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FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
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Colonel Paul L. Grosskruger
District Commander
U.S. Army Corps of Engineers
701 San Marco Boulevard, Room 372
Jacksonville, Florida 32207-8175

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Biological Opinion Date:	March 1, 2007
Applicant:	J.D. Nicewonder, Jr.
Project:	Mirasol
County:	Collier

Dear Colonel Grosskruger:

This document transmits the Fish and Wildlife Service's (Service) amended biological opinion for the construction of the Mirasol development project and its effects on the endangered Florida panther (*Puma concolor coryi*) and endangered wood stork (*Mycteria americana*) in accordance with section 7 of the Endangered Species Act of 1973 as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). The original biological opinion was issued on March 1, 2007. This amended biological opinion is being issued to clarify levels of incidental take associated with the endangered wood stork. This biological opinion also clarifies text associated with wet and dry fish biomass calculations, National Wetland Inventory and Florida Land Use Codes and Forms Classification Systems, and prey size selection of wood storks. The project site is located north of Immokalee Road and east of Interstate 75 (I-75) in Sections 10, 11, 15, and 22, Township 48 South, Range 26 East, Collier County, Florida (Figure 1).

This biological opinion is based on information provided by the U.S. Army Corps of Engineers (Corps) in their August 9, 2006, Public Notice, July 21, 2006, letter to the Service, information provided by Turrell & Associates, Incorporated (Turrell) dated February 5, 2007, and June 20, 2006; various meetings and phone conversations with Turrell; information provided by Agnolli Barber and Brundage (ABB); information provided by Johnson Engineering; information provided by WilsonMiller; and meetings, telephone conversations, electronic mail, and other sources of information. A complete administrative record of this consultation is on file at the Service's South Florida Ecological Services Office, Vero Beach, Florida.

In the Public Notice and letter to the Service, the Corps determined the Mirasol project "may affect" the endangered Florida panther and wood stork. The Corps also determined the project

"may affect, but is not likely to adversely affect" the threatened eastern indigo snake (*Drymarchon corais couperi*) and the endangered red-cockaded woodpecker (RCW) (*Picoides borealis*). Based on the information provided by the applicant and the Corps, and the applicant's agreement to follow the draft *Standard Protection Measures for the Eastern Indigo Snake* (Service 2004), the Service concurs with the Corps' determinations for the eastern indigo snake and the RCW. The Service also concurs with the Corps' request to initiate formal consultation for project effects to the Florida panther and wood stork.

The Corps Public Notice represented an application for fill and excavation in 652 acres of wetlands and other surface waters and to alter 116.58 acres of uplands, impacting 769 acres. The project site is 1,714 acres and consists of 1,486 acres of jurisdictional wetlands and 228 acres of uplands. Subsequent information received from the applicant indicates that the project is actually for fill and excavation in 645 acres of wetlands and other surface waters and to alter 127.62 acres of uplands on the 1,714-acre site, for a total project impact of 773 acres. The purpose of the project is to construct a residential and golf course community in the northern Collier County vicinity.

The majority of the project site was historically used for cattle pasture. Land use and habitat cover types include 219.92 acres of pine (*Pinus* spp.) flatwoods uplands, 11.90 acres of Brazilian pepper (*Schinus terebinthifolius*) uplands, 4.92 acres of road right-of-way, 4.29 acres of wet prairie, 0.27 acre of cattle pond, 1.43 acres of flag (*Iris* sp.) pond, 3.59 acres of Brazilian pepper wetlands, 1.39 acres of mixed hardwood forest, 383.64 acres of melaleuca (*Melaleuca quinquernervia*), 819.01 acres of pine flatwood wetlands, 140.88 acres of cypress, and 122.21 acres of mixed cypress (*Taxodium distichum*) /pine flatwoods. The invasive exotic, melaleuca, has encroached into the entire project site, with large portions of the site supporting densities greater than 75 percent coverage. Over 85 percent of the project site has melaleuca densities of greater than 50 percent coverage.

The project is bounded on the north by a series of farms and agricultural fields and a recently permitted residential development known as Bonita Beach Road RPD and bounded on the west by two permitted proposed developments, Parklands and Terafina, and an existing development called Olde Cypress. The southern property boundary abuts the Cocohatchee or Immokalee Road Canal. The northeast property boundary is undeveloped while the southeast boundary is adjacent to numerous small farms and out-parcels. Immediately to the east of these out-parcels is a former rock and gravel mine known as Mule Pen Quarry that has been converted into a residential development known as Heritage Bay (Figure 2).

For the originally proposed project, the Corps determined, in the Public Notice dated May 25, 2001, the Mirasol project "may affect" the endangered Florida panther, the endangered wood stork, the endangered red-cockaded woodpecker, and the threatened eastern indigo snake. The Corps provided a listed species analysis completed by Turrell and a revised determination by letter dated March 11, 2002, that the project "may affect, but is not likely to adversely affect" the Florida panther, the wood stork, the red-cockaded woodpecker, and the eastern indigo snake. By email response to the Corps dated April 29, 2002, the Service did not concur with these determinations. After reviewing information received from the Corps and the applicant's agent, Turrell, the Service provided the Corps with a letter dated July 11, 2002, concurring with the

Corps' revised determination of "may affect, but is not likely to adversely affect" for the red-cockaded woodpecker and eastern indigo snake but not concurring with the Corps' revised determination of "may affect, but not likely to adversely affect" for the wood stork or the Florida panther. By letter dated January 22, 2003, the Service stated it had received all information necessary to initiate formal consultation on both the endangered Florida panther and the endangered wood stork and stated a biological opinion would be provided to the Corps. The Service reviewed the original proposal (4-1-01-F-607) and issued a biological opinion on February 21, 2003, which was later revised on March 9, 2005. The Corps denied the permit for the project on December 7, 2005.

The applicant has modified the project design and has reduced impacts by eliminating wetland alterations associated with the proposed construction of the external flow way. Secondary impacts have also been reduced by relocating golf holes so that they act as buffers between the development and adjacent wetlands. The Mirasol project revisions will result in less impact to habitat and more benefits in terms of compensation.

Total development footprint, including both wetlands and uplands, will be approximately 830 acres on the Mirasol development site, of which 773 acres are development and 57 are preserves. The 57 acres of preserves include 55 acres of wetlands and 2 acres of uplands. The project is within the boundaries of the Primary Zone (Kautz et al. 2006) (Figure 3). The project is within the Service's Panther Focus Area for the Florida panther (Figure 4) and provides habitat suitable for use for foraging and dispersal.

The applicant is proposing to preserve 941 acres, 831 acres are wetlands and 110 acres are uplands. About 55 acres of forested wetlands and 2 acres of forested uplands would be enhanced and preserved within the developed portions of the project. The remaining 884 acres, which are adjacent to the development acreage, will be preserved and form a contiguous preserve with adjacent preserved lands. The 884 acres include 776 acres of wetlands and 108 acres of uplands. These lands are situated to the south and west of the National Audubon Society Corkscrew Swamp Sanctuary (Corkscrew) and are connected through other preservation lands to the Corkscrew Regional Ecosystem Watershed (CREW) project (Figure 2). Restoration of wetlands and uplands in this preserve will consist of the removal of exotic vegetation, ranging from 5 to 100 percent coverage, averaging 65 to 70 percent and the restoration of more diverse and appropriate native communities and placed under a conservation easement granted to the South Florida Water Management District (District). The on-site preserve is currently a mixture of hydric and mesic pine and pine/cypress flatwoods, with extensive levels of infestation of the invasive exotic melaleuca. This preserve will be contiguous to preserves for other projects totaling more than 1,400 acres. Total project footprint is 1,714 acres with 941 acres of preservation and 773 acres of development.

The applicant is also proposing the purchase of 27.68 wetland credits from Panther Island Mitigation Bank (estimated at 82 acres) and 750 panther habitat units (estimated at 8 PHUs per acre or 94 acres) from a yet-to-be determined preservation-site in the Primary Zone of the Panther Focus Area (Figure 4). The location of the proposed off-site compensation-site will be determined and lands secured prior to any site clearing. The applicant's proposed preservation acreage is estimated at 1,117 acres, which consist of 941 acres on-site, 82 acres in Panther Island Mitigation Bank, and 94 acres in a location to be determined in the primary zone.

The proposed compensation plan provides habitat preservation and restoration in Collier County, and benefits the survival and recovery of the Florida panther as referenced in the draft Panther Recovery Plan (Service 2006) goal 1.1.1.2.3. This goal recommends habitat preservation and restoration within the Primary Zone be provided in situations where land use intensification can not be avoided. The applicant has proposed equivalent habitat protection and restoration, to compensate for both the quantity and functional value of the lost habitat.

The Use of Best Scientific and Commercial Information by the Service

The Service uses the most current and up-to-date scientific and commercial information available. The nature of the scientific process dictates that information is constantly changing and improving as new studies are completed. The scientific method is an iterative process that builds on previous information. As the Service becomes aware of new information, we will ensure it is fully considered in our decisions, evaluations, reviews, and analyses as it relates to the base of scientific knowledge and any publications cited in our documents.

Specifically, there is one such document cited in this biological opinion the Service acknowledges has been affected in its cited form by new scientific information. The Service has taken these new sources of information into account when using this document to help guide our analysis and decisions. This document is the South Florida Multi-Species Recovery Plan (MSRP) of 1999 (Service 1999). In addition, the Service has examined Kautz et al. (2006) for its scientific validity, specifically with regards to comments and recommendations by other reviewers.

South Florida Multi-Species Recovery Plan

The MSRP was designed to be a living document and it was designed to be flexible to accommodate the change identified through ongoing and planned research and would be compatible with adaptive management strategies. These principals are set forth in both the transmittal letter from the Secretary of the Interior and in the document itself. As predicted, this is what indeed occurred in the intervening years since the MSRP was published. The Service uses the MSRP in the context it still presents useful information when taken in conjunction with all the new scientific information developed subsequent to its publication.

Kautz et al. (2006)

The Florida Panther Subteam was charged with developing a landscape-level strategy for the conservation of the Florida panther population in south Florida. The Subteam produced the draft Landscape Conservation Strategy for the Florida Panther in South Florida in December 2002 and provided it to the Service. Upon receipt, the Service began to use the information in the draft Landscape Conservation Strategy in its decision making processes and documents since it was part of the best scientific information available to the Service at the time. Since then some portions of the science and findings in the draft Landscape Conservation Strategy have been challenged. Many, but not all, of the Subteam members have refined the methodology, further analyzed the data, and better defined the results of the Landscape Conservation Strategy into the publication, referred to here as Kautz et al. (2006). Therefore, Kautz et al. (2006) and the analyses contained therein, along with all other best scientific and commercial data available, is referred to in this document and will be used in our decision making process until or unless new information suggests revisions are necessary.

Consultation History

The previous project was circulated under a Public Notice on May 25, 2001. The proposal was to construct an upscale residential and golf course community with an external flow way, as required by the District, to convey excess flood waters from upstream, around the project, to the Cocohatchee Canal. The previous proposal was to impact 659 acres of wetlands which were heavily infested with exotics. During the permitting process the applicant offered on-site restoration, enhancement and preservation of 792 acres of wetlands and 105 acres of uplands as mitigation for the proposed impacts.

On July 11, 2002, the Service concurred with the Corps' determination that the proposed project "may affect, not likely to adversely affect" the red-cockaded woodpecker and eastern indigo snake.

The Service issued their biological opinion on project impacts to wood storks and panthers in February 2003.

After revisions to the panther assessment methodologies and the collection of more site-specific forage fish production data, the Corps reinitiated consultation with the Service and the Service issued their revised biological opinion for the project on March 9, 2005, in which the Service concluded the proposed project was not likely to jeopardize the survival and recovery of the Florida panther or the wood stork.

On December 8, 2005, the Corps denied a Department of the Army permit for the project.

The applicant modified the project purpose and further reduced wetland impacts by eliminating the external flow way, amending the development footprint, and relocating golf holes to be adjacent to the wetland preserve. Flood plain impacts will be mitigated by an internal pass-through system of lakes that maintains the upstream stage at predevelopment levels during a 25 year 3 day storm event. The modified project plan reduces wetland impacts and increases the size of the wetland preserves.

On August 9 and August 24, 2006, the Corps issued public notices for a residential community to be known as "Mirasol."

On February 5, 2007, the Service received a revised species and habitat analysis for the wood stork.

On March 1, 2007, the Service provided the Corps with a biological opinion evaluating project effects to the wood stork and Florida panther. Following issuance of the biological opinion, the Service noted that the levels of incidental take associated with the endangered wood stork need clarification. The Service also noted that text associated with wet and dry fish biomass calculations, National Wetland Inventory and Florida Land Use Codes and Forms Classification Systems, and prey size selection of wood storks also needed clarification. The Service is providing this clarification in this document.

The Corps has a made a determination the project "may affect, but is not likely to affect" the RCW, and the eastern indigo snake. After reviewing information received from the Corps and the applicant's agent, Turrell, the Service concurs with the Corps' determinations for the

endangered RCW and the threatened eastern indigo snake. The Corps also determined the project "may affect" the Florida panther, and the wood stork and reinitiated formal consultation with the Service for these two species.

The Service has reviewed all information received pertinent to the Florida panther and the wood stork for the modified Mirasol project and concurs with the Corps' determination that this proposed project "may affect" the Florida panther and the wood stork. As of November 6, 2006, we received all information necessary for initiation of formal consultation on the Florida panther and the wood stork for this project as required in the regulations governing interagency consultations (50 CFR § 402.14). The Service is providing this biological opinion in conclusion of formal consultation.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

Proposed Action

The applicant has modified its project design and has further reduced wetland impacts from the May 2005 project plan by eliminating the external flow-way, modifying the site development plan, and relocating golf holes to be adjacent to the wetland preserve as a buffer. Compensating storage for flood plain impacts will be addressed by an internal pass-through system of lakes that maintains the upstream stage at predevelopment levels during a 25 year 3 day storm event. The revised application proposes to construct an upscale residential and golf course community to be known as "Mirasol." The proposed development would consist of residential areas (234 acres), lakes (148 acres), road right of way (52 acres), clubhouse/maintenance/sales buildings (22 acres), 36-hole golf course and paths (222 acres), open space within the development (95 acres), and preserves (941 acres). The project site is 1,713.45 acres and consists of 1,476.71 acres of jurisdictional wetlands and 236.74 acres of uplands. Jurisdictional areas consist of melaleuca, disturbed hydric pine, pine-cypress, and cypress communities. The project includes the discharge of approximately 2,100,000 cubic yards of fill material into 519 acres of wetlands and the excavation of 1,800,000 cubic yards of material from 127 acres of wetlands. Over 85 percent of the project site has melaleuca densities of greater than 50 percent coverage.

The project is bounded on the north by a series of farms and agricultural fields and a recently permitted residential development known as Bonita Beach Road RPD, and on the west by two permitted proposed developments, Parklands and Terafina, and an existing development called Olde Cypress. The southern property boundary abuts the Cocohatchee or Immokalee Road Canal. The northeast property boundary is undeveloped while the southeast boundary is adjacent to numerous small farms and out-parcels. Immediately to the east of these out-parcels is a former rock and gravel mine known as Mule Pen Quarry that has been converted into a residential development known as Heritage Bay (Figure 2).

The project will result in the direct loss of 773 acres of habitat suitable for foraging and dispersal by the Florida panther (see discussion under Wildlife Assessment). The remaining 941 acres on the 1,713-acre will be enhanced and preserved. The habitat loss represents 3,756 PHUs with a recommended compensation of 7,512 PHUs (see discussion under Habitat Assessment Methodology). The project is within the Florida panther Primary Zone (Kautz et al. 2006)

(Figure 3) and within the Service's Panther Focus Area (Figure 4). The applicant proposes to provide on-site compensation for project effects to the panther through the restoration and preservation of 941 acres on the project site (57 acres within project development and 884 acres within adjacent onsite preserve). The applicant is also proposing to purchase and protect the equivalent of 750 PHUs (about 94 acres) within the panther Primary Zone, and the purchase of 27.68 credits (about 82 acres) at PIMB in Collier County (Figure 6). All compensation-sites are located in the panther Primary Zone and provide compensation for the loss of 773 acres of lower quality habitat for foraging and dispersal presently available to the Florida panther. The total compensation proposal through both on-site and off-site protection and restoration is about 1,117 acres of higher quality panther habitat in areas surrounded by higher quality panther habitat (941 acres on-site 82 acres in PIMB, and 94 acres in primary zone).

The proposed compensation plan provides habitat preservation and restoration within and near the project area, and benefits the survival and recovery of the Florida panther as referenced in the draft Panther Recovery Plan (Service 2006) goal 1.1.1.2.3. This goal recommends habitat preservation and restoration within the Primary Zone be provided in situations where land use intensification can not be avoided. The applicant has proposed equivalent habitat protection and restoration, to compensate for both the quantity and functional value of the lost habitat.

Action Area

The Service's Panther Focus Area for the Florida panther includes lands in Charlotte, Glades, Hendry, Lee, Collier, Palm Beach, Broward, Miami-Dade, and Monroe Counties, as well as the southern portion of Highlands County (Figure 4). Developed urban coastal areas in eastern Palm Beach, Broward, and Miami-Dade Counties, and in western Charlotte, Lee, and Collier Counties were excluded because they contain little or no panther habitat and it is unlikely that panthers would use such areas.

Movements of Florida panthers are much larger than the project site and, therefore, the Service's action area is larger than the proposed action area identified by the Corps' public notice. The action area, which is a subset of the current panther range, includes those lands where the Service believes panthers may experience direct and indirect effects from the proposed development. Maehr et al. (1990a) monitored five solitary panthers continuously for 130-hour periods seasonally from 1986 to 1989, rarely observing measurable shifts in location during the day, but nocturnal shifts in location exceeding 20.0 kilometers (km) (12.4 miles) were not unusual. Maehr et al. (2002a) in a later report documented a "mean maximum dispersal distance" of 68.1 km (42.3 miles) for subadult males and 20.3 km (12.6 miles) for subadult females. In the same report Maehr et al. (2002a) documented a "mean dispersal distance" of 37.3 km (23.1 miles) for subadult males. Comiskey et al. (2002) documented a "mean dispersal distance" for subadult male panthers as an average distance of 40.1 km (24.9 miles) from their natal range, which is similar to the dispersal distance referenced by Maehr et al. (2002a).

Therefore, for both direct and indirect effects, the Service defined the action area (Figure 7) as all lands within a 25-mile radius of the Mirasol project, which is slightly greater than the mean dispersal distance for subadult males. This action area does not include urban lands or lands west of I-75. This action area includes areas anticipated to sustain direct and indirect effects, such as roadways experiencing increased traffic, areas with increased human disturbance (project

area and periphery of project), and areas in which habitat fragmentation and intraspecific aggression may be felt.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

Florida Panther

Status - Panther Biology/Ecology

The Florida panther, is the last subspecies of *Puma* (also known as mountain lion, cougar, painter, or catamount) still surviving in the eastern U.S. Historically occurring throughout the southeastern U.S. (Young and Goldman 1946), today the panther is restricted to less than 5 percent of its historic range in one breeding population of less than 100 animals, located in south Florida.

When Europeans first came to this country, pumas roamed most all of North, Central, and South America. Early settlers attempted to eradicate pumas by every means possible. By 1899, it was felt that Florida panthers had been restricted to peninsular Florida (Bangs 1899). By the late 1920s to mid 1930s it was thought by many that the Florida panther had been completely eliminated (Tinsley 1970). In 1935, Dave Newell, a Florida sportsman, hired Vince and Ernest Lee, Arizona houndsmen, to hunt for panthers in Florida. They killed eight in the Big Cypress Swamp (Newell 1935). Every survey conducted since then has confirmed that a panther population occurs in southern Florida south of the Caloosahatchee River, and no survey since then has been able to confirm a panther population outside of southern Florida.

Attempts to eradicate panthers and a decline in panther prey (primarily white-tailed deer) resulted in a panther population threatened with extinction. Prior to 1949, panthers could be killed in Florida at any time of the year. In 1950, the Florida Game and Freshwater Fish Commission (now the Florida Fish and Wildlife Conservation Commission [FWC]) declared the panther a regulated game species due to concerns over declining numbers. The FWC removed panthers from the game animal list in 1958 and gave them complete legal protection. On March 11, 1967, the Service listed the panther as endangered (32 FR 4001) throughout its historic range, and these animals received Federal protection under the passage of the Act. Also, the Florida Panther Act (State Statute 372.671), a 1978 Florida State law, made killing a panther a felony. The Florida panther is listed as endangered by the States of Florida, Georgia, Louisiana, and Mississippi.

Since the panther was designated as an endangered species prior to enactment of the Act, there was no formal listing package identifying threats to the species as required by section 4(a)(1) of the Act. However, the technical/agency draft of the Florida Panther Recovery Plan, third revision, addressed the five factor threats analysis (Service 2006). No critical habitat has been designated for the panther.

Taxonomy

The Florida panther was first described by Charles B. Cory in 1896 as *Felis concolor floridana* (Cory 1896). The type specimen was collected in Sebastian, Florida. Bangs (1899), however, believed the Florida panther was restricted to peninsular Florida and could not intergrade with

other *Felis* spp. Therefore, he assigned it full specific status and named it *Felis coryi* since *Felis floridana* had been used previously for a bobcat (*Lynx rufus*).

The taxonomic classification of the *Felis concolor* group was revised and described by Nelson and Goldman (1929) and Young and Goldman (1946). These authors differentiated 30 subspecies using geographic and morphometric (measurement of forms) criteria and reassigned the Florida panther to subspecific status as *Felis concolor coryi.* This designation also incorporated *F. arundivaga* which had been classified by Hollister (1911) from specimens collected in Louisiana into *F. c. coryi.* Nowell and Jackson (1996) reviewed the genus *Felis* and placed mountain lions, including the Florida panther, in the genus *Puma*.

Culver et al. (2000) examined genetic diversity within and among the described subspecies of *Puma concolor* using three groups of genetic markers and proposed a revision of the genus to include only six subspecies, one of which encompassed all puma in North America including the Florida panther. However, Culver et al. (2000) determined that the Florida panther was one of several smaller populations that had unique features, the number of polymorphic microsatellite loci and amount of variation were lower, and it was highly inbred (eight fixed loci). The degree to which the scientific community has accepted the results of Culver et al. (2000) and the proposed change in taxonomy is not resolved at this time. The Florida panther remains listed as a subspecies and continues to receive protection pursuant to the Act.

Species Description

An adult Florida panther is unspotted and typically rusty reddish-brown on the back, tawny on the sides, and pale gray underneath. There has never been a melanistic (black) puma documented in North America (Tinsley 1970, 1987). Adult males can reach a length of 7 feet (ft) (2.1 meters [m]) from their nose to the tip of their tail and may exceed 161 pounds (lbs) (73 kilograms [kg]) in weight; but, typically adult males average around 116 lbs (52.6 kg) and stand about 24-28 inches (in) (60-70 centimeters [cm]) at the shoulder (Roelke 1990). Female panthers are smaller with an average weight of 75 lbs (34 kg) and length of 6 ft (1.8 m) (Roelke 1990). The skull of the Florida panther is unique in that it has a broad, flat, frontal region, and broad, high-arched or upward-expanded nasal bones (Young and Goldman 1946).

Florida panther kittens are gray with dark brown or blackish spots and five bands around the tail. The spots gradually fade as the kittens grow older and are almost unnoticeable by the time they are 6 months old. At this age, their bright blue eyes slowly turn to the light-brown straw color of the adult (Belden 1988).

Three external characters—a right angle crook at the terminal end of the tail, a whorl of hair or cowlick in the middle of the back, and irregular, white flecking on the head, nape, and shoulders—not found in combination in other subspecies of *Puma* (Belden 1986), were commonly observed in Florida panthers through the mid-1990s. The kinked tail and cowlicks were considered manifestations of inbreeding (Seal 1994); whereas the white flecking was thought to be a result of scarring from tick bites (Maehr 1992, Wilkins et al. 1997). Four other abnormalities prevalent in the panther population prior to the mid-1990s included cryptorchidism (one or two undescended testicles), low sperm quality, atrial septal defects (the opening between two atria in the heart fails to close normally during fetal development), and immune deficiencies and were also suspected to be the result of low genetic variability (Roelke et al. 1993a).

A plan for genetic restoration and management of the Florida panther was developed in September 1994 (Seal 1994) and eight non-pregnant adult female Texas panthers (*Puma concolor stanleyana*) were released in five areas of south Florida from March to July 1995. Since this introgression, rates of genetic defects, including crooked tails and cowlicks, have dramatically decreased (Land et al. 2004). In addition, to date neither atrial septal defects nor cryptorchidism have been found in introgressed panthers (M. Cunningham, FWC, pers. comm. 2005). As of January 27, 2003, none of the eight female Texas panthers introduced in 1995 remain in the wild.

Population Trends and Distribution

The Florida panther once ranged throughout the southeastern U.S. from Arkansas and Louisiana eastward across Mississippi, Alabama, Georgia, Florida, and parts of South Carolina and Tennessee (Young and Goldman 1946). Historically, the panther intergraded to the north with *P. c. cougar*, to the west with *P. c. stanleyana*, and to the northwest with *P. c. hippolestes* (Young and Goldman 1946).

Although generally considered unreliable, sightings of panthers regularly occur throughout the Southeast. However, no populations of panthers have been found outside of south Florida for at least 30 years despite intensive searches (Belden et al. 1991, McBride et al. 1993, Clark et al. 2002). Survey reports and more than 70,000 locations of radio-collared panthers recorded between 1981 and 2004 clearly define the panther's current range. Reproduction is known only in the Big Cypress Swamp/Everglades physiographic region in Collier, Lee, Hendry, Miami-Dade, and Monroe Counties south of the Caloosahatchee River (Belden et al. 1991). Although the breeding segment of the panther population occurs only in south Florida, panthers have been documented north of the Caloosahatchee River over 125 times since February 1972. This has been confirmed through field sign (e.g., tracks, urine markers, scats), camera-trap photographs, seven highway mortalities, four radio-collared animals, two captured animals (one of which was radiocollared), and one skeleton. From 1972 through 2004, panthers have been confirmed in 11 counties (Flagler, Glades, Highlands, Hillsborough, Indian River, Okeechobee, Orange, Osceola, Polk, Sarasota, Volusia) north of the river (Belden et al. 1991, Belden and McBride 2005). However, no evidence of a female or reproduction has been documented north of the Caloosahatchee River since 1973 (Nowak and McBride 1974, Belden et al. 1991, Land and Taylor 1998, Land et al. 1999, Shindle et al. 2000, McBride 2002, Belden and McBride 2005).

Puma are wide ranging, secretive, and occur at low densities. However, their tracks, urine markers, and scats are readily found by trained observers, and resident populations are easily located. Van Dyke (1986a) determined that all resident puma, 78 percent of transient puma, and 57 percent of kittens could be detected by track searches in Utah. In south Florida, the Florida panther's limited range and low densities may make the population count derived from track searches more accurate than in Utah. During two month-long investigations – one late in 1972 and early 1973 and another in 1974 – funded by the World Wildlife Fund to determine if panthers still existed in Florida, McBride searched for signs of panthers in portions of south Florida. In 1972, McBride authenticated a road-killed male panther in Glades County and a female captured and released from a bobcat trap in Collier County (R. McBride, Livestock

Protection Company, pers. comm. 2005). In 1973, McBride captured one female in Glades County (Nowak and McBride 1974). Based on this preliminary evidence, Nowak and McBride (1974) estimated the "population from the Lake Okeechobee area southward to be about 20 or 30 individuals." In 1974, McBride found evidence of only two additional panthers in the Fakahatchee Strand and suggested that "there could be not more than ten individual panthers in the area around Lake Okeechobee and southward in the state" (Nowak and McBride 1975). This initial survey, while brief in nature, proved that panthers still existed in Florida and delineated areas where a more exhaustive search was warranted. After this initial investigation, more comprehensive surveys on both public and private lands were completed (Reeves 1978; Belden and McBride 1983a, b; Belden et al. 1991). Thirty individual panthers were identified during a wide-ranging survey in 1985 in south Florida (McBride 1985).

Maehr et al. (1991) provides the only published population estimate based on a substantial body of field data (Beier et al. 2003). Maehr et al. (1991) estimated a density of 1 panther/27,520 acres [11,137 hectares (ha)] based on 17 concurrently radiocollared and four uncollared panthers. They extrapolated this density to the area occupied (1,245,435 acres [504,012 ha]) by radio-collared panthers during the period 1985-1990 to achieve a population estimate of 46 adult panthers for southwest Florida (excluding Everglades National Park [ENP], eastern Big Cypress National Preserve [BCNP], and Glades and Highlands Counties). Beier et al. (2003), however, argued this estimate of density, although "reasonably rigorous," could not be extrapolated to other areas because it was not known whether densities were comparable in those areas.

More recently, McBride (2000, 2001, 2002, 2003) obtained minimum population counts (*i.e.*, number known alive) based on panthers treed with hounds, physical evidence (*e.g.*, tracks where radio-collared panthers were not known to occur), documentation by trail-camera photos, and sightings of uncollared panthers by a biologist or pilot from a monitoring plane or via ground telemetry. He counted adults and subadult panthers but not kittens at the den). The population estimate in 2000 was 62 panthers (McBride 2000), with estimates of 78 in 2001 (McBride 2001), 80 in 2002 (FWC 2002), 87 in 2003 (FWC 2003), 78 in 2004 (R. McBride, Personal Communication, 2006), 82 in 2005 (R. McBride, Personal Communication, 2006), and 96 in 2006 (R. McBride, Personal Communication, 2006).

Life History

Reproduction: Male Florida panthers are polygynous, maintaining large, overlapping home ranges containing several adult females and their dependent offspring. The first sexual encounters for males normally occur at about three years based on 26 radio-collared panthers of both sexes (Maehr et al. 1991). Based on genetics work, some males may become breeders as early as 17 months (W. Johnson, National Cancer Institute, pers. comm. 2005). Breeding activity peaks from December to March (Shindle et al. 2003). Litters (n = 82) are produced throughout the year, with 56-60 percent of births occurring between March and June (Jansen et al. 2005, Lotz et al. 2005). The greatest number of births occurs in May and June (Jansen et al. 2005, Lotz et al. 2005). Female panthers have bred as young as 18 months (Maehr et al. 1989) and successful reproduction has occurred up to 11 years old. Mean age of denning females is 4.6 ± 2.1 (standard deviation [sd]) years (Lotz et al. 2005). Age at first reproduction for 19 known-

aged female panthers averaged 2.2 ± 0.246 (sd) years and ranged from 1.8-3.2 years. Average litter size is 2.4 ± 0.91 (sd) kittens. Seventy percent of litters are comprised of either two or three kittens. Mean birth intervals (elapsed time between successive litters) are 19.8 ± 9.0 (sd) months for female panthers (n = 56) (range 4.1-36.5 months) (Lotz et al. 2005). Females that lose their litters generally produce another more quickly; five of seven females whose kittens were brought into captivity successfully produced another litter an average of 10.4 months after the removal of the initial litter (Land 1994).

Den sites are usually located in dense, understory vegetation, typically saw palmetto (*Serenoa repens*) (Maehr 1990, Shindle et al. 2003). Den sites are used for up to two months by female panthers and their litters from birth to weaning. Independence and dispersal of young typically occurs at 18 months, but may occur as early as one year (Maehr 1992).

Survivorship and Causes of Mortality: Mortality records for uncollared panthers have been kept since February 13, 1972, and for radio-collared panthers since February 10, 1981. One-hundred eighty-nine mortalities have been documented through October 30, 2006, with 86 (46 percent) of known deaths occurring in the past 5 years (FWC 2006a, FWC unpublished data). Overall, documented mortality averaged 3.6 per year through June 2001, and 16.0 per year from July 2001 through June 2006. Of the 189 total mortalities, 100 were radio-collared panthers that have died since 1981 (FWC 2006a, FWC unpublished data). From 1990-2004, mean annual survivorship of radio-collared adult panthers was greater for females (0.894 ± 0.099 sd) than males (0.779 ± 0.125 sd) (Lotz et al. 2005). Except for intraspecific aggression, the causes of mortality were found to be independent of gender (Lotz et al. 2005).

Intraspecific aggression was the leading cause of death for radio-collared panthers, accounting for 42 percent (Jansen et al. 2005, Lotz et al. 2005). Most intraspecific aggression occurs between male panthers; but, aggressive encounters between males and females, resulting in the death of the female, have occurred. Defense of kittens and\or a kill is suspected in half (5 of 10) of the known instances through 2003 (Shindle et al. 2003).

Unknown causes and collisions with vehicles accounted for 24 and 19 percent of radio-collared panther mortalities, respectively. From February 13, 1972, through June 30, 2006, Florida panther vehicular trauma (n=96), averaged 2.8 per year for radio-collared and uncollared panthers (FWC 2006a). Ten of the collisions were not fatal. Three additional panthers were killed by vehicles from July 1, 2006, through November 30, 2006 (FWC, unpublished data), bringing the total to 99 panthers killed or injured by vehicles.

Female panthers are considered adult residents if they are older than 18 months, have established home ranges and bred (Maehr et al. 1991). Land et al. (2004) reported that 23 of 24 female panthers first captured as kittens survived to become residents and 18 (78.3 percent) produced litters; one female was too young to determine residency. Male panthers are considered adult residents if they are older than three years and have established a home range that overlaps with females. Thirty-one male panthers were captured as kittens and 12 (38.7 percent) of these cats survived to become residents (Jansen et al. 2005, Lotz et al. 2005). "Successful male recruitment appears to depend on the death or home-range shift of a resident adult male" (Maehr et al. 1991).

Turnover in the breeding population is low with documented mortality in radio-collared panthers being greatest in subadults and non-resident males (Maehr et al. 1991, Shindle et al. 2003).

Den sites of female panthers have been visited since 1992 and the number of kittens that survived to 6 months for 38 of these litters has been documented. Florida and introgressed panther kitten survival to six months were estimated to be 52 and 72 percent, respectively, but were not significantly different (P = 0.2776) (Lotz et al. 2005). Survival of kittens greater than six months old was determined by following the fates of 55 radio-collared dependent-aged kittens, including 17 introgressed panthers from 1985 - 2004. Only 1 of these 55 kittens died before reaching independence, resulting in a 98.2 percent survival rate (Lotz et al. 2005). The FWC and NPS are continuing to compile and analyze existing reproductive and kitten data.

Dispersal: Panther dispersal begins after a juvenile becomes independent from its mother and continues until it establishes a home range. Dispersal distances are greater for males (n = 18) than females (n = 9) (42.5 mi [68.4 km] vs. 12.6 mi [20.3 km], respectively) and the maximum dispersal distance recorded for a young male was 139.2 mi (224.1 km) over a seven-month period followed by a secondary dispersal of 145 mi (233 km) (Maehr et al. 2002a). Males disperse an average distance of 25 mi (40 km); females typically remain in or disperse short distances from their natal ranges (Comiskey et al. 2002). Female dispersers are considered philopatric because they usually establish home ranges less than one average home range width from their natal range (Maehr et al. 2002a). Maehr et al. (2002a) reported that all female dispersers (n = 9) were successful at establishing a home range whereas only 63 percent of males (n = 18) were successful. Young panthers become independent at 14 months on average for both sexes, but male dispersals are longer in duration than for females (9.6 months and 7.0 months, respectively) (Maehr et al. 2002a). Dispersing males usually go through a period as transient (non-resident) subadults, moving through the fringes of the resident population and often occupying suboptimal habitat until an established range becomes vacant (Maehr 1997).

Most panther dispersal occurs south of the Caloosahatchee River with only four radio-collared panthers crossing the river and continuing north since 1981 (Land and Taylor 1998, Land et al. 1999, Shindle et al. 2000, Maehr et al. 2002a, Belden and McBride 2005). Western subspecies of *Puma* have been documented crossing wide, swift-flowing rivers up to a mile in width (Seidensticker et al. 1973, Anderson 1983). The Caloosahatchee River, a narrow (295-328 ft [90-100 m]), channelized river, probably is not a significant barrier to panther movements, but the combination of the river, State Route (SR) 80, and land uses along the river seems to have restricted panther dispersal northward (Maehr et al. 2002a). Documented physical evidence of at least 15 other uncollared male panthers have been confirmed north of the river since 1972, but no female panthers nor reproduction have been documented in this area since 1973 (Belden and McBride 2005).

Home Range Dynamics and Movements: Panthers require large areas to meet their needs. Numerous factors influence panther home range size including habitat quality, prey density, and landscape configuration (Belden 1988, Comiskey et al. 2002). Home range sizes of 26 radio-collared panthers monitored between 1985 and 1990 averaged 128,000 acres (51,800 ha) for resident adult males and 48,000 acres (19,425 ha) for resident adult females; transient males had

a home range of 153,599 acres (62,160 ha) (Maehr et al. 1991). Comiskey et al. (2002) examined the home range size for 50 adult panthers (residents greater than 1.5 years old) monitored in south Florida from 1981-2000 and found resident males had a mean home range of 160,639 acres (65,009 ha) and females had a mean home range of 97,920 acres (39,627 ha). Beier et al. (2003) found home range size estimates for panthers reported by Maehr et al. (1991) and Comiskey et al. (2002) to be reliable. Annual minimum convex polygon home range sizes of 52 adult radio-collared panthers monitored between 1998 and 2002 ranged from 15,360 – 293,759 acres (6,216 – 118,880 ha), averaging 89,600 acres (36,260 ha) for 20 resident adult males and 44,160 acres (17,871 ha) for 32 resident adult females (Land et al. 1999, Shindle et al. 2000, Shindle et al. 2001, Land et al. 2002). The most current estimate of home-range sizes (minimum convex polygon method) for established, non-dispersing, adult, radio-collared panthers averaged 29,056 acres (11,759 ha) for females (n = 11) and 62,528 acres (25,304 ha) for males (n = 11) (Lotz et al. 2005). The average home range was 35,089 acres (14,200 ha) for resident females (n = 6) and 137,143 acres (55,500 ha) (n = 5) for males located at BCNP (Jansen et al. 2005). Home ranges of resident adults tend to be stable unless influenced by the death of other residents; however, several males have shown significant home range shifts that may be related to aging (D. Jansen, National Park Service [NPS], pers. comm. 2005). Home-range overlap is extensive among resident females and limited among resident males (Maehr et al. 1991).

Activity levels for Florida panthers are greatest at night with peaks around sunrise and after sunset (Maehr et al. 1990a). The lowest activity levels occur during the middle of the day. Female panthers at natal dens follow a similar pattern with less difference between high and low activity periods.

Telemetry data indicate panthers typically do not return to the same resting site day after day, with the exception of females with dens or panthers remaining near kill sites for several days. The presence of physical evidence such as tracks, scats, and urine markers confirm that panthers move extensively within home ranges, visiting all parts of the range regularly in the course of hunting, breeding, and other activities (Maehr 1997, Comiskey et al. 2002). Males travel widely throughout their home ranges to maintain exclusive breeding rights to females. Females without kittens also move extensively within their ranges (Maehr 1997). Panthers are capable of moving large distances in short periods of time. Nightly panther movements of 12 mi (20 km) are not uncommon (Maehr et al. 1990a).

Intraspecific Interactions: Interactions between panthers occur indirectly through urine markers or directly through contact. Urine markers are made by piling ground litter using a backwards-pushing motion with the hind feet. This pile is then scent-marked with urine and occasionally feces. Both sexes make urine markers. Apparently males use them as a way to mark their territory and announce presence while females advertise their reproductive condition.

Adult females and their kittens interact more frequently than any other group of panthers. Interactions between adult male and female panthers last from one to seven days and usually result in pregnancy (Maehr et al. 1991). Aggressive interactions between males often result in serious injury or death. Independent subadult males have been known to associate with each other for several days and these interactions do not appear to be aggressive in nature.

Aggression between males is the most common cause of male mortality and an important determinant of male spatial and recruitment patterns based on radio-collared panthers (Maehr et al. 1991, Shindle et al. 2003). Aggressive encounters between radio-collared males and females also have been documented (Shindle et al. 2003, Jansen et al. 2005).

Food Habits: Primary panther preys are white-tailed deer (*Odocoileus virginianus*) and feral hog (*Sus scrofa*) (Maehr et al. 1990b, Dalrymple and Bass 1996). Generally, feral hogs constitute the greatest biomass consumed by panthers north of the Alligator Alley section of I-75, while white-tailed deer are the greatest biomass consumed to the south (Maehr et al. 1990b). Secondary prey includes raccoons (*Procyon lotor*), nine-banded armadillos (*Dasypus novemcinctus*), marsh rabbits (*Sylvilagus palustris*) (Maehr et al. 1990b) and alligators (*Alligator mississippiensis*) (Dalrymple and Bass 1996). No seasonal variation in diet has been detected. A resident adult male puma generally consumes one deer-sized prey every 8-11 days; this frequency would be 14-17 days for a resident female; and 3.3 days for a female with three 13-month-old kittens (Ackerman et al. 1986). Maehr et al. (1990b) documented domestic livestock infrequently in scats or kills, although cattle were readily available on their study area.

