4. AFFECTED ENVIRONMENT

The Affected Environment section succinctly describes the existing environmental resources of the areas that would be affected if any of the alternatives were implemented. This section describes only those environmental resources that are relevant to the decision to be made. It does not describe the entire existing environment, but only those environmental resources that would affect or that would be affected by the alternatives if they were implemented. This section, in conjunction with the description of the "No-Action" alternative forms the base line conditions for determining the environmental effects of the proposed action and reasonable alternatives.

4.1. GENERAL ENVIRONMENTAL SETTING

Lake Okeechobee is a subtropical lake in south Florida with a surface area of 730 square miles and an average depth of nine feet. As a result of this shallow depth, wind is a major influence on the lake. Prior to construction of a perimeter dike system, Lake Okeechobee was much larger than it is now, with an extensive wetland littoral zone along the shoreline. Today, Lake Okeechobee is constrained within the HHD, and the littoral zone is much smaller. As a result, when water levels are above 17 ft., NGVD, the entire littoral zone is flooded; leaving minimal habitat for wildlife that requires exposed ground. When water levels are below 11 ft., NGVD, the entire marsh is dry, and not available as habitat for fish or other aquatic life. Lake Okeechobee's littoral zone is characterized by emergent and submerged vegetation covering an area of approximately 150 square miles (25 percent of the lake's surface area), and is primarily located along the western shore of the lake (Havens et al., 1996) (Figure 4-1). The littoral zone is sensitive to nutrient loading and light availability (Havens, et al., 1999). The vegetation and cover types within the Lake Okeechobee region have been greatly altered during the last century. At present, the littoral zone vegetation consists of many native plant species but also consists of many less desirable and invasive and/or exotic species. The invasion of exotic vegetation has impacted the health and productivity of the littoral zone plant community. Anthropogenic disturbances such as altered hydrology and pollution, along with nutrients, can directly and indirectly affect the health of Lake Okeechobee.

The Caloosahatchee Estuary is a large system where the Caloosahatchee River freshwater mixes with the Gulf of Mexico (Figure 4-2). The westernmost structure, Franklin Lock and Dam (S-79), demarcates the beginning of the estuary, and acts as a barrier to salinity and tidal action. A shallow bay supporting seagrass beds with mud and sand flats throughout characterizes the lower region closest to the Gulf of Mexico. Mangroves are a dominant species occurring on undeveloped shorelines. An important upper estuarine plant species is the fresh water-brackish submerged grass, Vallisneria americana (tape grass). Downstream, beds of seagrass, Halodule wrightii, (shoal grass) extend from San Carlos Bay to near the Cape Coral Bridge. Oysters are also present in the estuary, in particular near the mouth of Shell Point.

Figure 4.1

Figure 4.2

The St. Lucie Estuary, which is part of the IRL ecosystem, is located on the East Coast of Florida (Figure 4-2). There are two forks of the St. Lucie Estuary, the North and the South that flow together and then eastward to the IRL and Atlantic Ocean at the St. Lucie Inlet. The C-44 Canal connects Lake Okeechobee to the St. Lucie River. The easternmost structure S-80 releases fresh water to the estuary. Both the Caloosahatchee and St. Lucie Estuaries attract a variety of commercial, recreational and educational activities such as fishing, boating, ecotourism, and sightseeing.

4.2. VEGETATION

The discussion of vegetation occurring within the study area is organized by physiographic area, beginning with Lake Okeechobee, the estuaries, EAA and concluding with the WCAs.

4.2.1. LAKE OKEECHOBEE BASIN

The vegetation and cover types within the Lake Okeechobee region have been greatly altered during the last century. Historically, the natural vegetation was a mix of freshwater marshes, hardwood swamps, cypress swamps, pond apple forests, and pine flatwoods. The freshwater marshes were the predominant cover type throughout, especially along the southern portion of the lake where it flowed into the Everglades.

These marshes were vegetated primarily with sawgrass (*Cladium jamaicense*) and scattered clumps of carolina willow (*Salix caroliniana*), sweetbay (*Magnolia virginiana*), and cypress (*Taxodium* sp.). Hardwood swamps dominated by red maple (Acer rubrum), sweetbay, and sweet gum (*Liquidambar styraciflua*) occurred in riverine areas feeding the lake, while cypress swamps were found in depressional areas throughout the region. Pine flatwoods composed of slash pine (*Pinus elliottii*), cabbage palm (*Sabal palmetto*), and saw palmetto (*Serenoa repens*) were prevalent in upland areas especially to the north.

Lake Okeechobee has an extensive littoral zone that occupies approximately 150 square miles (about 25 percent) of the lake's surface (Milleson, 1987). Littoral vegetation occurs along much of the lake's perimeter, but is most extensive along the southern and western borders (Milleson 1987). The littoral zone plant community is composed of a mosaic of emergent, submergent and natant plant species. Richardson and Harris (1995) refer to a total of 30 distinguishable vegetative community types in their digital cover map study. Emergent vegetation within the littoral zone is dominated by herbaceous species such as cattail (*Typha* spp.), spike rush (*Eleocharis cellulosa*), and torpedo grass (*Panicum repens*) which is an invasive exotic species. Other emergent vegetation observed includes bulrush (*Scirpus californicus*), sawgrass, pickerelweed (*Pontederia cordata*), duck potato (*Sagittaria* spp.), beakrush (*Rhynchospora tracyi*), wild rice (*Zizania aquatica*), arrowhead (*Sagittaria latifolia*), button bush (*Cephalanthus occidentalis*), sand cordgrass (*Spartina bakeri*), fuirena (*Fuirena scirpoidea*), rush (*Scirpus cubensis*), southern cutgrass (*Leersia hexandra*), maidencane (*Panicum hemitomon*) white-vine (*Sarcostemma clausum*), dogfennel

(*Eupatorium capillifolium*), mikania (*Mikania scandens*). Woody vegetation consist of primrose willow (*Ludwigia peruviana*), Carolina willow, and melaleuca (*Melaleuca quiquenervia*) an invasive exotic species. Over the years, there has been an on-going multi-agency effort to eradicate melaleuca. The eradication effort of melaleuca has been extremely effect.

The submerged vegetation is composed almost entirely of hydrilla (*Hydrilla verticillata*) which is an invasive exotic species, pondweed (*Potamogeton illinoensis*), bladderwort (*Utricularia* spp.), Chara (*Chara spp*.) and vallisneria, also known as wildcelery, eel grass, or tape grass (*Vallisneria americana*).

The natant, or floating, component of the littoral zone consists of lotus lily (*Nelumbo lutea*), fragrant water lily (*Nymphaea odorata* and *N. mexicana*), water hyacinth (*Eichhornia crassipes*) which is an invasive exotic species, water lettuce (*Pistia stratiotes*), duckweed (*Lemna* sp.), coinwort (H*ydrocotyle umbellata*), and ludwigia (*Ludwigia leptocarpa*).

Hydrilla is one of several problem species which occur on Lake Okeechobee. Although it provides good fish habitat, its prolific growth, as evidenced in Fisheating Bay in the mid 1990's, causes navigation and water quality problems. A significant expansion of cattail in the littoral zone has also been observed.

Melaleuca, a resilient species found in a variety of habitats, is one of the principal species of concern on Lake Okeechobee. Melaleuca is capable of displacing native vegetation, including sawgrass marsh (Laroche and Ferriter, 1992), and has been observed to displace native species in other marsh types, cypress-hardwood forests, and pine savanna (Schmitz and Hofstetter, 1994). Ewel (1990) described melaleuca sites in south Florida as having hydroperiods of six to nine months. Shomer and Drew (1982) noted that melaleuca colonization rates appeared to be inversely proportional to the length of the hydroperiod. Melaleuca may be observed adjacent to the rim canal, on spoil islands peripheral to the HHD, in wetland pockets behind the dike, and in the western littoral zone, where it has penetrated into the marsh over a mile from the rim canal near Moore Haven.

