampling generally occurred during the first week of each month. See Figure 2 for the approximate location of each site.

Within each cover type, site numbers are listed in numeric order.

		Marsh 0% - 10% Random site	P50 10% - 50% Random site	P75 50% -75% Random site	SDM >75% Sapling Random site	DMM >75% Mature Random site
Jan	94					
Feb	94					
Mar	94					
Apr	94					
May	94	2			3	
Jun	94			7	5	4
Jul	94					
Aug	94					
Sep	94	3	10	9		3
Oct	94	1	5	5	6	7
Nov	94	4	4	4	2	5
Dec	94	1	2	10*	8*	4
Jan	95	3	5*	6*	1	2
Feb	95	2	10	4	4*	3
Mar	95	4*	6	7	5	6*
Apr	95					
May	95					
Jun	95					
Jul	95	1*	4	7	7	4
Aug	95	1	4	4	7	3
Sep	95	3	2*	5	6	8
Oct	95	10	4	4	7	8
Nov	95	9	9	1	3	3
Dec	95	6				

* Indicates sampling performed, yet no animals captured
Shading indicates too dry for sampling

DOC#614

Listing of the three sites randomly selected each month for FAUNAL TRANSECTS. Shading indicates site conditions inappropriate for sampling.
In the case of faunal transects, inappropriate conditions were continuous standing water.
Sampling generally occurred during the third week of each month.
See Figure 2 for the approximate location of each site.

Within each cover type, site numbers are listed in numeric order.

		Marsh 0% - 10% Randomly selected sites			P50 10% - 50% Randomly selected sites			P75 50% -75% Randomly selected sites			SDM >75% Sapling Randomly selected sites			DMM >75% Mature Randomly selected sites		
Jan	94															
Feb	94															
Mar	94	3	4		1	3	5	1	3	7	2	8		2		9
Apr	94	2	4	8	2	6	10	5	9	10	1		10	1	5	
May	94	1	2	3	1	2	3	1	3	7	1	3	10	1	2	10
Jun	94	2	8	9	1	5	8	1	6	10	1	5	9	4	5	9
Jul	94	2	5	6		7	9		7			8	10	6	8	10
Aug	94	1	3	10	6	8	10	2	8	10	2	4	10	4	6	7
Sep	94	2	3	4	3	4	10	4	5	9	1	3	8	3	6	10
Oct	94	1	5	7	5	6	8	3	5	9	6	7	9	2	7	10
Nov	94															
Dec	94															
Jan	95															
Feb	95							1			2			4		9
Mar	95	6	8		6		10	1		10	2		8	1	5	6
Apr	95	2	4				8	3	4		2	6		3	5	
May	95	1	4	9	2	5	7	1	6	9	2	3		2	4	
Jun	95	1			4			1	2	5		5		3		
Jul	95															
Aug	95	1				4									4	
Sep	95															
Oct	95															
Nov	95															
Dec	95										1			1		

Shading indicates too wet for sampling

767

DOC#6 14

Listing of the three sites randomly selected each month for BIRD STRIP TRANSECTS.
In the case of bird strip transects, sampling was performed regardless of standing water conditions.
Sampling generally occurred during the third week of each month.
See Figure 2 for the approximate location of each site.

Within each cover type, site numbers are listed in numeric order.

		Marsh 0% - 10%			P50 10% - 50%			P75 50% -75%			SDM >75% Sapling			DMM >75% Mature		
		Randomly selected sites			Randomly selected sites			Randomly selected sites			Randomly selected sites			Randomly selected sites		
Jan	94	1*	2	other*	1*	2*	3*	1*	2	other*	1*	2*	other*	1*	2*	3*
Feb	94	1	2	3	1*	2*	3	1	2*	3	1*	2*	3*	1*	2*	3
Mar	94	1*	2*	3*	1*	2*	3*	2*	3	7*	3	5	other*	2*	3*	9*
Apr	94	2	8*	10	3	5*	6	1	5	other*	1*	5	10*	1	4	5*
May	94	2	3	4	2	4	10	2	4	10	1	3*	9	1*	3	10*
Jun	94	2	7	8*	1	2	8*	1	2	3	1	3	5*	1	3*	4*
Jul	94	1*	2	6	3	7*	9*	1	4	7	2*	5*	8	6	8*	10*
Aug	94	1	2*	10*	6*	8	10*	1*	8*	10*	3*	4*	8*	4	6	7
Sep	94	1	3	4*	8	9*	10	4	5*	9	1*	3	8*	3	5*	6*
Oct	94	1	5*	7	5	6	8	3	5*	9	6	7*	9	2*	7*	8
Nov	94	1	4*	6	4*	7	10	4	6	8	1	2	10	2	5*	8*
Dec	94	1	8*	10	2*	4	8*	4*	9	10	2	4	5*	2	4*	6*
Jan	95	2*	3*	7	4	6	7	3*	4	6	5*	9	10	2	4*	10
Feb	95	1	6*	8*	2	4	10	4	8*	10*	1	3	4*	3*	4*	10*
Mar	95	1	6	8	4	5*	10	5	7	10	2*	8*	9	5*	6*	8*
Apr	95	1	4	9	2	7	8*	3*	6	7*	5*	6*	7	3*	4*	5*
May	95	4*	7	8	4	5	7*	1*	6*	9	2*	4	5	2*	5	6*
Jun	95	2	5	8	5*	7	10	1	5*	10	5*	7	8*	3*	6*	10
Jul	95	1*	3	7*	3	4*	8*	4*	5*	7*	3*	4*	7*	4*	5*	6*
Aug	95	1*	4*	10	4*	7	8*	4*	7	9*	7*	9*	10*	3*	4*	10*
Sep	95	1	3	8	6*	7	10	1	5*	6	4*	6	9	4	5	10*
Oct	95	4	9*	10	1	5	10	1	7	9	1	7*	9*	2	8*	10*
Nov	95	3*	4*	9*	4*	7	9	1	8	9	3*	5*	7*	3*	8	9
Dec	95	5	6	10	3	5*	8	5	7*	10	3	6*	8	1	4*	7*

* Indicates sampling performed, yet no birds observed

DOC#6 1 4

Listing of the one site randomly selected each quarter for SMALL MAMMAL LIVE TRAPPING, SCENT AND BAIT STATIONS .
Shading indicates site conditions inappropriate for sampling. Asterisk (*) indicates sampling performed, but no animals were caught.
In the case of small mammal live trapping, scent and bait stations, inappropriate conditions were continuous standing water.
Sampling generally occurred during the first week of the second month in each quarter (e.g. February, May, August, or November).
See Figure 2 for the approximate location of each site.

	Marsh 0% - 10% Random site	P50 10% - 50% Random site	P75 50% -75% Random site	SDM >75% Sapling Random site	DMM >75% Mature Random site
1st Qtr	4	5	4	5	2
2nd Qtr		2	1	2	1
3rd Qrt		10+	10	9	10
4th Qrt					
5th Qrt		2	1	1+	1
6th Qrt	4	6	7*	5	6*
7th Qrt					
8th Qrt				1+	1+

* Indicates sampling performed, yet no animals captured
+Indicates site sampled because the first randomly selected site was too wet for sampling
Shading indicates too wet for sampling

DOC#6 1 4

Listing of the one site randomly selected each quarter for RED IMPORTED FIRE ANT MOUND SURVEYS. Shading indicates site conditions were inappropriate for sampling. In the case of Red imported fire ant mound surveys, inappropriate conditions were continuous standing water. Sampling generally occurred during the first week of the second month in each quarter (e.g. February, May, August, or November). See Figure 2 for the approximate location of each site.

Within each cover type, site numbers are listed in numeric order.