Infectious Diseases, Parasites, and Environmental Contaminants: *Viral Diseases*--Feline leukemia virus (FeLV) is common in domestic cats (*Felis catus*), but is quite rare in non-domestic felids. Routine testing for FeLV antigen (indicating active infection) in captured and necropsied panthers has been negative since testing began in 1978 to the fall of 2002. Between November 2002 and February 2003, however, two panthers tested FeLV antigen positive (Cunningham 2005). The following year, three more cases were diagnosed. All infected panthers had overlapping home ranges in the Okaloacoochee Slough ecosystem. Three panthers died due to suspected FeLV-related diseases (opportunistic bacterial infections and anemia) and the two others died from intraspecific aggression. Testing of serum samples collected from 1990-2005 for antibodies (indicating exposure) to FeLV indicated increasing exposure to FeLV beginning in the late 1990s and concentrated north of I-75. There was apparently minimal exposure to FeLV during this period south of I-75. Positive antibody titers in different areas at different times may indicate that multiple introductions of the virus into the panther population may have occurred. These smaller epizootics were apparently self-limiting and did not result in any known mortalities. Positive antibody titers, in the absence of an active infection (antigen positive), indicate panthers can be exposed and overcome the infection (Cunningham 2005). Management of the disease includes vaccination as well as removal of infected panthers to captivity for quarantine and supportive care. As of June 1, 2005, about one-third of the population had received at least one vaccination against FeLV (FWC and NPS, unpublished data). No new positive cases have been diagnosed since July 2004.

Pseudorabies virus (PRV) (Aujeszky's disease) causes respiratory and reproductive disorders in adult hogs and mortality in neonates, but is a rapidly fatal neurologic disease in carnivores. At least one panther died from PRV infection presumably through consumption of an infected feral hog (Glass et al. 1994). At least one panther has also died of rabies (Taylor et al. 2002). This panther was radiocollared but not vaccinated against the disease.

Feline immunodeficiency virus (FIV) is a retrovirus of felids that is endemic in the panther population. About 28 percent of Florida panthers were positive for antibodies to the puma lentivirus strain of FIV (Olmstead et al. 1992); however, the prevalence may be increasing. Between November 2004 and April 2005, 13 of 17 (76 percent) were positive (M. Cunningham, FWC, unpublished data). The cause of this increase is unknown but warrants continued monitoring and investigation. There is also evidence of exposure to Feline panleukopenia virus (PLV) in adult panthers (Roelke et al. 1993b) although no PLV-related mortalities are known to have occurred.

Serological evidence of other viral diseases in the panther population includes feline calicivirus, feline herpes virus, and West Nile virus (WNV). However these diseases are not believed to cause significant morbidity or mortality in the population. All panthers found dead due to unknown causes are tested for alphaviruses, flaviviruses (including WNV), and canine distemper virus. These viruses have not been detected in panthers by viral culture or polymerase chain reaction (FWC, unpublished data).

Other Infectious Diseases--Bacteria have played a role in free-ranging panther morbidity and mortality as opportunistic pathogens, taking advantage of pre-existing trauma or FeLV infections (FWC, unpublished data). Dermatophytosis (ringworm infection) has been diagnosed in several panthers and resulted in severe generalized infection in at least one (Rotstein et al. 1999). Severe infections may reflect an underlying immunocompromise, possibly resulting from inbreeding depression or immunosuppressive viral infections.

Parasites--The hookworm, *Ancylostoma pluridentatum,* is found in a high prevalence in the panther population. Other parasites identified from live-captured or necropsied panthers include eight arthropod species, eight nematode species, three cestode species, two trematode species, and three protozoa species (Forrester et al. 1985, Forrester 1992, Wehinger et al. 1995, Rotstein et al. 1999, Land et al. 2002). Of these only an arthropod, *Notoedres felis*, caused significant morbidity in at least one panther (Maehr et al. 1995).

Environmental Contaminants--Overall, mercury in south Florida biota has decreased over the last several years (Frederick et al. 2002). However, high mercury concentrations are still found in some panthers. At least one panther is thought to have died of mercury toxicosis and mercury has been implicated in the death of two other panthers in ENP (Roelke 1991). One individual panther had concentrations of 150 parts per million (ppm) mercury in its hair (Land et al. 2004). Elevated levels of p, p'– DDE were also detected in fat from that panther. The role of mercury and/or p, p'– DDE in this panther's death is unknown and no cause of death was determined despite extensive diagnostic testing. Elevated mercury concentrations have also been found in panthers from Florida Panther National Wildlife Refuge (FPNWR). Two sibling neonatal kittens from this area had hair mercury concentrations of 35 and 40 ppm. Although other factors were believed to have been responsible, these kittens did not survive to leave their natal den. Consistently high hair mercury values in ENP and FPNWR and the finding of elevated values in some portions of BCNP warrant continued monitoring (Land et al. 2004). Other environmental contaminants found in panthers include polychlorinated biphenyls (Arochlor 1260) and organochlorines (p, p'–DDE) (Dunbar 1995, Land et al. 2004).

Habitat Characteristics/Ecosystem

Landscape Composition: Noss and Cooperrider (1994) considered the landscape implications of maintaining viable panther populations. Assuming a male home range size of 137,599 acres (55,685 ha) (Maehr 1990), an adult sex ratio of 50:50 (Anderson 1983), and some margin of safety, they determined that a reserve network as large as 15,625–23,438 mi^2 (40,469-60,703 km^2) would be needed to support an effective population size of 50 individuals (equating to an actual adult population of 100-200 panthers [Ballou et al. 1989]). However, to provide for long-term persistence based on an effective population size of 500 individuals (equating to 1,000 - 2,000 adult panthers [Ballou et al. 1989]), could require as much as 156,251-234,376 mi^2 (404,687-607,031 km^2). This latter acreage corresponds to roughly 60-70 percent of the Florida panther's historical range. Although it is uncertain whether this much land is needed for panther recovery, it does provide some qualitative insight into the importance of habitat conservation across large landscapes for achieving a viable panther population (Noss and Cooperrider 1994).

Between 1981 and 2003, more than 55,000 locations on more than 100 radio-collared panthers were collected. Belden et al. (1988), Maehr et al. (1991), Maehr (1997), Kerkoff et al. (2000), and Comiskey et al. (2002) provide information on habitat use based on various subsets of these data. Since almost all data from radio-collars have been collected during daytime hours (generally 0700-1100), and because panthers are most active at night (Maehr et al. 1990a), daytime radio locations are insufficient to describe the full range of panther habitat use (Beyer and Haufler 1994, Comiskey et al. 2002, Beier et al. 2003, Dickson et al. 2005, Beier et al. 2006).

A landscape-level strategy for the conservation of the panther population in south Florida was developed using a Florida panther potential habitat model based on the following criteria: (1) forest patches greater than 4.95 acres (2 ha); (2) non-urban cover types within 656 ft (200m) of forest patches; and (3) exclusion of lands within 984 ft (300m) of urban areas (Kautz et al. 2006). In developing the model, data from radio-collared panthers collected from 1981 through 2000 were used to evaluate the relative importance of various land cover types as panther habitat, thus identifying landscape components important for panther habitat conservation. Those components were then combined with a least cost path analysis to delineate three panther habitat conservation zones for south Florida: (1) Primary Zone – lands essential to the long-term viability and persistence of the panther in the wild; (2) Secondary Zone - lands which few panthers use contiguous with the Primary Zone, but given sufficient habitat restoration could accommodate expansion of the panther population south of the Caloosahatchee River; and (3) Dispersal Zone - the area which may facilitate future panther expansion north of the Caloosahatchee River (Kautz et al. 2006) (Figure 3). The Primary Zone is currently occupied and supports the breeding population of panthers. Although panthers move through the Secondary and Dispersal Zones, they are not permanently occupied. The Secondary Zone could support panthers with sufficient restoration.

These zones vary in size, ownership, and land cover composition. The Primary Zone is 2,270,711 acres (918,928 ha) in size, 73 percent of which is publicly owned (R. Kautz, Dennis, Breedlove, and Associates, pers. comm. 2005), and includes portions of the BCNP, ENP, Fakahatchee Strand Preserve State Park (FSPSP), FPNWR, Okaloacoochee Slough State Forest, and Picayune Strand State Forest. This zone's composition is 45 percent forest, 41 percent

freshwater marsh, 7.6 percent agriculture lands, 2.6 percent prairie and shrub lands, and 0.52 percent urban lands (Kautz et al. 2006). The Secondary Zone is 812,157 acres (328,670 ha) in size, 38 percent of which is public land (R. Kautz, pers. comm. 2005). This zone's composition is 43 percent freshwater marsh, 36 percent agriculture, 11 percent forest, 6.1 percent prairie and shrub lands, and 2.3 percent low-density residential areas and open urban lands (Kautz et al. 2006). The Dispersal Zone is 28,160 acres (11,396 ha) in size, 12 percent of which is either publicly owned or in conservation easement. This zone's composition is 49 percent agriculture (primarily improved pasture and citrus groves), 29 percent forest (wetland and upland), 8.8 percent prairie and shrub land, 7.5 percent freshwater marsh, and 5.1 percent barren and urban lands (Kautz et al. 2006).

As part of their evaluation of occupied panther habitat, in addition to the average density estimate of one panther per 27,181 acres (11,000 ha) developed by Maehr et al. (1991), Kautz et al. (2006) estimated the present average density during the timeframe of the study, based on telemetry and other occurrence data, to average 1 panther per 31,923 acres (12,919 ha). In the following discussions of the number of panthers that a particular zone may support, the lower number is based on the 31,923 acres (12,919 ha) value (Kautz et al. 2006) and the higher number is based on the 27,181 acres (11,000 ha) value (Maehr et al. 1991).

Based on these average densities, the Primary Zone could support 71 to 84 panthers; the Secondary Zone 8 to 10 panthers without habitat restoration and 25 to 30 panthers with habitat restoration (existing high quality panther habitat currently present in the Secondary Zone is estimated at 32 percent of the available Secondary Zone lands); and the Dispersal Zone, 0 panthers. Taken together, the three zones in their current condition apparently have the capacity to support about 79 to 94 Florida panthers.

Kautz et al.'s (2006) assessment of available habitat south of the Caloosahatchee River determined non-urban lands in the Primary, Secondary, and Dispersal Zones were not sufficient to sustain a population of 240 individuals south of the Caloosahatchee River. However, Kautz et al. (2006) determined sufficient lands were available south of the Caloosahatchee River to support a population of 79 to 94 individuals (although not all lands are managed and protected).

Even though some suitable panther habitat remains in south-central Florida, it is widely scattered and fragmented (Belden and McBride 2005). Thatcher et al. (2006) used a statistical model in combination with a geographic information system to develop a multivariate landscape-scale habitat model based on the Mahalanobis distance statistic (D^2) to evaluate habitats in south central Florida for potential expansion of the Florida panther population. They identified 4 potential habitat patches: the Avon Park Bombing Range area, Fisheating Creek/Babcock-Webb Wildlife Management Area, eastern Fisheating Creek, and the Duette Park/Manatee County area. These habitat patches are smaller and more isolated compared with the current Florida panther range, and the landscape matrix where these habitat patches exist provides relatively poor habitat connectivity among the patches (Thatcher et al. 2006). Major highways and urban or agricultural development isolate these habitat patches, and they are rapidly being lost to the same development that threatens southern Florida (Belden and McBride 2005).

Diurnal Habitat Use: Diurnal panther locations appear to be within or closer to forested cover types, particularly cypress swamp, pinelands, hardwood swamp, and upland hardwood forests

(Belden 1986, Belden et al. 1988, Maehr 1990, Maehr et al. 1991, Maehr 1992, Smith and Bass 1994, Kerkhoff et al. 2000, Comiskey et al. 2002). Dense understory vegetation comprised of saw palmetto provides some of the most important resting and denning cover for panthers (Maehr 1990). Shindle et al. (2003) show that 73 percent of panther dens were in palmetto thickets.

Radio-collar data and ground tracking indicate panthers use the mosaic of habitats available to them as resting and denning sites, hunting grounds, and travel routes. These habitats include cypress swamps, hardwood hammocks, pine flatwoods, seasonally flooded prairies, freshwater marshes, and some agricultural lands. Although radio-collar monitoring indicates forest is a preferred cover type, panthers also utilize non-forest cover types (Belden et al. 1988, Maehr et al. 1991, Comiskey et al. 2002). Compositional analyses by Kautz et al. (2006) confirmed previous findings that forest patches comprise an important component of panther habitat in south Florida, but other natural and disturbed cover types are also present in the large landscapes that support panthers (Belden et al. 1988, Maehr et al. 1991, Comiskey et al. 2002). Kautz et al. (2006) found the smallest class of forest patches (*i.e.*, 9-26 acres [3.6-10.4 ha]) were the highest ranked forest patch sizes within panther home ranges; this indicates that forest patches of all sizes appear to be important components of the landscapes inhabited by panthers, not just the larger forest patches.

Nocturnal Habitat Use: Maehr et al. (1990a) provide the only descriptions of panther nocturnal activities and represent the available radiocollar data collected during night time hours. However, this paper does not provide analyses of nocturnal habitat use. Dickson et al. (2005) examined the movements of 10 female and 7 male puma at 15-minute intervals during 44 nocturnal periods of hunting or traveling in southern California. They found that traveling puma monitored over nocturnal periods used a broader range of habitats than what they appeared to use based on diurnal locations alone. The use of Global Positioning System (GPS) radiocollars is now being investigated to determine if this technology will be suitable to answer questions regarding Florida panther nocturnal habitat use.

Prey Habitat Use: Panther habitat selection is related to prey availability (Janis and Clark 1999, Dees et al. 2001) and, consequently, prey habitat use. Adequate cover and the size, distribution, and abundance of available prey species are critical factors to the persistence of panthers in south Florida and often determine the extent of panther use of an area. Duever et al. (1986) calculated a deer population of 1,760 in BCNP, based on Harlow (1959) deer density estimates of 1/210 acres (85 ha) in pine forest, 1/299 acres (121 ha) in swamps, 1/1,280 acres (518 ha) in prairie, 1/250 acres (101 ha) in marshes, and 1/111 acres (45 ha) in hammocks. Schortemeyer et al (1991) estimated deer densities at 1/49-247 acres (20-100 ha) in three management units of BCNP based on track counts and aerial surveys. Labisky et al. (1995) reported 1/49 acres (20 ha) in southeastern BCNP. Using track counts alone, McCown (1994) estimated 1/183-225 acres (74-91 ha) on the FPNWR and 1/133-200 acres (54-81 ha) in the FSPSP.

Hardwood hammocks and other forest cover types are important habitat for white-tailed deer and other panther prey (Harlow and Jones 1965, Belden et al. 1988, Maehr 1990, Maehr et al. 1991, Maehr 1992, Comiskey et al. 1994, Dees et al. 2001). Periodic understory brushfires (Dees et al. 2001) as well as increased amounts of edge (Miller 1993) may enhance deer use of hardwood hammocks, pine, and other forest cover types. However, wetland and other vegetation types can support high deer densities. In the Everglades, for example, deer appear to be adapted to a

mosaic of intergrading patches comprised of wet prairie, hardwood tree islands, and peripheral wetland habitat (Fleming et al. 1994, Labisky et al. 2003). High-nutrient deer forage, especially preferred by females, includes hydrophytic marsh plants, white waterlily (*Nymphaea odorata*), and swamp lily (*Crinum americana*) (Loveless 1959, Labisky et al. 2003). Wetland willow (*Salix spp.*) thickets provide nutritious browse for deer (Loveless 1959, Labisky et al. 2003).

Marshes, rangeland, and low-intensity agricultural areas support prey populations of deer and hogs. The importance of these habitat types to panthers cannot be dismissed based solely on use or lack of use when daytime telemetry are the only data available (Comiskey et al. 2002, Beier et al. 2003, Comiskey et al. 2004, Beier et al. 2006).

Travel and Dispersal Corridors: In the absence of direct field observations/measurements, Harrison (1992) suggested that landscape corridors for wide-ranging predators should be half the width of an average home range size. Following Harrison's (1992) suggestion, corridor widths for Florida panthers would range 6.1-10.9 mi (9.8-17.6 km) depending on whether the target animal was an adult female or a transient male. Beier (1995) suggested corridor widths for transient male puma in California could be as small as 30 percent of the average home range size of an adult. For Florida panthers, this would translate to a corridor width of 5.5 mi (8.8 km). Without supporting empirical evidence, Noss (1992) suggests regional corridors connecting larger hubs of habitat should be at least 1.0 mi (1.6 km) wide. Beier (1995) makes specific recommendations for very narrow corridor widths based on short corridor lengths in a California setting of wild lands completely surrounded by urban areas; he recommended corridors with a length less than 0.5 mi (0.8 km) should be more than 328 ft (100 m) wide, and corridors extending 0.6-4 mi (1-7 km) should be more than 1,312 ft (400 m) wide. The Dispersal Zone encompasses 44 mi^2 (113 km^2) with a mean width of 3.4 mi (5.4 km). Although it is not adequate to support even one panther, the Dispersal Zone is strategically located and expected to function as a critical landscape linkage to south-central Florida (Kautz et al. 2006). Transient male panthers currently utilize this Zone as they disperse northward into south-central Florida.

Panther Recovery Objectives

The recovery objectives identified in the draft third revision of the Florida Panther Recovery Plan (Service 2006) are to (1) maintain, restore, and expand the Florida panther population and its habitat in south Florida and, if feasible, expand the known occurrence of Florida panthers north of the Caloosahatchee River to maximize the probability of the long-term persistence of this metapopulation; (2) identify, secure, maintain, and restore habitat in potential reintroduction areas within the panther's historic range, and to establish viable populations of the panther outside south and south-central Florida; and (3) facilitate panther conservation and recovery through public awareness and education.

Panther Management and Conservation

Habitat Conservation and Protection

Panthers, because of their wide-ranging movements and extensive spatial requirements, are particularly sensitive to habitat fragmentation (Harris 1984). Mac et al. (1998) defines habitat fragmentation as: "The breaking up of a habitat into unconnected patches interspersed with other

habitat which may not be inhabitable by species occupying the habitat that was broken up. The breaking up is usually by human action, as, for example, the clearing of forest or grassland for agriculture, residential development, or overland electrical lines." The reference to "unconnected patches" is a central underpinning of the definition. For panther conservation, this definition underscores the need to maintain contiguous habitat and protected habitat corridors in key locations in south Florida and throughout the panther's historic range. Habitat fragmentation can result from road construction, urban development, and agricultural land conversions.

Habitat protection has been identified as being one of the most important elements to achieving panther recovery. While efforts have been made to secure habitat (Figure 8 and Table 1), continued action is needed to obtain additions to and inholdings for public lands, assure linkages are maintained, restore degraded and fragmented habitat, and obtain the support of private landowners for maintaining property in a manner that is compatible with panther use. Conservation lands used by panthers are held and managed by a variety of entities including FWS, NPS, Seminole Tribes of Florida, Miccosukee Tribe of Indians of Florida, FWC, Florida Department of Environmental Protection (FDEP), Florida Division of Forestry (FDOF), Water Management Districts (WMD), non-governmental organizations (NGO), counties, and private landowners.

Public Lands: Public lands in south Florida that benefit the panther are listed below and shown in Figure 8:

1. In 1947, ENP was established with 1,507,834 acres (610,201 ha) and in 1989 was expanded with the addition of 104,320 acres (42,217 ha).

2. In 1974, Congress approved the purchase and formation of BCNP, protecting 570,238 acres (230,768 ha), later 145,919 acres (59052 ha) were added.

3. In 1974, the State of Florida began acquiring land for the FSPSP, which encompasses over 80,000 acres (32,375 ha). Efforts are underway to acquire about 16,640 acres (6,734 ha).

4. In 1985, acquisition of Picayune Strand State Forest and Wildlife Management Area (WMA) began with the complex Golden Gate Estates subdivision buyouts and now comprises over 76,160 acres (30,821 ha). The Southern Golden Gate Estates buyout through State and Federal funds is complete. The South Belle Meade portion of Picayune Strand is about 90 percent purchased and although the State is no longer purchasing in South Belle Meade, Collier County's Transfer of Development Rights program is helping to secure the inholdings.

5. In 1989, FPNWR was established and now protects 26,240 acres (10,619 ha).

6. In 1989, the Corkscrew Regional Ecosystem Watershed Land and Water Trust, a public/private partnership, was established and to date has coordinated the purchase of 42 26,880 acres (10,878 ha).

7. In 1996, the South Florida WMD, purchased the 32,000 acres (12,950 ha) Okaloacoochee Slough State Forest.

8. In 2002 Spirit of the Wild WMA, consisting of over 7,040 acres (2,849 ha), was taken into public ownership by the State of Florida and is managed by FDOF.

9. In 2003, Dinner Island Ranch WMA consisting of 21,760 acres (8,806 ha) in southern Hendry County was taken into public ownership by the State of Florida and is managed by FDOF.

Tribal Lands: Lands of the Seminole Tribes of Florida and Miccosukee Tribe of Indians of Florida encompass over 350,079 acres (141,673 ha) in south Florida. Of these, 115,840 acres (46,879 ha) are used by panthers, and comprise 5 percent of the Primary Zone (R. Kautz, pers. comm. 2005). These lands are not specifically managed for the panther and are largely in cultivation.

Private Lands: A variety of Federal, State, and private incentives programs are available to assist private landowners and other individuals to protect and manage wildlife habitat. Voluntary agreements, estate planning, conservation easements, land exchanges, and mitigation banks are methods that hold untapped potential for conserving private lands. In 1954, the National Audubon Society established the nearly 10,880 acres (4,403 ha) Corkscrew Swamp Sanctuary. However, little additional private land has been protected south of the Caloosahatchee River for panther conservation. A number of properties identified by the State Acquisition and Restoration Council (ARC) for purchase by the Florida Forever Program are used by panthers (*e.g*., Devil's Garden, Half Circle F Ranch, Pal Mal, Panther Glades). North of the Caloosahatchee River, Fisheating Creek Conservation Easement, 41,600 acres (16,835 ha) in Glades County is a private holding used by dispersing male panthers. Also, 73,235 acres of the 90,845 acres Babcock Ranch were purchased in 2006 by the State of Florida and Lee County for conservation and agriculture. An additional 2,000 acres of this ranch were put into a conservation easement.

Habitat and Prey Management

Land management agencies in south Florida are implementing fire programs that mimic a natural fire regime through the suppression of human-caused wildfires and the application of prescribed natural fires. No studies have been conducted to determine the effects of invasive plant management on panthers. However invasive vegetation may reduce the panther's prey base by disrupting natural processes such as water flow and fire and by significantly reducing available forage for prey (Fleming et al. 1994). All public lands in south Florida have active invasive plant treatment programs. Management for panther prey consists of a variety of approaches such as habitat management and regulation of hunting and off-road vehicle (ORV) use.

Response to Management Activities

Few studies have examined the response of panthers to various land/habitat management activities. Dees et al. (2001) investigated panther habitat use in response to prescribed fire and found that panther use of pine habitats was greatest for the first year after the area had been burned and declined thereafter. Prescribed burning is believed to be important to panthers because prey species (*e.g*., deer and hogs) are attracted to burned habitats to take advantage of

changes in vegetation structure and composition, including exploiting hard mast that is exposed and increased quality or quantity of forage (Dees et al. 2001). Responses of puma to logging activities (Van Dyke et al. 1986b) indicate that they generally avoid areas within their home range with intensification of disturbance.

There is the potential for disturbance to panthers from recreational uses on public lands. Maehr (1990) reported that indirect human disturbance of panthers may include activities associated with hunting and that panther use of Bear Island (part of BCNP) is significantly less during the hunting season. Schortemeyer et al. (1991) examined the effects of deer hunting on panthers at BCNP between 1983 and 1990. They concluded that, based on telemetry data, panthers may be altering their use patterns as a result of hunting.

Janis and Clark (2002) compared the behavior of panthers before, during, and after the recreational deer and hog hunting season (October through December) on areas open (BCNP) and closed (FPNWR, FSPSP) to hunting. Variables examined were: (1) activity rates, (2) movement rates, (3) predation success, (4) home range size, (5) home range shifts, (6) proximity to ORV trails, (7) use of areas with concentrated human activity, and (8) habitat selection. Responses to hunting for variables most directly related to panther energy intake or expenditure (*i.e.*, activity rates, movement rates, predation success of females) were not detected (Janis and Clark 2002). However, panthers reduced their use of Bear Island, an area of concentrated human activity, and were found farther from ORV trails during the hunting season, indicative of a reaction to human disturbance (Janis and Clark 2002). Whereas the reaction to trails was probably minor and could be related to prey behavior, decreased use of Bear Island most likely reflects a direct reaction to human activity and resulted in increased use of adjacent private lands (Janis and Clark 2002).

Transportation Planning and Improvements

Construction of highways in wildlife habitat typically results in loss and fragmentation of habitat, traffic related mortality, and avoidance of associated human development. Roads can also result in habitat fragmentation, especially for females who are less likely to cross them (Maehr 1990).

There are presently 28 wildlife underpasses with associated fencing suitable for panther use along I-75 (Figure 9). There are four underpasses suitable for panther use currently existing, and two additional underpasses presently proposed by the Florida Department of Transportation (FDOT) along State Road 29 (SR 29) (Department of the Army Public Notice SAJ-2004-778) (Figure 9). Several additional panther/wildlife crossings are proposed along roadways in rural Lee and Collier Counties (Shindle et al. 2001). In addition, Collier County, in cooperation with the National Wildlife Federation and the Florida Wildlife Federation, is coordinating a study of the segment of CR 846 east of Immokalee and the section of Oil Well Road where the road crosses Camp Kies Strand by Dr. Reed Noss and Dr. Daniel Smith to determine the optimum location for wildlife crossing construction (WilsonMiller 2005). An additional crossing of Camp Kies Strand on CR 846 west of Immokalee is also being evaluated. However, vehicular trauma still occurs on outlying rural roads and the FWC is conducting a study to determine the impacts of vehicular collisions to panthers and studying ways to minimize panther vehicle collisions (Swanson et al. 2006).

No panther-vehicle collisions have been recorded in the immediate vicinity of wildlife crossings, with the exception of one collision in December 2005 on SR 29. There have been no collisions on east-west I-75 in the vicinity of crossings since installation in 1991. Prior to 1991, there were five recorded deaths from collisions. FDOT has also identified the location of and constructed wildlife crossings on SR 29. Proposed crossings A and B (Figure 9) will be in an area of 10 documented collisions from 1980 to 2004. Crossings C and D, north of I-75, were installed in 1995. There were two recorded collisions in the vicinity of crossing D from 1979 to 1990, but none at either C or D since crossing installation. Crossing E was installed in 1997. There has been one collision about 1 mile to the north in 2002. Crossing F was installed in 1999. There was one documented collision in the immediate vicinity in 1981, two collisions about 1.5 miles to the north since crossing installation, and one collision about 0.5 mile to the south in December 2005.

Agriculture, Development, and Mining

The Service developed a draft Panther Habitat Assessment methodology and refugia design in 2003 to help guide the agency in evaluating permit applications for projects that could affect panther habitat (see discussion below). This draft methodology was a way to assess the level of impacts to panthers expected from a given project, and to evaluate the effect of any proposed compensation offered by the project applicant. Prior to development of the methodology, the Service from March 1984 through July 2003 concluded consultation on 42 projects involving the panther and habitat preservation (Table 2). The minimum expected result of these projects is impacts to 76,919 acres and the preservation of 15,479 acres of panther habitat. Of the 76,919 acres of impacts, 38,932 acres are due to agricultural conversion and 37,982 acres to development and mining. Portions (10,370 acres) of the largest agricultural conversion project, the 28,700 acres by U.S. Sugar Corporation, were re-acquired by the Federal Government as a component of the Talisman Land Acquisition (Section 390 of the Federal Agricultural Improvement and Reform Act of 1996 [Public Law 104-127] Farm Bill Cooperative Agreement, FB4) for use in the Comprehensive Everglades Restoration Project. The non-agriculture impacts are permanent land losses, whereas the agricultural conversions may continue to provide some habitat functional value to panthers, depending on the type of conversion.

From August 2003 to February, 2007, the Service concluded consultations on 58 projects affecting 17,169 acres with preservation of 18,334 acres (Table 2). Following our refugia design assessment approach, the projects affected 7,287 acres in the Primary Zone, 5,911 acres in the Secondary Zone, and 3,965 acres in the Other Zone. Compensation provided included 15,118 acres in the Primary Zone, 652 acres in the Dispersal Zone, 2 acres in the Secondary Zone, and 1,410 acres in the Other Zone. The project affected lands were primarily agricultural fields consisting of row crops and citrus groves and natural lands with varying degrees of exotic vegetation. Functional habitat value of these lands to the Florida panther, following our Panther Habitat Assessment methodology provided a PHU loss from development of 74,505 PHUs, with a corresponding PHU preservation and enhancement complement of 143,133 PHUs. The preservation lands were generally native habitat lands or disturbed lands that included restoration components. Restoration components included exotic species removal, fire management, wetland hydrology improvement, improved forest management practices, and full habitat restoration from agriculture uses to native habitats.

Panther Habitat Evaluation and Compensation

Population Viability Analysis

Population Viability Analysis (PVA) has emerged as a key component of endangered species conservation. This process is designed to incorporate demographic information into models that predict if a population is likely to persist in the future. PVAs incorporate deterministic and stochastic events including demographic and environmental variation, and natural catastrophes. PVAs have also been criticized as being overly optimistic about future population levels (Brook et al. 1997) and should be viewed with caution; however, they are and have been shown to be surprisingly accurate for managing endangered taxa and evaluating different management practices (Brook 2000). They are also useful in conducting sensitivity analyses to determine where more precise information is needed (Hamilton and Moller 1995, Beissinger and Westphal 1998, Reed et al. 1998, Fieberg and Ellner 2000).

As originally defined by Shaffer (1981), "a minimum viable population for any given species in any given habitat is the smallest isolated population having a 99 percent chance of remaining extant for 1,000 years despite the foreseeable effects of demographic, environmental and genetic stochasticity, and natural catastrophes." However, the goal of 95 percent probability of persistence for 100 years is the standard recommended by population biologists and is used in management strategies and conservation planning, particularly for situations where it is difficult to accurately predict long-term effects (Shaffer 1978, 1981, 1987, Sarkar 2004).

Since 1981, 139 Florida panthers have been radio-collared and monitored on public and private lands throughout south Florida (Lotz et al. 2005). These data were used by researchers to estimate survival rates and fecundity and were incorporated into PVA models previously developed for the Florida panther (Seal et al. 1989, 1992, Cox et al. 1994, Kautz and Cox 2001, Maehr et al. 2002b). These models incorporated a range of different model parameters such as general sex ratios, kitten survival rates, age distributions, and various levels of habitat losses, density dependence, and intermittent catastrophes or epidemics. The outputs of these models predicted a variety of survival scenarios for the Florida panther and predicted population levels needed to ensure the survival of the species.

Root (2004) developed an updated set of PVA models for the Florida panther based on RAMAS GIS software (Akçakaya 2002). These models were used to perform a set of spatially explicit PVAs. Three general single-sex (i.e., females only) models were constructed using demographic variables from Maehr et al. (2002b) and other sources. A conservative model was based on Seal and Lacy (1989), a moderate model was based on Seal and Lacy (1992), and an optimistic model was based on the 1999 consensus model of Maehr et al. (2002b). In each model, first-year kitten survival was set at 62 percent based on recent information from routine panther population monitoring (Shindle et al. 2001). All models assumed a 1:1 sex ratio, a stable age distribution, 50 percent of females breeding in any year, and an initial population of 41 females (82 individuals including males), the approximate population size in 2001-2002 (McBride 2001, 2002).

Basic Versions: The basic versions of each model incorporated no catastrophes or epidemics, no change in habitat quality or amount, and a ceiling type of density dependence. The basic versions of the models incorporated a carrying capacity of 53 females (106 panthers - 50/50 sex ratio). Variants of the models were run with differing values for density dependence, various levels of habitat loss, and intermittent catastrophes or epidemics. Each simulation was run with 10,000 replications for a 100-year period. The minimum number of panthers needed to ensure a 95 percent probability of persistence for 100 years was estimated in a series of simulations in which initial abundance was increased until probability of extinction at 100 years was no greater than 5 percent. More detailed information concerning the PVA model parameters appears in Root (2004).

The results of these model runs predicted a probability of extinction for the conservative model of 78.5 percent in 100 years with a mean final total abundance of 3.5 females. Also, the probability of a large decline in abundance (50 percent) was 94.1 percent. The moderate model resulted in a 5 percent probability of extinction and mean final abundance of 42.3 females in 100 years. The probability of panther abundance declining by half the initial amount was 20 percent in 100 years under the moderate model. The optimistic model resulted in a 2 percent probability of extinction and mean final abundance of 51.2 females in 100 years. The probability of panther abundance declining by half the initial amount was only 9 percent in 100 years under the optimistic model. These models also provide a probability of persistence (100 percent minus probability of extinction) over a 100-year period of 95 percent for the moderate model and 98 percent for the optimistic model.

One Percent Habitat Loss: Model results were also provided by Root (2004) for probability of extinctions for 1 percent loss of habitat, within the first 25 years of the model run. The 1 percent loss of habitat equates to essentially all remaining non-urban privately owned lands in the Primary Zone and corresponds to the estimated rate of habitat loss (Root 2004) from 1986 to 1996 for the five southwest counties based on land use changes. For the moderate model, the model runs predict a probability of extinction increase of about one percent, from a probability of extinction of about 5 percent with no loss of habitat to 6 percent with 1.0 percent habitat loss per year, for the first 25 years. For the optimistic model, probability of extinction increased from about 2 percent with no loss of habitat to 3 percent with 1.0 percent habitat loss per year, for the first 25 years. These models also predicted the mean final abundance of females would decrease from 41 to 31 females, a 24.3 percent reduction for the moderate model and from 41 to 38 females, a 7.3 percent reduction for the optimistic model.

The model runs also predict a probability of persistence (100 percent minus the probability of extinction) over a 100-year period of about 94 percent for the moderate model and 97 percent for the optimistic model. The model runs, predict a mean final abundance of 62 individuals (31 females and 31 males) for the moderate model and 76 individuals (38 females and 38 males) for the optimistic model.

Population Guidelines: Kautz et al. (2006), following review of the output of Root's PVA models and those of other previous PVAs for the Florida panther, suggested a set of population guidelines for use in management and recovery of the Florida panther. These guidelines are:

(1) populations of less than 50 individuals are likely to become extinct in less than 100 years; (2) populations of 60 to 70 are barely viable and expected to decline by 25 percent over 100 years; (3) populations of 80 to 100 are likely stable but would still be subject to genetic problems (*i.e.*, heterozygosity would slowly decline); and (4) populations greater than 240 have a high probability of persistence for 100 years and are demographically stable and large enough to retain 90 percent of original genetic diversity.

Population guidelines for populations of panthers between 50 and 60 individuals and between 70 and 80 individuals were not specifically provided in Kautz et al. (2006). However, the Service views the guidelines in Kautz et al. (2006) as a continuum. Therefore, we consider populations of 50 to 60 individuals to be less than barely viable or not viable with declines in population and heterozygosity. Similarly, we consider populations of 70 to 80 to be more than barely viable or somewhat viable with some declines in population and heterozygosity. Like other population guidelines presented in Kautz et al. (2006), these assume no habitat loss or catastrophes.

PVA Summaries and Population Guidelines: Root's (2004) moderate model runs, which have a carrying capacity 53 females (106 individuals), show final populations of 42.3 females (84 total) and 31.2 females (62 total) with extinction rates of 5 percent and 6 percent, respectively, for the basic and 1 percent habitat loss scenarios. The predicted final populations in Root (2004) are 84 and 62 panthers for no loss of habitat and 1 percent loss of habitat, respectively, over a 100-year period.

Kautz et al.'s (2006) population guidelines applied to the Root (2004) moderate models for a population of 62 to 84 panthers, with or without habitat loss, respectively, describe the "with habitat loss" population as barely viable and expected to decline by 25 percent over a 100-year period. The "without habitat loss" is likely stable but would still be subject to genetic problems.

In conclusion, the Service believes the model runs show lands in the Primary Zone are important to the survival and recovery of the Florida panther and sufficient lands need to be managed and protected in south Florida to provide for a population of 80 to 100 panthers, the range defined as likely stable over 100 years, but subject to genetic problems. As discussed in the following section, the Service has developed a south Florida panther conservation goal that, through regulatory reviews and coordinated conservation efforts with land owners and resource management partners, provides a mechanism to achieve this goal.

Model Violations: The actual likelihood of population declines and extinctions may be different than the guidelines and models suggest, depending upon the number of and severity of assumptions violated. The Service realizes that habitat loss is occurring at an estimated 0.8 percent loss of habitat per year (R. Kautz, FWC, personal communication, 2003). The Service has accounted for some habitat loss and changes in habitat quality within its regulatory program, and specifically through its habitat assessment methodology (discussed below). For example, we have increased the base ratio used within this methodology to account for unexpected increases in habitat loss. Similarly, we consider changes in habitat quality and encourage habitat restoration wherever possible.

With regard to the assumption of no catastrophes, the Service has considered the recent outbreak of feline leukemia in the panther population at Okaloacoochee Slough as a potential catastrophe. The FWC is carefully monitoring the situation and it appears to be under control at this time due to a successful vaccination program. However, if the outbreak spreads into the population, the Service will consider this as a catastrophe and factor this into our decisions.

We acknowledge uncertainties exist, assumptions can be violated, and catastrophes can occur. The Service and the FWC, along with our partners, will continue to monitor the panther population and the south Florida landscape and incorporate any new information and changes into our decision-making process.

South Florida Panther Population Goal

The Service's goal for Florida panther conservation in south Florida is to locate, preserve, and restore sets of lands containing sufficient area and appropriate land cover types to ensure the long-term survival of a population of 80 to 100 individuals (adults and subadults) south of the Caloosahatchee River. The Service proposes to achieve this goal through land management partnerships with private landowners, through coordination with private landowners during review of development proposals, and through land management and acquisition programs with Federal, State, local, private, and Tribal partners. The acreages of lands necessary to achieve this goal, based on Kautz et al. (2006) average density of 31,923 acres (12,919 ha) per panther is 2,551,851 acres (1,032,720 ha) for 80 panthers or 3,189,813 acres (1,290,900 ha) for 100 panthers.

The principle regulatory mechanism that allows the Service to work directly with private land owners during review of development and land alteration projects is section 10 of the Act. The Service coordinates with Federal agencies pursuant to section 7 of the Act. In August 2000, the Service, to assist the Corps in assessing project effects to the Florida panther, developed the Florida panther final interim Standard Local Operating Procedures for Endangered Species (SLOPES) (Service 2000). The Florida panther SLOPES provide guidance to the Corps for assessing project effects to the Florida panther and recommends actions to minimize these effects. The Florida panther SLOPES also included a consultation area map that identified an action area where the Service believed land alteration projects may affect the Florida panther.

In the original SLOPES the consultation area map (MAP) was generated by the Service by overlaying existing and historical panther telemetry data on a profile of Florida and providing a connecting boundary surrounding most of these points. Since the development of the MAP, we have received more accurate and up-to-date information on Florida panther habitat usage. Specifically we have received two documents the Service believes reflects the most likely panther habitat usage profiles although documentation clearly shows panther use of areas outside these locations. These documents are the publications by Kautz et al. (2006) and Thatcher et al. (2006). Based on the information in these documents, we have clarified the boundaries of the MAP to better reflect areas where Florida panthers predominate (Figure 4) and refer to these areas cumulatively as the Panther Focus Area.

The Panther Focus Area was determined from the results of recent panther habitat models south of the Caloosahatchee River (Kautz et al. 2006) and north of the Caloosahatchee River (Thatcher et al. 2006). Kautz et al. (2006) model of landscape components important to Florida panther habitat conservation was based on an analysis of panther habitat use and forest patch size. This model was used in combination with radio-telemetry records, home range overlaps, land use/land cover data, and satellite imagery to delineate primary and secondary areas that would be most important and comprise a landscape mosaic of cover types important to help support of the current panther breeding population south of the Caloosahatchee River.

Thatcher et al. (2006) developed a habitat model using Florida panther home ranges in south Florida to identified landscape conditions (land-cover types, habitat patch size and configuration, road density and other human development activities, and other similar metrics) north of the Caloosahatchee River that were similar to those associated with the current panther breeding population.

The Panther Focus Area MAP, south of the Caloosahatchee River is divided into Primary, Secondary, and Dispersal Zones; and north of the Caloosahatchee River into the Primary Dispersal/Expansion Area.

Primary Zone is currently occupied and supports the only known breeding population of Florida panthers in the world. These lands are important to the long-term viability and persistence of the panther in the wild.

Secondary Zone lands are contiguous with the Primary Zone and although these lands are used to a lesser extent by panthers, they are important to the long-term viability and persistence of the panther in the wild. Panthers use these lands in a much lower density than in the Primary Zone.