Brazilian pepper (*Schinus terebinthifolius*), an invasive exotic species, is frequently associated with ditch banks (Barber 1994) and is commonly found along canal banks within Lake Okeechobee. Very little is known about its hydroperiod requirements, but Duever et al. (1986) found that it thrives in areas with three to four month hydroperiods, while Doren and Jones (1994) stated that it rarely grows on sites flooded longer than three to six months, and is absent from deeper wetland communities.

Australian pine (*Casurina* spp.), an invasive exotic species, is a major invader of short hydroperiod areas where it can be found in dense stands, which preclude establishment of native species. One of the species (*C. quinquenervia*) is intolerant of extended inundation, but another (*C. glauca*) invades sawgrass marsh and burned hardwood hammocks in the Everglades (Doren and Jones 1994). Australian pine is commonly found along the rim canal and in monotypic stands on the berm of the HHD and in areas behind the dike.

Another exotic that continues to plague resource managers throughout Lake Okeechobee is torpedograss, which is spreading rapidly into areas of spike rush, where it forms dense rooted mats and appears to be tolerant of a wide variety of hydroperiods. Other species include water hyacinth (native to South America) and water lettuce, which clog waterways and are found primarily in canals and backwater areas as well as in the lake, and both may root in wet soil. These latter two species, along with hydrilla, pose navigation problems for boaters and fisherman, flood control and water supply challenges for water managers, and are among the principal species targeted by aquatic plant control efforts by the Corps.

4.2.2. ESTUARINE VEGETATION

Seagrasses are undoubtedly among the most important vegetation of the Caloosahatchee Estuary. Seagrasses were once common in the St. Lucie Estuary, but virtually disappeared over the years. Seagrasses are more common in the IRL. Seagrass meadows improve water quality by removing nutrients, dissipating the effects of waves and currents, and by stabilizing bottom habitats, thereby reducing suspended solids. Seagrass beds support some of the most abundant fish populations in the IRL, with large species diversity. Seagrass and macroalgae (collectively referred to as SAV) are highly productive areas and are perhaps the most important habitat of the IRL (IRL CCMP, 1996). Pinfish (*Lagodon rhomboides*) and several species of mojarra (Gerreidae) are very abundant in the seagrass habitat. These species are known to feed on seagrasses and on the epiphytes and epifauna of the seagrasses, providing a critical link in the food chain between the primary producers and the higher level consumers such as the common snook (*Centropomus undecimalis*) and spotted seatrout (*Cynoscion nebulosus*).

The natural shoreline and inter-tidal areas of the St. Lucie Estuary were once populated by mangroves and other detritus producing vegetation, but now due to shoreline alterations supports very little vegetation. In many areas, seawalls and docks have replaced mangroves and seagrasses. Massive freshwater basin and Lake Okeechobee releases have caused SAV to virtually disappear from the St. Lucie Estuary as well as some areas of the IRL South closest to the St. Lucie Estuary (USACE, 2004). Most SAV coverage in the St. Lucie Estuary is now found near the IRL. Those species known to occur there are shoal grass (*Halodule wrightii*), wigeongrass (*Ruppia maritime*), and Johnson's seagrass (*Halophila johnsonii*).

In the Caloosahatchee River the primary species of importance is Vallisneria (*Vallisneria americana*), also known as tape grass and commonly found in still and fast flowing waters. Like the seagrasses of the St. Lucie Estuary and IRL, Vallisneria is used extensively as an indicator species as it has proven to be an excellent ecological representative for a wide variety of other biota for this area. Although Vallisneria is salt tolerant, it is a freshwater plant species. During times of extended low inflow conditions, when salinity is too high in the upper estuary, this grass becomes very sparse and can disappear completely (Doering et al., 2002). When growing conditions are favorable, the most extensive beds are found in the 640 acre area between Beautiful Island and the Ft. Myers Bridge which constitutes about 60 percent of the reported areal coverage of the species in the Caloosahatchee (SFWMD, 2002). Vallisneria is a valuable waterfowl food and is considered an excellent plant for fish spawning areas along the river margin. The seagrasses which occur in the Caloosahatchee Estuary are shoal grass, which is downstream in the estuary and extends beyond Shell Point; shoal grass and turtle grass are in San Carlos Bay and the lower Charlotte Harbor.

4.2.3. EVERGLADES AGRICULTURAL AREA

Lake Okeechobee provides water south to the EAA (Figure 4-3) through three structures, S-351, S-354, and S-352. The EAA, covering 1,122 square miles south of Lake Okeechobee is the largest contiguous area of historic Everglades cover that has been converted by land use practices. The EAA historically consisted of several different plant communities. A dense swamp of pond apple, willow and elderberry formed broad bands along the southern rim of Lake Okeechobee. The remainder of what is now the EAA was dominated by sawgrass marshes. The present EAA contains primarily agricultural cropland.

Figure 4-3

Several large tracts of land at the south end of the EAA were never directly converted to agricultural lands, although seasonal water patterns have been greatly altered by water management practices. These areas are known as the Holey Land and Rotenberger Wildlife Management Areas (WMAs), and the former Brown's Farm WMA (now converted to STA 2). These three areas comprise approximately 18 percent of the EAA and retain much of their historic sawgrass marsh and associated plant communities, although the plant cover has been altered by hydroperiod changes, fires, soil subsidence and invasion of exotic plant species and cattail. It is not expected that these areas will experience any modification to their existing in-flows under the LORS alternatives and are thus not further discussed.

4.2.4. WATER CONSERVATION AREAS (GREATER EVERGLADES)

Nearly all of the WCAs (Figure 4-3) are a patterned peatland, consisting of long, linear sawgrass ridges interspersed with teardrop-shaped tree islands (hammocks) and willow strands. Tree islands are a unique feature of the Everglades ecosystem. Tropical hardwoods are found on some of the relatively unaltered tree islands in the southern portion of the area. The landscape pattern of Ridge and Slough has been altered significantly but appears largely intact in portions of the Water Conservation Areas and into Everglades National Park (Science Coordinating Team 2003).

The Ridge and Slough patterns developed in broad, shallow to intermediate depth basins with peat substrate in response to the original hydrologic flow regimes of the Everglades. The dominant plant cover is sawgrass and/or buttonbush and/or mixed emergents. In general, there are now three recognizable types of basin wetland communities present:

1. Sawgrass ridges now interspersed, composed of sawgrass, with cattail, maidencane, arrowhead, pickerelweed, willow, button bush, wax myrtle (*Myrica cerifera*), and saltbush (*Baccharis glomeruliflora*).

2. Wet prairie, composed of beak rush, spike rush, maidencane, string lily (*Crinum americanum*), and white water lily.

3. Aquatic slough, composed of white water lily, floating heart (*Nymphoides aquatica*), spatterdock (*Nuphar luteum*), bacopa (*Bacopa caroliniana*), and bladderwort.

The following species are associated with some portions of this community: pond cypress (*Taxodium ascendens*), bald cypress (*Taxodium distichum*), willow, buttonbush, wax myrtle, sawgrass, and royal fern (*Osmunda regalis*).

A hydric hammock is a wetland forest community that occurs in lowlands over sandy, clay organic soil, often over limestone. Its water regime is mesic to hydric; climate is subtropical or temperate; and fire is rare or not a major factor. The following species are associated with this community: sweet bay (*Magnolia virginiana*), red bay (*Persea borbonia*), cocoplum (*Chrysobalanus icaco*), strangler fig (*Ficus aurea*), wax myrtle, willow, elderberry (*Sambucus simpsonii*), hackberry, cabbage palm (*Sabal palmetto*), red maple (*Acer rubrum*), false nettle (*Boehmeria cylindrica*), water oak (*Quercus nigra*), hornbeam, and needle palm (*Rhapidophyllum hystrix*).