	Marsh 0% - 10%			P50 10% - 50%			P75 50% -75%			SDM >75% Sapling			DMM >75% Mature		
	Randomly selected sites			Randomly selected sites			Randomly selected sites			Randomly selected sites			Randomly selected sites		
1st Qtr	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
2nd Qtr					2	6		5	9	2	5	9	1		
3rd Qrt	2			2			5			2				9	
4th Qrt															
5th Qrt				5			4	5		1			2	4	10
6th Qrt	5	6	10	2	4	5	1	2	4	2	5	6	2	4	6
7th Qrt				2			1			1			1	5	
8th Qrt				1			7			2					

Shading indicates too wet for sampling

DOC#6 1 4

APPENDIX C

APPENDIX C

RAREFACTION FORMULA AND STATISTICAL OUTPUTS

RAREFACTION FORMULA

The rarefaction curves were calculated by the following method (see Krebs, 1989) as:

$$E(S_n) = \text{ABSOLUTE SUM of } 1 - \left[\frac{\binom{N - N_i}{n}}{\binom{N}{n}}\right]$$

where $E(Sn_)$ = expected number of species in a random sample of n individuals

S = total number of species in species i

N_i = number of individuals in species i

N = total number of individuals in collection = SUM N_i

n = value of sample size (number of individuals) chosen from standardization (n = or < N)

N = number of combinations of n individuals that
n can be chosen from a set of N individuals = N!/n!(N-n)!

APPENDIX 3. CORRELATION MATRIX FOR RAIN FALL AND WATER LEVELS MACROINVERTEBRATES - PEARSON'S r FOR NO. SPP & INDIV. PER COVER TYPE REPLICATE - DRFIT FENCE DATA 1994-1995

CRITICAL r value, (p < 0.05) WITH 22 DEGREES OF FREEDOM = +/- 0.404

COVER TYPE SPP. & INDIV.	MIA WCMS RAINFALL	G - 972 WATER LEVEL	G - 975 WATER LEVEL	NO. SIGNIF.	DIRECTION
DMM1SP	0.0511	0.5833	0.4925	2	POSITIVE
DMM1IN	-0.0900	0.4837	0.4946	2	POSITIVE
DMM2SP	0.1795	0.8485	0.7805	2	POSITIVE
DMM2IN	0.2531	0.6014	0.5925	2	POSITIVE
DMM3SP	0.3282	0.6759	0.5193	2	POSITIVE
DMM3IN	0.4747	0.4307	0.3482	2	POSITIVE
SDM1SP	0.1591	0.5314	0.3968	1	POSITIVE
SDM1IN	-0.1147	0.3395	0.3433		
SDM2SP	0.2585	0.2735	-0.1421		
SDM2IN	0.4585	0.4752	0.2704	2	POSITIVE
SDM3SP	0.5553	0.6065	0.2870	2	POSITIVE
SDM3IN	0.4792	0.4937	0.3365	2	POSITIVE
P75_1SP	0.5244	0.8091	0.6411	3	POSITIVE
P75_1IN	0.4321	0.3966	0.3456	1	POSITIVE
P75_2SP	0.4031	0.8296	0.6481	2	POSITIVE
P75_2IN	0.5486	0.5149	0.3413	2	POSITIVE
P75_3SP	0.5241	0.4612	0.1689	2	POSITIVE
P75_3IN	0.5513	0.2552	0.1217	1	POSITIVE
P50_1SP	0.3776	0.5136	0.2562	1	POSITIVE
P50_1IN	-0.1258	0.0964	0.0402		
P50_2SP	0.4698	0.6337	0.3411	2	POSITIVE
P50_2IN	0.5661	0.4180	0.3010	2	POSITIVE
P50_3SP	0.1629	0.3111	-0.0988		
P50_3IN	0.0823	0.2677	0.0860		
MARSH1SP	0.3610	0.5243	0.2772	1	POSITIVE
MARSH1IN	-0.1004	0.0983	-0.0053		
MARSH2SP	0.3988	0.3045	-0.0571		
MARSH2IN	-0.0106	0.1313	0.0246		
MARSH3SP	0.2152	0.1801	-0.0873		
MARSH3IN	-0.2054	0.0626	0.0281		

DOC#6 14

APPENDIX 3. CORRELATION MATRIX FOR RAIN FALL AND WATER LEVELS
FISHES - PEARSON'S r FOR NO. SPP & INDIV. PER
COVER TYPE REPLICATE - DRFIT FENCE DATA 1994-1995
CRITICAL r value, (p < 0.05) WITH 22 DEGREES OF FREEDOM = +/- 0.404

COVER TYPE SPP. & INDIV.	MIA WCMS RAINFALL	G - 972 WATER LEVEL	G - 975 WATER LEVEL	NO. SIGNIF.	DIRECTION
DMM1IN	0.3089	0.3093	0.2971		
DMM2SP	0.3874	0.6560	0.6366	2	*POSITIVE*
DMM2IN	0.3560	0.4141	0.3988		
DMM3SP	0.3580	0.7983	0.7742	2	*POSITIVE*
DMM3IN	0.4080	0.2915	0.2377	1	*POSITIVE*
SDM1SP	0.0475	0.4597	0.4633	2	*POSITIVE*
SDM1IN	0.1006	0.3526	0.3528		
SDM2SP	-0.1282	0.3852	0.2388		
SDM2IN	-0.2504	0.0830	0.0036		
SDM3SP	0.2495	0.6569	0.4950	2	*POSITIVE*
SDM3IN	0.0398	0.3913	0.2473		
P75_1SP	0.2714	0.7849	0.7795	2	*POSITIVE*
P75_1IN	0.5212	0.4544	0.4143	3	*POSITIVE*
P75_2SP	0.3959	0.6637	0.5191	2	*POSITIVE*
P75_2IN	0.1416	0.3926	0.2697		
P75_3SP	0.3307	0.7250	0.6229	2	*POSITIVE*
P75_3IN	0.2611	0.2855	0.1869		
P50_1SP	0.2106	0.3371	0.1781		
P50_1IN	-0.1691	0.0671	0.0134		
P50_2SP	0.1246	0.8181	0.7945	2	*POSITIVE*
P50_2IN	0.4030	0.3422	0.2308		
P50_3SP	0.2646	0.6837	0.5100	2	*POSITIVE*
P50_3IN	0.1674	0.1678	-0.0856		
MARSH1SP	0.3907	0.3135	0.0635		
MARSH1IN	-0.0284	0.0561	-0.0935		
MARSH2SP	0.2942	0.2981	0.0529		
MARSH2IN	-0.0795	0.1272	-0.0000		
MARSH3SP	0.0314	0.2388	-0.0069		
MARSH3IN	-0.1111	0.0793	-0.0463		

DOC#6 1 4

APPENDIX 3. CORRELATION MATRIX FOR RAIN FALL AND WATER LEVELS
HERPTILES - PEARSON'S r FOR NO. SPP & INDIV. PER
COVER TYPE REPLICATE - DRFIT FENCE DATA 1994-1995
CRITICAL r value, ($p < 0.05$) WITH 22 DEGREES OF FREEDOM = +/- 0.404