Dispersal Zone is a known corridor between the Panther Focus Area south of the Caloosahatchee River to the Panther Focus Area north of the Caloosahatchee River. This Zone is necessary to facilitate the dispersal of panthers and future panther population expansion to areas north of the Caloosahatchee River. Marked panthers have been known to use this zone.

Primary Dispersal/Expansion Area is the Fisheating Creek/Babcock-Webb Wildlife Management Area region. These are lands identified by Thatcher et al. (2006) as potential panther habitat with the shortest habitat connection to the Panther Focus Area in south Florida. Several collared and uncollared male panthers have been documented in this area since 1973, and the last female documented north of the Caloosahatchee River was found in this area.

Landscape Preservation Need and Compensation Recommendations

Land Preservation Needs: To further refine the land preservation needs of the Florida panther and to specifically develop a landscape-level program for the conservation of the Florida panther population in south Florida, the Service as previously discussed, in February 2000, appointed a Florida Panther Subteam. The Subteam in addition to the assignments discussed previously, was

also charged with developing a landscape-level strategy for the conservation of the Florida panther population in south Florida. The results of this collaborative effort are partially presented in Kautz et al. (2006). One of the primary goals of this effort was to identify a strategically located set of lands containing sufficient area and appropriate land cover types to ensure the long-term survival of the south population of the Florida panther. Kautz et al. (2006) focused their efforts on the area south of the Caloosahatchee River, where the reproducing panther population currently exists.

Kautz et al. (2006) created an updated Florida panther potential habitat model based on the following criteria: (1) forest patches greater than 4.95 acres (2 ha); (2) non-urban cover types within 656 ft (200 m) of forest patches; and (3) exclusion of lands within 984 ft (300 m) of urban areas. The potential habitat map was reviewed in relation to telemetry data, recent satellite imagery (where available), and panther home range polygons. Boundaries were drawn around lands defined as the Primary Zone (Figure 5), defined as the most important area needed to support a self-sustaining panther population. Kautz et al. (2006) referred to these lands as essential; however, as observed in the two previous plans (Logan et al. 1993; Cox et al. 1994), lands within the boundaries of the Primary Zone included some urban areas and other lands not considered to be truly panther habitat (*i.e.*, active rock and sand mines). The landscape context of areas surrounding the Primary Zone was modeled and results were used to draw boundaries of the Secondary Zone (Figure 5), defined as the area capable of supporting the panther population in the Primary Zone, but where habitat restoration may be needed (Kautz et al. 2006).

Kautz et al. (2006) also identified, through a least cost path model, the route most likely to be used by panthers dispersing out of south Florida, crossing the Caloosahatchee River, and dispersing into south-central Florida. Kautz et al. (2006) used ArcView GIS© version 3.3 and ArcView Spatial Analyst© version 2 (Environmental Systems Research, Incorporated, Redlands, California) to construct the least-cost path models and identify optimum panther dispersal corridor(s). The least-cost path models operated on a cost surface that ranked suitability of the landscape for use by dispersing panthers with lower scores indicating higher likelihood of use by dispersing panthers. The lands within the boundaries of the least cost model prediction were defined as the Dispersal Zone (Figure 5). The preservation of lands within this zone is important for the survival and recovery of the Florida panther, as these lands are the dispersal pathways for expansion of the south Florida panther population. The Primary Zone covers 2,270,590 acres (918,895 ha); the Secondary Zone covers 812,104 acres (328,654 ha); and the Dispersal Zone covers 27,883 acres (11,284 ha); providing a total of 3,110,578 acres (1,258,833 ha) (Kautz et al. 2006).

As part of their evaluation of occupied panther habitat, in addition to the average density estimate of one panther per 27,181 acres (11,000 ha) developed by Maehr et al. (1991), Kautz et al. (2006) estimated the present average density during the timeframe of the study, based on telemetry and other occurrence data, to average 1 panther per 31,923 acres (12,919 ha). In the following discussions of the number of panthers that a particular zone may support, the lower number is based on the 31,923 acres (12,919 ha) value (Kautz et al. 2006) and the higher number is based on the 27,181 acres (11,000 ha) value (Maehr et al. 1991).

Based on these average densities, the Primary Zone could support 71 to 84 panthers; the Secondary Zone 8 to 10 panthers without habitat restoration and 25 to 30 panthers with habitat restoration (existing high quality panther habitat currently present in the Secondary Zone is estimated at 32 percent of the available Secondary Zone lands); and the Dispersal Zone, 0 panthers. Taken together, the three zones in their current condition apparently have the capacity to support approximately 79 to 94 Florida panthers.

Kautz et al.'s (2006) assessment of available habitat south of the Caloosahatchee River determined that non-urban lands in the Primary, Secondary, and Dispersal Zones were not sufficient to sustain a population of 240 individuals south of the Caloosahatchee River. However, Kautz et al. (2006) determined sufficient lands were available south of the Caloosahatchee River to support a population of 79 to 94 individuals (although not all lands are managed and protected).

Compensation Recommendations: To achieve our goal to locate, preserve, and restore sets of lands containing sufficient area and appropriate land cover types to ensure the long-term survival of a population of Florida panthers south of the Caloosahatchee River, the Service chose the mid point (90 panthers) in Kautz et al.'s (2006) population guidelines that a population of 80 to 100 panthers is likely to be stable, although subject to genetic problems, through 100 years. In addition, a population of 90 individuals is eight individuals greater than a population of 82 individuals, which according to the best available PVA (Root 2004) is 95 percent likely to persist over 100 years (assuming a 50:50 male to female ratio). These eight individuals provide a buffer for some of the assumptions in Root's (2004) PVA. Our process to determine compensation recommendations for project affects that cannot be avoided in both our section 7 and section 10 consultations is based on the amount and quality of habitat we believe is necessary to support a population of 90 panthers in south Florida.

The Service, based on Kautz et al.'s (2006) average panther population density of 31,923 acres per panther determined 2,873,070 acres of Primary Zone "equivalent" lands need to be protected and managed. This equivalency factor is needed, since Secondary Zone lands are of less value than Primary Zone lands to the panther, to assure that additional acreage (special consideration) is required in the Secondary Zone to compensate for its lower quality panther habitat. In other words, more than 31,923 acres per panther would be needed, hypothetically, if this acreage were all in the Secondary Zone (see discussion of Primary Zone equivalent lands in the following section). The combined acreage of lands within the Primary, Dispersal, and Secondary Zones is 3,110,577 acres (1,258,833 ha) (Kautz et al. 2006). Currently, 2,073,865 acres of Primary Zone equivalent lands are preserved, so 799,205 additional acres need to be preserved to support a population of 90 panthers in south Florida (2,873,070 minus 2,073,865 equals 799,205).

The Service also consults on lands outside of the Primary, Secondary, and Dispersal zones that may effect panthers such as agricultural lands that are adjacent to the Panther Focus Area and proposals in urbanized areas that could generate traffic in or adjacent to the Panther Focus Area or have other identifiable impacts.

Primary Zone Equivalent Lands: Kautz et al. (2006), through their habitat evaluation of lands important to the Florida panther, identified three sets of lands, *i.e.*, Primary Zone, Secondary Zone, and Dispersal Zone, and documented the relative importance of these lands to the Florida panther. These lands generally referred to as the panther core lands (Figure 5), include the majority of the home ranges of the current population of the Florida panther. The Service, in our evaluation of habitat needs for the Florida panther expanded the boundaries of the Kautz et al. (2006) lands to include those lands south of the Caloosahatchee River where additional telemetry points historically were recorded. These additional lands (about 819,995 acres), referred to as the "Other" Zone, are added to the lands in Kautz et al.'s (2006) panther core lands (Figure 5) and represent the lands within the Service's 2000 consultation area boundary south of the Caloosahatchee River as shown in Figure 4. These lands (core lands and other zone lands) together are referred to by the Service as the core area. The "Other" Zone lands, as well as the lands within the Secondary Zone, provide less landscape benefit to the Florida panther than the Primary and Dispersal Zones, but are important as a component of our goal to preserve sufficient lands to support a population of 90 panthers in South Florida.

To account for the lower landscape importance of these lands in our preservation goals and in our habitat assessment methodology, we assigned lands in the Other Zone a value of 0.33 and lands in the Secondary Zone a value of 0.69 to convert these lands to Primary Zone value, *i.e.*, Primary Zone equivalents (Table 3). Kautz et al. (2006) identifies the need for restoration in the Secondary Zone to achieve maximum benefits. To estimate the Primary Zone equivalent of Secondary Zone lands, we derived a relative habitat value (average PHU value) for each by comparing the habitat ranks estimated in Kautz et al. (2006 – Table 1) for each habitat type per zone. The average PHU value for the Primary Zone is 6.94 and for the Secondary Zone 4.79. Based on this analysis, the habitat value of the Secondary Zone is roughly 69 percent of the Primary Zone, and restoration is needed to achieve landscape function (4.79/6.94=0.69). Dispersal Zone lands are considered equivalent to Primary Zones lands with a 1/1 value. At-risk lands in the Other Zone total 819,995 acres. Actions on some of the Other Zone lands such as some actions in areas that have already been urbanized will not have an impact on panthers or their habitat, and these case-specific determinations will be made based on a review of the specific proposals. We estimate 80 percent of these actions will have an impact on achieving the panther population goal, and will monitor this carefully as we review proposed actions (819,995 times 0.8 equals 655,996 acres). Multiply this acreage (655,996 acres) by 0.33 to determine the acres of Primary Zone equivalent lands the Other Zone can provide (655,996 times 0.33 equals 216,479 acres of Primary Zone equivalent lands). Using this assessment, the 503,481 acres of Secondary Zone lands equate to 347,402 acres of Primary Zone equivalent lands. These equivalent values, 0.33 and 0.69, for Other and Secondary Zones, respectively, and 1/1 for Dispersal Zone, are important components in our assessment of compensation needs for a project in the panther consultation area and are components of our habitat assessment methodology as discussed below.

Habitat Assessment Methodology

To evaluate project effects to the Florida panther, the Service considers the contributions the project lands provide to the Florida panther, recognizing not all habitats provide the same functional value. Kautz et al. (2006) also recognized not all habitats provide the same habitat

value to the Florida panther and developed cost surface values for various habitat types, based on use by and presence in home ranges of panthers. The FWC (2006b), using a similar concept, assigned likely use values of habitats to dispersing panthers. The FWC's habitats were assigned habitat suitability rank between 0 and 10, with higher values indicating higher likely use by dispersing panthers.

The Service chose to evaluate project effects to the Florida panther through a similar process. We incorporated many of the same habitat types referenced in Kautz et al. (2006) and FWC (2006b) with several adjustments to the assigned habitat use values reflecting consolidation of similar types of habitats and the inclusion of Everglades Restoration water treatment and retention areas. We used these values as the basis for habitat evaluations and the recommended compensation values to minimize project effects to the Florida panther (Table 6), as discussed below.

Base Ratio: To develop a base ratio that will provide for the protection of sufficient acreage of Primary Zone equivalent lands for a population of 90 panthers from the acreage of Primary Zone equivalent non-urban lands at risk, we developed the following approach.

The available Primary Zone equivalent lands are estimated at 3,276,563 acres (actual acreage is 4,376,444 acres [the "actual acreage" value includes acres of lands in each category in the Secondary and Other Zones as well as the lands in the Primary Zone]) (see Table 3). Currently 2,073,865 acres of Primary Zone equivalent lands (actual acreage is 2,578,152 acres) of non-urban lands are preserved. The remaining non-urban at-risk private lands are estimated at 1,202,698 acres of Primary Zone equivalent lands (actual acreage is 1,798,295 acres). To meet the protected and managed lands goal for a population of 90 panthers, an additional 799,205 acres of Primary Zone equivalent lands are needed. The base ratio is determined by dividing the primary equivalents of at-risk habitat to be secured (799,205 acres) by the result of the acres of at-risk habitat in the Primary Zone (610,935 acres) times the value of the Primary Zone (1); plus the at-risk acres in the Dispersal Zone (27,883 acres) times the value of the Dispersal Zone (1); plus the at-risk acres in the Secondary Zone (503,481 acres) times the value of the Secondary Zone (0.69); plus the at-risk acres in the Other Zone (655,996 acres) times the value of the Other Zone (0.33); minus the at-risk acres of habitat to be protected (799,205 acres). The results of this formula provide a base value of 1.98.

$$799{,}205 / ((610{,}935 \times 1.0) + (27{,}883 \times 1) + (503{,}481 \times 0.69) + (655{,}996 \times 0.33)) - 799{,}205 = 1.98$$

In evaluating habitat losses in the consultation area, we used an estimate of 0.8 percent loss of habitat per year (R. Kautz , FWC, personal communication, 2004) to predict the amount of habitat loss anticipated in south Florida during the next 5 years (*i.e.*, 6,000 ha / year; 14,820 acres / year). We conservatively assumed that we would be aware of half of these projects. We assumed that half of the projects would occur in the Primary Zone and half would occur in the Secondary Zone. We estimated that over a 5-year period that about 37,000 acres would be developed without Federal review. We adjusted the base value from 1.98 to 2.23.

We also realize that collectively habitat losses from individual single-family residential developments will compromise the Service's goal to secure sufficient lands for a population of 90 panthers. We believe, on an individual basis, single-family residential developments by individual lot owners on lots no larger than 2.0 ha (5.0 acres) will not result in take of panthers on a lot-by-lot basis; however, collectively these losses may impact the panther. Panthers are a wide ranging species, and individually, a 2.0 ha (5.0 acre) habitat change will not have a measurable impact. Compensation for such small-scale losses on a lot-by-lot basis is unlikely to result in meaningful conservation benefits for the panther versus the more holistic landscape level conservation strategy used in our habitat assessment methodology. To account for these losses, we estimated about another 12,950 acres over a 5-year period (2,590 acres per year) would be developed through this avenue. We adjusted the base value from 2.23 to 2.48.

We also realize there is a need for road crossings in strategic locations and we believe there are projects that may not have habitat loss factors but will have traffic generation factors. The Service considers increases in traffic as an indirect effect from a project and can contribute to panther mortality. Therefore, we have added another 0.02 to the base ratio to address traffic impacts, which could provide an incentive to implement crossings in key locations. Following the same approached shown above, we adjusted the base ratio from 2.48 to the 2.5. The Service intends to re-evaluate this base ratio periodically and adjust as needed to make sure all adverse effects are adequately ameliorated and offset as required under section 7 of the Act and to achieve the Service's conservation goal for the Florida panther.

Landscape Multiplier: As discussed previously in the above section on Primary Zone Equivalent Lands, the location of a project in the landscape of the core area of the Florida panther is important. As we have previously discussed, lands in the Primary and Dispersal Zones are of the most importance in a landscape context to the Florida panther, with lands in the Secondary Zone of less importance, and lands in the Other Zone of lower importance. These zones affect the level of compensation the Service believes is necessary to minimize a project's effects to Florida panther habitat. Table 5 provides the landscape compensation multipliers for various compensation scenarios. As an example, if a project is in the Other Zone and compensation is proposed in the Primary Zone, a Primary Zone equivalent multiplier of 0.33 is applied to the PHUs (see discussion below) developed for the project. If the project is in the Secondary Zone and compensation is in the Primary Zone, then a Primary Zone equivalent multiplier of 0.69 is applied to the PHUs developed for the project.

Panther Habitat Units – Habitat Functional Value: Prior to applying the base ratio and landscape multipliers discussed above, we evaluate the project site and assign functional values to the habitats present. This is done by assigning each habitat type on-site a habitat suitability value from the habitats shown in Table 6. The habitat suitability value for each habitat type is then multiplied by the acreage of that habitat type resulting in a number representing PHUs. These PHUs are summed for a site total, which is used as a measurement of the functional value the habitat provides to the Florida panthers. This process is also followed for the compensation-sites.

Exotic Species Assessment: Since many habitat types in south Florida are infested with exotic plant species, which affects the functional value a habitat type provides to foraging wildlife species (*i.e.*, primarily deer and hog), we believe the presence of these species and the value these species provide to foraging wildlife needs to be considered in the habitat assessment methodology. As shown in Table 6, we have a habitat type and functional value shown for exotic species. This category includes not only the total acres of pure exotic species habitats present but also the percent-value acreages of the exotic species present in other habitat types.

For example, a site with 100 acres of pine flatwoods with 10 percent exotics would be treated in our habitat assessment methodology as 90 acres of pine flatwoods and 10 acres of exotics. Adding another 100 acres of cypress swamp with 10 percent exotics would change our site from 90 acres of pine flatwoods and 10 acres of exotics to 90 acres of pine flatwoods, 90 acres of cypress swamp, and 20 acres of exotics.

Habitat Assessment Methodology Application – Example: To illustrate the use of our habitat assessment methodology, we provide the following example. A 100-acre project site is proposed for a residential development. Plans call for the entire site to be cleared. The project site contains 90 acres of pine flatwoods and 10 acres of exotic vegetation, and is located in the "Secondary Zone." The applicant has offered habitat compensation in the "Primary Zone" to minimize the impacts of the project to the Florida panther. To calculate the PHUs provided by the site, we multiply the habitat acreage by the "habitat suitability value" for each habitat type and add those values to obtain a value of 840 PHUs ((90 acres of pine flatwoods x 9 [the habitat suitability value for pine flatwoods] = 810 PHUs) + (10 acres of exotic vegetation x 3 [the habitat suitability value for exotics] = 30 PHUs) = 840 PHUs). The value of 840 PHUs is then multiplied by the 2.5 (the base ratio) and 0.69 (the landscape multiplier) resulting in a value of 1,149 PHUs for the project site. In this example, the acquisition of lands in the Primary Zone containing at least 1,149 PHUs are recommended to compensate for the loss of habitat to the Florida panther resulting from this project.

A**nalysis of the species likely to be affected**

The Florida panther is an endangered animal restricted to two to three million acres of land (6 to 9 percent of the total land area of Florida) in south Florida. The panther is a wide-ranging species that requires a biotically diverse landscape to survive. Dispersing subadult males wander widely through unforested and disturbed habitat. Human population in south Florida has dramatically increased, from one million in 1950 to six million in 1990, resulting in secondary disturbances such as increased human presence and noise, light, air, and water pollution. Increasing human population has resulted in increasing impacts on native habitat and flora and fauna. Resulting threats to panthers include road mortality, habitat loss, habitat fragmentation, and human disturbance.

Wood Stork

The wood stork was federally listed under the Act as endangered on February 28, 1984. No critical habitat has been designated for the wood stork; therefore, none will be affected.

Species Description

The wood stork is a large, long-legged wading bird, with a head to tail length of 85 to 115 cm (33 to 45 inches [in]) and a wingspan of 150 to 165 cm (59 to 65 in) (Coulter et al. 1999). The plumage is white, except for iridescent black primary and secondary wing feathers and a short black tail. Wood storks fly with there neck and legs extended. On adults, the rough scaly skin of the head and neck is unfeathered and blackish in color, the legs are dark, and the feet are dull pink. The bill color is also blackish. During courtship and the early nesting season, adults have pale salmon coloring under the wings, fluffy undertail coverts that are longer than the tail, and their toes are bright pink. Immature wood storks, up to the age of about 3 years, have yellowish or straw-colored bills and varying amounts of dusky feathering on the head and neck (Coulter et al. 1999).

Life History

Wood stork nesting habitat consists of mangroves as low as 1 m (3 ft), cypress as tall as 30.5 m (100 ft), and various other live or dead shrubs or trees located in standing water (swamps) or on islands surrounded by relatively broad expanses of open water (Palmer 1962, Rodgers et al. 1987, Ogden 1991, Coulter et al. 1999). Wood storks nest colonially, often in conjunction with other wading bird species, and generally occupy the large-diameter trees at a colony site (Rodgers et al. 1996). The same colony site will be used for many years as long as the colony is undisturbed and sufficient feeding habitat remains in surrounding wetlands. However, not all storks nesting in a colony will return to the same site in subsequent years (Kushlan and Frohring 1986). Natural wetland nesting sites may be abandoned if surface water is removed from beneath the trees during the nesting season (Rodgers et al. 1996). In response to this type of changes to nest site hydrology, wood storks may abandon that site and establish a breeding colony in managed or impounded wetlands (Ogden 1991). Wood storks that abandon a colony early in the nesting season due to unsuitable hydrological conditions may re-nest in other nearby areas (Borkhataria et al. 2004; Crozier and Cook 2004). Between breeding seasons or while foraging wood storks may roost in trees over dry ground, on levees, or large patches of open ground. Wood storks may also roost within wetlands while foraging far from nest sites and outside of the breeding season (Gawlik 2002).

While the majority of stork nesting occurs within traditional stork rookeries, a handful of new stork nesting colonies are discovered each year (Meyer and Frederick 2004, Service unpublished data). These new colony locations may represent temporary shifts of historic colonies due to changes in local conditions, or they may represent formation of new colonies in areas where conditions have improved.

Wood storks forage in a wide variety of wetland types, where prey are available to storks and the water is shallow and open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987). Calm water, about 2 to 16 in (5 to 40 cm) in depth, and free of dense aquatic vegetation is ideal (Coulter and Bryan 1993). Typical foraging sites include freshwater marshes, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands such as stock ponds, shallow, seasonally flooded roadside or agricultural ditches, and managed impoundments (Coulter et al. 1999; Coulter and Bryan 1993).

Several factors affect the suitability of potential foraging habitat for wood storks. Suitable foraging habitats must provide both a sufficient density and biomass of forage fish and other prey, and have vegetation characteristics that allow storks to locate and capture prey. During nesting, these areas must also be sufficiently close to the colony to allow storks to efficiently deliver prey to nestlings. Hydrologic and environmental characteristics have strong affects on fish density, and these factors may be some of the most significant in determining foraging habitat suitability, particularly in southern Florida.

Within the wetland systems of southern Florida, the annual hydrologic pattern is very consistent, with water levels rising over 3 feet during the wet season (June-November), and then receding gradually during the dry season (December-May). Storks nest during the dry season, and rely on the drying wetlands to concentrate prey items in the ever-narrowing wetlands (Kahl 1964). Because of the continual change in water levels during the stork nesting period, any one site may only be suitable for stork foraging for a narrow window of time when wetlands have sufficiently dried to begin concentrating prey and making water depths suitable for storks to access the wetlands. Once the wetland has dried to where water levels are near the ground surface, the area is no longer suitable for stork foraging, and will not be suitable until water levels rise and the area is again repopulated with fish. Consequently, there is a general progression in the suitability of wetlands for foraging based on their hydroperiods, with the short hydroperiod wetlands being used early in the season, the mid-range hydroperiod sites being used during the middle of the nesting season, and the longest hydroperiod areas being used later in the season (Kahl 1964; Gawlik 2002).

In addition to the concentration of fish due to normal drying, several other factors affect fish abundance in potential foraging habitats. Longer hydroperiod areas generally support more fish and larger fish (Trexler et al. 2002; Jordan et al. 1998; Loftus and Ecklund 1994; Turner et al. 1999). In addition, nutrient enrichment (primarily phosphorus) within the oligotrophic Everglades wetlands generally results in increased density and biomass of fish in potential stork foraging sites (Rehage and Trexler *In Press*), and distances from dry-season refugia, such as canals, alligator holes, and similar long hydroperiod sites also affect fish density and biomass. Within the highly modified environments of southern Florida, fish availability varies with respect to hydrologic gradients, nutrient availability gradients, and it becomes very difficult to predict fish density. The foraging habitat for most wood stork colonies within southern Florida includes a wide variety of hydroperiod classes, nutrient conditions, and spatial variability.

Dense submerged and emergent vegetation may reduce foraging suitability by preventing storks from moving through the habitat and interfering with prey detection (Coulter and Bryan 1993). Some submerged and emergent vegetation does not detrimentally affect stork foraging, and may be important to maintaining fish populations. Average submerged and emergent vegetation cover at foraging sites was 26 and 29 percent, respectively, at foraging sites at a Georgia colony, and ranged from 0 to100 percent (Coulter and Bryan 1993). These cover values did not differ significantly from random wetland sites. Similarly, densely forested wetlands may preclude storks from accessing prey within the areas (Coulter and Bryan 1993). Storks tend to select foraging areas that have an open canopy, but occasionally use sites with 50 to 100 percent canopy closure (Coulter and Bryan 1993; O'Hare and Dalrymple 1997; Coulter et al. 1999).

Wood storks feed almost entirely on fish between 2 and 25 cm (1 to 10 in) in length (Kahl 1964; Ogden et al. 1976; Coulter 1987) but may occasionally consume crustaceans, amphibians, reptiles, mammals, birds, and arthropods. Wood storks generally use a specialized feeding behavior called tactilocation, or grope feeding, but also forage visually under some conditions (Kushlan 1979). Storks typically wade through the water with the beak immersed and open about 7 to 8 cm (2.5 to 3.5 in). When the wood stork encounters prey within its bill, the mandibles snap shut, the head is raised, and the food swallowed (Kahl 1964). Occasionally, wood storks stir the water with their feet in an attempt to startle hiding prey (Rand 1956; Kahl 1964; Kushlan 1979). This foraging method allows them to forage effectively in turbid waters, at night, and under other conditions when other wading birds that employ visual foraging may not be able to forage successfully.

Wood storks generally forage in wetlands within 50 km (31 miles) of the colony site (Bryan and Coulter 1987), but forage most frequently within 20 km (12 miles) of the colony (Coulter and Bryan 1993). Maintaining this wide range of feeding site options ensures sufficient wetlands of all sizes and varying hydroperiods are available, during shifts in seasonal and annual rainfall and surface water patterns, to support wood storks. Adults feed furthest from the nesting site prior to laying eggs, forage in wetlands closer to the colony site during incubation and early stages of raising the young, and then further away again when the young are able to fly. Wood storks generally use wet prairie ponds early in the dry season then shift to slough ponds later in the dry season thus following water levels as they recede into the ground (Browder 1984).

Gawlik (2002) characterized wood storks as “searchers” that employ a foraging strategy of seeking out areas of high density prey and optimal (shallow) water depths, and abandoning foraging sites when prey density begins to decrease below a particular efficiency threshold, but while prey was still sufficiently available that other wading bird species were still foraging in large numbers (Gawlik 2002). Wood stork choice of foraging sites was significantly related to both prey density and water depth (Gawlik 2002). Because of this strategy, wood stork foraging opportunities are more constrained than many of the other wading bird species (Gawlik 2002).

Breeding wood storks are believed to form new pair bonds every season. First age of breeding has been documented in 3- to 4-year-old birds but the average first age of breeding is unknown. Eggs are laid as early as October in south Florida and as late as June in north Florida (Rodgers 1990; Service unpublished data). A single clutch of two to five (average three) eggs is laid per breeding season but a second clutch may be laid if a nest failure occurs early in the breeding season (Coulter et al. 1999). There is variation among years in the clutch sizes, and clutch size does not appear to be related to longitude, nest data, nesting density, or nesting numbers, and may be related to habitat conditions at the time of laying. Egg laying is staggered and incubation, which lasts about 30 days, begins after the first egg is laid. Therefore the eggs hatch at different times and the nestlings vary in size (Coulter et al. 1999). The younger birds are first to die during times of scarce food.

The young fledge in about 8 weeks but will stay at the nest for 3 to 4 more weeks to be fed. Adults feed the young by regurgitating whole fish into the bottom of the nest about three to ten times per day. Feedings are more frequent when the birds are young (Coulter et al. 1999).

Feedings are less frequent when wood storks are forced to fly great distances to locate food (Bryan et al. 1995). The total nesting period from courtship and nest-building through independence of young, lasts approximately 100 to 120 days (Coulter et al. 1999). Within a colony, nest initiation may be asynchronous, and consequently, a colony may contain active breeding wood storks for a period significantly longer than the 120 days required for a pair to raise young to independence. Adults and independent young may continue to forage around the colony site for a relatively short period following the completion of breeding.

Wood storks produce an average of 1.29 fledglings per nest and 0.42 fledglings per egg which is a probability of survivorship from egg laying to fledgling of 42 percent (Rodgers and Schwikert 1997). The probability of survivorship from egg laying to day 14 is 80 percent, to day 28 (hatching) 70 percent, to day 42 (nestling 2 weeks of age) 62 percent, to day 56 (nestling 4 weeks of age) 56 percent, to day 70 (nestling 6 weeks) 50 percent and to day 84 (fledgling) 42 percent. The greatest losses occur from egg laying to hatching with a 30 percent loss of the nest productivity. From hatching to nestlings of 2 weeks of age, nest productivity loss is an additional 8 percent. Corresponding losses for the remainder of the nesting cycles are on the average of a 6 percent per 2 week increase in age of the nestling (Rodgers and Schwikert 1997).

During the period when a nesting colony is active, storks are dependent on consistent foraging opportunities in wetlands within approximately 30 km for the nest site, with the greatest energy demands occurring during the middle of the nestling period, when nestlings are 23 to 45 days old (Kahl 1964). The average wood stork family requires 201 kg (443 pounds) of fish during the breeding season, with 50 percent of the nestling stork's food requirement occurring during the middle third of the nestling period (Kahl 1964). Receding water levels are necessary in south Florida to concentrate suitable densities of forage fish (Kahl 1964; Kushlan et al. 1975).

Many researchers (Flemming et al. 1994; Ceilley and Bortone 2000) believe that the short hydroperiod wetlands provide a more important pre-nesting foraging food source and a greater effect on early nestling survival for wood storks than the foraging base (grams of fish per square meter) that is suggested in short hydroperiod wetlands. For instance, Loftus and Eklund (1994) provide an estimate of 50 fish per square meter for long hydroperiod wetlands and 10 fish per square-meter for short hydroperiod wetlands. As a result of the consistent pattern of drying that normally occurs during the stork nesting season, the short hydroperiod wetlands would also be the ones used for foraging early in the season when long hydroperiod wetlands remain too deep for storks to forage effectively, or sufficient prey concentration has not yet occurred as a result of drying.

Although the short hydroperiod wetlands support fewer fish and lower fish biomass per unit area than long hydroperiod wetlands, these short hydroperiod wetlands were historically more extensive and provided foraging areas for storks during colony establishment, courtship and nest-building, egg-laying, incubation, and the early stages of nestling provisioning. This period corresponds to the greatest periods of nest failure (*i.e.*, 30 percent and 8 percent, respectively from egg laying to hatching and from hatching to nestling survival to two weeks) (Rodgers and Schwikert 1997).

Based on Kahl's (1964) estimate that 201 kg are needed for the success of a nest, and that 50 percent of the foraging base is needed in the middle third of the nesting cycle when chicks are approximately 23-45 days old (Kahl 1962), it is estimated that about 50 kg are needed to meet the foraging needs of the adults and nestling in the first third of the nesting cycle. Considering the relatively low foraging values these short hydroperiod wetlands provide in relationship to corresponding long hydroperiod wetlands, a much larger acreages of these wetlands are needed to ensure survival and to sustain development of nestlings. The disproportionate reduction (85 percent) of this specific habitat loss known to have occurred from development and overdrainage has been proposed as a major cause of late colony formation and survivorship reduction in early nestling survival rates (Fleming et al. 1994b).

Storks that are not breeding do not require the same degree of fish concentration that is required to sustain successful nesting. Kahl (1964) estimated the food requirements for an individual free-flying stork to be approximately 502 g (live weight) per day. Storks that are not nesting are able to find sufficient prey to sustain themselves in many wetlands that would not be suitable to sustain adults and chicks during nesting.

Following the completion of the nesting season, both adult and fledgling wood storks generally begin to disperse away form the nesting colony. Fledglings have relatively high mortality rates within the first 6 months following fledging, most likely as a result of their lack of experience, including the selection of poor foraging locations (Hylton et al. 2006). Post-fledging survival also appears to be variable among years, probably reflecting the environmental variability that affects storks and their ability to forage (Hylton et al. 2006).

In southern Florida, both adult and juvenile storks consistently disperse northward following fledging in what has been described as a mass exodus (Kahl 1964). Storks in central Florida also appear to move northward following the completion of breeding, but generally do not move as far (Coulter et al. 1999). Many of the juvenile storks from southern Florida move far beyond Florida into Georgia, Alabama, Mississippi, and South Carolina (Coulter et al. 1999; Borkhataria et al. 2004; Borkhataria et al. 2006). Some flocks of juvenile storks have also been reported to move well beyond the breeding range of storks in the months following fledging (Kahl 1964). This post-breeding northward movement appears consistent across years.

Both adult and juvenile storks return southward in the late fall and early winter months. In a study employing satellite telemetry, Borkhataria et al. (2006) reported nearly all storks that had been tagged in the southeastern U.S moved into Florida near the beginning of the dry season, including all subadult storks that fledged from Florida and Georgia colonies. Adult storks that breed in Georgia remained in Florida until March, and then moved back to northern breeding colonies (Borkhataria et al. 2006). Overall, about 75 percent of all locations of radio-tagged wood storks occurred within Florida (Borkhataria et al. 2006). Preliminary analyses of the rangewide occurrence of wood storks in December, recorded during the annual Christmas bird surveys, suggest that the vast majority of the southeastern U.S. wood stork population occurs in central and southern Florida. Relative abundance of storks in this region was 10 to 100 times higher than in northern Florida and Georgia (Service unpublished data). As a result of these general population-level movement patterns, during the earlier period of the stork breeding

season in southern Florida, the wetlands upon which nesting storks depend are also being heavily used by a large portion of the southeastern U.S. wood stork population, including storks that breed in Georgia and the Carolinas, and subadult storks from throughout the stork's range. In addition, these same wetlands support a wide variety of other wading bird species (Gawlik 2002).

Population Dynamics

The United States breeding population of wood storks declined from an estimated 20,000 pairs in the 1930s to about 10,000 pairs by 1960 (49 FR 7332). The total number of nesting pairs in 1995 was 7,853 with 11 percent in South Carolina, 19 percent in Georgia, and 70 percent in Florida (Service 1997).

Since the 1960s, the wood stork population has declined in southern Florida and increased in northern Florida, Georgia, and South Carolina (Ogden et al. 1987). The number of nesting pairs in the Everglades and Big Cypress ecosystems (southern Florida) declined from 8,500 pairs in 1961 to 969 pairs in 1995. During the same period, nesting pairs in Georgia increased from 4 to 1,501 and nesting pairs in South Carolina increased from 11 to 829 (Service 1996). The number of nesting pairs in northern and central Florida doubled between 1976 and 1986 (Ogden 1991). Although Ogden (1991) attributed this to an increase in the availability of altered wetland and artificial wetland nesting sites, the regional increase coincided with the northward shift of the wood stork breeding population center and the overall population decline in the southeastern U.S.

Both the size and success of a wood stork colony varies from year to year based on availability of suitable wetland foraging areas, which can be affected by local rainfall patterns, regional weather patterns, and anthropogenic hydrologic management (Service 1996). The colony site may be vacant in years of drought due to inadequate foraging conditions in the surrounding area. Traditional colony nesting sites may be abandoned completely by storks when hydrological changes occur, removing surface water from beneath the colony trees. Conversely, nesting failures and colony abandonment may occur if unseasonable rainfall causes waters to rise when they are normally receding, thus dispersing rather than concentrating forage fish.

Between 1958 and 1985, the wood stork breeding population center shifted north from Lake Okeechobee to Polk County, a distance of about 132 km (82 miles). The 1976 breeding season was the last year when more pairs nested in south Florida than in central-north Florida. Productivity is generally higher in central-north Florida than south Florida. Whereas the number of colonies in south Florida has remained relatively stable, the number of colonies in central-north Florida region continues to increase (Ogden et al. 1987). The increase in central-north Florida is associated with an increase in colony numbers and not colony size. Colonies in the north are smaller than colonies in the south. Historically colonies in the south were associated with extensive wetlands and food was abundant. The implication is that food resources may be limiting colony sizes in central-north Florida (Ogden et al. 1987). Ogden et al. (1987) suggested the population shift is the result of deteriorating feeding conditions in south Florida and better nesting success rates in central-north Florida that compound population growth in that area.

The wood stork life history strategy has been characterized as a "bet-hedging" strategy (Hylton et al. 2006) in which high adult survival rates and the capability of relatively high reproductive output under favorable conditions allow the species to persist during poor conditions and capitalize on favorable environmental conditions. This life-history strategy may be adapted to variable environments (Hylton et al. 2006) such as the wetland systems of southern Florida.

Nest initiation date, colony size, nest abandonment, and fledging success of a wood stork colony varies from year to year based on availability of suitable wetland foraging areas, which can be affected by local rainfall patterns, regional weather patterns, and anthropogenic hydrologic management (Service 1997). A colony site may be vacant in years of drought or unfavorable conditions due to inadequate foraging conditions in the surrounding area (Kahl 1964). Traditional colony nesting sites may be abandoned completely by storks when hydrological changes occur such as removing surface water from beneath the colony trees (Service 1997; Coulter et al. 1999). Nesting failures and colony abandonment may also occur if unseasonable rainfall causes water levels to rise when they are normally receding, thus dispersing rather than concentrating forage fish (Kahl 1964; Service 1997; Coulter et al. 1999).

The annual climatological pattern that appeared to stimulate the heaviest nesting efforts by storks was a combination of the average or above-average rainfall during the summer rainy season prior to colony formation and an absence of unusually rainy or cold weather during the following winter-spring nesting season. This pattern produced widespread and prolonged flooding of summer marshes that maximized production of freshwater fishes, followed by steady drying that concentrated fish during the dry season when storks nest (Kahl 1964).

Status and Distribution

The wood stork is found from northern Argentina, eastern Peru, and western Ecuador north to Central America, Mexico, Cuba, Hispaniola, and the southeastern United States (AOU 1983). Only the population segment that breeds in the southeastern U.S. is listed as endangered. In the United States, wood storks were historically known to nest in all coastal states from Texas to South Carolina (Wayne 1910; Bent 1926; Howell 1932; Oberholser 1938; Dusi and Dusi 1968; Cone and Hall 1970; Oberholser and Kincaid 1974). Dahl (1990) estimates these states lost about 38 million acres, or 45.6 percent, of their historic wetlands between the 1780s and the 1980s. However, it is important to note wetlands and wetland losses are not evenly distributed in the landscape. Hefner et al. (1994) estimated 55 percent of the 2.3 million acres of the wetlands lost in the southeastern United States between the mid-1970s and mid-1980s were located in the Gulf-Atlantic Coastal Flats. These wetlands were strongly preferred by wood storks as nesting habitat. Currently, wood stork nesting is known to occur in Florida, Georgia, South Carolina, and North Carolina. Breeding colonies of wood storks are currently documented in all southern Florida counties except for Okeechobee County. Additional expansion of the breeding range of wood storks in the southeastern U.S. may continue in coming years, both to the north and possibly to the west along the Gulf Coast (Billy Brooks, Service, personal communication 2006).

The decline in the U.S. population of the wood stork is thought to be related to one or more of the following factors: (1) reduction in the number of available nesting sites; (2) lack of protection at nesting sites; and/or (3) loss of an adequate food base during the nesting season

(Ogden and Nesbitt 1979). Ogden and Nesbitt (1979) indicate a reduction in nesting sites is not the cause in the population decline, because the number of nesting sites used from year to year is relatively stable. They suggest loss of an adequate food base is a cause of wood stork declines. Changes in remaining wetland systems in Florida, including drainage and impoundment, may be a larger problem for wood storks than loss of foraging habitat (Ogden and Nesbitt 1979).

The primary cause of the wood stork population decline in the United States is loss of wetland habitats or loss of wetland function resulting in reduced prey availability. Almost any shallow wetland depression where fish become concentrated, either through local reproduction or receding water levels, may be used as feeding habitat by the wood stork during some portion of the year, but only a small portion of the available wetlands support foraging conditions (high prey density and favorable vegetation structure) that storks need to maintain growing nestlings. Browder et al. (1976; Browder 1978) documented the distribution and the total acreage of wetland types occurring south of Lake Okeechobee, Florida, for the period 1900 through 1973. We combined their data for habitat types known to be important foraging habitat for wood storks (cypress domes and strands, wet prairies, scrub cypress, freshwater marshes and sloughs, and saw grass marshes) and found these habitat types have been reduced by 35 percent since 1900.

The alteration of wetlands and the manipulation of wetland hydroperiods to suit human needs have also reduced the amount of habitat available to wood storks. The decrease in wood storks nesting on Cape Sable was related to the construction of the drainage canals during the 1920s (Kushlan and Frohring 1986). Water level manipulation can facilitate raccoon predation of wood stork nests when water is kept too low (alligators deter raccoon predation when water levels are high). Artificially high water levels may retard nest tree regeneration since many wetland tree species require periodic droughts to establish seedlings. Water level manipulation may decrease food productivity if the water levels and length of inundation do not match the breeding requirements of forage fish. Dry-downs of wetlands may selectively reduce the abundance of the larger forage fish species that wood storks tend to utilize, while still supporting smaller prey fish.