Vegetation within the WCA 1 consists of a matrix of wet prairies, sawgrass prairies, and aquatic slough communities with some Ridge and Slough patterning. Tree islands are interspersed throughout the area. Plant community cover within WCA 1 has shifted as a result of impoundment of the marsh by perimeter levees and alteration of hydroperiods by operation of the C&SF Project. The southern, lower elevation areas of WCA 1 have been flooded for long periods of time, while the northern portions of the area have experienced more frequent drying. Areas which have experienced shortened hydroperiods have experienced shifts to woody vegetation (wax myrtle and willow), while lower elevations have experienced shifts to more aquatic flora. In addition, WCA 1 currently includes approximately 6,000 acres (four percent total cover) of cattail marsh that was not present prior to the early 1960's. A number of factors influence establishment of cattails in the Everglades. These include physical disturbance of underlying soil profile by canal construction activities, proximity to seed sources, fire, hydrologic changes and the availability of nutrients. Exotic vegetation that was uncommon prior to 1965 is a growing problem. Melaleuca and Brazilian pepper are both rapidly spreading along the perimeter and into the interior marsh. Old World climbing fern (*Lygodium microphyllum*) is also a major invasive exotic species in WCA 1.

Major plant communities in WCA 2A now consist of remnant drowned tree islands, open water sloughs and large expanses of sawgrass, and sawgrass intermixed with dense cattail (*T. domingensis*) stands. Some remnant Ridge and Slough patterning remains. Remaining tree islands are found primarily at higher ground level elevations, located in the northwest corner of WCA 2A. Remnant (drowned) tree islands, dominated primarily by willow, are found scattered throughout the central and southern sections of WCA 2A.

Several studies conducted within WCA 2A show that cattails out-compete sawgrass in their ability to absorb nutrients. There is increased cattail production during years of high nutrient inflows (Toth, 1988; Davis, 1991). Cattails are considered a high nutrient status species that is opportunistic and highly competitive, relative to sawgrass, in nutrient-enriched situations (Toth, 1988; Davis, 1991). Davis (1991) concluded that both sawgrass and cattail increased annual production in response to elevated nutrient concentrations, but that cattail differed in its ability to increase plant production during years of high nutrient supply.

The community structure and species diversity of Everglades vegetation located north of I-75 (WCA 3A North) is very different from the wetland plant communities found south

of I-75 (WCA 3A South). Improvements made to the Miami Canal and impoundment of WCA 3A by levees during the early to mid-1900s have over-drained the north end of WCA 3A and shortened its natural hydroperiod. These hydrological changes have increased the frequency of severe peat fires that have resulted in loss of tree islands, sawgrass ridges, aquatic slough, and wet prairie habitat that were once characteristic of the area. Today, northern WCA 3A is largely dominated by sawgrass and lacks the natural structural diversity of plant communities seen in southern WCA 3A. Most of the Ridge and Slough patterning is severely degraded.

Over drainage of the northwestern portion of WCA 3A has allowed the invasion of a number of terrestrial species such as salt bush (*B. halmifolia*), dog fennel, and broom sedge (*Andropogon* spp.). Melaleuca has become well established in the southeastern corner of WCA 3A North, and is spreading to the north and west.

Everglades vegetation located in the central and southern portion of WCA 3A probably represents some of the best examples of original, undisturbed Everglades habitat left in south Florida. This region of the Everglades appears to have changed little since the 1940's, and contains a mosaic of tree islands, wet prairies, sawgrass stands, and aquatic sloughs similar to those reported by Loveless (1959). The existing Ridge and Slough patterning is largely intact spatially, although the vertical difference between ridge tops and slough bottoms has lessened.

The majority of vegetation within WCA 3A south can be described as typical Everglades habitat with some exceptions due largely to the canalization and construction of levees which compartmentalize the WCAs. Water depths in southern WCA 3A are deeper than they would be without levees and Tamiami Trail.

4.3. THREATENED AND ENDANGERED SPECIES

Federally endangered and threatened species known to occur within the project area include:

COMMON NAME	SCIENTIFIC NAME	STATUS
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E(CH)
Wood stork	*Mycteria americana*	E
West Indian manatee	*Trichechus manatus*	E(CH)
Bald eagle	*Haliaeetus leucocephalus*	T
Eastern indigo snake	*Drymarchon corais couperi*	T
Cape sable seaside sparrow	*Ammodramus maritimus mirabilis*	E
Okeechobee gourd	*Cucurbita okeechobeensis*	E
Small-toothed sawfish	*Pristis pectinata*	E
Johnson's seagrass	*Halophila johnsonii*	T

E=Endangered; T=Threatened; CH=Critical Habitat has been designated

4.3.1. EVERGLADE SNAIL KITE

The snail kite occupies the watersheds of the Everglades, Kissimmee River, Caloosahatchee River, the upper St. Johns River, and Lake Okeechobee. "Each of these watersheds has experienced, and continues to experience, pervasive degradation due to urban development and agricultural activities" (USFWS, 1999). Snail kite habitat consists of freshwater marshes and the shallow vegetated edges of lakes where the apple snail (*Pomacea paludosa*), the kite's main food source, can be found. Snail kite populations in Florida are highly nomadic and mobile; tracking favorable hydrologic conditions and food supplies, and thus avoiding local droughts. Snail kites move widely throughout the primary wetlands of the central and southern portions of the State of Florida. Lake Okeechobee and surrounding wetlands are major nesting and foraging habitat, particularly the large marsh in the southwestern portion of Lake Okeechobee and the area southwest of the inflow of the Kissimmee River (USFWS, 1999). Critical habitat was designated for the snail kite in 1977. Critical habitat includes the entire littoral zone and western shore of Lake Okeechobee.

The snail kite has a highly specialized diet typically composed of Florida apple snails, which are found in palustrine, emergent, long-hydroperiod wetlands. As a result, the snail kite's survival is directly dependent on the hydrology and water quality of its habitat (USFWS, 1999). Snail kites require foraging areas that are relatively clear and open in order to visually search for apple snails. Suitable foraging habitat for the snail kite is typically a combination of low profile marsh and a mix of shallow open water. Shallow wetlands with emergent vegetation such as spike rush, bulrush, and other native emergent wetland plant species provide good snail kite foraging habitat as long as the vegetation is not too dense to locate apple snails. Dense growth of plants reduces the ability of the snail kite to locate apple snails. The degradation of water quality in Lake Okeechobee, due in part to runoff of phosphorous from agriculture lands, promotes dense growth of both native and exotic vegetation, in particular cattail, water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*), which inhibits the ability of snail kites to find food. Bennetts and Kitchens (1997) noted that quality of habitat for kites is adversely influenced by changes in water quality and expansion of non-native plants. Lake Okeechobee has experienced high rates of phosphorus loading in recent decades due to altered land use in the watershed. At present, phosphorus loading is in excess of 500 metric tons per year (Havens & Gawlick, 2005), compared to the FDEP's recommended annual load of 140 metric tons (FDEP, 2001).

Snail kite nesting primarily occurs from December to July (peak in March-June), but can occur year-round. Nesting usually occurs over water, which deters predation. Nesting substrates include small trees such as willow and pond apple, and in herbaceous vegetation such as sawgrass, cattail, bulrush and reed. Kites appear to prefer woody vegetation when water levels are adequate to inundate the site (Rodgers, 1996). Nests are more frequently placed in herbaceous vegetation around Lake Okeechobee during periods of low water when dry conditions beneath willow stands (which tend to grow to the landward side of cattails, bulrushes and reeds) prevent snail kites from nesting in woody vegetation (USFWS, 1999). Nest collapse is rare in woody vegetation but common in non-woody vegetation, especially on lake margins (Rodgers, 1996).

Historically, Lake Okeechobee's littoral zone has provided one of South Florida's largest habitats for the snail kite (Bennetts and Kitchens, 1997). However, species experts have reported a decline in the overall Florida population estimate for the snail kite in recent years, as well as a lack of substantial numbers of snail kite nests in Lake Okeechobee. Observations since 1992 suggest a general degradation of nesting habitat in the littoral zone of Lake Okeechobee from the loss of willows in nesting areas (USFWS, 1999).