COVER TYPE SPP. & INDIV.	MIA WCMS RAINFALL	G - 972 WATER LEVEL	G - 975 WATER LEV	NO. SIGNIF.	DIRECTION
DMM1SPP	0.3000	0.0323	-0.2821		
DMM1IND	0.1092	-0.0991	-0.4265	*1*	*NEGATIVE*
DMM2SPP	0.1239	0.0681	-0.2995		
DMM2IND	0.1609	0.0606	-0.3001		
DMM3SPP	0.0713	-0.1680	-0.4389	*1*	*NEGATIVE*
DMM3IND	0.1593	-0.0457	-0.2828		
SDM1SPP	0.3825	0.3213	0.0653		
SDM1IND	0.1580	0.0018	-0.2730		
SDM2SPP	-0.2320	-0.2342	-0.4218	*1*	*NEGATIVE*
SDM2IND	-0.2099	-0.3075	-0.5118	*1*	*NEGATIVE*
SDM3SPP	0.2724	0.0433	-0.2468		
SDM3IND	0.1264	0.0006	-0.2969		
P75_1SPP	0.0116	0.3545	0.2130		
P75_1IND	-0.1157	0.2895	0.1568		
P75_2SPP	-0.1338	-0.3006	-0.4953		
P75_2IND	-0.1518	-0.3604	-0.4865	*1*	*NEGATIVE*
P75_3SPP	0.3176	0.5319	0.2774	*1*	*NEGATIVE*
P75_3IND	0.2815	0.3667	0.0308		
P50_1SPP	0.2117	0.1234	-0.0918		
P50_1IND	0.0190	0.0384	-0.1948		
P50_2SPP	0.1976	0.1148	-0.2998		
P50_2IND	0.1990	0.0971	-0.2980		
P50_3SPP	0.0069	-0.2216	-0.6323	*1*	*NEGATIVE*
P50_3IND	-0.0901	-0.2267	-0.6080	*1*	*NEGATIVE*
MRSH1SPP	0.1990	0.0839	-0.2954		
MRSH1IND	0.0008	0.0701	-0.1937		
MRSH2SPP	0.0250	-0.0333	-0.3595		
MRSH2IND	-0.0332	0.0098	-0.2912		
MRSH3SPP	-0.0820	-0.0519	-0.2392		
MRSH3IND	-0.0557	-0.0296	-0.2352		

DOC#6 1 4

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS

MACROINVERTEBRATES FROM DRIFT FENCE DATA 1994 -1995

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION
APPLE SNAIL	2.533	9.552	3.771	52.789	RANDOM
CRAYFISH	375.800	232485.743	618.642	8660.991	RANDOM
DRAGONFLY LARVAE	2.333	12.810	5.490	76.857	RANDOM
DYTISCID BEETLE	34.133	990.267	29.012	406.164	RANDOM
LETHOCERUS	27.733	743.210	26.798	375.178	RANDOM
GRASS SHRIMP	181.867	68362.981	375.896	5262.546	RANDOM
GYRINID BEETLE	0.600	1.257	2.095	29.333	RANDOM
LUBBER GRASSHOPPER	3.867	21.838	5.648	79.069	RANDOM
PAPER SNAIL	1.400	3.400	2.429	34.000	RANDOM
RAMSHORN SNAIL	2.400	14.257	5.940	83.167	RANDOM

DOC#6114

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS

FISHES FROM DRIFT FENCE DATA 1994 -1995

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION	COVER TYPES
GAR	0.133	0.267	2.000	28.000	CLUMPED	P75
YELLOW BULLHEAD CATFISH	0.067	0.067	1.000	14.000		
BROWN BULLHEAD CATFISH	0.133	0.124	0.929	13.000		
WALKING CATFISH	0.800	1.171	1.464	20.500		
SHEEPSHEAD MINNOW	0.133	0.124	0.929	13.000		
GOLDEN TOPMINNOW	22.467	420.695	18.725	262.154	CLUMPED	P50 MRSH
MARSH KILLIFISH	69.200	2411.743	34.852	487.925	CLUMPED	P75 SDM
FLAGFISH	34.933	995.352	28.493	398.901	CLUMPED	P50 MRSH
BLUEFIN KILLIFISH	5.267	30.781	5.844	81.823	CLUMPED	MARSH
PIKE KILLIFISH	7.067	168.781	23.884	334.377	CLUMPED	SDM
MOSQUITOFISH	253.533	36112.695	142.438	1994.127	CLUMPED	MR 5075
LEAST KILLIFISH	2.733	14.210	5.199	72.780	CLUMPED	MRSH P75
SAILFIN MOLLY	33.667	1118.238	33.215	465.010	CLUMPED	MR 5075
BOORK SILVERSIDE	0.067	0.067	1.000	14.000		
BLUESPOTTED SUNFISH	0.600	0.971	1.619	22.667		
WARMOUTH	1.667	2.381	1.429	20.000		
BLUEGILL	0.533	0.410	0.768	10.750		
DOLLAR SUNFISH	0.133	0.124	0.929	13.000		
REDEAR SUNFISH	7.133	63.552	8.909	124.729	CLUMPED	75 MR 50
SPOOTED SUNFISH	0.933	2.352	2.520	35.286	CLUMPED	MARSH
LARGE MOUTH BASS	0.133	0.124	0.929	13.000		
SWAMP DARTER	0.333	0.667	2.000	28.000	CLUMPED	SDM
OSCAR	1.400	23.971	17.122	239.714	CLUMPED	MARSH
JEWELFSH	70.600	5214.114	73.854	1033.960	CLUMPED	7550 SDM
BLACK ACARA	45.733	2100.210	45.923	642.921	CLUMPED	SD 50 DM
NICARAGUAN CICHLID	2.133	3.838	1.799	25.188		
SPOTTED TILAPIA	0.333	0.667	2.000	28.000	CLUMPED	P75

DOC#6114

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS

HERPTILES FROM DRIFT FENCE DATA 1994 -1995

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION	COVER TYPES
CRICKET FROG	0.933	1.638	1.755	24.571		
COTTONMOUTH	1.667	4.810	2.886	40.400	CLUMPED	P75 P50
AMPHIUMA	3.333	8.238	2.471	34.600	CLUMPED	P50 SDM
GREEN ANOLE	1.133	3.267	2.882	40.353	CLUMPED	MRSH P50
BROWN ANOLE	5.533	52.124	9.420	131.880	CLUMPED	DMM
OAK TOAD	6.267	46.495	7.419	103.872	CLUMPED	P75 SDM
SOUTHERN TOAD	1.133	4.267	3.765	52.706	CLUMPED	MARSH
SNAPPING TURTLE	0.200	0.171	0.857	12.000		
BLACK RACER	2.067	4.781	2.313	32.387	CLUMPED	SDM P75
RINGNECK SNAKE	0.200	0.171	0.857	12.000		
CORN SNAKE	0.400	0.543	1.357	19.000		
GREENHOUSE FROG	11.133	843.838	75.794	1061.114	CLUMPED	SDM DMM
S.E. 5-LINED SKINK	1.133	9.695	8.555	119.765	CLUMPED	P75
MUD SNAKE	0.467	0.838	1.796	25.143		
NARROWMOUTH TOAD	2.800	16.029	5.724	80.143	CLUMPED	SDM DMM
GREEN TREEFROG	0.733	1.924	2.623	36.727	CLUMPED	DMM
SQUIRREL TREEFROG	0.200	0.171	0.857	12.000		
MUD TURTLE	2.267	6.781	2.992	41.882	CLUMPED	MARSH
KINGSNAKE	0.333	0.524	1.571	22.000		
LITTLE GRASS FROG	0.067	0.067	1.000	14.000		
BANDED WATER SNAKE	3.000	4.429	1.476	20.667		
FL. GRN. WATER SNAKE	5.933	30.924	5.212	72.966	CLUMPED	MRSH P50
NEWT	0.467	0.838	1.796	25.143		
GLASS LIZARD	0.467	0.838	1.796	25.143		
CUBAN TREEFROG	0.667	1.095	1.643	23.000		
CHORUS FROG	0.067	0.067	1.000	14.000		
DWARF SIREN	0.067	0.067	1.000	14.000		
PIG FROG	5.000	18.714	3.743	52.400	CLUMPED	P50 P75
LEOPARD FROG	14.533	49.981	3.439	48.147	CLUMPED	P75 P50
CRAYFISH SNAKE	2.467	9.838	3.988	55.838	CLUMPED	P50 MRSH
SIREN	3.733	35.210	9.431	132.036	CLUMPED	DMM SDM
BOX TURTLE	0.333	0.238	0.714	10.000		
RIBBON SNAKE	2.200	2.029	0.922	12.909		
GARTER SNAKE	2.867	6.410	2.236	31.302	CLUMPED	P75