Since the 1970s, wood storks have also been observed to shift their nest sites to artificial impoundments or islands created by dredging activities (Ogden 1991). The percentage of nests in artificial habitats in central and north Florida has increased from approximately 10 percent of all nesting pairs in 1959 to 1960 to 60 to 82 percent between 1976 and 1986 (Ogden 1991). Nest trees in these artificially impounded sites often include exotic species such as Brazilian pepper or Australian pine (*Casuarina* spp.). Ogden (1996) has suggested the use of these artificial wetlands indicates wood storks are not finding suitable conditions within natural nesting habitat or they are finding better conditions at the artificial wetlands. The long-term effect of these nesting areas on wood stork populations is unclear.

Human disturbance is a factor known to have a detrimental affect on wood stork nesting (Service 1997). Wood storks have been known to desert nests when disturbed by humans, thus exposing eggs and young birds to the elements and to predation by gulls and fish crows. The role of chemical contamination in the decline of the wood stork is unclear. Pesticide levels high enough to cause eggshell thinning have been reported in wood storks but decreased productivity has not yet been linked to chemical contamination (Ohlendorf et al. 1978; Fleming et al. 1984). Burger et al. (1993) studied heavy metal and selenium levels in wood storks from Florida and Costa Rica.

Adult birds generally exhibited higher levels of contaminants than young birds. The authors attribute this to bioaccumulation in the adults who may be picking up contaminants at the colony nesting site and while foraging at other locations during the non-breeding season. There were higher levels of mercury in young birds from Florida than young birds or adults from Costa Rica. Young birds from Florida also exhibited higher levels of cadmium and lead than young birds from Costa Rica. The authors recommended the lead levels in Florida be monitored. Burger et al. (1993) drew no conclusions about the potential health effects to wood storks.

The wood stork population in the southeastern U.S. appears to be increasing. Preliminary population totals indicate that the stork population has reached its highest level since it was listed as endangered in 1984. In all, approximately 11,200 wood stork pairs nested within their breeding range in the southeastern U.S. Wood stork nesting was again recorded in North Carolina in 2006 after it was first documented there in 2005. This suggests that the northward expansion of wood stork nesting may be continuing. Several new colonies were located in 2006, including several in Florida. Of the preliminary total of 11,232 nesting pairs, 7,261 occurred within Florida. There were 1,919 nests recorded in Georgia, 1,963 in South Carolina, and 125 in North Carolina. Total nest numbers have also been over 9,000 in 2002 and 2003 (Service 2004). The number of colonies also continues to rise, and over 80 nesting colonies were reported in 2006 throughout the southeastern U.S. (Service, unpublished data), which is the highest to date in any one year.

The 2006 stork nesting season also appears to be very productive for storks throughout their range. While final productivity estimates are still not available, preliminary estimates are over 2.5 chicks per nest (Borkhataria et al. 2006). The apparent success this year is welcome news in light of the nearly complete failure of stork nesting in 2005 in southern Florida, and relatively poor nest success rates in this region that have occurred since 2002.

Recovery Goals

Measuring the biological aspect of the recovery of the wood stork is outlined in the Service's 1997 recovery plan. The plan's recovery criteria state that reclassification from endangered to threatened, could be considered when there are 6,000 nesting pairs and annual regional productivity is greater than 1.5 chicks per nest/year (calculated over a 3-year average). Delisting could be considered when there are 10,000 nesting pairs calculated over a 5-year period beginning at the time of reclassification and annual regional productivity is greater than 1.5 chicks per nest/year (calculated over a 5-year average). As a subset of the 10,000 nesting pairs, a minimum of 2,500 nesting pairs must occur in the Everglades and Big Cypress systems in south Florida. In 2001, the Service reinitiated another 5-year synoptic aerial survey effort for wood stork colonies throughout the southeast range of the species (Service 2003), and surveys have been conducted annually through 2006. Three-year averages calculated from nesting data from 2001 through 2006 indicate that the total nesting population has been consistently above the 6,000 threshold, and the averages have ranged from approximately 7,400 to over 8,700.

Wood Stork Nesting in the Southeastern U.S.

The 2006 estimate of total wood stork nesting pairs is the highest recorded since the stork was listed, and since the early 1960s (Table 7). The trend in the total nesting numbers shows a steady

increasing trend, with some degree of variation around the trend that occurs as a result of environmental conditions, etc. The number of known stork colonies has also shown a steady increase over time (Figure 10), so the increase in nesting effort is primarily occurring as a result of nesting in more places, and not as a result of growth in known colonies.

Wood Stork Nesting in the Everglades and Big Cypress Systems

There is confusion in the definition among the Service and species experts about what constitutes the boundaries of the Everglades and Big Cypress systems. The MSRP defines the Everglades and Big Cypress systems as those colonies south of Lake Okeechobee from Lee County on the west coast to Palm Beach County on the East Coast. Nesting pairs for colonies in this region totaled have been variable, but have shown a general pattern of decline within the past 4 to 5 years (Crozier and Gawlik 2003; Service 2003; Crozier and Cook 2004, Cook and Call 2005). However, in a review of the 10-year nesting data (Table 8, Figure 11), wood stork nesting success have shown a significant increase from the mid-1990 from an average of 400 to 500 pairs to a high of 4,549 pairs in 1999, with a three-year running average over the 10-year period ranging from 507 to 3,742 pairs with considerable variability over the 10-year period. These observed fluctuations in the nesting between years and nesting sites has been attributed primarily to variable hydrologic conditions during the nesting season (Crozier and Gawlik 2003; Crozier and Cook 2004). Frequent heavy rains during nesting can cause water levels to increase rapidly. The abrupt increases in water levels during nesting, termed reversals (Crozier and Gawlik 2003), may cause nest abandonment, re-nesting, late nest initiation, and poor fledging success. Abandonment and poor fledging success was reported to have affected most wading bird colonies in southern Florida during 2004 and 2005 (Crozier and Cook 2004, Cook and Call 2005).

Analysis of the species likely to be affected

The United States breeding population of wood storks declined from an estimated 20,000 pairs in the 1930s to about 10,000 pairs by 1960 (49 FR 7332). The total number of nesting pairs in 1995 was 7,853 with 11 percent in South Carolina, 19 percent in Georgia, and 70 percent in Florida (Service 1997). However, the wood stork population in the southeastern U.S. appears to be increasing. Preliminary population totals indicate that the stork population has reached its highest level since it was listed as endangered in 1984. In all, approximately 11,200 wood stork pairs nested within their breeding range in the southeastern U.S. Wood stork nesting was again recorded in North Carolina in 2006 after it was first documented there in 2005. This suggests the northward expansion of wood stork nesting may be continuing. Several new colonies were located in 2006, including several in Florida.

The primary cause of the wood stork population decline in the United States is loss of wetland habitats or loss of wetland function resulting in reduced prey availability. The alteration of wetlands and the manipulation of wetland hydroperiods to suit human needs have also reduced the amount of habitat available to wood storks and affected the prey base availability. The altered hydrology of these systems has also fostered the invasion of these systems by the exotic plant species, melaleuca. This plant species produces a dense understory and closed canopy, limiting suitability of these wetland systems to foraging by wood storks, although sufficient prey

base may be present in the wetlands. Increasing human population has resulted in increasing impacts on native habitat and flora and fauna. Resulting threats to wood storks include habitat loss, habitat fragmentation, and human disturbance.

ENVIRONMENTAL BASELINE – FLORIDA PANTHER

The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions, which occur simultaneously with the consultation in progress.

Status of the Species within the Action Area

As stated previously, for the purposes of this consultation, the action area includes the Corps' project area and surrounding lands frequently visited by panthers (Figure 7). The action area is a subset of the current geographic range of the panther and includes those lands that the Service believes may experience direct and indirect effects from the proposed development. Therefore, for both direct and indirect effects, the action area is defined as all lands within a 25-mile radius of the project. This action area does not include urban lands and lands west of I-75. The proposed action may have direct and indirect effects on the ability of panthers to breed, feed, and find shelter, and to disperse within the population.

The Service used current and historical radio-telemetry data, information on habitat quality, prey base, and evidence of uncollared panthers to evaluate panther use in the action area. Panther telemetry data are collected 3 days per-week from fixed-wing aircraft, usually in early to midmorning. However, researchers have shown panthers are most active between dusk and dawn (Maehr et al. 1990a, Beier 1995) and are typically at rest in dense ground cover during daytime monitoring flights (Land 1994). Therefore, telemetry locations may present an incomplete picture of panther activity patterns and habitat use (Comiskey et al. 2002). In addition, telemetry data alone may be misleading since less than half of the panther population is currently collared.

Although telemetry data may not provide a complete picture of panther activity patterns, telemetry locations are a good indicator, due to the extensive data set, of the approximate boundaries of home ranges, panther travel corridors, and the range of Florida panthers south of the Caloosahatchee River. The FWC also uses observational data collected during telemetry flights to assess the yearly breeding activity of radio-collared panthers. Female panthers accompanied by kittens or male panthers within close proximity of an adult female were assumed to have engaged in breeding activity during that year. Documentation by McBride (Shindle et al. 2003) shows that between July 2002 and June 2003, 12-collared panthers, 4-uncollared females, and 3-uncollared males had home ranges in or home ranges that overlapped or were immediately adjacent to the same survey unit as the Mirasol project. In addition, 8 other panthers that used this same survey unit previously died during this time period (Shindle et al. 2003). This unit, designated as Unit 5, includes the Florida Panther NWR, Corkscrew Swamp Sanctuary, and CREW.

Within the 25-mile radius action area, based on telemetry data as of January 2007, at least 27 living radio-collared panthers have overlapping home ranges. These panthers are FP 48 (female), FP 54 (male), FP 57 (female), FP 60 (male), FP 62 (male), FP 65 (male), FP 66 (female), FP 75 (female), FP 83 (female), FP 100 (female), FP 107 (female), FP 110 (female), FP 113 (male), FP 119 (male), FP 130 (male), FP 131 (male), FP 133 (male), FP 135 (male), FP 137 (male) and FP 139 (male), FP 140 (female), FP 141 (male), FP 143 (male), FP 144 (male), FP 146 (male), FP 147 (male), and FP 148 (female). In addition, McBride (2003) notes previous use of the action area by other panthers prior to their mortality. Six of these panthers are likely dispersing sub-adult males or sub-adult females without established territories. The nearest telemetry point to the site of a panther still alive as of this document, was FP 66 (female), recorded about 4 miles to the east. FP 92 (male) was documented less than 0.1 mile from the project site in July 2001; however, he died of unknown causes in September of that same year.

Historically, there have been a total of six radio-collared male and female panthers (FP 28, FP 64, FP 66 FP 92, FP 99, FP 104, and TX 101) recorded within 5 miles of the project site on 80 occasions based on telemetry data from February 1981 through June 30, 2006 (Figure 12). This translates to an average of 4.7 occurrences per year or one occurrence every 78 days. Panther 28 was documented 6 times in 1989 and died in 1992 from intraspecific aggression. Panther 64 was documented 8 times in 1998 and died in 1999 from intraspecific aggression. Panther 66 was documented 4 times and is alive with a home range in Belle Meade and FPNWR. Panther 92 was documented 19 times in 2001 and died in 2001 from unknown causes. Panther 99 was documented 37 times from 2001 to 2002 and died in 2002 from a vehicle collision. Panther 104 was documented 1 time in 2002 and died in 2006 from an infection. Texas puma 101 was documented 5 times in 1995 and died of unknown causes in 2000. No other radio-collared panthers have been documented within 5 miles of the project site since November 2002. The status and activities of uncollared Florida panthers within the action area are unknown. However, the Service believes the project site may occasionally be used by other non-collared panthers because it contains habitat types used by panthers and their prey, and the project vicinity has been used historically by panthers as indicated by telemetry locations.

Past and ongoing Federal and State actions affecting panther habitat in the action area include the issuance of Corps permits and State of Florida Environmental Resource Permits authorizing the filling of wetlands for development projects and other purposes. Since 1982, the Corps and the State have had a joint wetland permit application process, where all permit applications submitted to the State are copied to the Corps and vice versa. Within the 25-mile action area, the Service, since January 14, 1992, has formally consulted on 57 projects and informally consulted on 9 projects regarding the panther that were a result of Federal actions (database entries for formal consultations prior to 1992 are incomplete for projects in the action area). These projects have impacted or are expected to impact about 40,636 acres of panther habitat. These projects have also incorporated a total of 30,454 acres of preservation and restoration of panther habitat. The impacted lands generally are: (1) on the western fringe of occupied panther habitat; (2) vegetated with dense stands of exotic species, which may adversely affect the density of the panther prey base; and/or (3) support agricultural enterprises, *i.e.*, row crops, citrus, etc., which provide a lower quality habitat value to the Florida panther. The preserved lands, which are generally proximate to larger tracts of Federal, State, and other preserves, provide a higher

quality habitat value for the Florida panther. The Service determined in the biological opinions issued for the 57 Federal actions requiring formal consultation, that individually and cumulatively these projects do not jeopardize the survival and recovery of the Florida panther.

From July 2000 through September 2006, the Service also engaged in informal consultation for projects under 5 acres with the Corps for about 757 projects affecting about 764.1 acres in Collier County (primarily Northern Golden Gate Estates) and about 202.8 acres in Lee County (primarily Lehigh Acres) (database entries for informal consultations prior to 2000 are incomplete for projects in the consultation area). Almost all of these projects involved the construction of single-family residences in partially developed areas, each in most cases involving less than an acre of direct impact. Although panthers have been known to cross these areas to other parts of their range, prey base and denning utilization of these areas have been affected by the level of development and the additions of these residences is not expected to significantly further impact these habitat functions. For these actions, the Service concurred with the Corps' determination of "may affect, but is not likely to adversely affect" for these individual projects. These projects have been incorporated into the Service's environmental baseline for the Florida panther.

We have received information that within the action area, the Corps has, between March 16, 2004, and August 8, 2005, issued non-jurisdictional wetland determinations (isolated wetlands) for 10 projects totaling 3,779 acres in Collier County and for 10 projects totaling 276 acres in Lee County. These determinations were issued per jurisdictional guidance provided recently in the Supreme Court decision, *Solid Waste Agency of Northern Cook County vs. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001) and, therefore, they will not require a Federal Clean Water Act 404 wetland permit. These projects have been incorporated in the Service's environmental baseline for the Florida panther in this biological opinion and the Service has determined, based on the location of these projects (generally in the western fringe of the panther's geographic range), the quality of the habitat present on these project sites, and the overall status of the Florida panther, these projects individually and cumulatively do not jeopardize the survival and recovery of the Florida panther. However, since loss of panther foraging habitat may occur from construction of these projects and no Corps wetland permit is required, the Service is requesting the applicants pursue Habitat Conservation Plans in cooperation with the Service.

There have been 54 documented panther-vehicle collisions within the 25-mile action area (see Table 9 and Figure 9). The panther-vehicle collision closest to the project site (FP 99 [male]) occurred in 2002, on CR 846, about 7 miles east of the site. Another panther, UCFP 79 (female), was killed about 0.2 mile north of the FP 99 mortality on the same road in 2006. Four panther-vehicle collisions have occurred in the action area in 2006. One occurred 7 miles east of the project on CR 846; one occurred 17 miles south of the project on US 41; and, two occurred 11 miles and 25 miles north of the project on Corkscrew Road and I-75, respectively.

Activities within the action area have also benefited panthers. The issuance of Corps and State of Florida Environmental Resource Permits has preserved 30,454 acres of high quality panther habitat for permitted impacts to 40,636 acres of poor quality panther habitat (1992 to present). Installation of wildlife crossings under SR 29 and I-75 within the action area has also benefited the panther by protecting habitat connectivity and eliminating panther-vehicle collision

mortalities. Additional benefits have resulted from the acquisition of high quality habitat through acquisition programs by the other Federal, State, and County resource agencies. Table 10 provides a summary of the State and County acquisitions within the last 5 years.

Moreover, the management of public lands, including prescribed fire and eradication of exotic vegetation in the Picayune Strand State Forest, Fakahatchee Strand State Preserve, Florida Panther NWR, ENP, and other conservation areas, is intended to improve habitat for panther prey species, which benefits panthers within these areas.

Factors Affecting Species Environment within the Action Area

Factors that affect the species environment (positively and negatively) within the action area include, but are not limited to, the presence and construction of highways and urban development, agriculture, resource extraction, public lands management (prescribed fire, public use, exotic eradication, etc.), hydrological restoration projects, public and private land protection efforts, effects of genetic inbreeding, and genetic restoration.

Development activities may result in avoidance or limited use of remaining suitable habitat by panthers as well as habitat loss, habitat fragmentation, habitat degradation, and also an increase in risk of vehicular collision (*e.g.*, injury or death).

Public and private land management practices can have a positive, neutral, or negative effect, depending on the management goals. Land protection efforts will help to stabilize the extant population. Hunting of the panther is no longer sanctioned, although there still may be instances of intentional or unintentional shooting of individuals for various reasons.

Wildlife Value and Habitat Quality: As discussed previously in the status of the species, the Service believes the existing habitat conditions present on a site and the foraging value that a site provides to the Florida panther and panther prey species are an important parameter in assessing the importance of the project site to the Florida panther and other wildlife species. In order to assess this importance, the Service requires wildlife surveys and plant species compositions as part of the applicant's biological assessment prepared for the project.

***Wildlife Value*:** A protected species survey was initially conducted by Turrell from June 1999 to March 2000 utilizing belt transects and drift fence and bucket trap arrays. Turrell has also provided more recent observations based on on-going wildlife surveys. A survey for white-tailed deer (*Odocoileus virginianus*) and feral hog (*Sus scrofa*) tracks was conducted and eight sets of white-tail deer tracks were observed, but no feral hog tracks were observed. Based on the track surveys, the applicant calculated a deer density of one deer per 591 acres. Evidence of armadillo, bobcat and raccoon was observed during the surveys. Other small mammals also constituting panther prey may utilize the site. Bears, which also prey on small mammals, have been documented by their tracks in the northeastern portion of Section 15 and along Broken-Back Road to the east of the project site.

Based on the track surveys (Tyson 1952), deer densities on exotic-infested private lands in Lee County have averaged one deer per 591 acres (Turrell 2001) to one deer per 534 acres (Passarella Associates, Incorporated 2004). In comparison, deer densities on wildlife management areas average one deer per 165 acres to one deer per 250 acres (Steelman et al. 1999). Density estimates from deer tracks, however, should be viewed with caution. Track estimates are most appropriately used as long-term indicators (McCown 1991) and several factors can influence counts including weather, food abundance, population density, season, and availability of water (O'Connell et al. 1999).

The Service believes the habitats on the property provide marginal quality foraging for prey species, which directly affects value of the habitat to panthers, and specifically, the frequency and duration of use of the property by panthers. As discussed previously, white-tailed deer densities and other prey species are influenced by the quality of the foraging habitat present in an area. Monotypic stands of poor quality foraging plant species and the invasion of a site by exotic plants provide lower habitat foraging values and affect the utilization by and density of foraging species.

The habitats in the project area have also experienced similar vegetation changes. Historical vegetation on the property included a mosaic of upland and wetland habitats that provided a seasonal pattern of plant growth. However, past agricultural practices and the invasion of the habitats by the exotics, melaleuca and Brazilian pepper, have resulted in the growth of dense stands of monotypic, unpalatable plant species that provide poor quality foraging needs for resident deer populations. While the on-site preservation area, with its growth of invasive exotic plant species and altered hydrology also displays similar foraging restrictions, the proposed enhancements will result in a more diverse mosaic of plant species, which will provide an increased foraging value to panther prey species, especially resident deer populations.

Habitat Quality/Habitat Assessment Methodology Application: The application of the habitat assessment methodology including the base ratio, landscape multiplier, PHU determinations, and compensation recommendations, are presented below for the Mirasol project and compensation areas.

Table 11 illustrates the PHU calculations for the Mirasol project with impacts to 773 acres of land in the Primary Zone and compensation provided by the preservation and enhancement of about 1,117 acres of panther habitat (941 acres on-site, about 94 acres off-site, and about 82 acres at PIMB) in the Primary Zone. Table 11 shows the 773-acre impact area to presently support 3,756 PHUs. This value is multiplied by 2.0 to provide the base ratio compensation need, which is 7,512 PHUs. The Service had previously agreed, prior to the reinitiation of formal consultation with the Corps, that a base ratio of 2.0 would be the multiplier for recommended compensation for project functional habitat evaluations.

Since the project is located in the Primary Zone and compensation is in the Primary Zone, the base ratio PHUs are unaffected by the landscape compensation multiplier of 1.0.

The 1,117 acres provided by on-site (6,500) and off-site preserves (738) and credits at PIMB (750) provides for 7,988 PHUs. Therefore, the Service believes the impacts associated with the habitat lost by the proposed project will be minimized by the compensation actions proposed by

the applicant. The lands proposed for development are on the western limits of the panther's range and panther habitat value has been diminished by exotic infestation. Lands proposed for preservation are in the Primary Zone, adjacent to other natural lands, and will be consistent with the Service's panther goal to strategically locate, preserve, and restore sets of lands containing sufficient area and appropriate land cover types to ensure the long-term survival of the Florida panther population south of the Caloosahatchee River.

Conservation Measures:

The beneficial effects of the project include preservation of 1,117 acres of Primary Zone panther habitat. The habitat quality provided to the Florida panther through preservation and restoration will be superior to that of the areas to be impacted. Though the project will result in a net loss in number of acres of habitat available to the panther, the habitat quality provided to the Florida panther through restoration and preservation will be superior to that of the areas to be impacted, and the habitat will be protected in perpetuity. The off-site panther habitat compensation parcel and surrounding area are presently providing a diverse mosaic of native plant species, which provide foraging value to resident deer populations. The site will be managed to prevent infestation by exotic vegetation in perpetuity. PIMB is in an area where panther usage has been high historically, though fewer collared panthers have been documented using this area recently. The mitigation bank, however, is in the panther Primary Zone and contains habitat valuable for breeding, foraging, and dispersal by the Florida panther. The restoration and preservation of the habitats at PIMB as a result of the credits purchased for this project will increase the overall quality of the habitats to panthers and should result in increased use by panthers.

EFFECTS OF THE ACTION

This section analyzes the direct and indirect effects of the project on the Florida panther and Florida panther habitat.

Factors to be Considered

Residential, commercial, and industrial development projects may have a number of direct and indirect effects on the Florida panther and panther habitat. Direct impacts, which are primarily habitat based, may include: (1) the permanent loss and fragmentation of panther habitat; (2) the permanent loss and fragmentation of habitat that supports panther prey; (3) roadway improvements: (4) the loss of available habitat for foraging, breeding, and dispersing panthers; (5) a reduction in the geographic distribution of habitat for the species; (6) harassment by construction activities; and (7) habitat compensation. Indirect effects may include: (1) an increased risk of roadway mortality to panthers traversing the area due to the increase in vehicular traffic; (2) increased disturbance to panthers and panther prey in the project vicinity due to human activities (human/panther interactions); (3) the reduction in value of panther habitat adjacent to the project due to habitat fragmentation; and (4) a potential increase of intraspecific aggression between panthers due to reduction of the geographic distribution of habitat of the panther. These indirect effects are habitat based, with the exception of vehicular mortality, which could result in lethal "take." Intraspecific aggression, though habitat based, could also result in lethal "take."

This project site contains marginal quality panther habitat (see discussion under Wildlife Assessment) and is located within the western portion of the geographic range of the Florida panther. The timing of construction for this project, relative to sensitive periods of the panther's lifecycle, is unknown. Panthers have the potential to be found on and adjacent to the proposed construction footprint year-round. The project will be constructed in a single, disruptive event, and result in permanent loss and alteration of a portion of the existing ground cover on the project site. The time required to complete construction of the project is not known, but it is likely that land clearing associated with the development could be undertaken in phases over several years. The disturbance associated with the project will be permanent and result in a loss of habitat currently available to the panther.

Analyses for Effects of the Action

The 1,714-acre Mirasol project site forms essentially a cul-de-sac on the extreme western edge of the Florida panther Primary Zone as designated by Kautz et al. (2006), and is located inside the Panther Focus Area as defined by the Service. The site currently provides habitat of mostly low quality for the Florida panther (see discussion under Wildlife Assessment). The project site is located on the western fringe of occupied habitat, is adjacent to existing or previously permitted urban development, and is not located within known dispersal corridors (FWC 2006b) between larger publicly owned managed lands. The project will result in the conversion of 773 acres of marginal quality panther habitat on-site into residential development and golf course.

Compensation for the loss of 773 acres of panther habitat will be through the protection and restoration of 941 acres on-site and about 176 acres of panther habitat off-site. Lands preserved are in the Primary Zone (Kautz et al. 2006) of the panther core lands (Figure 5). Restoration will be primarily through the removal of non-native and nuisance vegetation with some hydrological enhancement. The total compensation will provide about 7,988 PHUs to minimize the impact of the loss of 3,756 PHUs.

Direct Effects

Direct effects are those effects that are caused by the proposed action, at the time of construction, are primarily habitat based, are reasonably certain to occur and include: (1) the permanent loss and fragmentation of panther habitat; (2) the permanent loss and fragmentation of habitat that supports panther prey; (3) roadway improvements: (4) the loss of available habitat for foraging, breeding, and dispersing panthers; (5) a reduction in the geographic distribution of habitat for the species; (6) harassment by construction activities; and (7) habitat compensation. The direct effects this project will have on the Florida panther within the action area are discussed below.

Permanent Loss and Fragmentation of Panther Habitat: The project will result in the loss of about 773 acres of habitat suitable for foraging and dispersal by the Florida panther. The remaining 941 acres on the 1,713-acre will be enhanced and preserved. The project lands are located inside and along the western edge of the Primary Zone. It is surrounded by existing or proposed development and agricultural activities. The land will be converted to residential development and golf course. The site offers a limited prey base and limited denning

opportunities due to the artificially elevated water levels throughout the site. Though the habitat value of the project site to the panther is marginal, the habitat loss may adversely affect the panther by decreasing the spatial extent of lands available to the panther.

Panthers, because of their wide-ranging movements and extensive spatial requirements, are also particularly sensitive to habitat fragmentation (Harris 1984). Mac et al. (1998) defines habitat fragmentation as: "The breaking up of a habitat into unconnected patches interspersed with other habitat, which may not be inhabitable by species occupying the habitat that was broken up. The breaking up is usually by human action, as, for example, the clearing of forest or grassland for agriculture, residential development, or overland electrical lines." The reference to "unconnected patches" is a central underpinning of the definition. For panther conservation, this definition underscores the need to maintain contiguous habitat and protected habitat corridors in key locations in south Florida. Habitat fragmentation can result from road construction, urban development, and agricultural land conversions within migratory patterns of panther prey species and affect the ability of panthers to move freely throughout their home ranges. Construction of highways in wildlife habitat typically results in loss and fragmentation of habitat, traffic related mortality, and avoidance of associated human development. Roads can also result in habitat fragmentation, especially for females who are less likely to cross them (Maehr 1990).

As described above, the project site is adjacent to existing and permitted urban development and roadways and is at the extreme west edge of the Service's Panther Focus Area. The property is not located within known dispersal or connection corridors (FWC 2006b) to larger publicly owned managed lands. As a result of our analysis, we believe that fragmentation of panther habitat is not expected to result from project implementation.

Permanent Loss and Fragmentation of Habitat that Supports Panther Prey: Prey surveys documented use of the site by white-tailed deer, primary panther prey species. Melaleuca, which has infested over 85 percent of the project site at densities of greater than 50 percent coverage, is of poor foraging value to these and other prey species. The project will result in the loss of about 773 acres of habitat available for use by panther prey species on the 1,713-acre project site. It is bounded by CR 846 and existing development to the south, agricultural activity to the north, and existing and proposed development to the west. The northeast property boundary is undeveloped while the southeast boundary is adjacent to numerous small farms and out-parcels. Immediately to the east of these out-parcels is a former rock and gravel mine known as Mule Pen Quarry that has been converted into a residential development known as Heritage Bay. Although the native habitats have been degraded by high densities of exotic plants and hydrological alteration, suggesting that the foraging value of panther prey habitat is generally poor, the loss of habitat may adversely affect the panther by decreasing the spatial extent of lands available for use by panther prey. As described above however, the project site is in an area adjacent to existing and permitted urban development and roadways and is at the extreme west edge of the consultation area. The property is not located within known dispersal or connection corridors (FWC 2006b) to larger publicly owned managed lands. Therefore, as a result of our analysis, fragmentation of panther prey habitat is not expected.

Road Way Improvements: No expansion of surrounding roads will occur as part of the Mirasol project. Some improvements may be necessary to enhance the existing lanes and drainage swales to meet public health and safety standards for ingress and egrass of vehicles to the project development.

Loss of Available Habitat for Foraging, Breeding, and Dispersing Panthers: The site is bounded by existing or proposed residential development to the west and south, agricultural activity to the north, and provides limited use potential for the panther due to the exotic infestation and the distance from the more commonly used core lands of the panther. According to the FWC, an un-collared animal is known to frequent Bird Rookery Swamp approximately three miles northeast of the project, and a collared animal has been tracked north of Twin Eagles Golf Course approximately five miles to the east of the Project. Another collared animal was tracked onto the northern section of the project site in 2002 where it spent time as it progressed further north. Two living panthers, FP 146 (male) and FP 148 (female) have been documented about 8 to 9 miles south of the project on numerous occasions in 2006. Prior to that, the last animal documented within 10 miles of the project was in 2003, which was TX 106. TX 106 was last documented on January 6, 2003, and removed from the wild on January 8, 2003. Since the habitat quality of the site is generally poor, as it is primarily exotic-infested with limited foraging value for prey species, we believe panther usage of the site is limited; however, habitat loss may adversely affect the panther by decreasing the spatial extent of lands available to the panther for foraging, breeding, and dispersing.

Reduction in the Geographic Distribution of Habitat for the Species: The project will result in the loss of about 773 acres of non-developed land along the western edge of the Panther Focus Area. This loss represents only 0.04 percent of the 1,962,294 acres of available non-urban private lands in south Florida in the core area of the Florida panther (Table 3). The Service believes the habitat values lost by the development will be minimized by the preservation and restoration actions proposed by the applicant. The lands proposed for development are primarily exotic-infested native communities on the western fringe of the occupied range of the Florida panther and are adjacent to existing roads, urban areas, agriculture, and mining to the south, west, north, and east, respectively. The lands proposed for preservation are consistent with the Service's panther conservation strategy to locate, preserve, and restore sets of lands containing sufficient area, access, and appropriate cover types to ensure the long-term survival of the Florida panther south of the Caloosahatchee River.

Harassment by Construction Activities: The timing of construction for this project, relative to sensitive periods of the panther's lifecycle, is unknown. However, land clearing associated with the development will be completed in phases over several years. There are no known den sites within the project boundaries and the quality and quantity of the habitat foraging base for prey species is low. Therefore, we believe panther usage of the property is limited and we do not believe project construction will result in direct panther mortality, but may result in temporary disturbance to resident or dispersing panthers.

Compensation: The impact of the habitat lost as a result of the development will be minimized by the preservation and restoration actions proposed by the applicant. The applicant's proposed

preservation acreage is estimated at 1,117 acres. The lands proposed for development are hydrologically disturbed, are invaded by exotic vegetation, are on the fringe of the currently occupied range of the Florida panther, are adjacent to urban areas and are adjacent to CR 846. The lands proposed for preservation are connected to other larger tracts of preserved lands and are consistent with the Service's panther goal to locate and preserve sets of lands containing sufficient area and appropriate cover types to ensure the long-term survival of the Florida panther south of the Caloosahatchee River.

Interrelated and Interdependent Actions

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. No interrelated or interdependent actions are expected to result from the project.

Indirect Effects

Indirect effects are those effects that result from the proposed action and are reasonably certain to occur. The indirect effects this project will have on the Florida panther within the action area are discussed below and in the assessment of functional habitat values previously discussed. They include: (1) an increased risk of roadway mortality to panthers traversing the area due to the increase in vehicular traffic; (2) increased disturbance to panthers and panther prey in the project vicinity due to human activities (human/panther interactions); (3) the reduction in value of panther habitat adjacent to the project due to habitat fragmentation; and (4) a potential increase of intraspecific aggression between panthers due to reduction of the geographic distribution of habitat of the panther.

Increased Risk of Roadway Mortality: In evaluating a project's potential to increase roadway mortality to the Florida panther, we consider the location of the project in relation to surrounding native habitats, preserved lands, and wildlife corridors that are frequently used by the Florida panther. We also consider the current configuration and traffic patterns of surrounding roadways and the projected increase and traffic patterns expected to result from the proposed action. We evaluate the habitats present on-site, their importance in providing foraging needs for the Florida panther and panther prey species, and if the site development would further restrict access to surrounding lands important to the Florida panther and panther prey species.

The project will result in minor increased vehicular traffic in the project vicinity during construction and operation. Vehicular mortality and injury data (see Table 9 and Figure 9) provided by the FWC indicate collisions with motor vehicles have been increasing since 2001 in the 25-mile radius project action area. In 2003 and 2004, there were seven documented panther-vehicle collisions per year within the project action area (Table 9). These 2 years represent the most panthers killed by vehicles in single years in the action area. Four panthers per year were killed in 2005 and 2006. Of the 54 documented collisions, 47 (87 percent) have occurred more than 10 miles away from the project site and 53 (98 percent) occurred more than 5 miles from the project site. There have been no panther-vehicle collisions closer than 5 miles from the project site.

According to traffic studies by Vanasse and Daylor, Incorporated, construction traffic will be coming from CR 846 and CR 951, which are south of the project. The access is along major roadways already heavily traveled. It is projected approximately 65 percent of the project traffic post construction will be to and from the west of the project on Immokalee Road (CR 846), 25 percent will be to/from the south of the project on CR 951, and 10 percent will be to/from the east of CR 951 on Immokalee Road. From a project average, daily traffic volume standpoint, 3,663 vehicles per day are projected on Immokalee Road to the west of the project, 1,409 vehicles per day are projected on CR 951 south of Immokalee Road, and 564 vehicles per day are projected on Immokalee Road to the east of CR 951. The projected project traffic estimated as a percentage of existing traffic represents an increase by about 9 percent of the existing traffic of Immokalee Road to the west of the project, by about 7 percent of the existing traffic on CR 951 south of Immokalee Road, and by about 3 percent of the existing traffic of Immokalee Road to the east of CR 951. From a percentage basis, the project traffic is projected to be 7 percent of the capacity of Immokalee Road to the west of the project, 3.1 percent of the capacity on CR 951 south of Immokalee Road, and 1 percent of the capacity of Immokalee Road to the east of CR 951.

The risk to the panther from collisions with vehicles as a result of the Mirasol project is difficult to quantify, the Service believes that the increase in traffic generated by the project may potentially contribute to mortality of panthers in the action area. Panthers are known to use the lands within the project vicinity and four panthers were killed within the project action area in 2006. The closest mortality was on CR 846 on-quarter mile north of the Collier County Fairgrounds on November 28, 2002, about 5 miles northeast of the proposed project site. Another panther, UCFP 79, was killed in that same vicinity on January 26, 2006. The most recent collision occurred on November 26, 2006. That panther, UCFP 88, was killed about 17 miles southwest of the project site on US 41 between Manatee Road and CR 951.

Panther and Prey Disturbance (Panther/Human Interactions): Potential increases in disturbance to the Florida panther and panther prey were evaluated. As discussed previously in our assessment of fragmentation, we considered habitat quality related factors and occurrence data for the Florida panther and panther prey species. This information is also the basis of our evaluation of disturbance to the Florida panther and to panther prey species. As discussed previously, the habitat on the project site consists of exotic-dominated wetland and upland communities that provide low quality habitat to the Florida panther. The site is primarily disturbed pine flatwoods, mixed hardwood-pine, and cypress swamp with greater than 50 percent melaleuca coverage over 85 percent of those habitat types, and thus exhibiting limited foraging value to panther prey species. Though panthers and panther prey may occasionally use the habitats within the project area, we believe panther usage of the property is infrequent and we do not believe project construction will result in a significant increase in panther/human interactions and prey disturbance.

Habitat Fragmentation: Considering our discussion of fragmentation under Direct Effects, the project site is located on the western fringe of occupied habitat, is adjacent to existing and proposed urban development, and is not located within known dispersal corridors to larger publicly owned managed lands important to the panther; therefore, fragmentation of panther habitat is not expected to result from project implementation. The project site is located on the

western fringe of the Panther Focus Area. It is surrounded by existing or proposed development and agricultural activities. Therefore, fragmentation of panther prey species habitat is not expected.

Intraspecific Aggression: Potential increases in intraspecific aggression and disturbance to the Florida panther were evaluated. As discussed previously in our assessment of fragmentation and habitat for panther and panther prey, we considered habitat quality related factors and occurrence data for the Florida panther and panther prey species as factors affecting intraspecific aggression.

Since 1987 there has been only one documented panther mortality attributed to intraspecific aggression within 10 miles of the project site. FP 64 (male) died about 9 miles northeast of the project site in March 1999. This animal was killed by an uncollared male in Audubon's Corkscrew Sanctuary. The project area, on the other hand, is surrounded by existing and approved development and is in an area that has been previously fragmented by roads and land conversion. As previously discussed, the habitats on the property provide for low quality foraging for prey, which directly affects the frequency and duration of use of the property by panthers. However, the reduction in the geographic range of habitat for dispersal and/or escape cover may contribute to a potential increased risk of death or injury of panthers in the action area due to intraspecific aggression.

Species Response to the Proposed Action

The proposed action will result in increased human activity and noise in the project area during construction of the project. However, since panthers are not commonly known to use lands within and adjacent to the project site, activities associated with construction of the Mirasol project are not anticipated to significantly increase risk of disturbance to panthers, though some temporary disturbance may occur.

The project will result in the loss of a relatively small amount (773 acres) of potential panther habitat according to the most current home range estimates of the Florida panther (Lotz et al. 2005). This represents 2.6 percent of a female panther's average home range (29,059 acres) and 1.2 percent of a male panther's average home range (62,542 acres). The project area provides mostly poor quality panther habitat and panthers are not known to commonly use the project area; however, the loss of habitat may contribute to increases in intraspecific aggression decreasing the spatial extent of lands available to the panther for foraging, breeding, and dispersing. We anticipate any resident panthers with home ranges overlapping or in the vicinity of the project area will adjust the size and location of their ranges to account for this loss and that adjustment is anticipated to occur in concert with project construction.

Panthers are sensitive to habitat fragmentation. However, the project site is located on the western fringe of occupied habitat, is adjacent to urban development, and is not located within known dispersal corridors (FWC 2006b) between larger publicly owned managed lands. Therefore, fragmentation of panther habitat is not expected to result from project implementation.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions

unrelated to the proposed action but located in the action area that would affect panthers are not considered in this section because they would require separate consultations pursuant to section 7 of the Act. To identify future private actions that would affect panthers and that may reasonably be certain to occur in the action area, the Service first identified the types of land alteration actions that could occur in the action area, then developed a mechanism to distinguish between those that will require future federal review and those that are not likely to be a future federal action, and thus meet the cumulative effects definition. To estimate future non-federal actions, the Service chose to identify and tabulate recent past non-federal actions and project this level of development as representative of future non-federal actions.

Within the action area, past and ongoing state and county actions affecting panther habitat include: (1) State of Florida DRI Orders (2001 to 2004); (2) Comprehensive Plan Amendments (2003 to 2004); (3) Lee and Collier County Zoning Amendments (2003 to 2004); (3) Collier County's PUDs (2001 to 2004); (4) Lee County's PUDs (2003 to April 2004); and (5) South Florida Water Management District's Environmental Resource Permits (2003 to 2004) (Figure 13). To evaluate these effects, the Service incorporated the Florida Land Use, Cover and Forms Classification System (FLUCCS) mapping to determine properties that may be exempt from Federal Clean Water Act section 404 wetland regulatory reviews by the Corps. To determine which of these projects would likely be exempt from Federal Clean Water Act section 404 wetland regulatory reviews by the Corps, we identified the percentage of the project site that was classified as wetland habitat, based on the FLUCCS mapping units. The mapping units relied on by the Service included the 600 series (wetland classifications) and the 411 and 419 pine flatwood classifications (hydric pine systems). For listing purposes, properties with less than 5 percent wetlands were considered by the Service to be generally exempt from regulatory review as these quantities of wetlands could be avoided by project design.

Within the action area, based on FLUCCS mapping, about 2,581 acres could be expected to be subject to development without Federal permit involvement through the Clean Water Act section 404 (Table 12). This level of development represents 9.0 percent of a female panther's average home range (29,059 acres) and 4.2 percent of a male panther's average home range (62,542 acres).

State and county land alteration permits in southwest Florida not part of those actions listed above, generally included single-family residential developments within Northern Golden Gate Estates and Lehigh Acres. Vacant lands within the area of Northern Golden Gate Estates (north of I-75), also within the action area, totaled about 34,028 acres as of September 2004 (Figure 14). To evaluate these effects, the Service overlaid the plat boundaries on 2004 aerials, queried the parcel data from Collier County's Property Appraisers Office, noted lots with developments, compared those to 2003 aerials, and noted the changes. Vacant lands within the area of Northern Golden Gate Estates (north of I-75) totaled about 35,768 acres as of August 2003. The breakdown of acres for August 2003 is: (1) wetlands, about 17,572 acres; (2) uplands, about 17,990 acres; and (3) water, about 210 acres. These changes were overlain on the National Wetlands Inventory (NWI) maps for presence of wetlands. This evaluation was used to estimate the acreage of properties that may be exempt from Federal Clean Water Act section 404 wetland regulatory reviews by the Corps. A comparison of the 2003 and 2004 data for Northern Golden Gate Estates indicates about 1,740 acres of land were converted from vacant to developed with the breakdown as: (1) wetlands, about 696 acres; and (2) uplands, about 1,740 acres.