The south/central Florida region, including Lake Okeechobee, has experienced extreme weather events over the past few years. For instance, a regional drought occurred in 2000-2001, and above average rainfall in 2004 and 2005. Above average rainfall coupled with very active hurricane seasons in 2004 and 2005, has allowed less favorable conditions in the littoral zone of Lake Okeechobee. The major hurricanes of 2004 (Frances and Jeanne) caused major ecological damage inside the lake, uprooting much of the lake's submerged vegetation and causing suspension and transport of soft mud sediments from the center of the lake to the shallow shoreline areas (Havens, 2005b). As a result Lake Okeechobee remained highly turbid for months after the hurricanes. The combination of high turbidity and deep water blocked light penetration to the lake bottom in shoreline areas (Havens, 2005). Lack of suitable light penetration can adversely impact SAV in Lake Okeechobee.

During years 2000-2001, snail kite survival dropped substantially in response to the regional drought (Kitchens et al., 2006). Lake Okeechobee had a record low stage of 9.2 ft., NGVD, at which time much of the shoal area became dry (Havens, et. al., 2005). Droughts, such as the one that occurred in 2000-2001, can severely impact the snail kite's forage and nesting habitats. In particular, snail availability to kites is greatly reduced during droughts (Beissinger, 1995). When droughts lead to a drying out (dry-down) of a breeding site during breeding season, they have a negative effect on survival and reproduction of snail kites (Bennets and Kitchens, 2000). To date, the assumption has been that during a drought, snail kites move from areas most affected by drought toward areas least affected by drought (Martin, et al., 2006). In extreme droughts, Lake Okeechobee is sometimes the only major wetland habitat with adequate water levels which are suitable for foraging and nesting (Havens & Gawlick, 2005). Havens and Gawlick (2005) report that the prolonged period of extreme low stage in 2000-2001 appeared to have nearly eliminated the apple snail population from Lake Okeechobee's littoral zone. However, it is also important to note that dry-downs are not necessarily harmful to apple snail populations, as long as they do not coincide with the peak period of egg-production or last for many months (Havens & Gawlick, 2005).

Even though drought conditions have negative effects, it is also recognized that occasional droughts are necessary to maintain native emergent vegetation such as spike rush, which is favorable to snail kite foraging.

Regulation of water stages in Lake Okeechobee is particularly important to maintain the balance of vegetative communities required for snail kites and the apple snail. Fluctuation and timing of lake stages affect the distribution of vegetative communities,

and overall habitat quality (nesting sites, foraging habitat) for the snail kite. According to USFWS (1999), a water stage of 14.5-15.0 ft. NGVD on Lake Okeechobee is recommended near the beginning of the snail kite nesting season during most years, with a gradual recession in late winter to late spring. This water stage coincides with several ecological studies on the littoral system of Lake Okeechobee. These studies have shown that a spring recession of lake levels from near 15 ft. to 12 ft. NGVD (January through May) favors nesting birds and other wildlife in the littoral marsh and allows for re-invigoration of willow stands (Smith et al., 1995). It is the extreme prolonged high and low lake levels which can be damaging to the Lake Okeechobee ecosystem. Factors contributing to habitat loss in Lake Okeechobee include prolonged periods of deep water and expansion of exotic vegetation (during low lake levels) such as torpedograss (Havens and Gawlick, 2005).

4.3.2. BALD EAGLE

The bald eagle is currently listed as threatened by the USFWS and the Florida Fish and Wildlife Conservation Commission (FFWCC). The bald eagle occurs in various habitats near lakes, large rivers and coastlines. Most breeding eagles construct nests within several hundred yards of open water (USFWS, 1999). Shorelines, such as the shorelines around Lake Okeechobee, the Okeechobee Waterway, and estuaries provide fishing and loafing perches, nest trees, and open flight paths for the bald eagle (USFWS, 1999). The bald eagle primarily feeds on fish, but is known to occasionally prey on small mammals and will feed on carrion. Bald eagles are known to nest around the study area. Nesting season occurs from October through May. The bald eagle mates for life and uses the same nesting site year after year, if the territory is available. According to the FFWCC database, for the period of 2000-2004, two nests were reported in close proximity to Lake Okeechobee. One nest, located in Palm Beach County near Lake Harbor, was last listed as active in 2003. The second nest, located in Glades County northeast of Lake Port, was active in 2004.

4.3.3. WOOD STORK

The wood stork is listed as endangered by the USFWS and the FFWCC. Wood storks forage in freshwater marshes, seasonally flooded roadside or agriculture ditches, narrow tidal creeks, shallow tidal pools, managed impoundments, and depressions in cypress heads and swamp sloughs. Wood storks typically feed on fish between 2 and 25 centimeters (cm) in length. Wood storks have nested in small numbers around Lake Okeechobee, and are regularly seen foraging in the area (Smith, et al., 1995). Data gathered by Smith, et al., (1995) indicate that wood storks are attracted to the lake in large numbers only when the stage is dropping below 15 ft., NGVD. A lake stage above 15 ft., NGVD eliminates most of the foraging habitat available to wading birds on the lake (Aumen and Gray, 1995), whereas a lake stage below 11.8 ft., NGVD reduces the diversity of available foraging habitats and the number of acceptable nesting colony sites (Smith et al., 1995). As Aumen and Gray (1995) discuss, a regulation schedule for Lake Okeechobee benefiting wading birds should include a moderately paced draw down in water level to below 15 ft., NGVD coincident with the dry season and the usual wading bird nesting season (January – June).

4.3.4. CAPE SABLE SEASIDE SPARROW

Cape Sable Seaside Sparrow (CSSS) are medium-sized sparrows restricted to the Florida peninsula. They are non-migratory residents of freshwater to brackish marshes (USFWS, 1999). CSSS have a very restricted range and occur only in the Everglades region of Miami-Dade and Monroe counties of South Florida (USFWS, 1999). Critical habitat for the sparrow was designated on August 11, 1977 under Title 50 of the Code of Federal Regulations Part 17.95 (50 CFR 17.95). A key constituent element for the CSSS should be a hydroperiod pattern that maintains the preferred vegetative communities for successful breeding. During the breeding season, surface water levels should be at or below the surface within the short-hydroperiod prairies, and should be achieved through adherence to a rainfall-driven operational schedule within its habitat (USFWS, 1999).

4.3.5. WEST INDIAN MANATEE

The West Indian manatee has been recognized as an endangered species since 1967. The manatee lives in freshwater, brackish, and marine habitats and prefers water depths of at least three to seven feet. Water temperature colder than 77 degrees Fahrenheit increases the manatee's susceptibility to cold stress and cold induced mortality. Primary threats to manatees today are attributed to collisions with watercraft, degradation of habitat, and accidents occurring at water control structures. Manatees feed on a variety of submerged, emergent and floating vegetations and usually forage in shallow grass beds adjacent to deeper channels. During the summer months, manatees range throughout water bodies of south Florida. In the winter months, manatees tend to congregate in warm water areas such as springs and power plant facilities. The utilization of Lake Okeechobee and the tributaries and canal systems in south Florida by the manatee is not uncommon. Manatees are often seen in the Caloosahatchee River, St. Lucie Canal and Lake Okeechobee. During winter, manatees congregate close to the Florida Power and Light power plant at Ft. Myers, adjacent to the Caloosahatchee River. A park has been established in this vicinity for manatee viewing. The manatee is known to move through the Okeechobee Waterway lock structures when traveling to and from the coast.