DOC#9914

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS
BIRDS FROM STRIP TRANSECT DATA 1994 -1995

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION	COVER TYPES
DOUBLE CRESTED CORMORANT	0.200	0.200	1.000	4.000	RANDOM	
GREAT-BLUE HERON	0.800	0.700	0.875	3.500	RANDOM	
GREEN HERON	1.200	1.200	1.000	4.000	RANDOM	
LITTLE BLUE HERON	0.600	0.800	1.333	5.333	RANDOM	
GREAT EGRET	1.800	7.200	4.000	16.000	CLUMPED	P50/MARSH
TRICOLOR HERON	0.400	0.300	0.750	3.000	RANDOM	
WOOD STORK	0.200	0.200	1.000	4.000	RANDOM	
RED SHOULDERED HAWK	0.400	0.800	2.000	8.000	RANDOM	
MARSH HAWK (N. HARRIER)	0.200	0.200	1.000	4.000	RANDOM	
AMERICAN KESTREL	0.200	0.200	1.000	4.000	RANDOM	
COMMON MOOREHEN	0.200	0.200	1.000	4.000	RANDOM	
COMMON SNIPE	1.400	4.300	3.071	12.286	CLUMPED	MARSH
MOURNING DOVE	0.200	0.200	1.000	4.000	RANDOM	
GROUND DOVE	0.200	0.200	1.000	4.000	RANDOM	
COMMON NIGHT HAWK	0.600	0.800	1.333	5.333	RANDOM	
BELTED KINGFISHER	0.800	1.200	1.500	6.000	RANDOM	
YELLOWSHAFTED FLICKER	0.800	3.200	4.000	16.000	CLUMPED	P75
RED BELLIED WOODPECKER	1.600	1.800	1.125	4.500	RANDOM	
YELLOW BELLIED SAPSUCKER	0.400	0.800	2.000	8.000	RANDOM	
DOWNY WOODPECKER	0.600	0.300	0.500	2.000	RANDOM	
WESTERN KINGBIRD	0.200	0.200	1.000	4.000	RANDOM	
GREAT CRESTED FLYCATCHER	0.400	0.800	2.000	8.000	RANDOM	
EASTERN PHOEBE	1.000	3.000	3.000	12.000	CLUMPED	P50
BLUEJAY	3.200	6.200	1.938	7.750	RANDOM	
HOUSE WREN	0.200	0.200	1.000	4.000	RANDOM	
CAROLINA WREN	3.600	30.300	8.417	33.667	CLUMPED	DMM/SDM
MOCKINGBIRD	1.200	4.700	3.917	15.667	CLUMPED	P75
GRAY CATBIRD	1.000	2.000	2.000	8.000	RANDOM	
BLUE GRAY GNATCATCHR	3.800	9.700	2.553	10.211	RANDOM	
LOGGERHEAD SHRIKE	2.200	5.700	2.591	10.364	RANDOM	
WHITE EYED VIREO	0.200	0.200	1.000	4.000	RANDOM	

CONTINUED ON NEXT PAGE

DOC#614

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS
BIRDS FROM STRIP TRANSECT DATA 1994 -1995 CONTINUED.

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION	COVER TYPES
BLACK WHITE WARBLER	0.600	0.800	1.333	5.333	RANDOM	
NORTHERN PARULA	0.600	0.800	1.333	5.333	RANDOM	
YELLOW RUMPED WARB	4.800	57.200	11.917	47.667	CLUMPED	P75
PRAIRIE WARBLER	2.800	19.200	6.857	27.429	CLUMPED	P75
PALM WARBLER	11.400	52.300	4.588	18.351	CLUMPED	P75/SDM/
COMMON YELLOWTHROAT	19.000	502.000	26.421	105.684	CLUMPED	MARSH
YELLOWBREASTED CHAT	0.400	0.300	0.750	3.000	RANDOM	
AMERICAN REDSTART	0.600	1.800	3.000	12.000	CLUMPED	SDM
MEADOWLARK	12.400	188.800	15.226	60.903	CLUMPED	P75/P50
RED-WINGED BACLKBIRD	11.800	408.700	34.636	138.542	CLUMPED	MARSH
BOAT TAILED GRACKLE	5.000	83.000	16.600	66.400	CLUMPED	P50
COMMON GRACKLE	0.600	0.800	1.333	5.333	RANDOM	
CARDINAL	2.200	4.700	2.136	8.545	RANDOM	
RUFOUS-SIDED TOWHEE	1.400	4.300	3.071	12.286	CLUMPED	SDM
SWAMP SPARROW	0.200	0.200	1.000	4.000	RANDOM	

DOC#6614

APPENDIX 3. INDEX OF DISPERSION CALCULATIONS AND INTERPRETATIONS

MAMMALS FROM TRAPS, STATIONS & FAUNAL TRANSECTS 1994-1995

	MEAN	VARIANCE	I INDEX	CHI SQUARE	INTERPRETATION	COVER TYPES
BLACK RAT	0.200	0.200	1.000	4.000	**RANDOM**	
BOBCAT	3.600	6.300	1.750	7.000	**RANDOM**	
COTTON MOUSE	1.000	2.000	2.000	8.000	**RANDOM**	
CAT DOMESTIC	0.400	0.800	2.000	8.000	**RANDOM**	
DOG DOMESTIC	4.400	3.300	0.750	3.000	**RANDOM**	
GRAY FOX	1.800	3.200	1.778	7.111	**RANDOM**	
HISPID COTTON RAT	3.200	7.700	2.406	9.625	**RANDOM**	
HOUSE MOUSE	0.200	0.200	1.000	4.000	**RANDOM**	
MARSH RABBIT	2.000	1.500	0.750	3.000	**RANDOM**	
MARSH RICE RAT	2.600	1.300	0.500	2.000	**RANDOM**	
NINE-BANDED ARMADILLO	2.400	18.800	7.833	31.333	**CLUMPED**	DMM
RACCOON	9.800	24.700	2.520	10.082	**RANDOM**	
OTTER	0.400	0.800	2.000	8.000	**RANDOM**	
S.E. SHORT-TAILED SHREW	0.200	0.200	1.000	4.000	**RANDOM**	
OPOSSUM	2.000	1.000	0.500	2.000	**RANDOM**	
DEERWHITE-TAILED DEER	4.800	2.200	0.458	1.833	**RANDOM**	

DOC#614

data file: KSRAW.STA [4 cases with 9 variables]
KOLMOGROV-SMIRNOV TEST Results Raw Data

FILE INFO PAGE:
DRIFT FENCE DATA INCLUDED AND EXCLUDED.
There is no significant difference in the data set whether the drfit fence data is included or excluded;
the trend (shape of the distribution) remains the same.