The evaluation process provided an estimate of 417 lots totaling 1,740 acres for Northern Golden Gate Estates. Therefore, using NWI mapping for the Northern Golden Gate Estates, a total of about 1,740 acres could be expected to be subject to development in a year in these areas without Federal permit involvement. Based on historical records for wetland permits issued by the Corps for these areas, most of these projects will involve the construction of single-family residences in partially developed areas and will involve less than an acre of impact. This level of development represents 3.59 percent of a female panther's average home range (29,059 acres) and 1.67 percent of a male panther's average home range (62,542 acres).

Vacant lands within the area of Lehigh Acres, also within the action area, totaled about 34,852 acres as of April 2003 (Figure 15). The breakdown of acres is: (1) wetlands, about 1,057 acres; (2) uplands, about 33,592 acres; and (3) water, about 202 acres. A review of aerial photography and Lee County building permit data for Lehigh Acres from the 1-year period prior to April 2003 indicates about 441 acres of land was converted from vacant to occupied, during the 1-year period. The breakdown of converted acres is estimated as: (1) wetlands, 66 acres; (2) uplands, 375 acres; and (3) water, 0 acres. Therefore, using NWI mapping, about 375 acres could be expected to be subject to development in a year in this area without Federal permit involvement.

In conclusion, the Service's cumulative effects analysis has identified about 4,000 acres within the action area that could be developed without Federal wetland permit involvement. This level of development, which the Service believes is representative of future non-Federal actions, is reasonably certain to occur and, therefore, meets the definition of cumulative effect. This level of projected future development represents 14 percent of a female panther's average home range (29,059 acres) and 6.5 percent of a male panther's average home range (62,542 acres), though the impacts will be scattered and generally located on the fringes of occupied panther habitat, supported primarily with disturbed vegetative communities, in row crops, or in partially developed areas. These lands represent 0.22 percent of the non-urban private lands at risk in the core area (1,962,294 acres) (Table 3). Based on the above analysis, we believe the loss of the habitat associated with these lands, though insignificant in the short term, may adversely impact the panther as development continues to occur in the future in the action area. The Service has accounted for some habitat loss and changes in habitat quality through its habitat assessment methodology and is encouraging state and county environmental staff to pursue section 10 (HCP) process to account for and compensate for adverse effects to the Florida panther.

SUMMARY OF EFFECTS

Panther Usage: The timing of construction for this project, relative to sensitive periods of the panther's lifecycle, is unknown. However, it is likely all land clearing associated with the development will be completed in phases over several years. There are no known den sites within the project boundaries and the quality and quantity of the foraging prey base is low. Though panthers likely use the habitats within the project's action area, we believe panther usage of the project site is infrequent and we do not believe project construction will result in direct panther mortality, but may result in temporary disturbance to resident or dispersing panthers.

Traffic: There will be traffic increases with project development. As discussed above and in previous sections, the lands on the project site provide limited value to the Florida panther and panther prey species, the site is adjacent to existing and proposed urban development, and the proposed action will further restrict suitability of the site for use by either resident or dispersing panthers. Panthers, however, are known to use the lands within the action area and collisions with motor vehicles have been increasing since 2001 in the project action area. Although the risk to the panther from collisions with vehicles as a result of the Mirasol project is difficult to quantify, the Service believes that the increase in traffic generated by the project may potentially contribute to mortality of panthers in the 25-mile radius action area.

Habitat Loss: The Service, based on the habitat evaluations discussed previously, believes the project will result in the direct and indirect loss of about 773 acres of mostly low quality panther habitat within the Primary Zone (see discussion under Wildlife Assessment). Habitat types are primarily exotic-infested wetlands and other natural communities. The prevalence of exotics within the project area provides limited foraging value to panther prey species. We believe panther usage of the site is limited; however, the permanent loss is anticipated to adversely affect the panthers in the action area by decreasing the spatial extent of lands available for foraging, breeding, and dispersing. This loss of about 773 acres of panther habitat represents 0.04 percent of the 1,962,294 acres of available non-urban private lands in the core area. This small loss (0.04 percent) of non-urban private lands on the western edge of the panther's range will not adversely affect the Service's land conservation and preservation goals.

Compensation: The project will provide for the preservation of about 1,117 acres of Primary Zone habitat. The functional value of the habitats to the panther will be maintained long-term through hydrological restoration and the removal of exotic vegetation. The preservation of these lands in the panther core area represents 0.14 percent of the 799,205 acres of private lands still needed for the population of 90 individuals. The preservation of about 1,117 acres of panther habitat in the Primary Zone will minimize the impact of the loss of 773 acres lower quality habitat to the panther and will further the Service's panther conservation goal.

The proposed compensation plan, which provides habitat preservation and restoration inside and outside the project action area, benefits the survival and recovery of the Florida panther as referenced in the draft Panther Recovery Plan (Service 2006) goal 1.1.1.2.3. This goal recommends that habitat preservation and restoration within the Primary Zone be provided in situations where land use intensification can not be avoided. The applicant has proposed equivalent habitat protection and restoration, to compensate for both the quantity and functional value of the lost habitat.

Fragmentation: The project site is also located on the western edge of occupied habitat, is adjacent to other existing and proposed development, and is not located within known dispersal corridors to larger publicly owned managed lands important to the panther. Therefore, fragmentation of panther habitat is not expected to result from project implementation.

Intraspecific Aggression: Potential increases in intraspecific aggression and disturbance to the Florida panther were evaluated. The Service believes, as previously discussed, the habitat on the property provides low quality foraging for prey species, which directly affects the frequency and duration of use of the property by panthers. However, the reduction in the geographic range of

habitat for dispersal and/or escape cover may contribute to a potential increased risk of death of injury of panthers in the action area due to intraspecific aggression.

Cumulative Analysis: In the cumulative analysis, the Service identified the potential loss of about 4,046 acres within the action area that could be developed without Federal wetland permit involvement and we believe this level of development represents future non-Federal actions expected to occur in the action area. This level of development represents a small percentage (0.22 percent of the 1,962,294 acres) of available non-urban private lands in the core area. In general, these lands are primarily within previously impacted areas or are in the western more urbanized portion of the Florida panther's consultation area. Although this small percentage of lands may be lost from the core area of private lands available for panther conservation, the Service believes the loss of these lands will not adversely affect the Service's land conservation and preservation goals.

Conservation Land Acquisitions: The State and County land acquisition programs acquired about 17,092 acres of lands within the action area from 2000 to 2004 (Table 10), which represents 2.1 percent of the 799,205 acres of private lands still needed for the population of 90 individuals. These lands are generally located within the core lands of the Florida panther and are intended to be actively managed for the benefit of many wildlife species including the Florida panther. The preservation of these lands in the panther core lands will have a beneficial effect on the panther and further the Service's goal in panther conservation.

CONCLUSION

In conclusion, the Service believes there will be no direct take in the form of mortality or injury of the Florida panther resulting from this project. However, the increase in traffic and potential increase in intraspecific aggression in the action area as a result of the project may potentially contribute to indirect take of panthers in the form of death or injury. This indirect take is difficult to quantify due to the wide-ranging habit of the species and the challenge of linking the death or injury of a single panther to increases in panther interactions (intraspecific aggression) or traffic generated as a result of the Mirasol project. The adverse affects of project-generated traffic and intraspecific aggression potential, however, is not anticipated to appreciably diminish or preclude the survival and recover of the panther. The loss of habitat from implementing the project, taking into consideration the status of the species, remaining habitat, and other factors considered by this biological opinion, such as the overall recovery objectives and other cumulative effects from actions in the action area, will be minimized by the conservation of other, more functionally valuable habitat. Taking all of the above into consideration, the Service believes the proposed construction and operation of the Mirasol project is not likely to jeopardize the continued existence of the Florida panther. Critical habitat has not been designated for this species; therefore, none will be affected.

ENVIRONMENTAL BASELINE – WOOD STORK

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which occur simultaneously with the consultation in progress. The project area is 1,713.45 acres and consists of 1,476.71 acres of

wetlands and 236.74 acres of uplands. The proposed development footprint is 830 acres, which includes a developed area of 773 acres and internal preserves of 57 acres. The 773 acre developed area includes 645 acres of wetlands and 127.6 acres of uplands. The internal preserves include 55 acres of wetlands and 2 acres of uplands. The applicant is also proposing an additional preserve of 884 acres adjacent to the development footprint. The 884 acre preserve consist of 776 acres of wetlands and 108 acres of uplands. Total on-site preserve is 941 acres, 884 acres adjacent to development footprint and 57 acres within the development footprint. The 941 acres includes 831 acres of wetlands and 110 acres of uplands.

Existing Project Area Habitat Conditions

The analysis of existing habitats expected to be impacted by the proposed project is based on vegetation mapping conducted by Turrell in their FLUCCS mapping provided in the Corps August 24, 2006 Public Notice. Information on the project site was also based on recent Service (2006) field verification surveys. The prevalent community type, although historically classified as pine and pine/cypress flatwoods is primarily a community dominated by the exotic forest species, melaleuca. In most vegetated communities recently surveyed by the Service during field visits, the community was classified as primarily a closed canopy forest, with an understory, when one was present, of remnant herbaceous graminoid species.

Melaleuca expansion into native habitat and density increases in previously invaded habitat have increased substantially from 1972 through 2006 as seen in aerial photographs over this time frame. It is expected melaleuca invasion and density increases over the project area would increase without the eradication efforts proposed by the project.

Status of Species within the Action Area

As stated previously, the Service has determined, for the purposes of this biological opinion, the action area is considered to include the project site and the CFAs of the three wood stork nesting colonies described previously (Figure 16). The action area for both direct and indirect effects encompasses approximately 1,621.1 square-miles of Collier, Lee, and Hendry Counties, Florida. The proposed action may have direct and indirect effects on the ability of wood storks to breed, feed, and find shelter within the action area.

Wood Stork Nesting in the Action Area

Three active nesting colonies are known to occur within the action area. Two of these colonies are located within Corkscrew, approximately 5.5 miles and 6.6 miles northeast of the project site. The third wood stork nesting colony is located approximately 16.5 miles east of the project site, just north of the Fakahatchee Strand State Preserve. Wood stork nest surveys have been conducted annually at these nesting colonies through aerial surveys (Meyer and Frederick 2004) and ground-based monitoring of stork numbers and reproductive success (J. Lauritsen, Corkscrew, personal communication, 2004). Data for the two colonies located in Corkscrew indicate 900 nests in 1999, 1,722 nests in 2000, no nest in 2001, 1,240 nests in 2002, 1,100 nests in 2003, and 520 nests in 2004. In 2005, birds attempted to nest but most nests were ultimately abandoned. In 2006, 800 pairs nested and 1,550 birds fledged with an average of 1.9 fledglings per nest (Lauritsen 2006). Additional data collected by the National Audubon Society indicate 2,538 wood storks fledged during 2000 and 3,160 fledged during 2002. In 2003 and 2004, 780 and 450 young were fledged, respectively (Audubon 2004). On average over the last 44 years,

1,654 nests are initiated yearly, producing an average of 2,161 fledged young, or 1.3 young fledged per nest. However, the 44-year average is somewhat misleading. Prior to 1968, as many as 5,000 wood stork nests were initiated annually. Nesting activity peaked in 1961 when 6,000 nests were initially producing a record 17,000 young fledged, or 2.8 fledged young per nest.

The production of wood stork colonies varies considerably between years and locations, apparently in response to differences in food availability; colonies limited by food resources may fledge an average of 0.5 to 1.0 young per active nest; colonies not limited by food resources may fledge between 2.0 and 3.0 young per active nest (Ogden 1996). The 44-year average indicates, at least for the two colonies at Corkscrew, these colonies are generally limited by food resources. During the year 2002, these colonies were not limited by food resources. No data on nest productivity is available for the colony north of Fakahatchee Strand State Preserve; however, based on the overlapping CFAs, it is likely these birds face many of the same foraging conditions as the storks nesting within Corkscrew.

Historical data on colony locations identifies the Everglades basin colonies and the Corkscrew colonies as the primary nesting locations for wood storks in south Florida (Ogden and Nesbitt 1979). In the late 1950s and early 1960s, the Corkscrew colonies accounted for 51 percent of the Florida population, and supported approximately 6,000 nesting pairs (Jason Lauritsen, Corkscrew, personal communication, 2002). Survey data collected between 1991 and 1995 indicate the Corkscrew colonies represent approximately 12 percent of the Florida population of nesting storks and this is consistently one of the largest nesting colonies in Florida. The original listing recognized the relationship between the declining wood stork population, the loss of suitable foraging habitat, and colony nesting failures, particularly in the breeding colonies in south Florida where human actions had reduced wetland areas by about 35 percent (Ogden and Nesbitt 1979). Although the Corkscrew colonies currently account for 12 percent of the Florida nesting population, these colonies continue to occasionally produce large numbers of young in south Florida (Service 1999). The acquisition and preservation of these colonies' habitat, and recovery of more natural hydropatterns within the foraging grounds surrounding these colonies, are recognized as critical to the recovery of wood storks in south Florida (Service 1997; 1999).

Historic and Current Patterns of Wood Storks in the Project Footprint

No data are available to indicate wood storks have historically nested in the Mirasol project area and none are known to have nested there since systematic statewide wading bird surveys were initiated in the 1970s.

Ongoing wildlife surveys have been conducted and documented by Turrell. During the survey periods wood storks have been observed perching on cypress and slash pine trees along the Cocohatchee Canal. Wood storks have also been documented foraging along the canal where water flows over an armored shoreline approximately 0.5 mile to the west of the property. Foraging has also been documented within an open pasture area immediately to the west of the property. No foraging has been documented on the Mirasol property by Turrell; however, wood storks were documented by Audubon of Florida foraging in wetlands at the Mirasol property on several occasions from late September through December 2006 (Jason Lauritsen, email communication, January 5, 2007).

Fish density investigations have been ongoing on the property for the last three years. During the course of this investigation, the site has been surveyed by Turrell every week while standing water was present and no storks have been observed foraging on the site.

The wood stork is known to forage within suitable wetland habitats located throughout the 1,621 square mile action area. Suitable wood stork foraging habitat consists of shallow wetlands with water depths of 2 to 15 inches. Data obtained from the NWI indicate approximately 473,462 acres of wetlands containing potentially suitable habitat for wood stork foraging occur within the action area (Figure 16). However, the inventory was last updated in 1984 and increasing development in Lee, Collier, and Hendry Counties has impacted some of these potential foraging areas. In order to provide a more accurate accounting of the wetlands within the core foraging areas of the three wood stork colonies, the Service used both the NWI and the FLUCCS maps. The specific step-by-step analysis used is referenced below.

The District maps are based on Florida Land Use Codes and Forms Classification System (FLUCCS) codes, which is a different land use classification than that used in the NWIs. Corresponding NWI and wetland FLUCCS codes that provide overlapping wetland categories are the 500 and 600 series FLUCCS codes. However, there are several FLUCCS codes in the 200 and 400 categories that could be either upland or wetland. For instance, the majority of the subject property on the District maps is depicted as 4119 (pine flatwood [an upland FLUCCS code designation]). U.S. Army Corps of Engineers (Corps) approved jurisdictional information on these types of habitats in the action area shows the majority of these properties as being hydric pine flatwoods and are considered wetlands although not classified as such by the FLUCCS codes. The District maps also do not allow for wetland determinations on agricultural activities, such as pastures (200 series). For this reason, our analysis used both sets of maps. Specifically, we used the 1984 NWI map as the base map and overlaid the District maps. We eliminated the NWI wetlands areas that the District maps depicted as developed. Those areas indicated on the District map as passive agricultural (such as pasture and fallow lands) that were also shown to be wetlands on the 1984 NWI maps were left in and counted as wetlands for purposes of this analysis. We also included those lands with a FLUCCS code of 4119 (hydric pine flatwoods) as wetlands in our analysis.

Factors Affecting Species Environment within the Action Area

Wood Stork Foraging Habitat

Researchers have shown wood storks forage most efficiently and effectively in habitats where prey densities are high, and the water shallow and canopy open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987). Prey availability to wood storks is dependent on a composite variable consisting of density (number or biomass/m^2) and the vulnerability of the prey items to capture (Gawlik 2002). For wood storks, prey vulnerability appears to be largely controlled by physical access to the foraging site, water depth, the density of submerged vegetation, and the species-specific characteristics of the prey. For example, fish populations may be very dense, but not available (vulnerable) because the water depth is too great (>30 cm) for storks or the tree canopy at the site is too dense for storks to land. Calm water, about 5 to 40 cm (2 to 16 in) in depth, and free of dense aquatic vegetation is ideal (Coulter and Bryan 1993).

Coulter and Bryan's (1993) study suggested wood storks preferred ponds and marshes, and visited areas with little or no canopy more frequently. Even in foraging sites in swamps, the canopy tended to be sparse. They suggested open canopies may have contributed to detection of the sites and more importantly may have allowed the storks to negotiate landing more easily than at closed-canopy sites. In their study the median amount of canopy cover where wood stork foraging was observed was 32 percent. Other researchers (Frederick, personnel communication, 2006 and Rodgers, personnel communication, 2006) also confirm wood storks will forage in woodlands, though the woodlands have to be fairly open and vegetation not very dense. Furthermore, the canopies must be open enough for wood storks to quickly take flight to avoid predators. In south Florida, they agree wood storks will forage in melaleuca-dominated wetlands when the trees are noncontinuous, in broken stands (blowdowns), in small islands, or sparsely distributed. They will not forage in melaleuca where the stem density is high and the canopy closed (Frederick, personnel communication, 2006).

Melaleuca-infested Wetlands

As discussed previously, wetland suitability for wood stork foraging is partially dependent on vegetation density. Melaleuca is a dense-stand growth plant species, effectively producing a closed canopy and dense understory growth pattern that generally limits a site's accessibility to foraging by wading birds. However, O'Hare and Dalrymple (1997) suggest that moderate infestations of melaleuca may have little effect on some species' productivity (*i.e.*, amphibians and reptiles) as long as critical abiotic factors such as hydrology remain. They also note as the levels of infestation increase, usage by wetland dependent species decreases. Their studies also show the number of fish species present in a wetland system remain stable at certain levels of melaleuca. However, the availability of the prey base for wood storks and other foraging wading birds is reduced by the restriction of access caused from dense and thick exotic vegetation. Wood storks and other wading birds can forage in these systems in open area pockets (*e.g.*, wind blow-downs), provide multiple conditions are optimal (*e.g.*, water depth, prey density). In O'Hare and Dalrmyple's study (1997), they identify five cover types and provide information on the number of wading bird species and the number of individuals observed within each of these vegetation classes. Their vegetation classes are:

DMM:	75 to 100 percent mature dense melaleuca coverage
DMS:	75 to 100 percent sapling dense melaleuca coverage
P75:	50 to 75 percent melaleuca coverage
P50:	0 to 50 percent melaleuca coverage
MAR (Marsh):	0 to 10 percent coverage

The number of wading bird (wetland-dependent) species and individuals per cover type is:

Cover Type	# of Species(S)	# of Individuals (I)
DMM	1	2
DMS	4	10
P75	10	59
P50	11	92
MAR	12	132

To develop an estimate of the importance a particular wetland type may have (based on density and aerial coverage by exotic species) to wetland dependent species, we developed a foraging suitability value using observational data from O'Hare and Dalrymple (1997). The Foraging Suitability Value (Table 13) is calculated by multiplying the number of species by the number of individuals and dividing this by the maximum number of individuals. This approach was developed to provide us with a method of assessing wetland acreages and their relationship to prey densities and prey availability. We consider wading bird use to be a general index of food availability. Based on this assessment we developed the following index:

Exotic Percentage	Foraging Suitability (Percent)
Systems with between 0 and 25 percent exotics	foraging suitability value of 100
Systems with between 25 and 50 percent exotics	foraging suitability value of 70
Systems with between 50 and 75 percent exotics	foraging suitability value of 37
Systems with between 75 and 90 percent exotics	foraging suitability value of 3
Systems with between 90 and 100 percent exotics	foraging suitability value of 0

Exotic Species in the Project Footprint

The prevalent community type, although historically classified as pine and pine/cypress flatwoods is primarily a community dominated by the exotic forest species, melaleuca. In most vegetated communities, the community was classified as primarily a closed canopy forest, with an understory, when one was present, of remnant herbaceous graminoid species.

As discussed previously, melaleuca expansion into native habitat and density increases within previously invaded habitat have increased substantially from 1972 through 2006 as seen in aerial photographs over this time frame. It is expected that melaleuca invasion and density increases over the project area would increase without the eradication efforts proposed by the project.

Table 14 provides a summary of all upland and wetland acreages within the project development footprint. However, since most upland land uses and wetlands with dense melaleuca coverage provide little to no foraging value to wood storks, the Table 15 provides only the suitable wetland habitat types within the project development footprint. A summary of the information from Tables 14 and 15 shows that about 645 out of the project's 1,477 acres of wetland cover types to be developed are within the development footprint (700 acres of wetlands are within the development footprint – 645 to be developed and 55 to be preserved). Of those 645 acres of wetland cover types, about 491 acres are suitable for wood stork foraging (154 acres with greater than 90 percent exotics), with a variance in functional value depending on the density of melaleuca.

Our first step in our assessment was to identify the amount of acreages that we believe provides foraging values to wading bird species (wood storks). For this step, we considered that the melaleuca cover type and cover types with greater than 90 percent melaleuca coverage provide no to minor foraging value to wood storks; they were therefore eliminated from the acreages of habitats that we believe are important for wood stork foraging. Applying this assessment to the wetland cover types in the Mirasol development footprint we estimate foraging loss to wood storks to be about 491 acres, although of varying value (Table 15).

Exotic Species in the Mirasol Action Area

As discussed previously, the Mirasol action area is in the overlapping core foraging areas of the three adjacent wood stork colonies. These colonies are:

- #619310 (CORK1) in Corkscrew Swamp Sanctuary, with approximately 285,286 acres of wetland cover types;

- #619018 (CORK2) also in Corkscrew Swamp Sanctuary, with approximately 292,149 acres of wetland cover types; and

- #619161 (CATH) (North Catherine Island) approximately 16.5 miles east-southeast of the project site, with approximately 394,040 acres of wetland cover types.

With overlap, all three colonies encompass approximately 481,666 acres of wetland cover types.

Based on aerial surveys and site inspections by Service personnel of wetland systems throughout the action area, we estimated that about 10% of the total CFA would have dense melaleuca coverage and would not be suitable for wood stork foraging. Following this approach, suitable foraging habitat within the CFAs is then estimated at 256,730 acres for CORK1, 267,934 acres for CORK2, and 354,636 acres for CATH (Table 16). All three colonies encompass 433,500 acres where wood stork suitable habitat for foraging may potentially occur. As in the Mirasol development area, the dense melaleuca areas (>90 percent) were considered to have minimal wood stork foraging value.

Fish Prey Density per Hydroperiod

Prey densities can be affected by the density and types of vegetation present in a wetland and by the hydroperiod of the wetland. In the O'Hare and Dalrymple (1997) study, the authors suggest that moderate infestations of melaleuca may have little effect on some species' productivity as long as critical abiotic factors such as hydrology remain, although dense melaleuca (greater than 75 percent canopy densities) do show a gradual reduction in prey bases. However, fish densities do vary with duration of hydroperiod and can have a significant effect on wood stork foraging and nest productivity. For instance, research on Everglades fish populations using a variety of quantitative sampling techniques (pull traps, throw traps, block nets) have shown that the density of small forage fish increases with hydroperiod: marshes inundated for <120 days average ± 4 fish/m^2; whereas those flooded for >340 days of the year average ± 25 fish/m^2 (Loftus and Eklund 1994; Trexler et al. 2002).

The Service (1999) described a short hydroperiod wetland as wetlands with between 0 and 180-day inundation, and long hydroperiod wetlands as greater than 180-day inundation. However, Trexler et al. (2002) defined short hydroperiod wetlands as systems with less than 300 days per year inundation. In our discussion of hydroperiods in this biological opinion, we are considering short hydroperiod wetlands to be those that have an inundation of 180 days or fewer.

The most current information on hydroperiods in the action area was developed by the District for evaluation of various restoration projects throughout the Everglades Protection Area. In their modeling efforts, they identified seven hydroperiods:

- Class 1 (0-60 days inundation)
- Class 2 (60-120 days inundation)
- Class 3 (120-180 days inundation)
- Class 4 (180-240 days inundation)
- Class 5 (240-300 days inundation)
- Class 6 (300-330 days inundation)
- Class 7 (330-365 days inundation)

Trexler et al. (2002) in studies in the Everglades provided densities, or the number of fish per square meter, for only six hydroperiods, although covering the same range of hydroperiods developed by the District. Trexler et al.'s (2002) hydroperiods and fish densities are:

	Density		Density
• Class 1 (0-120 days inundation)	= 2.0	• Class 4 (240-300 days inundation)	= 4.5
• Class 2 (120-180 days inundation)	= 3.0	• Class 5 (300-330 days inundation)	= 4.8
• Class 3 (180-240 days inundation)	= 4.0	• Class 6 (330-365 days inundation)	= 5.0

Trexler et al. (2002) fish densities are provide as the square root of the number of fish per square meter. For our assessment, we squared these numbers to provide fish per square meter, a simpler calculation when other prey density factors are included in our evaluation of adverse effects to listed species from the proposed action and also extrapolated the densities over seven hydroperiods, which is the District's number.

Based on the above discussion, the following mean annual fish densities were extrapolated to the seven District Model hydroperiods:

- Class 1 (0-60 days) = 2 fish/m^2
- Class 2 (60-120 days) = 4 fish/m^2
- Class 3 (120-180 days) = 9 fish/m^2
- Class 4 (180-240 days) =16 fish/m^2
- Class 5 (240-300 days) = 20 fish/m^2
- Class 6 (300-330 days) = 23 fish/m^2
- Class 7 (330-365 days) = 25 fish/m^2

Fish Biomass per Hydroperiod

However, a more important parameter than fish per square meter in defining fish densities is the biomass these fish provide. In the ENP and WCA-3 studies by Turner et al. (1999) and Trexler et al. (2002), the standing stock (biomass) of large and small fishes combined in unenriched Class 5 and 6 hydroperiod wetlands averaged between 5.5-6.5 g wet mass/m^2. However, in short hydroperiod wet prairies in Corkscrew Swamp biomass values were estimated between 2 -2.5 g wet mass/m^2 (wet mass represents between 2 and 2.5 times dry mass [Kushlan et al. 1986]). A value of 0.5 g dry mass/m^2 was reported by Turner et al. (1999) for Carlson and Duever (1979) wet prairies in Corkscrew Swamp. Relating this information to the hydroperiod classes developed by the District, we estimated the mean annual biomass densities per hydroperiod. For our assessment we considered Class 7 hydroperiod wetlands based on Turner et al. (1999) and Trexler et al. (2002) studies to have a mean annual biomass of 6.5 g wet mass/m^2. The

remaining biomass weights were determined as a direct proportion of the number of fish per total weight of fish for a Class 7 hydroperiod (6.5 grams divided by 25 fish equals 0.26 grams per fish). Based on the above discussion, the biomass per hydroperiod class is:

- Class 1 (0-60 days) = 0.5 grams/m^2
- Class 2 (60-120 days) = 1.0 grams/m^2
- Class 3 (120-180 days) = 2.3 grams/m^2
- Class 4 (180-240 days) = 4.2 grams/m^2
- Class 5 (240-300 days) = 5.2 grams/m^2
- Class 6 (300-330 days) = 6.0 grams/m^2
- Class 7 (330-365 days) = 6.5 grams/m^2

Wood Stork Suitable Prey Size per Hydroperiod

However, wood storks are highly selective in their feeding habits and in studies on fish consumed by wood storks, primarily sunfish and four other species of fish comprised over 85 percent of the number and 84 percent of the biomass of over 3,000 prey items collected from adult and nestling wood storks (Ogden et al. 1976). Ogden et al. (1976, 1978) noted that the key species consumed by wood storks included:

Sunfishes (*Centrarchidae*; 14% of individuals, 44% of biomass);
Yellow Bullhead (*Italurus natalis*; 2% of individuals, 12% of biomass);
Marsh killfish (*Fundulus confluentus*; 18% of individuals, 11% of biomass);
Flagfish (*Jordenella floridae*, 32% of individuals, 7% of biomass);
Sailfin Molly (*Poecilia latipinna*, 20% of individuals, 11% of biomass).

These species were also observed to be consumed in much greater proportions than they occur at feeding sites, and abundant smaller species (*e.g.*, mosquitofish, least killfish, bluefin killfish) are under-represented, which the researchers believed was probably because their small size does not elicit a bill-snapping reflex in these tactile feeders (Coulter et al. 1999). Their studies also showed that in addition to selecting larger species of fish, wood storks consumed individuals that are significantly larger (>3.5 cm) than the mean size available (2.5 cm), and many were greater than one-year old (Ogden et al. 1976; Coulter et al. 1999). Ogden et al.'s (1976 – Figure 4) also shows that wood storks also generally consumed fish that were between 1.5 and 9.0 cm in length.

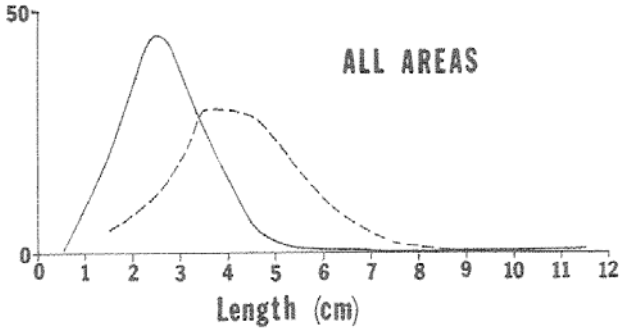

FIGURE 4. Length frequency distribution of fish available to and consumed by Wood Storks in different habitats.

In Ogden et al.'s (1979) figure 4, the dotted line is the distribution of fish consumed and the solid line is the available fish. Straight interpretation of the area under the dotted line curve represents the size classes of fish likely consumed by wood storks and is the basis of our determination of the amount of biomass that is within the size range of fish most likely consumed by wood storks.

To estimate that fraction of the available fish biomass that potentially might be consumed by wood storks, the following analysis was conducted. Trexler et al.'s (2002) 2-year throw-trap of absolute and relative fish abundance distributed across 20 study sites in the ENP and the WCAs was assumed to be representative of the Everglades fish assemblage available to wood storks (n = 37,718 specimens of 33 species). The mean biomass of each species within this fish fauna that fell within the wood stork prey size limits of 1.5-9.0 cm was estimated from the length and wet mass relationships for Everglades's animals developed by Kushlan et al. (1986). The proportion of each species that was outside of this prey length and biomass range was estimated using the species mean and variance provided in Kushlan et al. in Table 1 (1986). These biomass estimates assumed the length and mass distributions of each species was normally distributed and the fish biomass could be estimated by eliminating that portion of each species outside of this size range. Finally, these biomass estimates of available fish prey were standardized to a sum of 6.5 g/m^2 for Class 7 hydroperiod wetlands.

For example, in Appendix 1, in Kushlan et al. (1986) the warmouth (*Lepomis gulosus*) had an average biomass of 36.76 g/m^2 (Kushlan et al. 1986) and accounted for 4.8 percent of the freshwater Everglades ichthyofauna; after standardization, warmouth biomass would be about 0.5 g/m^2 of the total fish biomass in a 6.5 g/m^2 sample from long hydroperiod wetlands. However, the size frequency distribution (assumed normal) for warmouth indicate that 48 percent are too large for wood storks and 0.6 are too small, so the warmouth biomass within the wood stork's preferred size range is only 0.25 g/m^2. Using this approach summed over all species, in long hydroperiod wetlands only about 3.54 g/m^2 of the 6.5 g/m^2 sample consists of fish within the size range preferred by wood storks.

Alternatively, the preferred sunfishes and four other species that accounted for 84 percent of the biomass eaten by wood storks (Ogden et al. 1976) would total 2.34 g/m^2 under this approach; adding another 16 percent would suggest that 2.79 g/m^2 of fish are likely to be consumed by wood storks of the 6.5 g/m^2 that are available. The mean of these two estimates is 3.17 g/m^2 for long hydroperiod wetlands. This proportion of available fish prey of a suitable size (3.17 g/m^2 / 6.5 g/m^2 = 0.49) was then multiplied by the total fish biomass in each hydroperiod class to provide an estimate of the total biomass of a hydroperiod that is the appropriate size and species composition most likely consumed by wood storks. Following this approach, the biomass per hydroperiod potentially vulnerable to predation by wood storks is:

- Class 1 (0-60 days) = 0.25 grams/m^2
- Class 2 (60-120 days) = 0.49 grams/m^2
- Class 3 (120-180 days) = 1.13 grams/m^2
- Class 4 (180-240 days) = 2.1 grams/m^2
- Class 5 (240-300 days) = 2.5 grams/m^2
- Class 6 (300-330 days) = 2.9 grams/m^2
- Class 7 (330-365 days) = 3.2 grams/m^2

Wood Stork-Wading Bird Prey Consumption Competition

Another factor in assessing wood stork foraging potential is the likelihood that wood storks will be the wading bird species that actually consumes the concentrated prey. Fleming et al. (1994b) provides an estimate of 10 percent of the total biomass in their studies of wood stork foraging as the amount that is actually consumed by the storks. However, the Fleming et al. (1994b) estimate also includes a second factor, the suitability of the foraging site for wood storks, a factor that we have calculated separately. In their assessment these two factors accounted for a 90 percent reduction in the biomass actually consumed by the storks. We are considering that these two factors are equally important and are treated as equal components in the 90 percent reduction; therefore, we consider each factor to represent 45 percent of the reduction. In consideration of this approach, Fleming et al.'s (1994) estimate that 10 percent of the biomass would actually be consumed by storks would equate to an estimate that 55 percent of the available biomass would actually be consumed by the storks and is the factor we believe represents the amount of the prey base that is actually consumed by the wood stork.

Nest Productivity

Many researchers including Flemming et al. (1994) and Ceilley and Bortone (2000) believe the short hydroperiod wetlands provide a more important pre-nesting foraging food source and a greater early nestling survivor value for wood storks than the foraging base (grams of fish per square meter) suggests. Although the short hydroperiod wetlands provide less fish, these prey bases historically were more extensive and provided foraging needs of the pre-nesting storks and the early-age nestlings, which corresponds to the greatest periods of mortality in wood stork nest productivity.

The total nesting period, from courtship and nest-building through independence of young, lasts approximately 100 to 120 days (Coulter et al. 1999). Wood storks produce an average of 1.29 fledglings per nest and have a probability of survivorship from egg laying to fledgling of 42 percent (Rodgers and Schwikert 1997). The greatest losses occur from egg laying to hatching with a 30 percent loss of the nest productivity. The second highest level of loss occurs from hatching to nestlings of 2 weeks of age with an additional 8 percent. Corresponding losses for the remainder of the nesting cycles are on the average of 6 percent per two week increase in age of the nestling (Rodgers and Schwikert 1997).

Kahl (1964) estimated that 201 kg of forage was needed for a successful nest, with 50 percent of the nestling stork's food requirement occurring during the middle third of the nestling period. The remaining foraging needs (based on Kahl's (1964) productivity graph) are generally linear with an estimate of 25 percent (50 kg) needed to meet the foraging needs of the adults and nestling in the first third of the nesting cycle and 25 percent (50 kg) needed for fledging to dispersing juveniles.

Hydrology

***Action Area*:** The Service's action area for the project is the CFAs for the three wood stork colonies (Figure 17) and includes the footprint of the proposed development and preserve areas.

Alteration of hydrology and historical flow-ways resulting in restrictive flows and drainage, as demonstrated for the Cocohatchee basin, can negatively influence wetlands and other surface water systems important to wood storks through changes in seasonal flooding and drawdown cycles and extended periods of unusually high water or low water, resulting in changes in the vegetative community from a mixed open forest canopy with a herbaceous component to a closed canopy, dense forest without a herbaceous component.

The National Wetlands Inventory (NWI), the District Land Use Maps, and personal knowledge have been used to estimate wetland coverage and hydroperiod classes within the CFA of the three colony sites. As previously discussed, we consider short hydroperiods to be wetlands inundated for 180 days or fewer which includes Classes 1, 2, and 3. Following this approach, the wetland hydroperiods for three CFAs were estimated and are shown in Figure 18 and Table 16. The acreages in Table 16 are estimated from the NWI and SFWMD maps.

We estimate about 227,845 acres of short-hydroperiod wetlands are within the core foraging areas of the three rookeries, with an additional 253,821 acres of long-hydroperiod wetlands. Of this acreage, we estimate about 205,061 acres of short-hydroperiod and 228,439 acres of long-hydroperiod wetlands are suitable for wood stork foraging (10 percent of wetlands support melaleuca coverage greater than 90 percent).

***Project Wetlands*:** A similar assessment of the wetland hydroperiods for the proposed development footprint and preserve areas are provided in Figure 19 and Table 17. Tables 19, 20, and 21 provide the detailed assessment of these hydroperiods. The hydroperiods of the wood stork suitable foraging wetlands within the development footprint are estimated at 477.17 acres of short-hydroperiod wetlands and 14.14 acres of long hydroperiod wetlands.

The hydroperiods (Figure 20 and Table 18) of wood stork suitable foraging wetlands within the preserve footprints (existing conditions) are estimated at 394.6 acres of short-hydroperiod wetlands and 203.56 acres of long-hydroperiod wetlands. Following preserve hydroperiod restoration and wetland enhancements, which are components of the proposed action, wood stork suitable foraging wetlands are estimated at 507.56 acres of short-hydroperiod wetlands and 323.8.31 acres of long-hydroperiod wetlands, an increase of 233.2 acres of wood stork suitable foraging wetlands.

Summary of the Factors Affecting Vulnerability of Wetland Habitats to Wood Stork Foraging in the Action Area

Through the above discussions, we have identified that there are essentially four variables in assessing wood stork foraging habitat. The first is the density of melaleuca within habitats suitable for wood stork foraging, the second is the hydroperiod of the wetland affected, the third is the fish density (biomass) available to the wood stork from the biomass of the wetlands affected, and the fourth is the likelihood that the wood stork is the wetland species that actually consumes the concentrated prey. All four of these parameters when combined provide us with an estimate of the effect of wetland foraging loss and gains in grams of fish in our assessment of the effects of the action on wood storks.

As an example, a 50-acre wetland with 60 percent melaleuca coverage, with a Class 5 hydroperiod would provide about 102,950 grams (103 kg) of fish potentially vulnerable to predation by wood storks.

Fifty acres converts to 202,350 m^2; 60 percent melaleuca coverage equates to a 37 percent foraging potential; a Class 5 wetland has 2.5 grams of suitable fish per m^2; and 55 percent of the biomass is actually consumed by wood storks and not other species of wading birds. Thus, the following calculation can be made:

(202,350*.37*2.5*.55=102,950)

An underlying assumption of this assessment method is that fishes within these wetlands either are available to storks or become available at some point during the dry season. The declining water levels over time result in the prey in different wetlands becoming available to storks at some point during the spring dry-down.

EFFECTS OF THE ACTION - WOOD STORK

This section analyses the direct and indirect effects of the project on the wood stork and wood stork habitat. As defined by the Corps, the proposed action includes the construction of an upscale residential and golf course community to be known as "Mirasol." The proposed development would consist of residential areas (234 acres); lakes (148 acres); road right of way (52 acres); clubhouse, maintenance, and sales buildings (22 acres); a 36-hole golf course and paths (222 acres); open space (95 acres); and on-site preserves (941 acres). The project site is 1,713 acres and consists of 1,476 acres of jurisdictional wetlands and 237 acres of uplands. Jurisdictional areas consist of melaleuca, disturbed hydric pine, pine-cypress, and cypress communities. The project proposes to impact 645 acres of wetlands. The project also proposes compensatory mitigation through the enhancement and preservation of 941 acres on-site consisting of 831 acres of wetlands and 110 acres of uplands. Fifty-seven of the 941 acres of preserve are within the development footprint consisting of about 55 acres of forested wetlands and 2 acres of forested uplands that will be enhanced and preserved. The remaining 884 acres would be located north of the development and form a contiguous preserve with other adjacent preserves. The 884-acre preserve would consist of approximately 776 acres of forested wetlands, and 108 acres of uplands.

Factors to be Considered

Development pressures due to ongoing population growth in Collier and Lee Counties continue to threaten wetlands in the action area. Data from the U.S. Census Bureau indicate during the period of 1968 to 2000 the populations of Collier, Hendry, and Lee Counties have increased by 94, 78, and 88 percent, respectively. The population of this three-countywide area was estimated at 731,675 during the 2000 census, and is expected to continue to grow, with a concomitant increase in the filling of wetlands due to development.