4.3.6. OKEECHOBEE GOURD

The Okeechobee gourd is an annual or perennial, fibrous-rooted, high-climbing vine with tendrils, belonging to the gourd family *Cucurbitaceae* (USFWS, 1999). Today, the Okeechobee gourd has an extremely limited distribution. Lake Okeechobee is one of two areas where the gourd is currently found. There are several localized sites along the southeastern and northeastern shore of Lake Okeechobee, where this vine plant is known to grow. Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season. Water management levels in Lake Okeechobee affecting the snail kite and wood stork are also likely to affect the Okeechobee gourd. Fluctuating lake levels are necessary for the continued survival and recovery of the gourd within and around Lake Okeechobee. The endangered Okeechobee gourd flourishes when suitable soils are exposed during low water levels (USFWS, 1999).

4.3.7. EASTERN INDIGO SNAKE

The Eastern indigo snake has been classified as a threatened species by the USFWS and the FFWCC. The Eastern indigo snake is a large, black, non-venomous snake in North America. The Eastern indigo prefers drier habitats, but may be found in a variety of habitats from xeric sand hills, to cabbage palm hammocks, to hydric hardwood hammocks (Schaefer and Junkin, 1990). This species is generally an upland species snake, occupying a wide variety of habitat. The main reason for the snakes decline is habitat loss due to development. Further, as habitats become fragmented by roads, indigo snakes become increasingly vulnerable to highway mortality as they travel through their large territories (Schaefer and Junkin, 1990). The HHD and other levees within the Lake Okeechobee project area would be the primary area the snake would utilize.

4.3.8. SMALLTOOTH SAWFISH

The endangered smalltooth sawfish (*Pristis pectinata*) is one of two species of sawfish that inhabit United States (U.S.) waters. The U.S. population of smalltooth sawfish experienced severe range reduction and decline over the last century. The biology and ecology of *P. pectinata* is poorly known and the species was thought to be close to extirpation from the U.S. waters before moderate numbers of individuals were recently documented in Florida, particularly south and southwest Florida. The smalltooth sawfish was listed as a Federally endangered species in 2003.

Smalltooth sawfish commonly reach 5.5 meters. Little is known about the life history of these animals, but they may live up to 25-30 years and mature after about 10 years. Like many elasmobranches (e.g. sharks), smalltooth sawfish are ovoviviparous, meaning the mother holds the eggs inside her until the young are ready to be born. Sawfish species inhabit shallow coastal waters of tropical seas and estuaries throughout the world. Sawfish are most often found within a mile of land such as in estuaries, river mouths, bays, or inlets. They occur in a wide range of habitat types including seagrass flats, mud bottoms, oyster bars, sand bottoms, artificial reefs, cocral reefs, and mangrove shorelines. They can also be found miles up rivers in low salinity conditions. The smalltooth sawfish is found in the Caloosahatchee River, particularly in the lower parts of the river near the mouth (personal correspondence, G. Poulakis, FFWCC). This portion of the river is where the majority of sawfish are caught and tagged by FFWCC for research and monitoring purposes. Additionally, anglers most commonly report seeing and catching the species in the lower parts of the river near the mouth.

Smalltooth sawfish generally eat whatever small schooling fish may be abundant locally, such as mullet. They may also feed on crustaceans and other benthic organisms. The sawfish has been seen as “stirring the mud with its saw” to locate its prey, or attacking schools of small fish by slashing sideways with its saw and eating the wounded fish (NMFS, 2000).

4.3.9. JOHNSON’S SEAGRASS

The threatened Johnson’s seagrass (*Halophila johnsonii*) has been found growing only along approximately 200 kilometers (km) (approximately 125 miles) of the coastline in

southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy, 1997). Kenworthy suggested that horizontally spreading rapid growth patterns and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms H. johnsonii's limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay.

Johnson's seagrass occurs over varied depths, environmental conditions, sand substrates, and water quality. In tidal channels, H. johnsonii is found in coarse sand substrates, although it has been found growing on sandy shoals in soft mud near canals and rivers where salinity may fluctuate widely (Virnstein et al., 1997).

Areas of concern for this species include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into seagrass areas reduce the amount of sunlight available for photosynthesis.

4.3.10. STATE LISTED SPECIES

Additional State listed species present within the effected area, and which may be affected by regulation schedule alternatives are presented in Table 4-1.

Table 4.1

4.4. FISH AND WILDLIFE RESOURCES

As with the above discussion of existing vegetation, the below discussion of fish and wildlife resources inhabiting the study area is organized by physiographic area, beginning with Lake Okeechobee itself, the estuaries, EAA and concluding with the WCAs.

4.4.1. LAKE OKEECHOBEE

The area around Lake Okeechobee includes a wide variety of habitat opportunities for wildlife, including wading and migratory birds, many mammals, amphibians, and reptiles, as well as prey species such as crayfish, prawns, apple snails (Pomacea paludosa), and aquatic insects. The U.S. Fish and Wildlife Service (USFWS) has designated six wildlife species as threatened or endangered and likely to occur in the vicinity of the Lake Okeechobee study area (Section 3.3). There are also State-listed species present within and around Lake Okeechobee, including several of the wading bird species that are not on the Federal list. The Corps conducted a two year wildlife survey within the western littoral zone of Lake Okeechobee, gathering baseline data for key habitat types for reptiles, amphibians, and migratory and resident birds (USACE, 1999). Much of the information below was gathered from the study.

Lake Okeechobee is home to a large number of fish species, some of which are valued as commercial and sportfish, and others serving as part of the cornerstone of the littoral zone food web. The USACE (1999) found numerous small fish species, including the Cyprinodontids such as the golden topminnow (*Fundulus chrysotus*), the least killifish (*Heterandria formosa*), and the Florida flagfish (*Jordanella floridae*) which are important food resources for wading birds, amphibians, and reptiles. Over a five year period (1987-1991), mean annual commercial harvest was 2,008 metric tons (Fox, et al., 1992, 1993). Commercially important fish species included white catfish, bluegill, and red-ear sunfish.

Additionally, Furse and Fox (1994) revealed that numerous sportfish occur in the littoral zone. The largemouth bass (*Micropterus salmoides*) is one of the most popular gamefish in the State of Florida, and is a major predator of small fish, amphibians, birds, and reptiles. Additionally, the black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and redear sunfish (*L. microlophus*) are sportfish found in high numbers in the littoral zone.

Macroinvertebrate diversity in the western littoral zone provides yet another vital component to the food web. Macroinvertebrate species incidentally sampled during field investigations in the western littoral zone included the apple snail, an important food resource of the snail kite (*Rostrhamus sociabilis plumbeus*), crayfish (*Procambarus* spp.), grass shrimp (*Paleomonetus paludosus*), and Dytiscid beetles (*Dytiscidae*).

Significant changes in recent years have been observed on Lake Okeechobee. Valuable fish habitat including bulrush, spike rush and SAV has been lost and/or replaced by exotic species such as torpedograss and hydrilla. Reports of muddy, turbid water, and drowned vegetation are not uncommon among the public and fisherman. Fishing guides report fish spawning has been poor for the last five years. Others report that shiners (an important bait fish) are becoming increasingly difficult to find and more and more fisherman are forced to the same areas to fish for them.

A major area of concern to the life cycle of fish and wildlife species is the western littoral zone and marsh, thus the description below will focus on this area as a representative of similar littoral resources around the lake.

The western littoral zone provides tremendous foraging and nesting habit for a wide range of avifauna. Previous studies (Smith and Collopy, 1995; David, 1994) have documented birds including the endangered wood stork (*Mycteria americana*), the Federally and State endangered snail kite, great blue heron (*Ardea herodias*), white ibis (*Eudocimus albus*), pied-billed grebe (*Podilymbus podiceps*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), little blue heron (*E. caerulea*), tricolored heron (*E. tricolor*), and common moorhen (*Gallinula chloropus*) that have commonly been observed utilizing the study area.

Other birds that may utilize the littoral zone include the threatened bald eagle (*Haliaeetus leucocephalus*), black skimmer (*Rhyncops niger*), brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*), and anhinga (*Anhinga anhinga*).