VARIABLE SPECIFICATIONS:

No	Name	Format	MD Code	Long Label
1	DATA	9.1	-9999	DATA CODED AS 1=WITH, 2=WITHOUT DRFIT DATA
2	P_LEVEL	8.4	-9999	PROBABILITY LEVEL ALL ARE p> 0.05, NOT SIGNIF.
3	MEANGRP1	9.2	-9999	GROUP 1 MEAN
4	MEANGRP2	9.2	-9999	GROUP 2 MEAN
5	STD_DEV1	9.2	-9999	
6	STD_DEV2	9.2	-9999	
7	VALID_N	8.2	-9999	
8	MAX_NEG	8.1	-9999	
9	MAX_POS	8.2	-9999	

0 CASE	1 DATA	2 P_LEVEL	3 MEANGRP1	4 MEANGRP2	5 STD_DEV1	6 STD_DEV2	7 VALID_N	8 MAX_NEG	9 MAX_POS
WETLAND	#SPECIES	p > .10	33.00	24.00	6.63	6.28	5&5	0.0	.60
WETLAND	#SPECIES	p > .10	29.40	26.40	10.26	9.02	5&5	0.0	.40
NON-WETL	#INDIVID	p > .05	291.80	105.20	74.08	67.92	5&5	0.0	.80
NON-WETL	#INDIVID	p > .10	179.40	112.20	104.86	57.06	5&5	0.0	.60

DOC#614

data file: BOTHYRS.STA [24 cases with 7 variables]
MEAN MONTHLY WATER LEVELS AT 7 GAGES 1994 - 1995

0 CASE	1 G1488	2 G976	3 G3253	4 G594	5 G968	6 G975	7 G972
JAN 1994	6.590	4.660	3.060		6.520	5.890	4.300
FEB	6.590	4.820	3.240		6.620	5.900	4.520
MAR	6.530	4.660	2.080		6.850	5.740	4.250
APR	6.200	4.050	1.480		6.520	5.280	4.810
MAY	6.140	4.570	2.830	6.340	6.280	5.380	4.890
JUN	5.980	4.580	3.580	6.330	6.220	5.430	5.050
JUL	5.860	4.380	3.360	6.150	6.220	5.160	4.750
AUG	6.510	5.200	4.820	6.760	7.220	5.980	5.350
SEP	6.970	5.720	5.840	7.210	7.740	6.430	5.590
OCT	7.160	6.140	6.180	7.270	7.780	6.560	5.650
NOV	7.320	5.990		7.400	8.080	6.710	5.770
DEC	7.320	5.960		7.350	8.130	6.660	5.740
JAN 1995	7.240	5.870		7.320	7.820	6.560	5.670
FEB	6.980	5.330	5.060	7.020	7.210	6.150	5.310
MAR	6.830	5.220	4.530	6.910	6.980	6.000	5.160
APR	6.590	4.490	2.640	6.280	6.760	5.640	4.800
MAY	6.390	4.290	2.010	6.120	6.550	5.520	4.690
JUN	6.720	4.930	3.830	6.700	6.880	6.060	5.270
JUL	6.900	5.800	6.060	7.060	7.080	6.350	5.480
AUG	6.950	5.460	5.720	6.920	7.310	6.290	5.460
SEP	7.130	5.540	5.770	6.990	7.610	6.410	5.490
OCT	7.420	5.960	6.070	7.270	8.010	6.780	5.760
NOV	7.060	5.630	6.010		7.650	6.500	5.550
DEC	6.870	5.170	4.910		7.180	6.150	5.320

STAT. BASIC STATS	Analysis of Variance (codeyrs.sta) Marked effects are significant at p < .05000 Parametric One-way ANOVA							
Variable	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
WATER	153.3977*	6*	25.56628*	83.18409*	152*	.547264*	46.71656*	0.00*

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (codeyrs.sta) Independent (grouping) variable: CODE Kruskal-Wallis test: H (6, N= 159) = 116.7597 p =.0000		
Depend.: WATER	Code	Valid N	Sum of Ranks
Group 1	G1488	24	2810.000
Group 2	G976	24	1003.000
Group 3	G3253	21	681.000
Group 4	G594	18	2203.000
Group 5	G968	24	3132.000
Group 6	G975	24	1931.000
Group 7	G972	24	960.000

data file: ANOVAS2.STA [15 cases with 4 variables]
MACROINVERTEBRATE DATA FOR ANOVAS

	1 COVER	2 NO_INDS	3 NO_SPP	4 DIVRSITY
1	DMM	274.000	8.000	1.476
2	DMM	328.000	7.000	.714
3	DMM	199.000	10.000	1.322
4	SDM	501.000	9.000	1.432
5	SDM	287.000	6.000	.931
6	SDM	778.000	8.000	.846
7	P75	918.000	7.000	.896
8	P75	472.000	8.000	1.204
9	P75	206.000	7.000	1.987
10	P50	575.000	6.000	.855
11	P50	785.000	7.000	1.000
12	P50	2112.000	8.000	.667
13	MARSH	394.000	7.000	1.205
14	MARSH	887.000	9.000	.983
15	MARSH	774.000	8.000	.696

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 6.600000 p =.1586		
Depend.: NO_INDS	Code	Valid N	Sum of Ranks
DMM	1	3	9.00000
SDM	2	3	23.00000
P75	3	3	23.00000
P50	4	3	36.00000
MARSH	5	3	29.00000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 2.333334 p =.6747		
Depend.: NO_SPP	Code	Valid N	Sum of Ranks
DMM	1	3	30.00000
SDM	2	3	25.00000
P75	3	3	20.00000
P50	4	3	16.50000
MARSH	5	3	28.50000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 2.733334 p =.6034		
Depend.: DIVRSITY	Code	Valid N	Sum of Ranks
DMM	1	3	29.00000
SDM	2	3	24.00000
P75	3	3	31.00000
P50	4	3	15.00000
MARSH	5	3	21.00000

data file: ANOVAS2.STA [15 cases with 4 variables]
DATA FOR ANOVAS FOR FISHES

	1 COVER	2 NO_INDS	3 NO_SPP	4 DIVRSITY
1	DMM	198.000	10.000	2.387
2	DMM	185.000	17.000	2.289
3	DMM	543.000	12.000	1.580
4	SDM	156.000	13.000	2.627
5	SDM	175.000	12.000	1.767
6	SDM	584.000	13.000	2.701
7	P75	734.000	12.000	2.305
8	P75	650.000	12.000	2.430
9	P75	935.000	17.000	2.498
10	P50	636.000	16.000	2.561
11	P50	1111.000	14.000	2.215
12	P50	1031.000	12.000	2.219
13	MARSH	514.000	18.000	2.245
14	MARSH	505.000	16.000	2.525
15	MARSH	471.000	16.000	2.175

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 10.50000 p =.0328		
Depend.: NO_INDS	Code	Valid N	Sum of Ranks
DMM	1	3	15.00000
SDM	2	3	12.00000
P75	3	3	36.00000
P50	4	3	39.00000
MARSH	5	3	18.00000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 4.028716 p =.4022		
Depend.: NO_SPP	Code	Valid N	Sum of Ranks
DMM	1	3	18.50000
SDM	2	3	19.00000
P75	3	3	21.50000
P50	4	3	24.00000
MARSH	5	3	37.00000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 2.266666 p =.6868		
Depend.: DIVRSITY	Code	Valid N	Sum of Ranks
DMM	1	3	17.00000
SDM	2	3	31.00000
P75	3	3	29.00000
P50	4	3	22.00000
MARSH	5	3	21.00000

data file: ANOVAS2.STA [15 cases with 4 variables]
AMPHIBIAN AND REPTILE DATA FOR ANOVAS

	1 COVER	2 NO__INDS	3 NO__SPP	4 DIVRSITY
1	DMM	99.000	8.000	3.439
2	DMM	85.000	21.000	3.477
3	DMM	76.000	17.000	3.112
4	SDM	173.000	15.000	3.296
5	SDM	58.000	16.000	3.537
6	SDM	100.000	18.000	3.634
7	P75	96.000	22.000	3.418
8	P75	112.000	22.000	3.790
9	P75	75.000	20.000	3.895
10	P50	73.000	16.000	2.133
11	P50	64.000	17.000	3.647
12	P50	86.000	16.000	3.737
13	MARSH	85.000	16.000	2.193
14	MARSH	46.000	15.000	3.519
15	MARSH	33.000	12.000	3.367

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 4.867023 p =.3012		
Depend.: NO__INDS	Code	Valid N	Sum of Ranks
DMM	1	3	27.50000
SDM	2	3	31.00000
P75	3	3	31.00000
P50	4	3	19.00000
MARSH	5	3	11.50000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 7.584398 p =.1081		
Depend.: NO__SPP	Code	Valid N	Sum of Ranks
DMM	1	3	23.50000
SDM	2	3	21.00000
P75	3	3	41.00000
P50	4	3	22.50000
MARSH	5	3	12.00000