Residential, commercial, and industrial development projects may have a number of direct and indirect effects on the wood stork and wood stork habitat. Direct impacts, which are primarily habitat based, may include: (1) the permanent loss of available habitat for foraging, feeding,

breeding, and dispersing wood storks; (2) changes in hydroperiods of wetlands that supports wood stork foraging, feeding, breeding, and dispersing wood storks; (3) the fragmentation of wood stork habitat; (4) harassment by construction activities; (5) a reduction in the geographic distribution of habitat for the species; and (6) habitat compensation. Indirect effects may include: (1) increases in disturbance frequency, intensity or severity to wood storks in the project vicinity due to human activities; (2) changes in the wood stork prey base; and (3) changes in the value of wood stork habitat adjacent to the project due to project related hydrological alterations. These indirect effects are habitat based.

This project site contains wood stork foraging habitat and is located within the CFA of three wood stork colonies. The timing of construction for this project, relative to sensitive periods of the wood stork's lifecycle, is unknown. Wood storks may be found on and adjacent to the proposed construction footprint year-round. The project will be constructed in a single, disruptive event, and result in permanent loss and alteration of a portion of the existing ground cover on the project site. The time required to complete construction of the project is not known, but it is likely land clearing associated with the development could be undertaken in phases over several years. The disturbance associated with the project will be permanent and result in a loss of habitat currently available to the wood stork; however, fragmentation of habitat will not occur due to the proposed project's position in the landscape of existing development. We evaluated impacts to storks using the method described in the Environmental Baseline Section above, which combines the effects of canopy cover and prey availability on the relative suitability of these wetlands for stork foraging. Impacts to storks were determined based on the calculated reduction in prey availability (biomass).

Analyses for Effects of the Action

Wood storks, as previously discussed, forage most efficiently and effectively in habitats where prey densities are high, and the water shallow and open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987). Calm water, about 2 to 16 in (5 to 40 cm) in depth, and free of dense aquatic vegetation is ideal (Coulter and Bryan 1993). Typical foraging sites include freshwater marshes, ponds, hardwood and cypress swamps, narrow tidal creeks or shallow tidal pools, and artificial wetlands such as stock ponds, shallow, seasonally flooded roadside or agricultural ditches, and managed impoundments.

Habitat: As discussed in the previous section on Factors Affecting the Species and Environments within the Action Area, suitable wood stork foraging habitat within the footprint of the project site is affected by the density of exotic plant species and percent of canopy closure within affected wetlands. Based on these discussions, suitable wood stork habitat is estimated at about 491 acres (Table 15) with significant variance in functional value; although about 645 acres (Table 14) of the project area are vegetated wetland communities. As discussed previously, we believe that dense melaleuca (>90 percent), because of its restrictive canopy, has effectively precluded wood storks from foraging in these communities. The remaining communities, although with varying densities of exotic species, still provide some foraging value to the wood stork, though the value is dependant on the density of the exotic species. Based on wading bird richness values (the number of species and the number of individuals) provided in the O'Hare and Dalrymple (1997) study, we estimated wetland communities with between 75 and

90 percent melaleuca coverage provided a wood stork foraging suitability value of 3 percent, between 50 to 75 percent melaleuca coverage provided a wood stork foraging suitability value of 37 percent, between 25 and 50 percent melaleuca coverage provided a wood stork foraging suitability value of 70 percent, and between 0 to 25 percent melaleuca coverage provided a wood stork foraging suitability value of 100 percent (Table 13).

Wood Stork Assessment: Wood storks forage most efficiently and effectively in habitats where prey densities are high and the water shallow and open enough to hunt successfully (Ogden et al. 1978; Browder 1984; Coulter 1987). In the previous section, we provided an assessment of the openness of the wetlands and their importance to wood stork foraging. The second component of importance to wood stork foraging efficiency is related to prey fish densities, which are referenced as the number of fish per m^2 (a quantity measurement), or the grams of fish per m^2 (a biomass measurement). The most important factor affecting these parameters is the existing hydroperiod of the wetlands affected. The shorter the hydroperiod, the less the amount of time available for growth and maturation of fish prey species within the hydrated wetlands, which generally results in less numbers and lower biomass of fish in these systems. Researchers in fish density studies in ENP, WCA-3, and Corkscrew Swamp provided standing stock (biomass) of large and small fishes for various wetland hydroperiods (Turner et al. 1999, Trexler et al. 2002, Carlson and Duever 1979).

However, as previously discussed, wood storks are very selective in the size of fish they consume, generally between 1.5 and 9.0 cm in length and usually greater than one year old (Ogden et al. 1976, Coulter et al. 1999). Factoring this size restriction and species preference into the standing stock (biomass) of large and small fishes referenced above, we determined the biomass of each hydroperiod that would be consumed by storks based on preferred size. By incorporating the last remaining factor in the prey density foraging value to wood stork, the amount of the prey base actually consumed by wood stork per hydroperiod (55 percent of the available wood stork suitable biomass, which is based on Fleming et al.'s [1994b] studies [see detailed discussion in the Factors Affecting the Species and the Environment in the Action Area]), we can estimate the amount of biomass actually consumed in grams/ m^2 per hydroperiod.

As an example, a 50-acre wetland with 60 percent melaleuca coverage, with a Class 5 hydroperiod would provide about 102,950 grams (103 kg) of fish potentially vulnerable to predation by wood storks. Fifty acres converts to 202,350 m^2; 60 percent melaleuca coverage equates to a 37 percent foraging potential; a Class 5 wetland has 2.5 grams of suitable fish per m^2; and 55 percent of the biomass is actually consumed by wood storks and not other species of wading birds. Thus, the following calculation can be made:

(202,350*.37*2.5*.55=102,950)

***Project Footprint Foraging Prey Base Assessment*:** Following this approach, a foraging prey base evaluation of the proposed project footprints based on the above information provides a biomass foraging loss to wood storks of 273 kilograms of fish biomass (Table 20). The prey base loss is based on 491 acres of suitable wood stork foraging habitat with a range of functional value. The exotic species density habitat suitability values range from 3 percent to 100 percent, depending on the density of exotic vegetation. The hydroperiods vary from Class 2 (60 to 120 days)

to Class 5 (240 to 300 days) with 51 percent of the project footprint represented by Class 3. We consider the wood stork suitable fish density (grams per m^2 per hydroperiod class) to be as described in the earlier section relating to fish densities in each wetland class. As previously noted, the wood stork consumption percentage is 55 percent (*i.e.*, 55 percent of the biomass will actually be consumed by wood storks).

Direct Effects

Direct effects are those effects caused by the proposed action at the time of construction, are primarily habitat based, are reasonably certain to occur, and include: (1) the permanent loss of available habitat for foraging, feeding, breeding, and dispersing wood storks; (2) changes in hydroperiods of wetlands that supports wood stork foraging, feeding, breeding, and dispersing wood storks; (3) the fragmentation of wood stork habitat; (4) harassment by construction activities; (5) a reduction in the geographic distribution of habitat for the species; and (6) habitat compensation. The direct effects this project will have on the wood stork within the action area are discussed below.

***Permanent Loss of Habitat*:** The project will result in the loss of approximately 645 acres of wetlands on the site. The land will be converted to support a residential/golf course community. Habitat quality for wood storks is generally poor, as it is primarily disturbed flatwoods supporting an average of 65 percent exotics. In our assessment of wood stork foraging suitability, we estimated that of the 645 acres of wetlands, only 491 are considered suitable for foraging by wood storks, with a range of functional value. This loss represents approximately 0.1 percent of the available foraging area within each of the three colonies whose CFAs overlap the project (Table 16). No wood storks are known to have nested within the project area and all of the wading bird censuses conducted to date have demonstrated that the area is periodically used by resident and or migratory, over-wintering wood storks. Therefore, based on the analyses provided above on the level of melaleuca infestation within the project wetlands and the analysis of project area foraging base in the Environmental Baseline, we believe there will be a loss of 491 acres of wood stork foraging habitat of varying foraging value to the wood stork.

***Changes in the Mosaic of Hydroperiods*:** Stork nesting success generally relies on a mosaic of hydroperiods within the core foraging area of the colony. Storks nest during the dry season, and rely on the drying wetlands to concentrate prey items in the ever-narrowing wetlands (Kahl 1964). Because of the continual change in water levels during the stork nesting period, any one site may only be suitable for stork foraging for a narrow window of time when wetlands have sufficiently dried to begin concentrating prey, making water depths suitable for storks to access the prey. Once the wetland has dried to where the water levels are near the ground surface, the area is no longer suitable for stork foraging, and will not be suitable until water levels rise and the area is again repopulated with fish. Consequently, there is a general progression in the suitability of wetlands for foraging based on their hydroperiods, with the short hydroperiod wetland used early in the season, the mid-range hydroperiod sites being used during the middle of the nesting season, and the longest hydroperiod areas being used later in the season (Kahl 1964; Gawlik 2002).

In our evaluation of hydroperiods within the wood stork action area (overlap of all three rookeries), we determined that of the available wetlands within the action area (481,666 acres), there were about 227,845 acres of short-hydroperiod wetlands of which only 205,061 acres were suitable for wood stork foraging (10 percent with greater than 90 percent coverage of exotics). Short-hydroperiod wetlands in the project footprint total about 575.66 acres of which about 477.17 acres are suitable for wood stork foraging. The loss of the 477.17 acres of short-hydroperiod wetlands suitable for wood stork foraging represents about 0.11 percent of the short-hydroperiod wetlands in the action area. Long-hydroperiod wetlands in the project footprint total about 69.7 acres of which about 14 acres are suitable for wood stork foraging, this loss of long-hydroperiod wetlands represents about 0.006 percent of the available long-hydroperiod wetlands in the action area.

In our assessment of the Mirasol development footprint, we noted that the predominant wetland hydroperiod was a Class 3 (51 percent) with an average of 120 to 180 days inundation. To complete this analysis, we assumed the existing available foraging habitat acreages would be available with or without the project. We calculated the proposed development will result in the loss of 272,745 grams (272.7 kg) of fish biomass, of which 243,356 grams (243.4 kg) represent short-hydroperiod wetlands, and 29,389.7 grams (29 kg) represent long-hydroperiod wetlands (Table 20).

In our assessment of the preservation lands (Tables 20 and 21), we determined that prior to restoration the preserve lands, these lands provide for an existing foraging base of 978,227 grams (978.3 kg) of fish biomass and following restoration these lands provide 2,842,045.9 grams (2,842.1 kg) of fish biomass, an increase of 1,863,818.9 grams (1,864 kg) of fish biomass.

Since the importance of short-hydroperiod wetlands in relationship to early nesting productivity of a wood stork colony is extremely critical, as discussed previously, we also calculated the productivity of both short- and long-hydroperiod wetlands separately. The existing preserve lands currently provide 212,412.6 grams (212.4 kg) of short-hydroperiod fish biomass with a corresponding long-hydroperiod productivity of 765,814 grams (765.9 kg) of fish biomass. Following restoration, the preserve lands will provide 1,252,345 grams (1,252.3 kg) of fish biomass of short-hydroperiod wetlands and 1,589,700.1 grams (1,589.7 kg) of long-hydroperiod fish biomass.

Following the above analysis, the restoration actions proposed for the preserve lands will provide an increase of 1,039,932 grams (1,139.9 kg) of fish biomass in short-hydroperiod wetlands and 823,886 grams (823.9 kg) of fish biomass in long-hydroperiod wetlands. Considering that the expected fish productivity loss from the proposed development is 272,745 grams (272.7 kg) of fish biomass, of which 243,356 grams (243.4 kg) represent short-hydroperiod wetlands, and 29,389.7 (29 kg) represent long-hydroperiod wetlands, the proposed restoration actions will provide a 4.27 fold increase in availability of fish biomass for short-hydroperiod wetlands, and a 28.03 fold increase in availability of fish biomass of long-hydroperiod wetlands.

However, as we discussed previously, bio-mass production in individual classes of wetland hydroperiods as it relates to nesting productivity of a wood stork colony is extremely critical in the overall success of a colony. Therefore, we also calculated the productivity of both short- and long-hydroperiod wetlands separately by hydroperiod (Table 19). As shown in Table 19, Class 2 hydroperiod wetlands show an overall loss of 66.69 acres and a corresponding loss of 33.68 kg of fish biomass. Class 3 hydroperiod wetlands show an overall loss of 297.53 acres of wetlands

but with an increase of 830.25 kg of fish biomass. The biomass increase is associated with the restoration of wetlands within the preserve areas. Class 4 hydroperiod wetlands show an over all increase of 107.16 acres of wetlands with a corresponding increase of 730.8 kg of fish biomass. Class 5 wetlands show an overall loss of 1.06 acres of wetlands, but with an increase of 63.7 kg of fish biomass. Again, the biomass increase is associated with the restoration of wetlands within the preserve areas.

In our evaluation of project affects to wood storks foraging across all hydroperiods, we believe project related foraging losses need to be offset in our evaluation of take. As shown in Table 19, wood stork biomass foraging losses from the proposed development are compensated for in the enhancements of the preserve lands with the exception of the losses associated with Class 2 hydroperiod wetlands. Our evaluation shows an overall loss of 66.69 acres with a corresponding loss of 33.68 kg of fish biomass. We will use this biomass loss as the basis for estimating take.

To summarize the discussion above, the project development will result in the loss of 645 acres of wetlands, of which 491 acres are suited for wood stork foraging (154 acres with melaleuca coverage greater than 90 percent are not considered suitable for wood stork foraging). The proposed preservation lands consist of 941 acres, with 831 acres of wetlands and 110 acres of uplands. Within the 831 acres of wetlands, only 598 acres are suitable for wood stork foraging prior to enhancement (233 acres with melaleuca coverage greater than 90 percent are not considered suitable for wood stork foraging). Following enhancement, all 831 acres are suitable for wood stork foraging. The hydroperiod class analysis, by individual hydroperiod classes, shows that over all, the project development will result in a loss of 273 kgrams of fish biomass from wetland losses in the project development. The proposed restorations will provide an increase of 1,864 kgrams of biomass over existing baseline of the wetlands in the preserve. The net increase in 1,591 kgrams of fish biomass for the project (1864 – 273 = 1,591). However, on an individual hydroperiod analysis, the project development will result in the loss of 33.68 kgrams of fish biomass associated with a class 2 hydroperiod. All the other hydroperiod classes show an increase in the fish biomass available for wood stork foraging following enhancement of the preserve wetlands. Since our analysis shows a loss of 33.68 kgrams of fish biomass in the class 2 hydroperiod, this loss represent an adverse effect to wood stork foraging base and is the value for our estimate of incidental take for wood stork nest productivity.

***Fragmentation of Habitat*:** Mac et al. (1998) define habitat fragmentation as, "The breaking up of a habitat into unconnected patches interspersed with other habitat which may not be inhabitable by species occupying the habitat that was broken up. The breaking up is usually by human action, as, for example, the clearing of forest or grassland for agriculture, residential development, or overland electrical lines." In the case of the proposed project, habitat will be affected by the development of the property. However, in a larger framework, the Mirasol project area is located adjacent to urban development and is in an area of intense development pressure; therefore, fragmentation of wood stork habitat is not expected to result from project implementation. The project site proposes a large preserve area that connects existing and proposed preserve areas to the west with existing and proposed preserved lands to the east. For these reasons, fragmentation of wood stork foraging habitat is not expected.

Construction: The timing of construction for this project relative to sensitive periods of the wood stork's lifecycle is unknown. However, it is likely all land clearing associated with the

development will occur in phases over several years. There are no known roosting or colony sites within the project boundaries and the quality and quantity of the foraging prey base (based on previous discussion of habitat quality and foraging values) is low. Therefore, we believe wood stork usage of the property is limited and we do not believe project construction will result in direct wood stork harassment or mortality.

Reduction in Geographic Distribution of Habitat: The wood stork population in the southeastern United States appears to be continuing to grow. Preliminary population totals indicate that the stork population has reached its highest level since it was listed as endangered 1984. In all, approximately 10,900 wood stork pairs nested within their breeding range in the southeastern U.S. Wood stork nesting was again recorded in North Carolina in 2006 after it was first documented there in 2005. This suggests the northward expansion of wood stork nesting may be continuing. Several new colonies were located in 2006, including several in Florida. The number of colonies also continues to rise, and over 80 nesting colonies were reported in 2006 throughout the southeastern U.S. (Service unpublished data), which is the highest to date in any one year. The proposed Mirasol project will not significantly reduce the geographic distribution of habitat and the distribution of the species.

Compensation: Wood stork habitat lost by the development will be offset by the preservation and enhancement of about 831 acres of wetlands on-site, of which about 55 acres of forested wetlands would be enhanced and preserved within the developed portions of the project and the remaining 776 acres would be located north of the development and form a contiguous preserve with additional off-site preserve lands. In addition, the project will also provide another 27.68 wetland mitigation credits (about 82 acres), and will provide approximately about 94 acres of additional preserve lands that also provide foraging benefit to wood storks. The lands proposed for development are primarily hydrologically disturbed, exotic infested, and are adjacent to CR 846 and existing urban areas. The lands proposed for preservation are connected to other larger tracts of preserved lands and are consistent with the Service's wood stork goal to acquire, enhance, preserve, and recover natural hydropatterns within foraging habitat of the wood stork

Interrelated and Interdependent Actions

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. No interrelated or interdependent actions are expected to result from the project.

Indirect Effects

Indirect effects are defined as those effects that are caused by the proposed action, and are later in time but are still reasonably certain to occur (50 CFR 402.02). The indirect effects this project may have on the wood stork within the action area are discussed below. They include: (1) increases in disturbance frequency, intensity or severity to wood storks in the project vicinity due to human activities; (2) changes in the wood stork prey base; and (3) changes in value of wood stork habitat adjacent to the project due to project related hydrological alterations.

Increased Disturbance: The timing of construction for this project, relative to sensitive periods of the wood stork's lifecycle, is unknown. Wood storks may be found on and adjacent to the proposed construction footprint year-round. The project will be constructed in a single, disruptive event, and result in permanent loss and alteration of a portion of the existing ground cover on the project site. The time required to complete construction of the project is not known, but it is likely land clearing associated with the development could be undertaken in phases over several years. The on-site wetland preserves, which provide a foraging prey base for wood storks in a suburban setting, may increase the likelihood of harassment and disturbance to the species. However, this is a common occurrence throughout the species range and is not expected to adversely affect the wood stork. In order to minimize potential human/stork interactions, the project is proposing to educate all residents (through literature and signage) as to the potential presence of wood storks around the community.

Changes in Wood Stork Prey Base:

Prey Base Loss: The proposed action will result in the loss of 645 acres of wetlands, of which 491 are considered suitable for foraging by wood storks. In our assessment of adverse effects to the resident prey base available to foraging wood storks, we calculated an at-risk prey base of 273 kilograms of fish biomass (Table 20), of which 89 percent is attributed to short hydroperiod wetlands (243 kg). The hydroperiods vary from Class 2 (60 to 120 days) to Class 5 (240 to 300 days) with 66 percent of the project footprint represented by Class 3. We do not believe additional indirect affects to the prey base will occur.

Prey Base Increase: Increases in the availability of potential foraging habitat and prey resulting from the proposed restoration and enhancement measures are expected to exceed the estimated loss of 273 kg of fish prey base lost to project. The restoration and enhancement activities result in an increase in wood stork suitable foraging biomass of 1,864 kg (Table 21 and 21). The exotic species density habitat suitability values range from 0 percent to 100 percent, depending on the habitat polygon. The hydroperiods range from Class 2 (60 to 120 days) to Class 6 (300 to 330 days) with 61percent of the mitigation area represented by Class 3 (120 to 180 days). The wood stork suitable fish density (grams per m^2 per hydroperiod class) is as described in the earlier section relating to fish densities in each wetland class. As previously noted, the wood stork consumption percentage is 55 percent (*i.e.*, 55 percent of the biomass will actually be consumed by wood storks).

We estimate the applicant's restoration work will provide an increase of 1,039.9 kg of fish biomass in short-hydroperiod wetlands and 823.9 kg of fish biomass in long-hydroperiod wetlands (1,039.9 plus 823.9 equals 1,863.8 [1,864]). Considering the expected fish productivity loss from the proposed development is 272.7 kg of fish biomass, of which 243.4 kg represent short-hydroperiod wetlands, and 29.4 kg represent long-hydroperiod wetlands, the proposed restoration actions will provide a 4.27 fold increase in availability of fish biomass for short-hydroperiod wetlands, and a 28.03 fold increase in availability of fish biomass of long-hydroperiod wetlands.

However, as we discussed previously, we evaluate wood stork biomass productivity per hydroperiod class and based on our analysis, we believe the project will result in the loss of 33.67 kg of fish biomass associated with the loss of 66.69 acres of Class 2 hydroperiod wetlands. This biomass loss is our basis of estimating take.

Changes in value of wood stork habitat adjacent to the project due to project related hydrological alterations: During the mid 1970s, a significant acreage north of the Project was converted to vegetable crop production. Additional development activities were also occurring to the west. This resulted in a system of berms being constructed, which effectively funneled the surface water from thousands of acres (which historically occurred as sheet flow over a broad area of ± 15 miles) into a highly restricted flow-way with relatively few outfalls to the Cocohatchee Canal. This water, directed into the Project area via the restrictions, routing, agricultural pumping and the berm adjacent to the Cocohatchee Canal, backs up across the Project site for extended periods during the summer. Water lines, lichen lines, and adventitious roots on melaleuca trees are visible in most areas. These biological indicators reflect the water levels elevated by the off-site flows from the north. This altered hydrology caused the wetlands within the Project site and adjacent lands to expand through flooding and degradation of the upland communities. However, these hydroperiod is extremely variable and ground water levels typically drop to more than four feet below grade during the dry season, facilitating the colonization of the area by melaleuca and debilitating the restoration of appropriate native communities. Over 85 percent of the Project site has melaleuca densities of greater than 50 percent coverage. The applicant has incorporated into the on-site wetland preserves, and the adjacent preservation wetlands a series of control structures designed to regulate and temper the seasonal changes in hydroperiods and restore these systems to more natural communities. These changes, as discussed in the previous section are expected to result in an increase in the amount and availability of fish biomass to wood stork foraging.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

To determine the cumulative effects of the project on the wood stork, the Service has analyzed future actions reasonably certain to occur within an action area. For evaluation purposes, the Service is considering the action area for the wood stork to include the CFAs of all three nesting colonies as they encompass the project area or a portion of it (Figure 17). The process to identify cumulative effects follows the same procedure identified for the Florida panther.

Within the action area, past and ongoing State and County actions affecting wood stork habitat include: (1) State of Florida DRI Orders (2001 to 2004); (2) Comprehensive Plan Amendments (2003 to 2004); (3) Lee and Collier County Zoning Amendments (2003 to 2004); (3) Collier County's PUDs (2001 to 2004); (4) Lee County's PUDs (2003 to April 2004); and (5) South Florida Water Management District's Environmental Resource Permits (2003 to 2004) (Figure 13). To evaluate these effects, the Service incorporated the Florida Land Use, Cover and Forms Classification System (FLUCCS) mapping to determine properties that may be exempt from Federal Clean Water Act section 404 wetland regulatory reviews by the Corps. To determine which of these projects would likely be exempt from Federal Clean Water Act section 404 wetland regulatory reviews by the Corps, we identified the percentage of the project site that was classified as wetland habitat, based on the FLUCCS mapping units. The mapping units relied on

by the Service included the 600 series (wetland classifications) and the 411 and 419 pine flatwood classifications (hydric pine systems). For listing purposes, properties with less than 5 percent wetlands were considered by the Service to be generally exempt from regulatory review as these quantities of wetlands could be avoided by project design. We initially identified 76 projects affecting 1,210 acres of wetlands associated with 87,784 acres. Of this list, we are aware or have reviewed 29 of these projects affecting 1,063 acres of wetlands associated with 75,574 acres. For our assessments purposes, we identified 47 projects within the combined wood stork foraging area encompassing about 12,201 acres affecting 147 acres of wetlands (Table 23, Figure 21). We added to this the 762 acres of wetlands associated with the proposed developments in Northern Golden Gate Estates and Lehigh Acres for a total of 909 acres of wetlands associated with development of about 13,689 acres. The Service believes these 909 acres of wetlands may be developed without Federal review. As shown in Table 23, cumulative wetland impacts within the action area constitute less than 0.02 percent of all wetlands available to wood storks in the three CFAs.

Although these wetlands may be adversely affected by non-federally reviewed actions and the productivity as a foraging prey base for wood storks may be affected, we believe based on the status of species discussed previously and the status of the species in the action area, the loss/reduction of foraging value to the wood storks associated with these systems is not significant (0.02 percent).

SUMMARY OF EFFECTS – WOOD STORK

The project will result in the direct loss of 645 acres of wetland on the site of which about 154 acres is not considered suitable for foraging by wood storks primarily due to the high density of melaleuca. Any loss of potential wood stork foraging habitat attributable to the project will be offset by the preservation and enhancement of about 831 acres of on-site wetlands, of which about 55 acres of forested wetlands would be enhanced and preserved within the developed portions of the project and the remaining 776 acres would be located north of the development and form a contiguous preserve with additional off-site preserve lands. In addition, the project is proposing to purchase 27.68 wetland mitigation credits (equating to about 82 acres), and will also provide about 94 acres of off-site preserve as part of their panther compensation. Wetlands within this off-site preserve will also support wood stork foraging.

However, as we discussed previously, we evaluate wood stork biomass productivity per hydroperiod class and based on our analysis, we believe the project will result in the loss of 33.67 kg of fish biomass associated with the loss of 66.69 acres of Class 2 hydroperiod wetlands. This biomass loss is our basis of estimating take.

CONCLUSION – WOOD STORK

After reviewing the status of the wood stork, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the development of Mirasol by J.D. Nicewonder, Jr., as proposed, is not likely to jeopardize the continued existence of the wood stork. No critical habitat has been designated for this species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." "Harm" is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking, that is incidental to and not intended as part of the agency action, is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The terms and conditions described below are nondiscretionary and must be undertaken by the Corps so they become binding conditions of any grant or permit issued to J.D. Nicewonder, Jr., as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require J.D. Nicewonder, Jr., to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protection coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or J.D. Nicewonder, Jr., must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Florida Panther

The Service anticipates that incidental take of the Florida panther will be difficult to detect for the following reasons: (1) the Florida panther is wide-ranging; (2) the lands on the project site provide limited value to the Florida panther and panther prey species; and (3) lands adjacent to the project site consists of existing and proposed urban development that reduce their suitability for use by either resident or dispersing panthers. Therefore, the Service does not anticipate construction of the project will result in the direct mortality or injury of any Florida panthers. However, the Service anticipates indirect take of the panther in the form of harm and harassment because of potential increases in traffic and interspecific aggression within the 25-mile radius action area. This level of incidental take may be monitored with the loss of 773 acres of panther habitat within the Primary Zone.

Wood Storks

The Service anticipates incidental take of wood storks will be difficult to detect for the following reasons: (1) wood storks forage over a wide area; (2) the CFA includes all wetlands within 18.6 miles of the colony site; and (3) losses in nesting productivity may be masked by seasonal

fluctuations in numbers based on other natural causes affecting food availability, such as drought or flooding, which will also affect foraging efficiency and nesting success.

We estimated the project will result in the permanent loss of about 491 acres of available wood stork foraging habitat. We also estimated there would be a loss of about 273 kg of forage biomass available to the wood stork. However, the applicant has proposed conservation measures that will ultimately increase the amount of available foraging habitat and available forage biomass. As a result of the restoration and preservation of wetland within and outside of the project area, we determined the Mirasol project will result in a net gain of 1,591 kg of fish biomass (1,864 kg - 273 kg) from the restoration and enhancement of the 831 acres of mainly short hydroperiod suitable wood stork foraging habitat biomass. The 1,591 kg of fish biomass represents 797 kg of short-hydroperiod and 794 kg of long-hydroperiod fish biomass productivity. Since we believe, in general, short-hydroperiod wetlands are critical limiting factors in the action area, the proposed action, with its preserve enhancements, will provide a net increase in nest productivity associated with short-hydroperiod wetlands of about 16 nests over base conditions (797 divided by 50 equals 15.9). We also note a corresponding increase of 5 nest over base conditions for long hydroperiod wetlands (794 divided by 150 equals 5.3).

However, as we discussed previously, we evaluate wood stork biomass productivity per hydroperiod class and based on our analysis, we believe the project will result in the loss of 33.67 kg of fish biomass associated with the loss of 66.69 acres of Class 2 hydroperiod wetlands (short hydroperiod). This biomass loss represents a loss of the productivity of one nest per year (33.67 divided by 50 equals 0.67) over base conditions of Class 2 hydroperiod wetlands.

In addition to direct effects on the non-nesting wood storks, increases in foraging opportunities resulting from the proposed action may also decrease the likelihood these non-nesting wood storks will compete for prey with nesting wood storks. Because we can not reliably predict the degree of competition or the number of non-nesting storks that forage in this area, we are unable to quantify any incidental take resulting from decreased competition.

The Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712), or the Bald Eagle Protection Act of 1940, as amended (16 U.S.C. 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined this level of anticipated take is not likely to result in jeopardy to listed species or destruction or adverse modification of critical habitat to either species.

REASONABLE AND PRUDENT MEASURES

The Service believes the Corps and the applicant have developed a project that has conservation measures necessary and appropriate to minimize the effect of incidental take of the Florida

panther and wood stork. In summary, to compensate for impacts to 773 acres of habitat, J.D. Nicewonder, Jr., proposes to enhance and preserve 941 acres on the project site, 94 acres off-site and about 82 acres of habitat associated with 27.68 mitigation bank credits at PIMB in Collier County, for a total preservation proposal of 1,117 acres.

To minimize take of wood storks, the Service considers it necessary and appropriate to collect hydrological data to ensure hydrological impacts do not occur to the on-site preserve and off-site wetlands within the project vicinity.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline reporting/monitoring requirements. The terms and conditions described below are non-discretionary, and must be undertaken by the Corps so they become binding conditions of any grant or permit issued to J.D. Nicewonder, Jr., as appropriate, for the exemption in section 7(o)(2) to apply.

The Corps has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require J.D. Nicewonder, Jr., to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protection coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or J.D. Nicewonder, Jr., must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement (50 CFR § 402.14(i)(3)). Although we have not identified any specific Reasonable and Prudent Measures not incorporated in the project, we are providing the following for clarification:

1. The preservation-sites will be managed in perpetuity for the control of invasive exotic vegetation as defined by the Florida Exotic Pest Plant Council's Pest Plant List Committee's 2001 List of Invasive Species (Category 1)(2005);

2. The Corps will provide a copy of the final permit to the Service upon issuance. The Corps will monitor the permit conditions regarding conservation measures to minimize incidental take of panthers by providing the Service a report on implementation and compliance with the conservation measure within 1 year of the issuance date of the permit;

3. **Monitor hydrological effects throughout the project area:** The applicant will place three water level data loggers (Global Water Instrumentation WL1S or similar) and two logging type rain gauges within the project boundaries. The water level loggers will be placed inside of 2 inch PVC pipe wells and sunk to a depth of approximately 8 feet below ground level. This will place the loggers below the water table and will allow for continuous monitoring of the water levels, above and below ground, experienced on the site. The rain gauges will be set to collect and record rainfall events on a daily basis so comparisons can be

made with the on-site rainfall and water levels experienced. Locations for the loggers for both the rainfall and water level are shown as an exhibit in the site monitoring plan.

In addition to the on-site data collection, additional information will be included in the data comparisons from stations already set up within the Service's identified action area for the wood stork. The District, the U.S. Geological Survey, and the National Resource Conservation Service all have data collection stations set up within this area. The information collected by these agencies is currently available via the internet. The information is presented on the District's website at http://www.sfwmd.gov/org/ema/dbhydro/index.html.

The surface water levels and rainfall data will be included in a report that will be given to the Corps and the Service on an annual basis. This monitoring will be done in conjunction with the vegetative and exotic removal monitoring conducted for the project. The reports will be produced annually for 5 years after the construction.

4. **Monitor Wood Stork Productivity:** In conjunction with the rainfall and water level data collection, the applicant will monitor the productivity of storks utilizing the Corkscrew colony. The Corkscrew staff already monitors the productivity of the colony in the form of the number of nests constructed as well as the number of young fledged. This information is available and will be included in the annual reports presented to the Corps and the Service.

5. **Monitor Forage Fish Productivity:** Since the Service estimated potential incidental take based of forage production, the project will implement a monitoring program to estimate the forage fish production on the project site preserves. The applicant will also document the utilization of the preserve by wood storks. This information will be useful in conjunction with the available productivity and hydrological data to determine if the project design serves to increase or decrease foraging opportunities.

   Sampling sites will be established along transects that will incorporate all of the different wetland communities in the on-site preserves. The proposed transect locations are shown as an exhibit in the site monitoring plan. The main habitats to be sampled are hydric pine flatwoods, hypericum prairie, and cypress. The sampling device will be a 1 m^2 Wegener ring or similar throw trap. The ring will be thrown at various points along the transect to cover a representative portion of the habitat area. All fish caught inside the ring will be identified and counted. Results will be presented in the annual report to the agencies.

6. **Annual Report:** An annual report will be presented to the Corps and to the Service in order to comply with 50 CFR part 402.14(i)(3), which states "In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement." The report will contain the following information:

   a. The current status of the construction of the project as well as any construction phases or milestones that have been completed;

b. A summary of the rainfall data collected on-site as well as data from the other agency rainfall monitoring stations identified in the report;
c. A summary of the on-site water level data as well as the off-site data available from the other agency monitoring stations;
d. Current status of the exotic removal and regeneration of the native vegetation throughout the preserve area and the off-site preserve lands;
e. Ongoing results of the forage fish sampling including species diversity and densities broken down by habitat types and water depths; and
f. Any observed on-site foraging by wood storks. Included in this information will be number of storks observed, habitat or general area observed, number of days or duration of observation, and estimated foraging efficiency.

7. Upon locating a dead, injured, or sick threatened or endangered species, initial notification must be made to the nearest Service Law Enforcement Office; Fish and Wildlife Service; 9549 Koger Boulevard, Suite 111; St. Petersburg, Florida 33702; 727-570-5398. Secondary notification should be made to the FWC; South Region; 3900 Drane Field Road; Lakeland, Florida; 33811-1299; 1-800-282-8002; and

8. Care should be taken in handling sick or injured specimens to ensure effective treatment and care or in the handling of dead specimens to preserve biological material in the best possible state for later analysis as to the cause of death. In conjunction with the care of sick or injured panthers or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service is not proposing any conservation recommendations at this time.

REINITIATION NOTICE

This concludes formal consultation on the Mirasol development project. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; (3) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the

amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Thank you for your cooperation and effort in protecting fish and wildlife resources. If you have any questions regarding this project, please contact Allen Webb at 772-562-3909, extension 246.

Sincerely yours,

Paul Souza
Field Supervisor
South Florida Ecological Services Office

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LITERATURE CITED

Ackerman, B. B., F. G. Lindzey, and T. P. Hemker. 1986. Predictive energetics model for cougars. Pages 333-352 in S. D. Miller and D. D. Everett (eds). Cats of the world: biology, conservation, and management. National Wildlife Federation and Caesar Kleberg Wildlife Research Institute, Washington, D. C. and Kingsville, TX.

Akçakaya, H.R. 2002. RAMAS GIS: Linking spatial data with population viability analysis (version 4.0). Applied Biomathetics, Setauket, New York.

American Ornithologists Union. 1983. Checklist of North American birds. Sixth Edition. American Ornithologists Union; Baltimore, Maryland.

Anderson, A. E. 1983. A critical review of literature on puma (Felis concolor). Special Report No. 54. Colorado Division of Wildlife, Fort Collins, CO.

Ballou, J. D., T. J. Foose, R. C. Lacy, and U. S. Seal. 1989. Florida panther (Felis concolor coryi) population viability analysis and recommendations. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Bangs, O. 1899. The Florida puma. Proceedings of the Biological Society of Washington 13:15-17.

Beier P., M. R. Vaughan, M. J. Conroy, and H. Quigley. 2003. An analysis of scientific literature related to the Florida panther. Final report, Project NG01-105, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Beier P., M. R. Vaughan, M. J. Conroy, and H. Quigley. In press. Evaluating scientific inferences about the Florida panther. Journal of Wildlife Management.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59:228-237.

Beissinger, S.R. and M.I. Westphal. 1998. On the use of demographic models of population viability in endangered species management. Journal Wildlife Management 62:821-841.

Belden, R. C. 1986. Florida panther recovery plan implementation - a 1983 progress report. Pages 159-172 in S. D. Miller and D. D. Everett (eds). Cats of the world: biology, conservation, and management. National Wildlife Federation and Caesar Kleberg Wildlife Research Institute, Washington, D.C. and Kingsville, TX.

Belden, R. C. 1988. The Florida panther. Pages 515-532 in Audubon Wildlife Report 1988/1989. National Audubon Society, New York, NY.

Belden, R. C., and R. T. McBride. 1983a. Florida panther surveys - Big Cypress National Preserve. Final report to Hughes and Hughes Oil and Gas Company.

Belden, R. C., and R. T. McBride. 2005. Florida panther peripheral areas survey final report 1998-2004. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Belden, R. C., W. B. Frankenberger, and J. C. Roof. 1991. Florida panther distribution. Final Report 7501, E-1 II-E-1. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Belden, R. C., W. B. Frankenberger, R. T. McBride, and S. T. Schwikert. 1988. Panther habitat use in southern Florida. Journal of Wildlife Management 52:660-663.

Bent, A.C. 1926. Life histories of North American marsh birds. U.S. National Museum Bulletin 135; Washington, D.C.

Beyer, D. E., Jr., and J. B. Haufler. 1994. Diurnal versus 24-hour sampling of habitat use. Journal of Wildlife Management 58:178-180.

Borkhataria, R., P. Frederick, and B. Hylton. 2004. Nesting success and productivity of South Florida wood storks in 2004. Unpublished report to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Borkhataria, R., P.C. Frederick, and A.L. Bryan. 2006b. Analysis of wood stork (Mycteria americana) locations in Florida and throughout the southeast from satellite transmitters and band returns. Unpublished report to the U.S. Fish and Wildlife Service
Brook, B. 2000. Pessimistic and optimistic bias in population viability analysis. Biology Conservation 14:564-566.

Brook, B.W., L. Lim, R. Harden, and R. Frankham. 1997. Does population viability analysis software predict the behaviour of real populations? A restrospecitve study of the Lord Howe Island Woodhen Tricholimnas sylvestris (Sclater). Biology Conservation 82:119-128.

Browder, J.S. 1978. A modeling study of water, wetlands, and wood storks. In Wading Birds. A. Sprunt IV, J.C. Ogden, and S. Winckler (Eds). National Audubon Society. Research Report Number 7: 325-346.

Browder, J.S. 1984. Wood stork feeding areas in southwest Florida. Florida Field Naturalist 12:81 96.

Browder, J.S., C. Littlejohn, and D. Young. 1976. The Florida Study. Center for Wetlands, University of Florida, Gainesville, and Bureau of Comprehensive Planning, Florida Department of Administration, Tallahassee.

Bryan, A.L., Jr., and M.C. Coulter. 1987. Foraging characteristics of wood storks in East-Central Georgia, U.S.A. Colonial Waterbirds 10(2):157-161.

Bryan, A.L., Jr., M.C. Coulter, and C.J. Pennycuick. 1995. Foraging strategies and energetic costs of foraging flights by breeding wood storks. Condor 97(1):133-140.

Burger, J., J.A. Rodgers, Jr., and M. Gochfeld. 1993. Heavy metal and selenium levels in endangered woods storks Mycteria americana from nesting colonies in Florida and Costa Rica. Arch. Environ. Contam. Toxicol. 24:417-420.

Carlson, J. E. and M. J. Duever. 1979. Seasonal fish population fluctuation in south Florida swamps. Proceedings of Annual Conference of Southeastern Association of Fish and Wildlife Agencies 31: 603-611.

Ceilley, D.W. and S.A. Bortone. 2000. A survey of freshwater fishes in the hydric flatwoods of flint pen strand, Lee County, Florida. Proceedings of the 27th Annual Conference on Ecosystems Restoration and Creation, 70-91. Hillsborough Community Colle
Clark J. D., D. Huber, and C. Servheen. 2002. Bear reintroductions: lessons and challenges. Ursus 13:335-345.

Comiskey, E. J., A. C. Eller, Jr., and D. W. Perkins. 2004. Evaluating impacts to Florida panther habitat: how porous is the umbrella? Southeastern Naturalist 3:51-74.

Comiskey, E. J., L. J. Gross, D. M. Fleming, M. A. Huston, O. L. Bass, Jr., H. Luh, and Y. Wu. 1994. A spatially-explicit individual-based simulation model for Florida panther and white-tailed deer in the Everglades and Big Cypress landscapes. Pages 494-503 in D. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Comiskey, E. J., O. L. Bass, Jr., L. J. Gross, R. T. McBride, and R. Salinas. 2002. Panthers and forests in south Florida: an ecological perspective. Conservation Ecology 6:18.