According to range maps presented in Conant and Collins (1991), reptile and amphibian diversity should be quite high in littoral and marsh areas of Lake Okeechobee. Studied species on Lake Okeechobee include the American alligator (*Alligator mississippiensis*) and the Florida soft-shelled turtle (*Apalone ferox*) (USACE, 1999). Currently, no published inventories are available on the diversity of reptiles and amphibians inhabiting the western littoral zone of Lake Okeechobee.

The Corps found large numbers of the greater siren (*Siren lacertina*) along with the green water snake (*Nerodia floridana*) and the banded water snake (*N. fasciata*). Additional common species sampled included frogs such as the southern leopard frog (*Rana utricularia*), the green tree frog (*Hyla cinerea*), and the squirrel tree frog (*H. squirrela*). The American alligator was the only listed species of reptile recorded by the Corps and there are no listed species of amphibians currently known to utilize the study area.

Of additional interest is the possibility of colonization of exotic amphibians and reptiles within Lake Okeechobee. Several reports from local residents have confirmed sightings of non-native species of lizards, such as the green iguana (*Iguana iguana*), the spiny-tailed iguana (*Ctenosaura pectinata*), and the brown basilisk (*Basiliscus vittatus*). Established populations of such species could be extremely harmful to native reptile and amphibian populations.

Lake Okeechobee also provides major resources for mammals. The Okeechobee Waterway, a designated channel that runs around the perimeter of the lake, as well as across the lake, provides habitat for the endangered West Indian manatee (*Trichechus manatus latirostris*). Additionally, river otters (*Lutra canadensis*), bobcats (*Felis rufus*), and the Florida water rat *(Neofiber alleni*), a species of special concern as listed by the Florida Committee for Rare and Endangered Plants and Animals, have been observed within the lake.

4.4.2. NORTHERN ESTUARIES

The northern estuaries refer to the St. Lucie Estuary on the east coast of Florida (which flows into the IRL) and the Caloosahatchee Estuary on the west coast of Florida. The IRL system is a biogeographic transition zone, fed by the St. Lucie Estuary, rich in habitats and species, with the highest species diversity of any estuary in North America (Gilmore, 1977). Approximately 4,315 different plant and animal species have been identified in the lagoon system. Included are 2,965 species of animals, 1,350 species of plants, 700 species of fish and 310 species of birds (IRL CCMP, 1996). Species diversity is generally high near inlets and toward the south, and low near cities where nutrient input, freshwater input, sedimentation, and turbidity are high and where large areas of mangroves and seagrasses have been lost. For biological communities and fisheries, seagrass and mangrove habitats are extremely important (Virnstein and Campbell, 1987). Much of the habitat loss has occurred as the result of the direct effects of shoreline development, navigational improvements, and marsh management practices.

Most of the predominantly freshwater fishes recorded from the Lagoon system, such as minnows (*Cyprinidae*), bullhead catfishes (*Ictaluridae*), and sunfishes (*Centrarchidae*) are found mainly or exclusively in the tributary streams including the streams feeding the St. Lucie. Examples of other species in this habitat include all of the ubiquitous forms mentioned above as well as Florida gar; gizzard shad; flagfish; bluefin killifish (*Lucania goodei*); mosquitofish (*Gambusia affinis*); least killifish; sailfin molly (*Poecilia latipinna*); inland silverside (*Menidia beryllina*); gulf pipefish (*Syngnathus scovelli*); leatherjack (*Oligoplites saurus*); gray snapper (*Lutjanus griseus*); Irish pompano (*Diapterus auratus*); silver jenny (*Eucinostomus gula*); fat sleeper (*Dormitator maculatus*); bigmouth sleeper (*Gobiomorus dormitor*); and lined sole (*Achirus lineatus*). Fish species that specialize in creek-mouth habitats include yellowfin menhaden (*Brevoortia smithi*); gafftopsail catfish (*Bagre marinus*); timucu, a needlefish (*Strongylura timucu*); gulf killifish (*Fundulus grandis*); striped killifish (*F. majalis*); mosquitofish; sailfin molly; lined seahorse (*Hippocampus erectus*); chain pipefish (*S. louisianae*); gulf pipefish; tarpon snook (*Centropomus pectinatus*); Atlantic bumper (*Chloroscombrus chrysurus*); gray snapper; Irish pompano; silver jenny; great barracuda (Sphyraena barracuda); gobies, sleepers, puffers, filefish (*Monacanthus* spp.) and many others.

In addition to finfish, the estuaries and IRL support a variety of shellfish. Blue crabs, stone crabs, hard clams and oysters are important estuarine commercial species. The blue crab accounted for approximately 80 percent of shellfish landings in the IRL between 1958 and 1988 (IRL CCMP, 1996). Oysters are an important indicator organism and are known to be sensitive to salinity changes in their environment.

The Caloosahatchee Estuary starts at the W.P. Franklin Lock and continues downstream nearly 30 miles to San Carlos Bay. Although various changes have historically occurred in the Caloosahatchee Estuary (channelization, shoreline hardening, point and non-point source pollution impacts), the estuary sustains numerous and diverse fish and wildlife populations. Important resources within the estuarine portions of the Caloosahatchee are SAV (i.e. seagrasses), oyster bars, open bottom community, and mangrove-lined shorelines. These communities provide important habitat supporting many wildlife species.

Manatees, waterfowl, and wading birds rely on seagrass communities as foraging area. SAV are an integral nursery area for commercially and recreationally important fish and shellfish. Seagrass communities provide critical refugia for juvenile fish such as redfish, grouper, snook, and spotted seatrout. In addition, the upper and middle portions of the Caloosahatchee River support a blue crab fishery. Oyster bars and open bottoms of sand, mud, shell, and bedrock provide important habitat and food for other estuarine species. They harbor a rich macro invertebrate community that is utilized by wading birds, as well as shorebirds and fish.

In the Caloosahatchee Estuary, mangroves support fish and macro invertebrate communities by providing a protected nursery area. Important marine and estuarine species that spend part of their life cycle in the mangrove community include snook, snapper, tarpon, jack, sheepshead, red drum, ladyfish, blue crab, and shrimp. Mangrove forests also provide important foraging and nesting habitat for diverse populations of birds.

During the dry season, inflows are too low and supplemental input from Lake Okeechobee is required to maintain a viable salinity gradient in the estuary. Mean monthly flows >2800 cfs have been known to cause mortality of marine seagrasses and other organisms near the mouth of the Caloosahatchee Estuary. Mean monthly flows >4500 cfs have been known to begin to cause mortality of seagrasses in the adjacent San Carlos Bay.

During the dry season salt water from the Gulf of Mexico can intrude up the estuary all the way to the Franklin Lock and Dam referred to as S-79. Too much salt in the upper estuary will significantly impact the brackish water organisms that normally inhabit this region. During the driest times, a mean monthly flow of 450 cfs at S-79 is required to maintain viable salinity conditions in the upper estuary.

Spring is a critical period in estuarine systems because many estuarine dependent organisms reproduce at this time. High flows, >2800 cfs in the Caloosahatchee and 2000 cfs in the St. Lucie, have been known to prevent the early life stages of fish, shellfish and other commercially and recreationally important species from utilizing estuarine habitat. Alternatives with the fewest number of mean monthly flows exceeding these limits are preferred.

4.4.3. EVERGLADES AGRICULTURAL AREA

Wildlife habitat within the EAA is mostly limited to the canal systems. Flooded and cultivated agricultural fields attract feeding birds, especially waders. The Holey Land and Rotenberger WMAs located at the south end of the EAA support populations of wading birds, deer, hogs and waterfowl. Wading birds and some raptors also frequent the flooded fields and canals. Raptors find abundant food sources in small mammals, snakes and other reptiles which often inhabit sugar cane fields. The extensive canal system supports fish species that normally would not be common inhabitants of the Everglades marshes, but are typically found in lakes. These fish include black crappie, catfish, and shad. Oscars (*Astronotus* spp.), spotted tilapia (*Tilapia mariae*), walking catfish (*Clarias batrachus*), and the black acara (*Cichlasoma bimaculatum*) are examples of exotic fish species that have become established within the region.