STAT. NONPAR STATS	Kruskal-Wallis ANOVA by Ranks (anovas2.sta) Independent (grouping) variable: COVER Kruskal-Wallis test: H (4, N= 15) = 3.766669 p =.4385		
Depend.: DIVRSITY	Code	Valid N	Sum of Ranks
DMM	1	3	18.00000
SDM	2	3	25.00000
P75	3	3	35.00000
P50	4	3	26.00000
MARSH	5	3	16.00000

STAT. BASIC STATS	Correlations (bothyrs.sta) Marked correlations are significant at p < .05000 N=15 (Casewise deletion of missing data)						
Variable	G1488	G976	G3253	G594	G968	G975	G972
G1488	1.00	.87 *	.79 *	.89 *	.94 *	.96 *	.84 *
G976	.87 *	1.00	.96 *	.98 *	.91 *	.95 *	.96 *
G3253	.79 *	.96 *	1.00	.95 *	.85 *	.89 *	.95 *
G594	.89 *	.98 *	.95 *	1.00	.91 *	.95 *	.96 *
G968	.94 *	.91 *	.85 *	.91 *	1.00	.96 *	.90 *
G975	.96 *	.95 *	.89 *	.95 *	.96 *	1.00	.95 *
G972	.84 *	.96 *	.95 *	.96 *	.90 *	.95 *	1.00

DOC#6 14

data file: G972DATA.STA [12 cases with 11 variables]
USGS G972 MONTHLY MEAN WATER LEVELS 1985-1995

0 C.	1 YR85	2 YR86	3 YR87	4 YR88	5 YR89	6 YR90	7 YR91	8 YR92	9 YR93	10 YR94	11 YR95
JAN	4.570	5.440	5.420	5.570	4.900	4.260	3.530	4.870	5.260	4.300	5.670
FEB	4.080	5.330	5.380	5.530	4.410	4.290	3.730	4.790	4.960	4.520	5.310
MAR	3.970	5.360	5.460	5.500	4.220	4.100	3.750	4.110	4.920	4.250	5.160
APR	3.790	5.440	5.470	5.290	3.510	4.020	4.020	3.890	4.740	4.810	4.800
MAY	3.190	4.780	5.230	5.180	3.370	3.350	3.650		4.130	4.890	4.690
JUN	3.470	5.200	5.020	5.420	3.680	4.180	4.260		4.710	5.050	5.270
JUL	5.060	5.640	5.150	5.570	4.420	4.300	4.740		4.900	4.750	5.480
AUG	5.410	5.630	5.040	5.730	4.530	4.780	5.330		4.970	5.350	5.460
SEP	5.510	5.640	5.240	5.720	4.820	4.900	5.440		5.030	5.590	5.490
OCT	5.590	5.510	5.480	5.650	4.910	4.940		4.920	5.150	5.650	5.760
NOV	5.500	5.460	5.550	5.480	4.470	4.160		5.280	4.760	5.770	5.550
DEC	5.440	5.440	5.560	5.060	4.310	3.440	4.950	5.100	4.320	5.740	5.320

STAT. BASIC STATS	Analysis of Variance (anova972.sta) Marked effects are significant at p < .05000 UGSG G972, 1985-1995, MEAN MONTHLY WATER LEVELS							
Variable	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
WATR972	25.94165*	10*	2.594165*	27.93725*	114*	.245064*	10.58568*	.000000*

DOC#6 1 4

data file: G975DATA.STA [12 cases with 11 variables]

0 C.	1 YR85	2 YR86	3 YR87	4 YR88	5 YR89	6 YR90	7 YR91	8 YR92	9 YR93	10 YR94	11 YR95
JAN	4.660	6.020	5.810	5.960	4.620	3.720	3.170	5.340		5.890	6.560
FEB	4.010	5.790	5.600	5.860	4.080	3.730	3.610	4.710		5.900	6.150
MAR	3.770	5.790	5.780	5.710	3.880	3.690	3.470	4.260		5.740	6.000
APR	3.850	5.990	5.700	5.190	3.490	3.950	3.570	4.010	5.910	5.280	5.640
MAY	2.850	5.160	4.990	4.680	3.250	3.200	3.850	3.010	5.560	5.380	5.520
JUN	3.360	5.310	4.420	5.660	3.580	4.350	4.740	5.640	5.980	5.430	6.060
JUL	5.420	6.170	4.770	6.130	4.480	4.300	5.760	5.910	6.020	5.160	6.350
AUG	5.860	6.250	4.750	6.300	4.810	4.620	6.090	6.290	5.960	5.980	6.290
SEP	6.200	6.280	5.220	6.300	5.260	4.950	6.200	6.240	6.000	6.430	6.410
OCT	6.270	6.120	5.810	6.260	5.280	5.330	6.410		6.200	6.560	6.780
NOV	6.210	5.920	5.970	5.950	4.450	4.440	6.170		6.080	6.710	6.500
DEC	6.070	5.820	5.940	5.140	4.260	3.390	5.780		5.930	6.660	6.150

STAT. BASIC STATS	Analysis of Variance (anova975.sta) Marked effects are significant at p < .05000 USGS G975 1985-1995, MEAN MONTHLY WATER LEVELS							
Variable	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
WATR975	58.26828*	10*	5.826828*	67.74906*	115*	.589122*	9.890693*	.000000*

APPENDIX D

APPENDIX D

Glossary of the common names and latin names of each species found to date in the Lake Belt Study Area. Includes species found in areas other than the five defined cover types (such as along roads or in canals). Species are organized alphabetically within each class, by common name. The **Status** column indicates species considered exotic in the area. The **GFC** column indicates species listed as Endangered (E), Threatened (T), or Species of Special Concern (SSC) by the State of Florida. The **FWS** column indicates species listed as endagered (E), Threatened (T), of Cndidate for Listing (C1 or C2) by the USFWS. For Amphibians, Reptiles, Birds and Mammals, the **Wetland Use** column indicates whether a species requires wetland habitat for 9 to 12 months each year (Dependent), 1 to 9 months each year (Seasonal) or less than 1 month each year (Independent). Refer to text for further details. For Birds only, the **Season** column indicates whether the species resides in southern Florida all year (Resident), only during certain seasons (Winter or Summer) or pass throught during springand/or fall migration (Transient). In general, Resident and Summer species breed in southern Florida. Animals other than Birds are year round residents of southern Florida (i.e. non-migratory).

Common name	*Latin name*	Status	GFC	FWS	Wetland Use	Season
Class : Butterfly						
Black swallowtail	*Papilio polyxenes asterius*					
Buckeye	*Junonia coenia*					
Giant swallowtail	*Papilio cresphontes*					
Gulf fritillary	*Dione vanillae nigrior*					
Little metalmark	*Calephelis virginiensis*					
Orange julia long wing	*Dryas iulia largo*					
Oval satyr	*Neonympha areolata*					
Viceroy	*Basilarchia archippus*					
White peacock	*Anartia jatrophae*					
Zebra long wing	*Heliconius charitonius*					
Class : Dragonfly						
Blue dasher	*Pachydiplax longipennis*					
Corporal skimmer	*Libellula exusta deplanata*					
Damselfly nymph	*Zygopteran species*					
Dragonfly nymph	*Anisopteran species*					
Eastern amberwing	*Perithemis tenera*					
Eastern pondhawk	*Erythemis simplicollis*					
Fourspotted pennant	*Brachymesia gravida*					
Golden-winged skimmer	*Libellula auripennis*					
Halloween pennant	*Celithemis eponina*					