Cone, W.C. and J.V. Hall. 1970. Wood ibis found nesting in Okeefenokee Refuge. Oriole 35:14.

Cook, M.I. and E. M. Call. 2005. South Florida Wading Bird Report, Volume 10. Unpublished Report, South Florida Water Management District. September 2005.

Cory, C. B. 1896. Hunting and fishing in Florida. Estes and Lauriat, Boston, MA.

Coulter, M.C. 1987. Foraging and breeding ecology of wood storks in East-Central Georgia. Pages 21-27. *In* R.R. Odom, K.A. Riddleberger, and J.C. Ozier, eds. Proceedings of the Third Southeastern Nongame and Endangered Wildlife Symposium. Georgia Dept. Natur. Resources, Game and Fish Division.

Coulter, M.C. and A.L. Bryan, Jr. 1993. Foraging ecology of wood storks (Mycteria americana) in east central Georgia: Characteristics of foraging sites. Colonial Waterbirds 16:59 70.

Coulter, M.C., J.A. Rodgers, J.C. Ogden, and F.C. Depkin. 1999. Wood stork (Mycteria americana). In: The Birds of north America, No. 409 9A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvania.

Cox J., R. Kautz, M. MacLaughlin, and T. Gilbert. 1994. Closing the gaps in Florida's wildlife habitat conservation system. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Crozier, G.E. and D.E. Gawlik. 2003. South Florida Wading Bird Report, Volume 9. Unpublished report, South Florida Water Management District. November 2003.

Crozier, G.E. and M.I. Cook. 2004. South Florida Wading Bird Report, Volume 10. Unpublished report, South Florida Water Management District. November 2004.

Culver, M., W. E. Johnson, J. Pecon-Slattery, and S. J. O'Brien. 2000. Genomic ancestry of the American puma (Puma concolor). Journal of Heredity 91:186-197.

Cunningham, M. W. 2005. Epizootiology of feline leukemia virus in the Florida panther. M.S. Thesis. University of Florida, Gainesville, FL.

Dahl, T.E. 1990. Wetlands losses in the United States 1780s to 1980s. U.S. Department of the Interior, Fish and Wildlife Service; Washington, D.C.

Dalrymple, G. H., and O. L. Bass. 1996. The diet of the Florida panther in Everglades National Park, Florida. Bulletin of the Florida Museum of Natural History 39:173-193.

Dees, C. S., J. D. Clark, and F. T. Van Manen. 2001. Florida panther habitat use in response to prescribed fire. Journal of Wildlife Management 65:141-147.

Dickson, B. G., J. S. Jenness, and P. Beier. 2005. Influence of vegetation, topography, and roads on cougar movement in Southern California. Journal of Wildlife Management 69:264-276.

Duever, M. J., J. E. Carlson, J. F. Meeder, L. C. Duever, L. H. Gunderson, L. A. Riopelle, T. R. Alexander, R. L. Myers, and D. P. Spangler. 1986. The Big Cypress National Preserve. Research Report 8. National Audubon Society, New York, NY.

Duever, M.J., J.E. Carlson, J.F. Meeder, L.C. Duever, L.H. Gunderson, L.A. Riopelle, T.R. Alexander, R.F. Myers, and D.P. Spangler. 1979. Resource Inventory and Analysis of the Big Cypress National Preserve. Ecosystem Research Unit, National Audubon So Dunbar, M. R. 1995. Florida panther biomedical investigations. Annual performance report. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Dusi, J.L. and R.T. Dusi. 1968. Evidence for the breeding of the wood stork in Alabama. Alabama Birds 16:14 16.

Fieberg, J., and S. P. Ellner. 2000. When is it meaningful to estimate an extinction probability? Ecology 81:2040-2047.

Fleming, M., J. Schortemeyer, and J. Ault. 1994a. Distribution, abundance, and demography of white-tailed deer in the Everglades. Pages 247-274 in D. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

Fleming, W.J., J.A. Rodgers, Jr., and C.J. Stafford. 1984. Contaminants in wood stork eggs and their effects on reproduction, Florida, 1982. Colonial Waterbirds 7:88-93.

Flemming, D.M., W.F. Wolff, and D.L. DeAngelis. 1994. Importance of landscape heterogeneity to wood storks. Florida Everglades Management 18: 743-757.

Florida Exotic Pest Plant Council's Pest Plant List Committee. 2005. List of Invasive Species. Florida Exotic Pest Plant Council. April 2005. Gainesville, Florida. [online] URL: http://www.fleppc. org/Plantlist/list.htm.

Florida Fish and Wildlife Conservation Commission (FWC). 2006a. Annual report on the research and management of Florida panthers: 2005-2006. Fish and Wildlife Research Institute and Division of Habitat and Species Conservation. Naples, FL.

Florida Fish and Wildlife Conservation Commission (FWC). 2006b. Use of least cost pathways to identify key highway segments for panther conservation. Tallahassee, Florida.

Forrester, D. J. 1992. Parasites and diseases of wild mammals in Florida. University Press of Florida, Gainesville, FL.

Forrester, D. J., J. A. Conti, and R. C. Belden. 1985. Parasites of the Florida panther (Felis concolor coryi). Proceedings of the Helminthological Society of Washington 52:95-97.

Frederick, P. C., M. G. Spalding, and R. Dusek. 2002. Wading birds as bioindicators of mercury contamination in Florida, USA; annual and geographic variation. Environmental Toxicology and Chemistry 21:163-167.

Gawlik, D.E. 2002. The effects of prey availability on the numerical response of wading birds. Ecological Monographs 72(3): 329-346.

Glass, C. M., R. G. McLean, J. B. Katz, D. S. Maehr, C. B. Cropp, L. J. Kirk, A. J. McKeirnan, and J. F. Evermann. 1994. Isolation of pseudorabies (Aujeszky's disease) virus from a Florida panther. Journal of Wildlife Diseases 30:180-184.

Hamilton, S., and H. Moller. 1995. Can PVA models using computer packages offer useful conservation advice? Sooty shearwaters Puffinus griseus in New Zealand as a case study. Biological Conservation 73:107-117.

Harlow, R. F. 1959. An evaluation of white tailed deer habitat in Florida. Florida Game and Fresh Water Fish Commission Technical Bulletin 5, Tallahassee, FL.

Harlow, R. F., and F. K. Jones. 1965. The white-tailed deer in Florida. Florida Game and Fresh Water Fish Commission Technical Bulletin 9, Tallahassee, FL.

Harris, L. D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago, IL.

Harrison, R. L. 1992. Toward a theory of inter-refuge corridor design. Conservation Biology 6:293-295.

Hefner, J.M., B.O. Wilen, T.E. Dahl, and W.E. Frayer. 1994. Southeast wetlands; status and trends, mid-1970s to mid-1980s. U.S. Department of the Interior, Fish and Wildlife Service; Atlanta, Georgia.

Hollister, N. 1911. The Louisiana puma. Proceedings of the Biological Society of Washington 24:175-178.

Howell, A.H. 1932. Florida bird life. Coward McCann; New York, New York.

Hylton, R.A., P.C. Frederick, T.E. De La Fuente, and M.G. Spalding. 2006. Effects of nestling health on postfledging survival of wood storks. Condor 108:97-106.

Janis, M. W., and J. D. Clark. 1999. The effects of recreational deer and hog hunting on the behavior of Florida panthers. Final report to Big Cypress National Preserve, National Park Service, Ochopee, FL.

Janis, M. W., and J. D. Clark. 2002. Responses of Florida panthers to recreational deer and hog hunting. Journal of Wildlife Management 66:839-848.

Jansen, D. K., S. R. Schulze, and A. T. Johnson. 2005. Florida panther (Puma concolor coryi) research and monitoring in Big Cypress National Preserve. Annual report 2004-2005. National Park Service, Ochopee, FL.

Jordan, A.R., D.M. Mills, G. Ewing and J.M. Lyle. 1998. Assessment of inshore habitats around Tasmania for life-history stages of commercial finfish species, Published by Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Hobart.

Kahl, M. P. 1962. Bioenergetics and growth of nestling Wood Storks. Condor 64:169-183.

Kahl, M.P., Jr. 1964. Food ecology of the wood stork (Mycteria americana) in Florida. Ecological Monographs 34:97 117.

Kautz, R. S., and J. A. Cox. 2001. Strategic habitats for biodiversity conservation in Florida. Conservation Biology 15:55-77.

Kautz, R., R. Kawula, T. Hoctor, J. Comiskey, D. Jansen, D. Jennings, J. Kasbohm, F. Mazzotti, R. McBride, L. Richardson, and K. Root. 2006. How much is enough? Landscape-scale conservation for the Florida panther. Biological Conservation.

Kerkhoff, A. J., B. T. Milne, and D. S. Maehr. 2000. Toward a panther-centered view of the forests of south Florida. Conservation Ecology 4:1.

Kushlan, J.A. 1979. Prey choice by tactile foraging wading birds. Proceedings of the Colonial Waterbird Group 3:133 142.

Kushlan, J.A. and P.C. Frohring. 1986. The history of the southern Florida wood stork population. Wilson Bulletin 98(3):368-386.

Kushlan, J.A., J.C. Ogden, and A.L. Higer. 1975. Relation of water level and fish availability to wood stork reproduction in the southern Everglades, Florida. U.S. Geological Survey open file report 75 434. U.S. Government Printing Office; Washington, D.C.

Labisky, R. F., C. C. Hurd, M. K. Oli, and R. S. Barwick. 2003. Foods of white-tailed deer in the Florida Everglades: the significance of Crinum. Southeastern Naturalist 2:261-270.

Labisky, R. F., M. C. Boulay, K. E. Miller, R. A. Sargent, Jr., and J. M. Zultowskil. 1995. Population ecology of white-tailed deer in Big Cypress National Preserve and Everglades National Park. Final report to National Park Service, Ochopee, FL.

Land, D., and S. K. Taylor. 1998. Florida panther genetic restoration and management annual report 1997-98. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Land, D., B. Shindle, D. Singler, and S. K. Taylor. 1999. Florida panther genetic restoration annual report 1998-99. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Land, D., D. Shindle, M. Cunningham, M. Lotz, and B. Ferree. 2004. Florida panther genetic restoration and management annual report 2003-04. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Land, D., M. Cunningham, R. McBride, D. Shindle, and M. Lotz. 2002. Florida panther genetic restoration and management annual report 2001-02. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Land, E. D. 1994. Response of the wild Florida panther population to removals for captive breeding. Final Report 7571. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Lauritsen, J. 2006. Wood stork foraging assessment (Pilot Study); and an analysis of the historic data from Corkscrew's stork colony in light of hydrologic conditions. Unpublished report to the U.S. Fish and Wildlife Service, South Florida Ecological Services Office; Vero Beach, Florida.

Loftus, W.F. and A. Eklund. 1994. Long-term dynamics of an Everglades small-fish assemblage Pp. 461-484 in Everglades: The ecosystem and its restoration, Davis, S.M. and Ogden, J. C. (Eds.) St. Lucie Press, Delray, Florida.

Logan, T.J., A.C. Eller, Jr., R. Morrell, D. Ruffner, and J. Sewell. 1993. Florida panther habitat preservation plan - south Florida population. Prepared for the Florida Panther Interagency Committee.

Lotz, M., D. Land, M. Cunningham, and B. Ferree. 2005. Florida panther annual report 2004-05. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Loveless, C. M. 1959. The Everglades deer herd life history and management. Florida Game and Fresh Water Fish Commission Technical Bulletin 6, Tallahassee, FL.

Mac, M.J., P.A. Opler, C.E. Puckett Haecker, and P.D. Doran. 1998. Status and trends of the nation's biological resources. 2 vols. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia.

Maehr, D. S. 1990. Florida panther movements, social organization, and habitat utilization. Final Performance Report 7502. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Maehr, D. S. 1992. Florida panther. Pages 176 189 in S.R. Humphrey (ed). Rare and endangered biota of Florida. Volume I: mammals. University Press of Florida, Gainesville, FL.

Maehr, D. S. 1997. The comparative ecology of bobcat, black bear, and Florida panther in south Florida. Bulletin of the Florida Museum of Natural History 40:1-176.

Maehr, D. S., E. C. Greiner, J. E. Lanier, and D. Murphy. 1995. Notoedric mange in the Florida panther (Felis concolor coryi). Journal of Wildlife Diseases 31:251-254.

Maehr, D. S., E. D. Land, and J. C. Roof. 1991. Social ecology of Florida panthers. National Geographic Research & Exploration 7:414-431.

Maehr, D. S., E. D. Land, D. B. Shindle, O. L. Bass, and T. S. Hoctor. 2002a. Florida panther dispersal and conservation. Biological Conservation 106:187-197.

Maehr, D. S., E. D. Land, J. C. Roof, and J. W. McCown. 1990b. Day beds, natal dens, and activity of Florida panthers. Proceedings of Annual Conference of Southeastern Fish and Wildlife Agencies 44:310-318.

Maehr, D. S., J. C. Roof, E. D. Land, and J. W. McCown. 1989. First reproduction of a panther (Felis concolor coryi) in southwestern Florida, U.S.A. Mammalia 53: 129-131.

Maehr, D. S., R. C. Belden, E. D. Land, and L. Wilkins. 1990a. Food habits of panthers in southwest Florida. Journal of Wildlife Management 54:420-423.

McBride, R. T. 1985. Population status of the Florida panther in Everglades National Park and Big Cypress National Preserve. Report to National Park Service in fulfillment of Contract #RFP 5280-84 04, Homestead, FL.

McBride, R. T. 2000. Current panther distribution and habitat use: a review of field notes, fall 1999-winter 2000. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2001. Current panther distribution, population trends, and habitat use: report of field work: fall 2000-winter 2001. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2002. Current panther distribution and conservation implications -- highlights of field work: fall 2001 -- winter 2002. Report to Florida Panther Subteam of MERIT, U.S. Fish and Wildlife Service, Vero Beach, FL.

McBride, R. T. 2003. The documented panther population (DPP) and its current distribution from July 1, 2002 to June 30, 2003. Appendix IV in D. Shindle, M. Cunningham, D. Land, R. McBride, M. Lotz, and B. Ferree. Florida panther genetic restoration and management. Annual report 93112503002. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

McCown, J. W. 1994. Big Cypress deer/panther relationships: deer herd health and reproduction. Pages 197-217 in D. B. Jordan (ed). Proceedings of the Florida Panther Conference. U.S. Fish and Wildlife Service, Gainesville, FL.

McCown, J.W. 1991. Big Cypress Deer/Panther Relationships: Deer Herd Health and Reproduction. Final Report. Study Number: 7508. Bureau of Wildlife Research, Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.

Meyer, K.D. and P.C. Frederick. 2004. Survey of Florida's wood stork (Mycteria americana) nesting colonies, 2004. Unpublished report to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Miller, K. E. 1993. Habitat use by white-tailed deer in the Everglades: tree islands in a seasonally flooded landscape. M.S. Thesis. University of Florida, Gainesville, FL.

Nelson, E. W., and E. A. Goldman. 1929. List of the pumas with three described as new. Journal of Mammalogy 10:345-350.

Newell, David. 1935. Panther. The Saturday Evening Post. July 13:10-11, 70-72.

Noss, R. F. 1992. The wildlands project land conservation strategy. Wild Earth (Special Issue):10-25.

Noss, R. F., and A.Y. Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D.C.

Nowak, R. M., and R. T. McBride. 1974. Status survey of the Florida panther. Project 973. World Wildlife Fund Yearbook 1973-74:237-242.

Nowak, R. M., and R. T. McBride. 1975. Status of the Florida panther. Project 973. World Wildlife Fund Yearbook 1974-75:245-46.

Nowell, K., and P. Jackson. 1996. Status survey and conservation action plan: Wild cats. International Union for Conservation of Nature and Natural Resources. Burlington Press, Cambridge, U.K.

Oberholser, H.C. 1938. The bird life of Louisiana. Louisiana Department of Conservation, Bulletin 28.

Oberholser, H.C. and E.B. Kincaid, Jr. 1974. The bird life of Texas. University of Texas Press; Austin, Texas.

O'Connell, A.F. Jr., L. Ilse, and J. Zimmer. 1999. Annotated bibliography of methodologies to census, estimate, and monitor the size of white-tailed deer Odocoileus virginianus populations. Department of the Interior, National Park Service, Boston Support Office. Technical Report NPS/BSO-RNR/NRTR/00-2. 67 pages.

Ogden, J.C. 1991. Nesting by wood storks in natural, altered, and artificial wetlands in central and northern Florida. Colonial Waterbirds 14:39 45.

Ogden, J.C. 1996. Wood Stork in J.A. Rodgers, H. Kale II, and H.T. Smith, eds. Rare and endangered biota of Florida. University Press of Florida; Gainesville, Florida.

Ogden, J.C. and S.A. Nesbitt. 1979. Recent wood stork population trends in the United States. Wilson Bulletin. 91(4): 512-523.

Ogden, J.C., D.A. McCrimmon, Jr., G.T. Bancroft, and B.W. Patty. 1987. Breeding populations of the wood stork in the southeastern United States. Condor. 89:752 759.

Ogden, J.C., J.A. Kushlan, and J.T. Tilmant. 1976. Prey selectivity by the wood stork. Condor 78(3):324 330.

Ogden, J.C., J.A. Kushlan, and J.T. Tilmant. 1978. The food habits and nesting success of wood storks in Everglades National Park in 1974. U.S. Department of the Interior, National Park Service, Natural Resources Report No. 16.

O'Hare, N.K. and G.H. Dalrymple, 1997. Wildlife in Southern Everglades Invaded by Melaleuca (Melaleuca quinquenervia). 41 Bulletin of the Florida Museum of Natural History 1-68. University of Florida; Gainesville, FL.

Ohlendorf, H.M., E.E. Klass, and T.E. Kaiser. 1978. Environmental pollutants and eggshell thinning in the black-crowned night heron. In Wading Birds. A. Sprunt IV, J.C. Ogden, and S. Winckler (Eds). National Audubon Society. Research Report Number 7:63-82.

Olmstead, R. A., R. Langley, M. E. Roelke, R. M. Goeken, D. Adger-Johnson, J. P. Goff, J. P. Albert, C. Packer, M. K. Laurenson, T. M. Caro, L. Scheepers, D. E. Wildt, M. Bush, J. S. Martenson, and S. J. O'Brien. 1992. Worldwide prevalence of lentivirus infection in wild feline species: epidemiologic and phylogenetic aspects. Journal of Virology 66:6008-6018.

Palmer, R.S. 1962. Handbook of North American birds, Volume 1, Loons through Flamingos. Yale University Press; New Haven, Connecticut.

Passarella and Associates, Incorporated (PAI). 2004. White-Tailed Deer Census Report. Terafina Development. PAI and Associates, Incorporated; Fort Myers, Florida.

Rand, A.L. 1956. Foot stirring as a feeding habit of wood ibis and other birds. American Midland Naturalist 55:96 100.

Reed, J. M., P. D. Doerr, and J. R. Walters. 1988. Minimum viable population size of the red-cockaded woodpecker. Journal of Wildlife Management 50:239-247.

Reeves, K. A. 1978. Preliminary investigation of the Florida panther in Big Cypress Swamp. Unpublished report. Everglades National Park, Homestead, FL.

Rehage, J.S. and J.C. Trexler. In Press. Assessing the Net Effect of Anthropogenic Disturbance on Aquatic Communities in Wetlands: Community Structure Relative to Distance from Canals. Hydrobiologia

Rodgers, J.A. and S.T. Schwikert. 1997. Breeding success and chronology of wood storks (Mycteria americana) in northern and central Florida, USA. Ibis 139:76-91.

Rodgers, J.A., Jr. 1990. Breeding chronology and clutch information for the wood stork from museum collections. Journal of Field Ornithology 61(1):47 53.

Rodgers, J.A., Jr., A.S. Wenner, and S.T. Schwikert. 1987. Population dynamics of wood storks in north and central Florida. Colonial Waterbirds 10:151 156.

Rodgers, J.A., Jr., S.T. Schwikert, and A. Shapiro-Wenner. 1996. Nesting habitat of wood storks in north and central Florida, USA. Colonial Waterbirds 19(1):1-21.

Roelke, M. E. 1990. Florida panther biomedical investigation. Final Performance Report 7506. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Roelke, M. E. 1991. Florida panther biomedical investigation. Annual performance report, Study no. 7506. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Roelke, M. E., D. J. Forrester, E. R. Jacobsen, G. V. Kollias, F. W. Scott, M. C. Barr, J. F. Evermann, and E. C. Pirtle. 1993b. Seroprevalence of infectious disease agents in free-ranging Florida panthers (Felis concolor coryi). Journal of Wildlife Diseases 29:36-49.

Roelke, M. E., J. S. Martenson, and S. J. O'Brien. 1993a. The consequences of demographic reduction and genetic depletion in the endangered Florida panther. Current Biology 3:340-350.

Root, K. 2004. Florida panther (Puma concolor coryi): Using models to guide recovery efforts. Pages 491-504 in H. R. Akcakaya, M. Burgman, O. Kindvall, C. C. Wood, P. Sjogren-Gulve, J. Hatfield, and M. McCarthy (eds). Species Conservation and Management, Case Studies. Oxford University Press, New York, NY.

Rotstein, D. S., R. Thomas, K. Helmick, S. B. Citino, S. K. Taylor, and M. R. Dunbar. 1999. Dermatophyte infections in free-ranging Florida panthers (Felis concolor coryi). Journal of Zoo and Wildlife Medicine 30:281-284.

Sarkar, S. 2004. Conservation Biology: The Stanford Encyclopedia of Philosophy (Winter 2004 Edition), Edward N. Zalta (ed.). [online] URL: http://plato.stanford.edu/archives/ win2004/entries/conservation-biology.

Schortemeyer, J. L., D. S. Maehr, J. W. McCown, E. D. Land, and P. D. Manor. 1991. Prey management for the Florida panther: a unique role for wildlife managers. Transactions of the North American Wildlife and Natural Resources Conference 56:512-526.

Seal, U. S. (ed). 1994. A plan for genetic restoration and management of the Florida panther (Felis concolor coryi). Report to the Florida Game and Fresh Water Fish Commission, by the Conservation Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seal, U. S., and R. C. Lacy (eds). 1989. Florida panther (Felis concolor coryi) viability analysis and species survival plan. Report to the U. S. Fish and Wildlife Service, by the Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seal, U. S., and R. C. Lacy (eds). 1992. Genetic management strategies and population viability of the Florida panther (Felis concolor coryi). Report to the U. S. Fish and Wildlife Service, by the Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, MN.

Seidensticker, J. C., IV, M. G. Hornocker, W. V. Wiles, and J. P. Messick. 1973. Mountain lion social organization in the Idaho primitive area. Wildlife Monographs 35:1-60.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. BioScience 31:131-134.

Shaffer, M. L. 1987. Minimum viable populations: coping with uncertainty. Pages 69-86 in M. E. Soulé (ed). Viable populations for conservation. Cambridge University Press, NY.

Shaffer, M. L. 1978. "Determining Minimum Viable Population Sizes: A Case Study of the Grizzly Bear." Ph. D. Dissertation, Duke University.

Shindle D., M. Cunningham, D. Land, R. McBride, M. Lotz, and B. Ferree. 2003. Florida panther genetic restoration and management. Annual Report 93112503002. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Shindle, D., D. Land, K. Charlton, and R. McBride. 2000. Florida panther genetic restoration and management. Annual Report 7500. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Shindle, D., D. Land, M. Cunningham, and M. Lotz. 2001. Florida panther genetic restoration and management. Annual Report 7500. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Smith, T. R., and O. L. Bass, Jr. 1994. Landscape, white-tailed deer, and the distribution of Florida panthers in the Everglades. Pages 693-708 in S. M. Davis and J. C. Ogden (eds). Everglades: the ecosystem and its restoration. Delray Beach, FL.

Steelman, H.G., J.A. Bozzo, and J.L. Schortemeyer. 1999. Big Cypress National Preserve Deer and Hog Annual Report.

Swanson, K., D. Land, R. Kautz, and R. Kawula. In review. Use of least cost pathways to identify key highway segments for panther conservation. Unpublished report. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Taylor, S. K., C. D. Buergelt, M. E. Roelke-Parker, B. L. Homer, and D. S. Rotstein. 2002. Causes of mortality of free-ranging Florida panthers. Journal of Wildlife Diseases 38:107-114.

Thatcher, C., F. T. van Manen, and J. D. Clark. 2006. Identifying suitable sites for Florida panther reintroduction. Journal of Wildlife Management.

Tinsley, J. B. 1987. The puma: legendary lion of the Americas. Texas Western Press, University of Texas, El Paso, TX.

Tinsley, J. B. 1970. The Florida panther. Great Outdoors Publishing Company, St. Petersburg, FL.

Trexler, J.C., W.F. Loftus, F. Jordan, J.H. Chick, K.L. Kandl, T.C. McElroy, and O.L. Bass. 2002. Ecological scale and its implications for freshwater fishes in the Florida Everglades. Pages 153-182 In The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An ecosystem sourcebook (J. W. Porter and K. G. Porter, eds.). CRC Press, Boca Raton, Florida.

Turner, A.W., J.C. Trexler, C.F. Jordan, S.J. Slack, P. Geddes, J.H. Chick, and W.F. Loftus. 1999. Targeting ecosystem features for conservation: standing crops in the Everglades. Conservation Biology 13(4):898-911.

Turrell and Associates, Incorporated (Turrell). 2001. White-Tailed Deer Census Report. Collier Regional Medical Center Development. Turrell and Associates, Incorporated; Naples, Florida.

Tyson, E. L. 1952. Estimating deer populations from tracks. Annual Conference of Southeastern Association of Fish and Wildlife Agencies 6: 3-15.

U.S. Fish and Wildlife Service. 1996. Revised recovery plan for the U.S. breeding population of the wood stork. U.S. Fish and Wildlife Service. Atlanta, Georgia.

U.S. Fish and Wildlife Service. 1997. Revised recovery plan for the U.S. breeding population of the wood stork. U.S. Fish and Wildlife Service; Atlanta, Georgia.

U.S. Fish and Wildlife Service. 1999. Multi-species recovery plan (MSRP) for south Florida. Fish and Wildlife Service; Vero Beach, Florida.

U.S. Fish and Wildlife Service (Service). 2000. Florida panther final interim standard local operating procedures (SLOPES) for endangered species. Fish and Wildlife Service; Vero Beach, Florida.

U.S. Fish and Wildlife Service. 2003. Wood Stork Report. Volume 2, Number 1. March 2003. U.S. Fish and Wildlife Service, Jacksonville, Florida.

U.S. Fish and Wildlife Service. 2004. Wood stork report. Volume 3, Number 1, April 2004. U.S. Fish and Wildlife Service; Jacksonville, Florida.

U.S. Fish and Wildlife Service (Service). 2006. Florida panther recovery plan: third revision. January 2006. Prepared by the Florida Panther Recovery Team and the South Florida Ecological Services Office. Fish and Wildlife Service; Atlanta, Georgia.

Van Dyke, F. G., R. H. Brocke, and H. G. Shaw. 1986a. Use of road track counts as indices of mountain lion presence. Journal Wildlife Management 50:102-109.

Van Dyke, F. G., R. H. Brocke, H. G. Shaw, B. B. Ackerman, T. P. Hemker, and F. G. Lindzey. 1986b. Reactions of mountain lions to logging and human activity. Journal of Wildlife Management 50:95-102.

Wayne, A.T. 1910. Birds of South Carolina. Contributions to the Charleston Museum No.1.

Wehinger, K. A., M. E. Roelke, and E. C. Greiner. 1995. Ixodid ticks from Florida panthers and bobcats in Florida. Journal of Wildlife Diseases 31:480-485.

Wilkins, L., J. M. Arias-Reveron, B. Stith, M. E. Roelke, and R. C. Belden. 1997. The Florida panther (Puma concolor coryi): a morphological investigation of the subspecies with a comparison to other North and South American cougars. Bulletin of the Florida Museum of Natural History 40:221-269.

WilsonMiller. 2005. Email message to the Fish and Wildlife Service, South Florida Ecological Services Office, dated February 11, 2005.

Young, S. P., and E. A. Goldman. 1946. The puma-mysterious American cat. American Wildlife Institute, Washington, D.C.

Table 1.* Targeted and Acquired Acreage Totals of Conservation Lands in South Florida Directly Affecting the Panther within the Consultation Area.

Name	Targeted[1] Acreage	Acquired Acreage	Indian Reservation
Federal Conservation Lands			
Everglades National Park	1,508,537	1,508,537	--
Big Cypress National Preserve	720,000	720,000	--
Florida Panther National Wildlife Refuge	26,400	26,400	--
Subtotal	**2,254,937**	**2,254,937**	--
State of Florida: Florida Forever Program			
Belle Meade	28,505	19,107	--
Corkscrew Regional Ecosystem Watershed	69,500	24,028	--
Twelvemile Slough	15,653	7,530	--
Panther Glades	57,604	22,536	--
Devil's Garden	82,508	0	--
Caloosahatchee Ecoscape	18,497	2,994	--
Babcock Ranch	91,361	0	--
Fisheating Creek	176,760	59,910	--
Subtotal	**540,388**	**136,105**	**--**
State of Florida: Other State Acquisitions			
Water Conservation Area Number 3	491,506	491,506	--
Holey Land Wildlife Management Area	33,350	33,350	--
Rotenberger Wildlife Management Area	25,019	20,659	--
Fakahatchee Strand State Preserve	74,374	58,373	--
Picayune Strand State Forest	55,200	55,200	--
Okaloacoochee Slough State Forest and WMA	34,962	34,962	--
Babcock-Webb Wildlife Management Area	79,013	79,013	--
Subtotal	**793,424**	**773,063**	**--**
Indian Reservations[2]			
Miccosukee Indian Reservation	--	--	81,874
Big Cypress Seminole Indian Reservation	--	--	68,205
Brighton Seminole Indian Reservation	--	--	37,447
Subtotal	**--**	**--**	**187,526**
GRAND TOTALS	**3,588,749**	**3,164,105**	**187,526**

1 Targeted acres not available for all lands. In Such cases, targeted equals acquired acreage.

2 Indian lands are included due to their mention in the MSRP. Acreages taken from GIS data.

* Table 2 was excerpted from the Brief of Amicus (2003). However, the lands shown as acquired in this table may include some private in-holdings and may include lands currently under sales negotiations or condemnation actions.

Table 2. Habitat preservation efforts resulting from formal and informal consultations with the Service for projects affecting Florida panther habitat from March 1984 to October 2006.

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
03/29/84	4-1-83-195	83M-1317	Ford Test Track	Collier	530	0	0	0
02/21/85	4-1-85-018	unknown	I-75	Broward Collier	1,517	0	0	0
10/17/86	4-1-87-016 4-1-87-017	unknown	Exxon Master Plan	Collier	9	0	0	0
01/07/87	4-1-86-303	86IPM-20130	Citrus Grove	Collier	11,178	0	0	0
01/11/88	4-1-88-029	unknown	NERCO - Clements Energy	Collier	3	0	0	0
02/23/88	4-1-88-055	unknown	Shell Western E&P	Collier Dade Monroe	0	0	0	0
02/10/89	4-1-89-001	FAP IR-75-4(88)81	SR 29/I-75 Interchange	Collier	350	0	0	0
08/15/90	4-1-90-289	unknown	I-75 Recreational Access	Collier	150	0	0	0
09/24/90	4-1-90-212	89IPD-20207	U.S. Sugar Corporation	Hendry	28,740	700	0	700
03/12/91	4-1-91-229	90IPO-02507	Lourdes Cereceda	Dade	97	0	0	0
01/14/92	4-1-91-325	199101279	Dooner Gulf Coast Citrus	Collier	40	40	0	40
09/25/92	4-1-92-340	unknown	STOF, BCSIR Citrus Grove	Hendry	1,995	0	0	0
06/18/93	4-1-93-217	199200393	Corkscrew Road	Lee	107	0	0	0
02/25/94	4-1-94-209	199301131	Daniels Road Extension	Lee	65	0	0	0
05/09/94	4-1-93-251	199202019	Corkscrew Enterprises	Lee	900	100	100	200
10/27/94	4-1-94-430	199302371 199400807 199400808	Florida Gulf Coast University Treeline Boulevard	Lee	1,088	526	0	526
05/24/95	4-1-95-230	199302130	Turner River Access	Collier	1,936	0	0	0
08/07/95	4-1-95-274	199405501	Bonita Bay Properties	Collier	509	491	0	491

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
08/15/95	4-1-94-214	199301495	SW Florida Airport Access Road	Lee	14	0	0	0
09/19/96	4-1-95-F-230	199302052 199301404	I-75 Access Points	Broward	116	0	0	0
03/10/98	4-1-98-F-3	L30 (BICY)	Calumet Florida	Collier Broward Dade	0	0	0	0
03/27/98	4-1-97-F-635	199604158	Willow Run Quarry	Collier	359	190	0	190
06/11/99	4-1-98-F-398	199800622	STOF Water Conservation Plan	Hendry	1,091	0	0	0
09/27/99	4-1-98-F-310	199130802	Daniels Parkway	Lee	2,093	0	94	94
12/08/99	4-1-98-F-517	199607574	Cypress Creek Farms	Collier	239	0	24	24
04/17/00	4-1-98-F-428	199507483	Miromar	Lee	1,323	0	194	194
06/09/00	4-1-99-F-553	199900619	Naples Reserve	Collier	833	0	320	320
02/21/01	4-1-00-F-135	199803037	Corkscrew Ranch	Lee	106	0	0	0
04/17/01	4-1-00-F-584	200001436	Sun City	Lee	1,183	0	408	408
07/30/01	4-1-94-357	199003460	Naples Golf Estates	Collier	439	175	0	175
08/31/01	4-1-00-F-183	199900411	Colonial Golf Club	Lee	1,083	0	640	640
12/14/01	4-1-00-F-585	199301156	SW Florida Airport	Lee	8,058	0	6,986	6,986
01/30/02	4-1-98-F-372	199402492	Florida Rock	Lee	5,269	802	0	802
03/07/02	4-1-00-F-178	199901251	Southern Marsh Golf	Collier	121	75	80	155
04/24/02	4-1-01-F-148	199901378	Hawk’s Haven	Lee	1,531	267	0	267
09/24/02	4-1-01-F-135	200001574	Verandah	Lee	1,456	0	320	320
10/08/02	4-1-02-F-014	199602945	Winding Cypress	Collier	1,088	840	1,030	1,870
05/19/03	4-1-02-F-1741	200200970	Apex Center	Lee	95	10	18	28
06/10/03	4-1-01-F-1955	200003795	Walnut Lakes	Collier	157	21	145	166
06/18/03	4-1-01-F-136	199701947	Twin Eagles Phase II	Collier	593	57	98	155

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
06/23/03	4-1-01-F-143	199905571	Airport Technology	Lee	116	55	175	230
07/02/03	4-1-98-F-428	199507483	Miromar	Lee	342	158	340	498
09/04/03	4-1-02-F-1486	200206725	State Road 80	Lee	33	2	12	14
10/06/03	4-1-02-F-0027	200102043	Bonita Beach Road	Lee	1,117	145	640	785
12/29/03	4-1-02-F-1743	200202926	The Forum	Lee	650	0	310	310
01/18/05	4-1-04-F-4259	199702228	Bonita Springs Utilities	Lee	79	0	108	108
02/21/03 03/09/05	4-1-01-F-607	200001926	Mirasol	Collier	800	914	145	1,059
03/31/05	4-1-04-F-5656	200306759	Gateway Shoppes II	Collier	82	0	122	122
04/08/05	4-1-04-F-8176	2004-5312	Seminole Mine	Broward	110	0	220	220
04/29/05	4-1-04-F-5780 4-1-04-F-5982	2003-5331 2003-6965	Arborwood and Treeline Avenue	Lee	2,329	0	1,700	1,700
06/06/05	4-1-03-F-7855	2003-11156	Collier Regional Medical	Collier	44	0	64	64
06/14/04 03/21/05	4-1-04-F-5744	199603501	Terafina	Collier	437	210	261	471
02/22/05 03/16/05 06/29/05 04/04/06	4-1-04-F-6866	200309416	Ava Maria DRI	Collier	5,027	0	6,114	6,114
06/29/05	4-1-03-F-3915	199806220	Wenthworth Estates	Collier	917	0	458	458
07/15/05	4-1-04-F-5786	199405829	Land's End Preserve	Collier	231	0	61	61
09/08/05	4-1-04-F-5260	200106580	Parklands Collier	Collier	489	157	434	591
09/23/05 10/26/05	4-1-04-F-9348	200101122	Super Target-Tarpon Bay Plaza	Collier	34	0	20	20
11/23/05	4-1-04-F-6043	20034914	Summit Place	Collier	108	0	61	61
11/29/05	4-1-04-F-8847	20048995	STOF Administrative Complex	Collier	6	0	8	8
12/06/05	4-1-03-F-3483	200302409	SW Florida Commerce	Lee	207	0	305	305

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
			Center					
12/06/05	4-1-04-F-6691	200310689	Rattlesnake Hammock Road Widening	Collier	23	0	23	23
01/04/06	4-1-04-F-8388	2004554	Immokalee Regional Airport - Phase I	Collier	67	0	43	43
01/04/06	4-1-04-F-9777	20048577	Logan Boulevard Extension	Collier	30	0	10	10
1/13/06	4-1-04-F-6707	20042404	Journey's End	Collier	66	0	34	34
01/26/06	4-1-04-F-8940	20047053	The Orchard	Lee	93	0	81	81
02/19/06	4-1-05-F-11724	2005834	Firano at Naples	Collier	24	0	19	19
02/22/06	4-1-04-F-6504	200491	Corkscrew Road	Lee	20	0	47	47
02/23/06	4-1-04-F-5244	200312276	Summit Church	Lee	10	0	13	13
03/31/06	4-1-05-F-11343	20051909	Coral Keys Homes	Miami-Dade	41	0	61	61
05/05/06	41420-2006-I-0274	2005-6176	Santa Barbara , Davis to Radio Road, Widening	Collier	6	0	3	3
05/9/06	41420-2006-I-0263	20056298	Santa Barbara and Radio Road Widening	Collier	29	0	20	20
05/9/06	41420-2006-F -0089	20043248	Collier Boulevard, Immokalee Rd. to Goldengate Blvd.	Collier	14	0	16	16
05/16/06	4-1-05-F-10309	19971924	Sabal Bay	Collier	1,017	1,313	223	1,536
06/05/06	4-1-05-I-8486	20041688	Seacrest School	Collier	31	0	16	16
06/09/06	4-1-05-I-10965	200303733	HHJ Development	Dade	3	0	4	4
06/14/06	4-1-05-F-11855	200411010	Keysgate School	Dade	39	0	62	62

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
06/15/06	41420-2006-FA-0811 and I-0362	20056149	Collier County Wellfield	Collier	29	0	36	36
07/12/06	41420-2006-F-0282	200311150	Cypress Shadows	Lee	244	0	326	326
07/28/06	4-1-04-F-12330	20047920	Hamilton Place	Dade	10	0	50	50
07/28/06	4-1-04-F-7279	20041695	Raffia Preserve	Collier	131	0	119	119
08/15/06	41420-2006-I-0151	20031963	Naples Custom Homes	Collier	10	0	9	9
08/21/06	4-1-03-F-3127	19956797	Atlantic Civil Agriculture Expansion	Dade	981	0	1553	1553
08/21/06	4-1-03-I-0540	20041813	ASGM Business Park	Collier	41	0	25	25
9/12/06	41420-2006-FA-0589 and F-0554	20037414	Miccosukee Government Complex	Dade	17	0	37	37
9/22/06	41420-2006-I-0355	20040047	Immokalee Seminole Reservation Road Improvements	Collier	17	0	35	35
10/16/06	41420-2006-FA-1488 and F-0442	199507483	Miromar Lakes Addition	Lee	366	0	390	390
10/05/06	41420-2006-I-0616	20065295	New Curve on Corkscrew Road	Lee	12	0	18	18
10/18/06	41420-2007-FA-0029 and F-0787	2004777	Treeline Preserve	Lee	97	0	95	95
10/25/06	41420-2006-FA-1129 and F-0442	20047046	Koreshan Boulevard Extension	Lee	14	0	31	31
10/26/06	41420-2006-FA-1636 and F-0787	200306755	Jetway Tradeport	Lee	38	0	51.5	52

Date	Service Log Number	Corps Application Number	Project Name	County	Habitat Impacts (Acres)	Habitat Preserved On-site (Acres)	Habitat Preserved Off-site (Acres)	Total Habitat Preserved (Acres)
10/26/06	41420-2006-I-0849	20055702	Marina Del Lago	Lee	49	0	36	36
10/27/06	41420-2006-I-0203	20057180	Living Word Family Church	Collier	18	0	35	35
10/30/06	41420-2006-I-0607	200604878	SeminoleTribe Access Road	Hendry	2	0	5	5
11/15/06	41420-2006-TA-0727	N/A	Liberty Landing	Collier	27	0	19	19
pending	41420-2006-F-0850	200312445	Airport Interstate Commerce Park	Lee	323	0	371	371
02/21/03 03/09/05 05/03/07	4-1-01-F-607	200001926	Mirasol	Collier	773	941	182	1,117
pending	4-1-04-F-6112	20021683	Alico Airpark (Haul Ventures)	Collier	241	75	414	489
				Totals	94,088	7,349	26,464	33,814

Table 3: Undeveloped Privately Owned Land within Florida Panther Core Area

	Acres	Primary Equivalent Factor	Primary Equivalent Acres
Primary	610,935	1.00	610,935
Dispersal	27,883	1.00	27,883
Secondary	503,481	0.69	347,402
Other	655,996*	0.33	216,479

*** About 819,995 acres are at risk in the other zone with about 80 percent with resource value**

Table 4: Land Held for Conservation within the Florida Panther Core Area

	Acres	Primary Equivalent Factor	Primary Equivalent Acres
Primary	1,659,657	1.00	1,659,657
Dispersal	0	1.00	0
Secondary	308,623	0.69	212,950
Other	609,872	0.33	201,258

Table 5. Landscape Compensation Multipliers

Zone of Impacted Lands	Zone of Compensation Lands	Multiplier
Primary	Secondary	1.45
Secondary	Primary	0.69
Other	Secondary	0.48
Other	Primary	0.33

Table 6. Habitat suitability values for use in assessing habitat value to the Florida panther.