4.4.4. WATER CONSERVATION AREAS (GREATER EVERGLADES)

The WCAs as a whole contain a number of important species whose existence, population numbers and sustainability are markedly influenced by water levels. The American alligator, a keystone Everglades species, has rebounded in terms of population numbers since the 1960's when the reptile was placed on the endangered species list by the USFWS. Alligators, it is believed, play an important ecological function by maintaining "gator holes", or depressions, in the muck which are thought to provide refuge for aquatic organisms during times of drought and concentrates food sources for wading birds. High water during periods of nest construction which occurs from June to early July (Woodward et al., 1989) decreases the availability of nesting sites. If conditions become too dry, water levels may fall too low to maintain gator holes, forcing the animal to seek other areas to survive.

Other important reptile species commonly encountered within the study area include a number of species of turtles, lizards, and snakes. Turtle species include the snapping turtle (*Chelydra serpentina*), striped mud turtle (Kinosternon bauri), mud turtle (*K. subruburm*), cooter (*Chrysemys floridana*), Florida chicken turtle (*Deirochelys*

reticularia), and Florida softshell turtle (*Trionys ferox*). Lizards such as the green anole (*Anolis carolinensis*), are found in the central Everglades, and several species of skinks occur more commonly in terrestrial habitats. Numerous snakes inhabit the wetland and terrestrial environments. Drier habitats support such species as the Florida brown snake (*Storeria dekayi*), southern ringneck snake (*Diadophis punctatus*), southern black racer (*Coluber constrictor*), scarlet snake (*Cemophora coccinea*), and two rattlesnakes (*Sistrurus miliarius* and *Crotalus adamanteus*). The eastern indigo snake (*Drymarchon corais*), a Federally listed threatened species, and the Florida pine snake (*Pituophis melanoleucus mugitus*), a State species of special concern, may also exist in drier areas of the study area. Wetter habitats support more aquatic species such as the water snake (*Natrix sipedon*), the green water snake, mud snake (*Francia abacura*), eastern garter snake (*Thamnophis sirtalis*), ribbon snake (*T. sauritus*), rat snake (*Elaphe obsoleta*), and the Florida cottonmouth (*Agkistrodon piscivorus*) (McDiarmid and Pritchard, 1978).

Important amphibians, known to occur in south Florida, include the Everglades bullfrog, or pig frog (*R. grylio*), Florida cricket frog (*Acris gryllus*) and southern leopard frog, southern chorus frog (*Pseudacris nigrita*) and various tree frogs are common to tree islands and cypress forests. Salamanders inhabit the densely vegetated, still or slow-moving waters of the sawgrass marshes and wet prairies. They include the greater siren and the Everglades dwarf siren (*Pseudobranchus striatus*). Toads such as the eastern narrow-mouth toad (*Gastrophryne carolinensis*) also occur within the study area.

Colonial wading birds (*Ciconiformes*) are a conspicuous component of the wildlife communities that utilize the WCAs as both feeding and breeding habitat. These include 11 species of herons and egrets, two species of ibis, the wood stork, and the roseate spoonbill (Robertson and Kushlan, 1984). Historically, white ibis has been the most abundant colonial wading bird species within the WCAs. Surveys indicate that the great egret is the second most abundant species (Frederick and Collopy, 1988). The great blue heron, little blue heron, tricolored heron, green backed heron (*Butorides striatus*), snowy egret (*E. thula*), cattle egret (*Bubulcus ibis*), black crowned night heron (Nycticorax nycticorax), and yellow crowned night heron (*N. violacea*), are also common wading bird species found throughout the WCAs. The roseate spoonbill (*Ajaia ajaja*), a State listed species of special concern, and the wood stork, a Federally listed endangered species, both occur within the WCAs. The WCAs support additional aquatic avifauna, such as the limpkin (*Aramus guarauna*), two bitterns (*Ixobrycus exilis and Botarus lentiginosus*), the anhinga, as well as a number of resident and migratory waterfowl.

The Everglades fish community is composed of a variety of forage fish important in the diet of many wading birds, sport fish, native species and exotics introduced partly through aquacultural practices and the aquarium trade. Forage species include the Florida flagfish, bluefin killifish, least killifish, shiners, mosquito fish, and sailfin molly.

Generally, Everglades sport fish are harvested from the borrow canals that surround the marsh. As water levels in the canal and marsh rise, fish populations disperse into the interior marsh and reproduce with minimum competition and predation. As water levels recede, fish concentrate into the deeper waters of the surrounding canals, where they

become available as prey for wildlife and fishermen. In some instances, the canal fishery has experienced major fish kills due to overcrowding and oxygen depletion. The WCAs provide a valuable sport fishery for south Florida. Many of the canals, notably along U.S. Highway 41, Interstate-75, and in the L-35B and L-67A provide valuable recreational fishing for largemouth bass, sunfish, oscar, gar, bowfin (*Amia calva*), catfish and other species.

Besides supporting a valuable recreational fishery for the region, fish communities in the WCAs provide a major food source for Everglades wading birds, alligators, and other carnivorous reptiles and mammals. Fish community structure and abundance is highly dependent on water levels. Consequently, fishing success by humans or wildlife is also dependent on water levels (Dineen, 1974). For a more complete listing of common Everglades fishes reference Gunderson and Loftus (1993).

Several game and non-game wildlife species occur within the WCA system including: white-tailed deer (*Odocoileus virginianus*), common snipe (*Capella gallinago*), and marsh rabbit (*Sylvilagus palustris*). Blue-winged teal (*Anas discors*), mottled ducks (*A. fulvigula*) and other game waterfowl are found in the sloughs of the northeast corner. Feral hogs (*Sus scrofa*) may also be present in drier areas or on tree islands.

4.5. ESSENTIAL FISH HABITAT

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1976 and the 1996 Sustainable Fisheries Act, an Essential Fish Habitat (EFH) Assessment is necessary for implementation of the Preferred Alternative. An EFH Assessment is a review of the proposed action and its potential impacts to EFH. The rules promulgated by the National Marine Fisheries Service (NMFS) in 1997 and 2002 further clarify EFH by definition as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." *Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include areas historically used by fish where appropriate. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle.

Only species managed under a federal fishery management plan (FMP) are covered under (50 CFR 600). The act requires federal agencies to consult on activities that may adversely influence EFH designated in the FMPs. The activities may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. The adverse result(s) must be evaluated individually and cumulatively.

The St. Lucie Estuary and the Southern IRL are within the jurisdiction of the South Atlantic Fishery Management Council (SAFMC) and are located in areas designated as EFH for estuarine waters, mangroves, seagrasses, and live bottom communities. The estuary provides EFH for adult and juvenile red drum (*Sciaenops ocellatus*), shrimp, spiny lobster (*Panulirus argus*), and the snapper-grouper complex. In addition, the nearshore hardbottom habitat outside of the St. Lucie and Ft. Pierce Inlets is designated as EFH Areas of Special Concern for the snapper-grouper complex.

The Caloosahatchee Estuary is within the jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC). In the estuary, EFH is defined as all estuarine waters and substrates (mud, sand, shell, rock and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and the adjacent inter-tidal vegetation (marshes and mangroves). The estuary provides EFH for adult and juvenile brown shrimp (*Penaeus aztecus*), pink shrimp (*Panaeus duorarum*), white shrimp (*Penaeus setiferus*), gray snapper (*Lutjanus griseus*), red drum (*Sciaenops ocellatus*), Spanish mackerel (*Scomberomorus maculates*), spiny lobster (*Panulirus argus*), stone crab (*Menippe mercenaria*), and gulf stone crab (*Menippe adina*).

In conformance with the 1996 amendment to the MSFCMA, the information provided in the SEIS will comprise the required EFH Assessment. The SEIS will be coordinated with the NMFS Habitat Conservation Division which will initiate consultation under the MSFCMA.