DOC#6914

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Twilight damer	*Gynacantha nervosa*					
Class : Invertebrate						
Apple snail	*Pomacea paludosa*					
Columbian ram's horn	*Marisa rotula*	Exotic				
Common pond snail	*Physa spp.*					
Crayfish	*Procambarus alleni*					
Dytiscid beetles	*Dytiscidae*					
Giant water bug	*Lethocerus americanus*					
Grass shrimp	*Paleomonetus paludosus*					
Gyrinid beetles	*Gyrinidae*					
Lubber	*Romalea microptera*					
Papershell snail	*Stagnicola sp*					
Ram's horn	*Biomphalaria havenensis*					
Class : Fishes						
Black acara	*Cichlasoma bimaculatum*	Exotic				
Bluefin killifish	*Lucania goodei*					
Bluegill	*Lepomis macrochirus*					
Bluespotted sunfish	*Enneacanthus gloriosus*					
Bowfin	*Amia calva*					
Brook silverside	*Labidesthes sicculus*					
Brown bullhead catfish	*Ameriurus nebulosus*					
Dollar sunfish	*Lepomis marginatus*					
Flagfish	*Jordanella floridae*					
Gar	*Lepidosteus platyrhinchus*					
Golden topminnow	*Fundulus chrysotus*					
Jewelfish	*Hemichromis letoumeauxi*	Exotic				
Large mouth bass	*Micropterus salmoides*					
Least killifish	*Heterandria formosa*					
Marsh killifish	*Fundulus confluentus*					
Mosquito fish	*Gambusia holbrooki*					
Nicaraguan cichlid	*Cichlasoma managuense*	Exotic				
Oscar	*Astronotus ocellatus*	Exotic				
Peacock bass	*Cichla ocellaris*	Exotic				

DOC#6 14

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Pike killifish	*Belonesox belizanus*	Exotic				
Redear sunfish	*Lepomis microlophus*					
Sailfin molly	*Poecilia latipinna*					
Sheepshead minnow	*Cyprinodon variegatus*					
Spotted sunfish	*Lepomis punctatus*					
Spotted tilapia	*Tilapia mariae*	Exotic				
Striped mullet	*Mugil cephalus*					
Swamp darter	*Etheostoma fusiforme*					
Walking catfish	*Clarias batrachus*	Exotic				
Warmouth	*Lepomis gulosus*					
Yellow bullhead catfish	*Amelurus natalis*					
Class : Amphibian						
Cuban treefrog	*Osteopilus septentrionalis*	Exotic			Seasonal	
Dwarf siren	*Pseudobranchus striatus*				Dependent	
Eastern narrowmouth toad	*Gastrophryne carolinensis*				Seasonal	
Florida chorus frog	*Pseudacris nigrita*				Seasonal	
Greater siren	*Siren lacertina*				Dependent	
Green treefrog	*Hyla cinerea*				Seasonal	
Greenhouse frog	*Eleutherodactylus planirostris*	Exotic			Independent	
Little grass frog	*Limnaoedus ocularus*				Seasonal	
Oak toad	*Bufo quercicus*				Seasonal	
Peninsula newt	*Notophthalmus viridescens*				Dependent	
Pig frog	*Rana grylio*				Dependent	
Southern cricket frog	*Acris gryllus*				Seasonal	
Southern leopard frog	*Rana sphenocephala*				Dependent	
Southern toad	*Bufo terrestris*				Seasonal	
Squirrel treefrog	*Hyla squirella*				Seasonal	
Two-toed amphiuma	*Amphiuma means*				Dependent	
Class : Reptile						
American alligator	*Alligator mississippiensis*		SSC	T	Dependent	
Black racer	*Coluber constrictor*				Independent	
Brown anole	*Anolis sagrei*	Exotic			Independent	
Brown water snake	*Nerodia taxispilota*				Dependent	

DOC#6914

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Chicken turtle	*Deirochelys reticularia*				Dependent	
Cottonmouth	*Agkistrodon piscivorous*				Dependent	
Eastern garter snake	*Thamnophis sirtalis*				Seasonal	
Five-lined skink	*Eumeces inexpectatus*				Independent	
Florida box turtle	*Terrapene carolina bauri*				Seasonal	
Florida green water snake	*Nerodia floridana*				Dependent	
Florida kingsnake	*Lampropeltis getula floridana*				Seasonal	
Florida redbelly turtle	*Pseudemys nelsoni*				Dependent	
Florida snapping turtle	*Chelydra serpentina*				Dependent	
Florida softshell turtle	*Apalone ferox*				Dependent	
Florida water snake	*Nerodia fasciata*				Dependent	
Gopher tortoise	*Gopherus polyphemus*		SSC	C2	Independent	
Green anole	*Anolis carolinensis*				Independent	
Island glass lizard	*Ophisaurus compressus*			C2	Independent	
Mud snake	*Farancia abacura*				Dependent	
Peninsula cooter	*Pseudemys floridana*				Dependent	
Peninsula ribbon snake	*Thamnophis sauritus*				Seasonal	
Red rat snake	*Elaphe guttata*				Independent	
Rough green snake	*Opheodrys aetivus*				Independent	
Southern ringneck snake	*Diadophis punctatus*				Independent	
Striped crayfish snake	*Regina alleni*				Dependent	
Striped mud turtle	*Kinosternon baurii*				Dependent	
Yellow rat snake	*Elaphe obsoleta*				Independent	
Class : Bird						
American coot	*Fulica americana*				Dependent	Resident
American kestrel	*Falco sparverius*		T	C2	Independent	Winter
American redstart	*Setophaga ruticilla*				Independent	Winter
American robin	*Turdus migratorius*				Independent	Winter
Anhinga	*Anhinga anhinga*				Dependent	Resident
Barn swallow	*Hirundo rustica*				Independent	Transient
Belted kingfisher	*Megaceryle alcyon*				Dependent	Winter
Black crowned night heron	*Nycticorax nycticorax*				Dependent	Resident
Black necked stilt	*Himantopus mexicanus*				Dependent	Resident
Black throated blue warbler	*Dendroica caerulescens*				Independent	Winter
Black throated green warbler	*Dendoica nigrescens*				Independent	Winter

DOC#6914

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Black vulture	*Coragyps atratus*				Independent	Resident
Black white warbler	*Mniotilta varia*				Independent	Winter
Blackpoll warbler	*Dendroica striata*				Independent	Transient
Blue-gray gnatcatcher	*Polioptila caerulea*				Independent	Winter
Bluejay	*Cyanocitta cristata*				Independent	Resident
Boat tailed grackle	*Quiscalus major*				Dependent	Resident
Bobwhite quail	*Colinus virginianus*				Independent	Resident
Budgie	*Melosdittacus undulatus*	Exotic			Independent	Resident
Cape may warbler	*Dendroica tigrina*				Independent	Winter
Cardinal	*Cardinalis cardinalis*				Independent	Resident
Carolina wren	*Thryothorus ludovicianus*				Independent	Resident
Cattle egret	*Bubulcus ibis*				Independent	Resident
Common grackle	*Quiscalus quiscula*				Independent	Resident
Common moorhen	*Gallinula chloropus*				Dependent	Resident
Common nighthawk	*Chordeiles minor*				Independent	Resident
Common snipe	*Capella gallinago*				Dependent	Winter
Common yellowthroat	*Geothlypis trichas*				Dependent	Resident
Double crested cormorant	*Phalacrocorax auritus*				Dependent	Resident
Downy woodpecker	*Picoides pubescens*				Independent	Resident
Eastern kingbird	*Tyrannus tyrannus*				Independent	Resident
Eastern phoebe	*Sayornis phoebe*				Independent	Winter
Eurasian collared-dove	*Streptopelia decaocto*	Exotic			Independent	Resident
European starling	*Sturnus vulgaris*	Exotic			Independent	Resident
Glossy ibis	*Plegedis falcinellus*				Dependent	Resident
Gray catbird	*Dumetella carolinensis*				Independent	Winter
Great blue heron	*Ardea herodias*				Dependent	Resident
Great crested flycatcher	*Mylarchus crinitus*				Independent	Resident
Great egret	*Casmerodius albus*				Dependent	Resident
Greater yellowlegs	*Tringa melanoleuca*				Dependent	Winter
Green heron	*Butorides striatus*				Dependent	Resident
Ground dove	*Columbina passerina*				Independent	Resident
Hermit thrush	*Catharus guttatus*				Independent	Winter
Hooded merganser	*Lophodytes cucullatus*				Dependent	Winter
House wren	*Troglodytes aedon*				Independent	Winter
Killdeer	*Charadrius vociferus*				Independent	Resident
King rail	*Rallus elegans*				Dependent	Resident
Least tern	*Sterna albifrons*		T		Dependent	Summer