4.6. COASTAL BARRIER RESOURCES

There are no coastal barrier resources in the project study area.

4.7. FLOOD PROTECTION

One of the primary functions of the C&SF Project is to provide a highly-efficient flood control system designed to keep urban and agricultural areas dry in the wet season by discharging excess water to tide or into the WCAs and ENP. Flood control works on Lake Okeechobee consist of a system of about 1,000 miles of encircling levees designed to withstand a severe combination of flood stage and hurricane occurrence, plus the regulatory outlets of St. Lucie Canal and the Caloosahatchee River. The design discharge of Moore Haven Spillway is 9,300 cfs and St. Lucie Spillway is about 16,000 cfs (USACE, 1999). Following removal of local runoff from the agricultural areas south of the lake, an additional regulatory capability of several thousand cfs is available through the Miami, North New River, Hillsboro, and West Palm Beach Canals by pumping into the three WCAs. The crest elevation of the levee system surrounding the lake ranges from 32 to 45 ft., NGVD. The likelihood of overtopping the levees from excess storage is nearly non-existent. Possible flooding due to overtopping of levees within the HHD system is limited to short duration events involving wave runup in addition to hurricane-induced storm surge.

4.8. WATER SUPPLY

As one of its planned purposes, Lake Okeechobee supplies water for agricultural irrigation, municipalities, industry, and ENP, and for regional groundwater control and salinity control.

A primary use of Lake Okeechobee is to provide water supply for adjacent urban and agricultural lands and a backup water supply for lower east and west coast Florida counties. Currently, C-43 provides an important source of potable water for Lee County and the City of Ft. Myers and is also used as a source of water for irrigation by agriculture.

During years of normal rainfall, the WSE regulation schedule allows for an ample supply of water to be stored in Lake Okeechobee during wet periods for use during the dry season.

During dry periods, increased water usage and large dry season water losses due to evapotranspiration require an operational water allocation plan for Lake Okeechobee, especially when regional water supplies become low and may not meet anticipated service area demands. The SFWMD has developed a water supply management plan that requires various actions to be taken according to the severity of the conditions exhibited in the lake regulation schedule. The basis of this plan is an allocation scheme which parcels out lake water based on estimated water use for the remainder of the dry season. A target water level in Lake Okeechobee is established for the beginning of the wet season (June 1st) and allotments are computed such that lake water levels will not fall below the critical target stage, assuming average climatic conditions. Operational flexibility is built into the plan to make available the special actions that proved successful during the 1981–1982 drought.

4.9. WATER QUALITY

Lake Okeechobee
Waters of Lake Okeechobee have been designated by the State of Florida as Class I Waters, suitable for potable water supplies, and Class III, recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Water quality data indicate that Lake Okeechobee is currently in a eutrophic condition, primarily due to excessive nutrient loads from the agricultural sources both north and south of the lake. Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or not supplying their designated uses. According to FDEP's 1998 303(d) list, the water quality of Lake Okeechobee is impaired due to phosphorus, dissolved oxygen, iron, un-ionized ammonia, coliforms and chlorides. High phosphorus concentrations resulting from human-induced hydrologic and land use modifications are the predominant reason for impairment (FDEP, 2001). The total phosphorus concentrations that currently exist in the lake are in excess of the amount needed for a healthy ecosystem. The in-lake total phosphorus concentrations have doubled over the last 50-years as a result of increased inputs from the watershed (FDEP, 2001). From 1995 to 2000, the average concentration of total phosphorus in the pelagic region of Lake Okeechobee was approximately 100 parts per billion (ppb) (FDEP, 2001). In September 2004, hurricanes Frances and Jeanne passed just to the northeast of Lake Okeechobee producing winds in the 70 to 80 miles per hour (mph) range to the lake. Due to the lake's average shallow depth, wind easily affects sediment suspension. Total phosphorus concentrations climbed to levels as much as four to five times higher than normal as a result of the 2004 hurricanes (SFWMD, 2005). The EPA and the FDEP have prepared and approved a Total Maximum Daily Load (TMDL) for phosphorus for the Lake (FDEP, 2001) which is hereby incorporated by reference. The purpose of this TMDL is to attain acceptable phosphorus loads in the lake.

Caloosahatchee River Basin
Water quality conditions are degraded in the upper and lower areas of the Caloosahatchee River Basin due to agricultural and urban runoff, respectively. The channelized section of the river also shows degraded water quality conditions, due to agricultural inputs, as compared to tributaries lying in less developed areas of the basin. Problems associated with the degraded areas are typified by low dissolved oxygen levels, elevated conductivity, and decreased biodiversity. Conditions in the urbanized sections of the basin are influenced by non-point stormwater flows, and are manifested in the river by elevated chlorophyll levels, algal blooms, periodic fish kills, and low dissolved oxygen levels. Although wastewater discharges remain a problem, the estuary is presently more seriously affected by high-nutrient waters from the river

and tributaries, and stormwater runoff from cities. Nutrient and chlorophyll levels are high, and small algal blooms occur regularly. When there are discharges of fresh water from Lake Okeechobee to the Caloosahatchee River, the ambient water quality and the salinity of the river can be affected. Salinity effects are only experienced downstream of the W.P. Franklin Lock (S-79) since the river is freshwater downstream of the lake to that point and usually only a concern when discharge events exceed 2800 cfs at the S-79 structure for longer than 14 consecutive days. Water quality effects may be experienced all the way down the river from elevated nutrient concentrations in the lake water relative to the river water. These effects would be of concern during any discharge of water, even those falling within the optimum flow range of 450-2800 cfs. These discharges of lake water are just a piece of the puzzle of water quality conditions in the Caloosahatchee River and estuary.

St. Lucie River Basin

Water quality conditions along the St. Lucie River are rated as good in less developed areas of the basin. However, conditions are degraded in urbanized areas along the extensive network of canals that drain this area. High volume discharges from Lake Okeechobee also contribute to degraded water quality conditions in the St. Lucie River Basin.

4.10. HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

A preliminary assessment indicated no evidence of HTRW affecting this action.

4.11. AIR QUALITY

No significant sources of air quality pollutants are located in the Lake Okeechobee and waterway vicinity.

4.12. NOISE

Ambient noise levels are low to moderate in the Lake Okeechobee region. The major noise producing sources are vehicular and boat traffic.

4.13. AESTHETIC RESOURCES

Lake Okeechobee, the Caloosahatchee River Basin and the St. Lucie Estuary have several landscape features that are aesthetically appealing to tourists and local communities.

4.14. RECREATION RESOURCES

Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries are considered popular recreational resources in South Florida. Fishing, recreational boating, sightseeing, wildlife watching, camping and swimming are just a few of the recreational activities residents and visitors participate in. Lake Okeechobee is host to more than 500 permitted bass fishing tournaments annually and ranks as the top bass fishing lake in the U.S. (Havens, et al., 2004a).

4.15. NAVIGATION

A navigable waterway exists from the Intracoastal Waterway at St. Lucie Inlet on the Atlantic Coast across the State by way of St. Lucie Canal, Lake Okeechobee, and Caloosahatchee River to the Gulf of Mexico. The Caloosahatchee River is the western navigational channel for the Okeechobee Waterway. When the Lake Okeechobee stage is below 12.56 ft., NGVD, the authorized project depth is not maintained. The waterway consists of 154 miles of navigation channel, including the lake itself. Commercial and recreational navigation via the Okeechobee Waterway takes advantage of this shortcut across the Florida peninsula.

4.16. HISTORIC PROPERTIES

This action was coordinated in accordance with Section 106 of the *National Historic Preservation Act* (NHPA) of 1966, as amended, and 36 CFR, Part 800: *Protection of Historic Properties*. The State Historic Preservation Officer (SHPO) advises and assists the Corps in identifying historic properties (archaeological, architectural, and historical) listed, or eligible for listing, in the *National Register of Historic Places*, assessing the project's effects, and considering alternatives to avoid or minimize effects.