797

DOC#614

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Lesser yellowlegs	*Tringa flavipes*				Dependent	Winter
Little blue heron	*Florida caerulea*		SSC		Dependent	Resident
Loggerhead shrike	*Lanius ludovicianus*			C2	Independent	Winter
Marsh hawk	*Circus cyaneus*				Seasonal	Winter
Marsh wren	*Cistothorus palustris*				Dependent	Winter
Meadowlark	*Sturnella magna*				Seasonal	Resident
Merlin	*Falco columbarius*				Independent	Winter
Mockingbird	*Mimus polyglottos*				Independent	Resident
Mottled duck	*Anas fulvigula*				Dependent	Resident
Mourning dove	*Zenaida macroura*				Independent	Resident
Muscovy	*Cairina moschata*	Exotic			Dependent	Resident
Northern parula warbler	*Parula americana*				Independent	Winter
Osprey	*Pandion haliaetus*				Dependent	Resident
Ovenbird	*Seiurus aurocapillus*				Independent	Winter
Palm warbler	*Dendroica palmarum*				Independent	Winter
Philadelphia vireo	*Vireo philadelphicus*				Independent	Transient
Pied billed grebe	*Podilymbus podiceps*				Dependent	Resident
Pileated woodpecker	*Dryocopus pileatus*				Independent	Resident
Prairie warbler	*Dendroica discolor*				Seasonal	Resident
Prothonotary warbler	*Prothonotaria citrea*				Independent	Transient
Red-bellied woodpecker	*Melanerpes carolinus*				Independent	Resident
Red-shouldered hawk	*Buteo lineatus*				Independent	Resident
Red-tailed hawk	*Buteo jamaicensis*				Independent	Resident
Red-winged blackbird	*Agelaius phoeniceus*				Dependent	Resident
Roseate spoonbill	*Ajaia ajaia*		SSC		Dependent	Resident
Rubythroated hummingbird	*Archilochus colubris*				Independent	Winter
Rufous-sided towhee	*Pipilo erythrophthalmus*				Independent	Resident
Savannah sparrow	*Passerculus sandwichensis*				Seasonal	Winter
Snowy egret	*Egretta thula*		SSC		Dependent	Resident
Summer tanager	*Piranga rubra*				Independent	Transient
Swainson's hawk	*Buteo regalis*				Independent	Winter
Swamp sparrow	*Melospiza georgiana*				Dependent	Winter
Tricolor heron	*Hydranassa tricolor*		SSC		Dependent	Resident
Turkey vulture	*Cathartes aura*				Independent	Resident
Western kingbird	*Tyrannus verticalis*				Independent	Winter
White eye vireo	*Vireo griseus*				Independent	Resident
White ibis	*Eudocimus albus*		SSC		Dependent	Resident

DOC#6 1 4

Common name	Latin name	Status	GFC	FWS	Wetland Use	Season
Willet	*Catoptrophorus semipalmatus*				Dependent	Winter
Wood stork	*Mycteria americana*		E	E	Dependent	Resident
Yellow crowned night heron	*Nyctanassa violacea*				Dependent	Resident
Yellow rumped warbler	*Dedroica coronata*				Independent	Winter
Yellow-bellied sapsucker	*Sphyrapicus varius*				Independent	Winter
Yellowbreasted chat	*Icteria virens*				Independent	Resident
Yellowshafted flicker	*Colaptes auratus*				Independent	Resident
Class : Mammal						
Black rat	*Rattus rattus*	Exotic			Independent	
Bobcat	*Felis rufus*				Independent	
Cotton mouse	*Peromyscus gossypinus*				Independent	
Domestic cat	*Felis domesticus*	Exotic			Independent	
Domestic dog	*Canis familiaris*	Exotic			Independent	
Gray fox	*Urocyon cinereoargenteus*				Independent	
Hispid cotton rat	*Sigmodon hispidus*				Independent	
House mouse	*Mus musculus*	Exotic			Independent	
Marsh rabbit	*Sylvilagus palustris*				Seasonal	
Marsh rice rat	*Oryzomys palustris*				Seasonal	
Nine-banded armadillo	*Dasypus novemcinctus*	Exotic			Independent	
Raccoon	*Procyon lotor*				Independent	
River otter	*Lutra canadensis*				Dependent	
Southern short-tailed shrew	*Blarina carolinensis*				Independent	
Virginia opossum	*Didelphis virginiana*				Independent	
White-tailed deer	*Odocoileus virginianus*				Independent	

DOC#6 1 4

APPENDIX E

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CLARIFICATIONS OF SPECIES IDENTIFICATION OR DESIGNATIONS

Fourth Quarter Clarifications

The invertebrate genus *Belostoma*, the Giant Water Bug, has recently been renamed *Lethocerus*.

In previous quarterly reports, one species of exotic fish was incorrectly identified as *Cichlasoma urophthalmus*, the Mayan Cichlid. The correct identification is *Hemichromis bimaculatum*, the Jewelfish.

Fifth Quarter Clarifications

The specific name of the Jewelfish has been changed from *Hemichromis bimaculatum* to *Hemichromis letourneauxi*.

Sixth Quarter Clarifications

The Nine-banded armadillo (*Dasypus novemcinctus*) was listed as a "native" species in previous quarterly reports. It is better considered an "exotic" species and is categorized as such henceforth (Layne, 1984).

Seventh Quarter Clarifications

No clarifications were required at this time.

Eighth Quarter Clarifications

No species clarifications were required at this time. However, cover type abbreviations have been changed to correspond with the abbreviations used by EAS Engineering, Inc., on the vegetation map of the area. The new abbreviations are as follows, with the abbreviations used in previous reports given in parantheses:

DM	75 - 100% mature dense melaleuca coverage (CT 1)
DMS	75 - 100% sapling dense melaleuca coverage (CT 2)
P75	50 - 75% melaleuca coverage (CT 3)
P50	10 - 50% melaleuca coverage (CT 4)
Prairie	0 - 10% melaleuca coverage (marsh) (CT 5)

Draft Final Report Clarifications

Cover type designations were slightly modified. The most significant modification was the use of "Marsh", instead of "Prairie" for the 0% - 10% melaleuca covertype. Based upon current hydrology, vegetation and soils, most habitats with less than 10% melaleuca coverage are long-hydroperiod marshes, not short hydroperiod prairies. Additionally "DMM" and "SDM" are used instead of "DM" and "DMS",

respectively, to avoid confusion in the small print of figures.

Ten juvenile cichlids were trapped in a drift fence array in November 1995 (eighth quarter) at a SDM site. These cichlids were incorrectly identified as Black acara (*Cichlasoma bimaculatum*). The correct identification is Nicaraguan cichlid (*C. managuense*; species identification confirmed by staff of the Non-indigenous Fishes Program, National Biological Service, Gainesville).

Previous reports listed the Ringed turtle dove (*Streptopelia risoria*). Recent reviews of southern Florida avifauna listed this non-native species as Eurasian collared dove (*Streptorisoria decaocto*; Robertson and Woolfenden, 1992).

Final Report Clarifications

The Southeastern American kestrel (*Falco sparverius paulus*) was previously overlooked as a "listed" species. It is designated as "Threatened" at the State level and "C2" at the Federal level.