Land Cover Type	Value	Land Cover Type	Value	Land Cover Type	Value
Water	0	STA	4.5	Cypress swamp	9
Urban	0	Shrub swamp	5	Sand pine scrub	9
Coastal strand	1	Shrub and brush	5	Sandhill	9
Reservoir	1.5	Dry prairie	6	Hardwood-Pine forest	9
Mangrove swamp	2	Grassland/pasture	7	Pine forest	9
Salt marsh	2	Freshwater marsh	9	Xeric oak scrub	10
Exotic plants	3	Bottomland hardwood	9	Hardwood forest	10
Cropland	4	Bay swamp	9		
Orchards/groves	4	Hardwood swamp	9		

Table 7. Wood Stork Nesting Data in the Southeastern U.S. (Gawlik 1987, Service 2006)

YEAR	TOTAL		FLORIDA		GEORGIA		SOUTH CAROLINA		NORTH CAROLINA	
	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies
1981	4,442	22	2,365	19	275	2	11	1		
1982	3,575	22	778	19	135	2	20	1		
1983	5,983	25	2,350	22	363	2	20	1		
1984	6,245	29	1,550	25	576	3	22	1		
1985	5,193	23	1,455	17	557	5	74	1		
1986	5,835	36	5,067	29	648	4	120	3		
1987			**		506	5	194	3		
1988			**		311	4	179	3		
1989			**		543	6	376	3		
1990			**		709	10	536	6		
1991	4,073	37	2,293	23	969	9	664	3		
1992			**		1,091	9	475	3		
1993	6,729	43	4,262	28	1,661	11	806	3		
1994	5,768	47	3,589	26	1,468	14	712	7		
1995	7,853	54	5,617	33	1,501	17	829	6		
1996			**		1,480	18	953	7		

YEAR	TOTAL		FLORIDA		GEORGIA		SOUTH CAROLINA		NORTH CAROLINA	
	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies	Nesting Pairs	Colonies
1997	5,166	59	2,870	36	1,379	15	917	8		
1998			**		1,665	15	1,093	10		
1999	9,000	63	7341	42	1,139	13	520	8		
2000			**		566	7	1,236	11		
2001	4,998	44	2,662	22	1,162	12	1,174	9		
2002	7,855	70	5,463	48	1,256	14	1,136	10		
2003	9,551	78	6,449	49	1,653	18	1,356	11		
2004	8,857	93	5,227	63	1,596	17	2,034	13		
2005	5,560	74	2,336	41	1,817	19	1,407	14	32	1
2006	11,232	81	7,216	49	1,928	21	1,963	12	125	1

**Some data from Florida not readily available due to inconsistent survey or reporting.

Table 8. Total Number of Wood Stork Nesting Pairs within the Everglades and Big Cypress Basins, 1996 to Present

Year	Nesting Pairs	3-Year Running Average
1996	600	-
1997	445	-
1998	475	507
1999	4,549	1,823
2000	3,996	3,007
2001	2,681	3,742
2002	2,880	3,186
2003	2,386	2,649
2004	1,015	2,094
2005	634	1,345
2006	2,710	1,453

Table 9. Panther-Vehicle Collisions within the Mirasol Action Area as of February 5, 2007.

Distance from Project	Roadway	Year	Sex	Panther	Result
24 miles southeast	SR 29	1979	F	UCFP04	Death
22 miles east	SR 29	1980	M	UCFP05	Death
22 miles southeast	SR 84	1983	M	FP01	Death
20 miles southeast	SR 84	1984	F	UCFP12	Death
20 miles southeast	SR 84	1985	F	UCFP13	Death
21 miles southeast	SR 84	1985	M	FP04	Death
14 miles south	CR 951	1985	F	NONE	Injury
25 miles southeast	SR 29	1985	M	FP07	Death
20 miles southeast	SR 84	1986	F	UCFP15	Death
23 miles east	CR 858	1987	M	FP20	Injury
22 miles east	SR 29	1988	M	FP13	Death
18 miles north	Daniels Road	1989	M	FP28	Injury
17 miles northeast	CR 850	1989	M	UCFP18	Death
24 miles southeast	SR 29	1990	M	FP37	Death
22 miles east	SR 29	1991	F	UCFP20	Death
14 northwest	Alico Road	1992	M	NONE	Injury
22 miles east	SR 29	1992	F	UCFP21	Death
18 miles northwest	Daniels Road	1993	M	UCFP22	Death
25 miles northeast	CR 846	1993	M	FP50	Death
22 miles east	SR 29	1994	F	FP31	Death
23 miles northeast	CR 846	1995	F	FP52	Death
25 miles northeast	CR 846	1997	?	UCFP31	Death
23 miles southeast	SR 29	1998	M	FP64	Death
23 miles southeast	SR 29	1998	M	FP51	Injury
21 miles east	CR 858	2000	M	K76	Death
21 miles northeast	CR 846	2000	M	UCFP35	Death
24 miles northeast	CR 846	2000	F	UCFP37	Death
22 miles east	SR 29	2001	M	UCFP41	Death
22 miles east	SR 29	2002	M	FP98	Death
25 miles northeast	CR 846	2002	F	UCFP48	Death
22 miles northeast	CR 846	2002	F	UCFP49	Death
7 miles east	CR 846	2002	M	FP99	Death
14 miles northeast	CR 846	2003	M	UCFP50	Death
22 miles east	SR 29	2003	F	FP106	Death
22 miles east	SR 29	2003	F	UCFP53	Death
22 miles east	SR 29	2003	M	UCFP54	Death
14 miles northeast	CR 846	2003	F	UCFP58	Death
21 miles east	CR 858	2003	F	UCFP59	Death
23 miles southeast	US 41	2003	M	UCFP60	Death
10 miles southeast	I-75	2004	M	UCFP63	Death

Distance from Project	Roadway	Year	Sex	Panther	Result
23 miles southeast	SR 29	2004	M	UCFP65	Death
14 miles southeast	I-75	2004	M	UCFP66	Death
11 miles south	US 41	2004	M	K156	Death
11 miles south	I-75	2004	M	K94	Death
22 miles east	SR 29	2004	F	UCFP69	Death
22 miles east	SR 29	2004	F	UCFP70	Death
14 miles south	CR 951	2005	M	UCFP73	Death
22 miles northeast	SR 29	2005	M	UCFP75	Death
11 miles south	CR 951	2005	M	K153	Death
17 miles south	US 41	2005	M	UCFP76	Death
7 miles east	CR 846	2006	F	UCFP79	Death
25 miles north	I-75	2006	M	UCFP81	Death
11 miles north	Corkscrew Road	2006	M	UCFP87	Death
17 miles south	US 41	2006	F	UCFP88	Death

Table 10. County and State Acquisitions within the Action Area (Acres)

Year	*County*	*State*
1999	67.20	8,838.85
2000	542.03	2,179.29
2001	590.89	2,449.52
2002	2,054.02	3,558.82
2003	116.55	65.95
2004	**	**
Totals	3,370.69	17,092.43

**Data unavailable

Table 11
Florida Panther Habitat Matrix
Panther Habitat Units

Land Cover Types	Habitat Values	Project Development 773 acres				On-site Preserve 941 acres				Off-site Preserve PIMB 82 acres				Off-site Preserve Primary Zone 94 acres			
		Functional Units Needed 7512*				Functional Units Provided 6500**				Functional Units Provided 738				Functional Units Provided 750*** average of 8 PHU's per acre			
		Pre		Post		Pre		Post		Pre		Post		Pre		Post	
		Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU	Acres	PHU
Water/Urban	0	0	0	773	0	1	0	31	0								
Exotic Plants	3	553	1659			607	1822	0	0								
Hardwood Swamp	9	1	9			1	9	1	9								
Cypress Swamp	9	44	393			102	917	119	1075	41	369	0	0				
Pine Forest	9	174	1563			228	2048	780	7024	41	369	0	0				
Freshwater Marsh	9	0	0			1	9	8	74								
Dry Prairie	6	2	12			1	6	1	6								
Subtotal		773	3756	773	0	941	4812	941	8188	82	738	0	0				

* The Service had previously agreed, prior to the reinitiation of formal consultation with the Corps, that a base ratio of 2.0 would be the multiplier for recommended compensation for project functional habitat evaluations.

** Functional Units provided is one-half of the difference between pre and post enhancement values added to the pre value.

*** As part of the applicant's compensation proposal, an additional 750 PHUs are proposed for acquisition within Primary Zone lands.

Table 12. Mirasol Consultation Area Project List – Panthers

Less than 5 percent Wetland Acres						
Project Name	**Wetland Acres**	**Total Acres**	**Percent Wetland Acres**	**DRI**	**PUD**	**District**
BOB EVANS FT MYERS	0.00	0.23	0.00%			2003
BONITA BEACH RD / BONITA GRANDE INTERSECTION IMPROVEMENTS	0.00	0.17	0.00%			2004
BONITA BEACH RD / BONITA GRANDE INTERSECTION IMPROVEMENTS	0.00	0.40	0.00%			2004
BONITA BEACH RD / BONITA GRANDE INTERSECTION IMPROVEMENTS	0.00	0.38	0.00%			2004
CALOOSA LAKES	0.00	196.74	0.00%			2003
CITY GATE COMMERCE CENTER	0.00	10.83	0.00%			2003
DAVES TOWING	0.00	0.67	0.00%			2003
DAVIS CROSSINGS	0.00	20.86	0.00%			2003
FLEET LEGACY AT LEHIGH	0.00	9.38	0.00%			2003
IMMOKALEE FIFTH STREET DITCH PROJECT	0.00	0.88	0.00%			2003
IMMOKALEE FLORIDA SPECIALTIES DITCH ENCLOSURE	0.00	1.24	0.00%			2003
LEE COUNTY ELEMENTARY SCHOOL S	0.00	47.08	0.00%			2004
OAK RIDGE SUBDIVISION	0.00	1.02	0.00%			2003
PALM STREET OUTFALL IMPROVEMENTS	0.00	0.46	0.00%			2003
QUARRY LAKE ESTATES	0.00	41.23	0.00%			2004
R AND L CARRIERS FORT MYERS	0.00	41.26	0.00%			2003
ROOKERY BAY PEDESTRIAN BRIDGE CROSSING	0.00	0.23	0.00%			2003
SHADOW LAKES (F.K.A. BELL PRESERVE)	0.00	0.23	0.00%			2003
SIX MILE CYPRESS PLAZA ROAD REALIGNMENT	0.00	0.22	0.00%			2004
TAYLOR ROAD / HOMESTEAD ROAD TURN LANE	0.00	0.45	0.00%			2003
TIERRA BAY	0.00	66.26	0.00%			2004
VAN ROEKEL AND VAN ROEKEL DVM PH1	0.00	0.72	0.00%			2003
WALLS CORNER LOT	0.00	0.23	0.00%			2003
WOODWARD MANOR	0.00	10.35	0.00%			2003
ASTRON PLAZA	0.00	8.56	0.00%		2004	
COLONADES AT SANTA BARBARA	0.00	6.83	0.00%		2004	
DA VINCI ESTATES IN OLDE CYPRESS	0.00	40.37	0.00%		2001	
IMMOKOLEE SENIOR HOUSING	0.00	7.44	0.00%		2004	
MILLER SQUARE	0.00	1.9	0.00%		2003	
SALVATION ARMY	0.00	6.51	0.00%		2001	
SANDPIPER VILLAGE	0.00	14.99	0.00%		2002	
MANDALAY	0.00	28.06	0.00%		2003	
AIRPORT SOUTH INTERCHANGE CPD	0.00	31.65	0.00%		2002	
CPD EAST COUNTY WATER CONTROL DISTRICT CPD	0.00	3.18	0.00%		2004	
VILLAGE WALK - BONITA SPRINGS	0.04	631.33	0.01%			2003
BRISTOL PINES	0.01	22.77	0.04%		2004	
SEACREST UPPER SCHOOL CAMPUS	0.01	9.97	0.10%			2004
CORKSCREW GROWERS SEC 3 RPD/CPD	3.60	652.91	0.55%		2002	
LEE PARKLANDS - NORTHWEST MODIFICATIONS	3.53	316.71	1.11%			2003
MAGNOLIA SQUARE PHASE 3	0.57	42.83	1.33%			2004
JOEL BLVD SIDEWALK IMPROVEMENTS (CTY RD 884)	0.21	11.83	1.78%			2003
JAMERSON EXCAVATION	2.54	125.21	2.03%			2004
LEE BOULEVARD 130	4.17	139.14	2.99%			2003
COLLIER REGIONAL MEDICAL	0.83	18.48	4.49%			2003
FIRST NATIONAL BANK OF FLORIDA/NAPLES LAKES BRANCH	0.41	8.96	4.57%			2003
		2,581.15				

Table 13. Foraging Suitability Values for Various Densities of Exotics

Cover Type	# of Species (S)	# of Individuals (I)	S * I	Foraging Suitability Value
DMM	1	2	2	0
DMS	4	10	40	3
P75	10	59	590	37
P50	11	92	1089	70
MAR	12	132	1584*	100

* Represents maximum number of individuals

Table 14. Acreages of Habitats within the Impact Footprint

	Pre-Development Acreage Total	< 25% Melaleuca Coverage	25% - 50% Melaleuca Coverage	50% - 75% Melaleuca Coverage	75%-90% Melaleuca Coverage	90%-100% Melaleuca Coverage
UPLANDS						
411 – Pine Flatwoods	122.70	18.51	72.58		31.61	
ROW – Road Right-of-way	4.92			4.92		
WETLANDS						
424 – Melaleuca	154.04				42.5	111.51
617 – Mixed Wetland Hardwoods	1.25		1.25			
621 – Cypress	10.78	2.79	6.00	1.99		
624 – Pine / Cypress Flatwood	32.04		4.88	16.60	10.56	
625 – Hydric Pine Flatwood	443.80		80.58	116.13	247.09	
643 – Disturbed Prairie	3.44	3.44				
DEVELOPMENT TOTAL	**772.97**	**24.74**	**165.29**	**139.64**	**331.79**	**111.51**

Table 15. Acres of Suitable Foraging Habitat within the Development Footprint

	Pre-Development Acreage	**< 25% Melaleuca Coverage**	**25% - 50% Melaleuca Coverage**	**50% - 75% Melaleuca Coverage**	**75% - 90% Melaleuca Coverage**
617 – Mixed Wetland Hardwoods	1.25		1.25		
621 – Cypress	10.78	0.03	2.76	7.99	
624 – Pine / Cypress Flatwood	28.51		4.88	9.63	10.56
625 – Hydric Pine Flatwood	450.27		80.58	123.1	247.09
643 – Disturbed Prairie	3.44	3.44			
TOTAL	**491.31**	**3.47**	**89.47**	**140.72**	**257.65**

Table 16. Hydroperiod Classes of Wetlands Suitable for Wood Stork Foraging in the Action Area and Suitable Wood Stork Foraging Area.

Hydroperiod	**Combined Core Foraging Area Acreage**	**Combined Suitable Wood Stork Core Foraging Area Acreage**
Class 1 - 0 to 60 days	227,845	205,061
Class 2 - 60 to 120 days		
Class 3 - 120 to 180 days		
Class 4 - 180 to 240 days	253,821	228,439
Class 5 - 240 to 300 days		
Class 6 - 300 to 330 days		
Class 7 - 330 to 365 days		
TOTAL	**481,666**	**433,500**

Table 17. Hydroperiod Classes of Wetlands Suitable for Wood Stork Foraging in the Project Area.

Hydroperiod	Development Footprint
Class 1 - 0 to 60 Days	
Class 2 - 60 to 120 Days	66.69
Class 3 - 120 to 180 Days	410.48
Class 4 - 180 to 240 Days	13.08
Class 5 - 240 to 300 Days	1.06
Class 6 - 300 to 330 Days	
Class 7 - 330 to 365 days	
TOTAL	**491.31**

Table 18. Hydroperiod Classes of Wetlands Suitable for Wood Stork Foraging in the Preserve Area. (Pre and Post enhancement activities)

Hydroperiod	Preserve Area Footprint Pre-Enhancement	Preserve Area Footprint Post-Enhancement
Class 1 - 0 to 60 Days		
Class 2 - 60 to 120 Days	17.01	17.01
Class 3 - 120 to 180 Days	377.60	490.55
Class 4 - 180 to 240 Days	118.22	238.46
Class 5 - 240 to 300 Days	85.07	85.07
Class 6 - 300 to 330 Days	0.27	0.27
Class 7 - 330 to 365 days		
TOTAL	**598.17**	**831.36**

Table 19. Acreage and Biomass in Individual Hydroperiod Classes of Wetlands Suitable for Wood Stork Foraging in the Development and the pre and post Restoration of the Preserves.

Hydroperiod	Existing Footprint		Preserve Area				Net Change*	
			Pre Enhancement		Post Enhancement			
	Acres	Kgrams	Acres	Kgrams	Acres	Kgrams	Acres	Kgrams
Class 1 - 0 to 60 Days								
Class 2 - 60 to 120 Days	66.69	44.97	17.01	7.26	17.01	18.55	-66.69	-33.68
Class 3 - 120 to 180 Days	410.48	198.39	377.60	205.15	490.55	1,233.79	-297.53	830.25
Class 4 - 180 to 240 Days	13.08	25.70	118.22	358.09	238.46	1,114.59	107.16	730.80
Class 5 - 240 to 300 Days	1.06	3.69	85.07	405.98	85.07	473.37	-1.06	63.70
Class 6 - 300 to 330 Days			0.27	1.74	0.27	1.74	0.00	0.00
Class 7 - 330 to 365 days								
TOTAL	**491.31**	**272.75**	**598.17**	**978.22**	**831.36**	**2,842.04**	**-258.12**	**1,591.07**

- The acreage net change is based on the overall increase/decrease in suitable wood stork foraging habitat within the project. The project will result in the loss of 645 acres of wetlands, of which 491 are considered suitable for wood stork foraging. The preserves include 831 acres of wetlands of which 598 acres are suitable, without restoration, for wood stork foraging. Following restoration, all 831 acres are suitable for wood stork foraging. Although restoration provides an increase of 233 acres of wood stork foraging habitat, the project development provides a loss of 491 acres of foraging habitat with an overall project loss of 258 acres of wood foraging habitat.

- The biomass net change is based on the overall increase/decrease of fish biomass available to wood storks. The proposed development will provide a loss of 273 kg of biomass. The preserves, prior to enhancement, provide a biomass of 978 kg, with a post enhancement value of 2,842 kg, equating to an increase of 1,864 kg of biomass. Subtraction the development loss from the biomass increase from the preserve restoration, the proposed action provides a net increase of 1,591 kg of biomass available for wood stork foraging.

Table 20. Wood Stork Suitable Foraging Prey Base Loss (Development Area)

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetland Impacts (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
1	424/624	Melaleuca(>75%) / Cypress / Pine	2.37	2	9591.06	0.03	0.49	0.55	77.54
3	621	Cypress / Melaleuca (>50%)	2.50	4	10117.15	0.37	2.10	0.55	4323.56
4	424	Melaleuca	42.50	3	171991.55	0	1.13	0.55	0
6	624/424	Pine / Cypress / Melaleuca (>50%)	6.97	3	28206.61	0.37	1.13	0.55	6486.25
8	624	Pine / Cypress / Melaleuca (>75%)	8.19	3	33143.78	0.03	1.13	0.55	617.97
14	625/424	Pine Flatwoods / Melaleuca (>50%)	1.68	3	6798.72	0.37	1.13	0.55	1563.40
20	424/625	Melaleuca(>50%) / Pine Flatwoods	29.71	3	120232.21	0.37	1.13	0.55	27648.00
21	643	Disturbed Wet Prairie	3.44	3	13921.20	1.00	1.13	0.55	8652.02
24	621	Cypress / Melaleuca (>25%)	0.82	5	3318.43	0.70	2.50	0.55	3193.98
26	625/424	Pine Flatwoods / Melaleuca (>25%)	30.71	2	124279.07	0.70	0.49	0.55	23445.25
27	424	Melaleuca	9.24	3	37392.99	0	1.13	0.55	0
28	621	Cypress / Melaleuca (>50%)	0.69	4	2792.33	0.37	2.10	0.55	1193.30
34	625/424	Pine Flatwoods / Melaleuca (>25%)	19.51	2	78954.24	0.70	0.49	0.55	14894.72
35	621	Cypress	0.03	4	121.41	1.00	2.10	0.55	140.22
36	625/424	Pine Flatwoods / Melaleuca (>25%)	16.30	3	65963.82	0.70	1.13	0.55	28697.56
38	424	Melaleuca	46.75	3	189190.71	0	1.13	0.55	0
41	621	Cypress / Melaleuca (>25%)	0.22	4	890.31	0.70	2.10	0.55	719.81
42	624	Pine / Cypress / Melaleuca (>25%)	4.88	3	19748.68	0.70	1.13	0.55	8591.66
44	424/625	Melaleuca(>50%) / Pine Flatwoods	18.44	3	74624.10	0.37	1.13	0.55	17160.18
45	621	Cypress / Melaleuca (>25%)	0.70	4	2832.80	0.70	2.10	0.55	2290.32
46	424/625	Melaleuca(>50%) / Pine Flatwoods	12.59	3	50949.97	0.37	1.13	0.55	11716.20
47	424/625	Melaleuca(>75%) / Pine Flatwoods	3.29	3	13314.17	0.03	1.13	0.55	248.24
50	424/625	Melaleuca(>75%) / Pine Flatwoods	54.38	3	220068.25	0.03	1.13	0.55	4103.17
52	621	Cypress / Melaleuca (>50%)	1.31	4	5301.39	0.37	2.10	0.55	2265.55
54	621	Cypress / Melaleuca (>50%)	1.50	4	6070.29	0.37	2.10	0.55	2594.14
55	424/624	Melaleuca(>50%)/Cypress/Pine	3.36	4	13597.45	0.37	2.10	0.55	5810.87
56	424/621	Cypress / Melaleuca (>50%)	1.75	4	7082.01	0.37	2.10	0.55	3026.49
57	424/624	Melaleuca(>50%)/Cypress/Pine	6.27	3	25373.81	0.37	1.13	0.55	5834.83
58	617	Mixed Wetland Hardwoods	1.25	2	5058.58	1.00	0.49	0.55	1363.29
61	424/625	Melaleuca(>75%) / Pine Flatwoods	28.91	3	116994.72	0.03	1.13	0.55	2181.37
64	424/625	Melaleuca(>75%) / Pine Flatwoods	28.37	3	114809.42	0.03	1.13	0.55	2140.62
65	424/625	Melaleuca(>75%) / Pine Flatwoods	8.91	3	36057.52	0.03	1.13	0.55	672.29
68	621	Cypress / Melaleuca (>25%)	1.02	4	4127.80	0.70	2.10	0.55	3337.32
70	424/625	Melaleuca(>50%) / Pine Flatwoods	5.57	3	22541.01	0.37	1.13	0.55	5183.42
71	424/625	Melaleuca(>25%) / Pine Flatwoods	8.85	3	35814.71	0.70	1.13	0.55	15581.19
76	424/625	Melaleuca(>50%) / Pine Flatwoods	12.11	2	49007.47	0.37	0.49	0.55	4886.78
79	424/625	Melaleuca(>75%) / Pine Flatwoods	20.65	3	83567.66	0.03	1.13	0.55	1558.12
82	621	Cypress / Melaleuca (>50%)	0.24	5	971.25	0.37	2.50	0.55	494.12
85	424	Melaleuca	55.55	4	224803.07	0	2.10	0.55	0
86	424/625	Melaleuca(>75%) / Pine Flatwoods	3.84	3	15539.94	0.03	1.13	0.55	289.74

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetland Impacts (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
87	424/625	Melaleuca(>25%) / Pine Flatwoods	2.99	3	12100.11	0.70	1.13	0.55	5264.15
89	424/625	Melaleuca(>50%) / Pine Flatwoods	0.74	2	2994.68	0.37	0.49	0.55	298.61
90	424/625	Melaleuca(>75%) / Pine Flatwoods	98.60	3	399020.40	0.03	1.13	0.55	7439.74
92	424/625	Melaleuca(>25%) / Pine Flatwoods	2.22	3	8984.03	0.70	1.13	0.55	3908.50
100	424/625	Melaleuca(>50%) / Pine Flatwoods	27.49	3	111248.18	0.37	1.13	0.55	25582.08
101	424/625	Melaleuca(>50%) / Pine Flatwoods	7.80	3	31565.51	0.37	1.13	0.55	7258.65
102	424/625	Melaleuca(>75%) / Pine Flatwoods	0.14	3	566.56	0.03	1.13	0.55	10.56
							TOTAL		**272,745.8**

Table 21. Mirasol Preserve – Wood Stork Suitable Foraging Prey Base Pre-Enhancement

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
20	424/625	Melaleuca(>50%) / Pine Flatwoods	3.43	3	13,880.73	0.37	1.13	0.55	3,191.94
21	643	Disturbed Wet Prairie	0.85	3	3,439.83	1.00	1.13	0.55	2,137.85
22	621	Cypress	4.36	5	17,644.31	1.00	2.50	0.55	24,260.93
23	624	Pine / Cypress	2.67	4	10,805.12	1.00	2.10	0.55	12,479.91
26	625/424	Pine Flatwoods / Melaleuca (>25%)	0.96	2	3,884.99	0.70	0.49	0.55	732.90
30	621	Cypress	6.34	4	25,657.09	1.00	2.10	0.55	29,633.94
35	621	Cypress	0.55	4	2,225.77	1.00	2.10	0.55	2,570.77
36	625/424	Pine Flatwoods / Melaleuca (>25%)	2.72	3	11,007.46	0.70	1.13	0.55	4,788.80
38	424	Melaleuca	1.39	3	5,625.14	0	1.13	0.55	0.00
41	621	Cypress / Melaleuca (>25%)	1.27	4	5,139.51	0.70	2.10	0.55	4,155.30
42	624	Pine / Cypress / Melaleuca (>25%)	0.88	3	3,561.24	0.70	1.13	0.55	1,549.32
44	424/625	Melaleuca(>50%) / Pine Flatwoods	0.16	3	647.50	0.37	1.13	0.55	148.90
45	621	Cypress / Melaleuca (>25%)	4.87	4	19,708.21	0.70	2.10	0.55	15,934.09
46	424/625	Melaleuca(>50%) / Pine Flatwoods	0.02	3	80.94	0.37	1.13	0.55	18.61
50	424/625	Melaleuca(>75%) / Pine Flatwoods	3.17	3	12,828.55	0.03	1.13	0.55	239.19
53	621	Cypress / Melaleuca (>25%)	1.82	4	7,365.29	0.70	2.10	0.55	5,954.83
54	621	Cypress / Melaleuca (>50%)	1.31	4	5,301.39	0.37	2.10	0.55	2,265.55
55	424/624	Melaleuca(>50%)/Cypress/Pine	0.09	4	364.22	0.37	2.10	0.55	155.65
57	424/624	Melaleuca(>50%)/Cypress/Pine	0.53	3	2,144.84	0.37	1.13	0.55	493.22
58	617	Mixed Wetland Hardwoods	0.14	2	566.56	0.70	0.49	0.55	106.88
59	621	Cypress	0.88	5	3,561.24	1.00	2.50	0.55	4,896.70
60	621	Cypress	3.93	4	15,904.16	1.00	2.10	0.55	18,369.30
61	424/625	Melaleuca(>75%) / Pine Flatwoods	2.00	3	8,093.72	0.03	1.13	0.55	150.91
68	621	Cypress / Melaleuca (>25%)	0.64	4	2,589.99	0.70	2.10	0.55	2,094.01

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
70	424/625	Melaleuca(>50%) / Pine Flatwoods	0.42	3	1,699.68	0.37	1.13	0.55	390.85
71	424/625	Melaleuca(>25%) / Pine Flatwoods	2.83	3	11,452.61	0.70	1.13	0.55	4,982.46
81	621	Cypress / Melaleuca (>50%)	2.60	5	10,521.84	0.37	2.50	0.55	5,352.98
82	621	Cypress / Melaleuca (>50%)	0.13	5	526.09	0.37	2.50	0.55	267.65
84	540	Cattle Pond	0.08	6	323.75	1.00	2.90	0.55	516.38
85	424	Melaleuca	18.53	4	74,988.32	0	2.10	0.55	0.00
86	424/625	Melaleuca(>75%) / Pine Flatwoods	10.35	3	41,885.00	0.03	1.13	0.55	780.95
89	424/625	Melaleuca(>50%) / Pine Flatwoods	15.91	2	64,385.54	0.37	0.49	0.55	6,420.20
90	424/625	Melaleuca(>75%) / Pine Flatwoods	7.73	3	31,282.23	0.03	1.13	0.55	583.26
92	424/625	Melaleuca(>25%) / Pine Flatwoods	5.92	3	23,957.41	0.70	1.13	0.55	10,422.67
93	625	Hydric Pine Flatwoods	2.34	3	9,469.65	1.00	1.13	0.55	5,885.39
94	621	Cypress	18.57	5	75,150.19	1.00	2.50	0.55	103,331.51
95	424/624	Melaleuca(>25%)/Cypress/Pine	20.43	3	82,677.35	0.70	1.13	0.55	35,968.78
96	424/625	Melaleuca(>25%) / Pine Flatwoods	5.77	3	23,350.38	0.70	1.13	0.55	10,158.58
97	621	Cypress	0.39	5	1,578.28	1.00	2.50	0.55	2,170.13
99	424/625	Melaleuca(>50%) / Pine Flatwoods	1.93	3	7,810.44	0.37	1.13	0.55	1,796.05
100	424/625	Melaleuca(>75%) / Pine Flatwoods	40.24	3	162,845.65	0.03	1.13	0.55	3,036.26
101	424/625	Melaleuca(>50%) / Pine Flatwoods	22.84	3	92,430.28	0.37	1.13	0.55	21,254.81
102	424/625	Melaleuca(>75%) / Pine Flatwoods	8.27	3	33,467.53	0.03	1.13	0.55	624.00
105	424/625	Melaleuca(>75%) / Pine Flatwoods	7.55	4	30,553.79	0.03	2.10	0.55	1,058.69
106	424/625	Melaleuca(>25%) / Pine Flatwoods	1.41	4	5,706.07	0.70	2.10	0.55	4,613.36
107	424/625	Melaleuca(>50%) / Pine Flatwoods	21.33	4	86,319.52	0.37	2.10	0.55	36,888.65
108	424/625	Melaleuca(>75%) / Pine Flatwoods	2.85	4	11,533.55	0.03	2.10	0.55	399.64
109	540	Cattle Pond	0.19	6	768.90	1.00	2.90	0.55	1,226.40
114	621	Cypress	21.11	4	85,429.21	1.00	2.10	0.55	98,670.74
115	424/625	Melaleuca(>75%) / Pine Flatwoods	6.59	3	26,668.81	0.03	1.13	0.55	497.24
118	424	Melaleuca	107.97	3	436,939.47	0	1.13	0.55	0.00
119	424/625	Melaleuca(>25%) / Pine Flatwoods	12.63	4	51,111.84	0.70	2.10	0.55	41,323.92
124	424/624	Melaleuca(>50%)/Cypress/Pine	9.14	3	36,988.30	0.37	1.13	0.55	8,505.64
125	424/625	Melaleuca(>50%)/ Pine Flatwoods	6.37	3	25,778.50	0.37	1.13	0.55	5,927.89
126	621	Cypress	1.16	4	4,694.36	1.00	2.10	0.55	5,421.98
127	424/624	Melaleuca(>50%)/Cypress/Pine	1.29	3	5,220.45	0.37	1.13	0.55	1,200.47
129	424/621	Melaleuca(>25%)/Cypress	3.46	4	14,002.14	0.70	2.10	0.55	11,320.73
131	424	Melaleuca	2.71	4	10,966.99	0	2.10	0.55	0.00
132	424/621	Melaleuca(>25%)/Cypress	3.67	5	14,851.98	0.70	2.50	0.55	14,295.03
134	424/625	Melaleuca(>75%) / Pine Flatwoods	62.54	3	253,090.62	0.03	1.13	0.55	4,718.87
135	424	Melaleuca	42.41	4	171,627.33	0	2.10	0.55	0.00
137	424/625	Melaleuca(>75%) / Pine Flatwoods	32.88	3	133,060.76	0.03	1.13	0.55	2,480.92
138	424/625	Melaleuca(>50%)/ Pine Flatwoods	11.67	3	47,226.86	0.37	1.13	0.55	10,860.05
143	422	Brazilian Pepper	3.59	3	14,528.23	0	1.13	0.55	0.00
144	621	Cypress	9.11	5	36,866.89	1.00	2.50	0.55	50,691.98
145	424	Melaleuca	5.34	4	21,610.23	0	2.10	0.55	0.00

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
146	424	Melaleuca	19.58	4	79,237.52	0	2.10	0.55	0.00
147	424/624	Melaleuca(>50%)/ Pine / Cypress	2.53	4	10,238.56	0.37	2.10	0.55	4,375.45
148	424/621	Melaleuca(>25%)/Cypress	15.38	5	62,240.71	0.70	2.50	0.55	59,906.68
149	424/625	Melaleuca(>25%) / Pine Flatwoods	9.28	4	37,554.86	0.70	2.10	0.55	30,363.10
150	424/625	Melaleuca(>75%) / Pine Flatwoods	25.99	3	105,177.89	0.03	1.13	0.55	1,961.04
153	424/625	Melaleuca(>50%)/ Pine Flatwoods	12.43	3	50,302.47	0.37	1.13	0.55	11,567.30
156	424/625	Melaleuca(>50%)/ Pine Flatwoods	3.91	3	15,823.22	0.37	1.13	0.55	3,638.63
157	424	Melaleuca	15.47	4	62,604.92	0	2.10	0.55	0.00
158	424/625	Melaleuca(>50%)/ Pine Flatwoods	7.29	3	29,501.61	0.37	1.13	0.55	6,784.04
159	424/625	Melaleuca(>25%) / Pine Flatwoods	0.70	3	2,832.80	0.70	1.13	0.55	1,232.41
160	621	Cypress	9.58	5	38,768.92	1.00	2.50	0.55	53,307.26
161	640	Flag Pond	1.43	5	5,787.01	1.00	2.50	0.55	7,957.14
162	424/621	Melaleuca(>50%)/Cypress/Pine	7.42	5	30,027.70	0.37	2.50	0.55	15,276.59
163	424	Melaleuca	4.34	4	17,563.37	0	2.10	0.55	0.00
165	424/624	Melaleuca(>50%)/Cypress/Pine	0.89	4	3,601.71	0.37	2.10	0.55	1,539.19
166	621	Cypress	3.05	5	12,342.92	1.00	2.50	0.55	16,971.52
167	424/624	Melaleuca(>50%)/Cypress/Pine	2.25	3	9,105.44	0.37	1.13	0.55	2,093.84
168	424/625	Melaleuca(>75%)/Cypress/Pine	38.94	3	157,584.73	0.03	1.13	0.55	2,938.17
169	424/624	Melaleuca(>50%)/Cypress/Pine	3.07	4	12,423.86	0.37	2.10	0.55	5,309.34
170	424/624	Melaleuca(>50%)/Cypress/Pine	0.79	4	3,197.02	0.37	2.10	0.55	1,366.25
172	621	Cypress	2.12	5	8,579.34	1.00	2.50	0.55	11,796.60
174	424	Melaleuca	11.86	4	47,995.76	0	2.10	0.55	0.00
175	424/624	Melaleuca(>25%)/Cypress/Pine	6.67	4	26,992.56	0.70	2.10	0.55	21,823.48
177	621	Cypress	5.49	5	22,217.26	1.00	2.50	0.55	30,548.73
178	621	Cypress	0.89	5	3,601.71	1.00	2.50	0.55	4,952.34
179	625	Hydric Pine Flatwoods	12.78	3	51,718.87	1.00	1.13	0.55	32,143.28
TOTALS									**978,226.99**

Table 22. Mirasol Preserve – Wood Stork Suitable Foraging Prey Base Post Construction

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
20	424/625	Melaleuca(>50%) / Pine Flatwoods	3.43	3	13,880.73	1.00	1.13	0.55	8,626.87
21	643	Disturbed Wet Prairie	0.85	3	3,439.83	1.00	1.13	0.55	2,137.85
22	621	Cypress	4.36	5	17,644.31	1.00	2.50	0.55	24,260.93
23	624	Pine / Cypress	2.67	4	10,805.12	1.00	2.10	0.55	12,479.91
26	625/424	Pine Flatwoods / Melaleuca (>25%)	0.96	2	3,884.99	1.00	0.49	0.55	1,047.00

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
30	621	Cypress	6.34	4	25,657.09	1.00	2.10	0.55	29,633.94
35	621	Cypress	0.55	4	2,225.77	1.00	2.10	0.55	2,570.77
36	625/424	Pine Flatwoods / Melaleuca (>25%)	2.72	3	11,007.46	1.00	1.13	0.55	6,841.14
38	424	Melaleuca	1.39	3	5,625.14	1.00	1.13	0.55	3,496.02
41	621	Cypress / Melaleuca (>25%)	1.27	4	5,139.51	1.00	2.10	0.55	5,936.14
42	624	Pine / Cypress / Melaleuca (>25%)	0.88	3	3,561.24	1.00	1.13	0.55	2,213.31
44	424/625	Melaleuca(>50%) / Pine Flatwoods	0.16	3	647.50	1.00	1.13	0.55	402.42
45	621	Cypress / Melaleuca (>25%)	4.87	4	19,708.21	1.00	2.10	0.55	22,762.98
46	424/625	Melaleuca(>50%) / Pine Flatwoods	0.02	3	80.94	1.00	1.13	0.55	50.30
50	424/625	Melaleuca(>75%) / Pine Flatwoods	3.17	3	12,828.55	1.00	1.13	0.55	7,972.94
53	621	Cypress / Melaleuca (>25%)	1.82	4	7,365.29	1.00	2.10	0.55	8,506.90
54	621	Cypress / Melaleuca (>50%)	1.31	4	5,301.39	1.00	2.10	0.55	6,123.10
55	424/624	Melaleuca(>50%)/Cypress/Pine	0.09	4	364.22	1.00	2.10	0.55	420.67
57	424/624	Melaleuca(>50%)/Cypress/Pine	0.53	3	2,144.84	1.00	1.13	0.55	1,333.02
58	617	Mixed Wetland Hardwoods	0.14	2	566.56	1.00	0.49	0.55	152.69
59	621	Cypress	0.88	5	3,561.24	1.00	2.50	0.55	4,896.70
60	621	Cypress	3.93	4	15,904.16	1.00	2.10	0.55	18,369.30
61	424/625	Melaleuca(>75%) / Pine Flatwoods	2.00	3	8,093.72	1.00	1.13	0.55	5,030.25
68	621	Cypress / Melaleuca (>25%)	0.64	4	2,589.99	1.00	2.10	0.55	2,991.44
70	424/625	Melaleuca(>50%) / Pine Flatwoods	0.42	3	1,699.68	1.00	1.13	0.55	1,056.35
71	424/625	Melaleuca(>25%) / Pine Flatwoods	2.83	3	11,452.61	1.00	1.13	0.55	7,117.80
81	621	Cypress / Melaleuca (>50%)	2.60	5	10,521.84	1.00	2.50	0.55	14,467.52
82	621	Cypress / Melaleuca (>50%)	0.13	5	526.09	1.00	2.50	0.55	723.38
84	540	Cattle Pond	0.08	6	323.75	1.00	2.90	0.55	516.38
85	424	Melaleuca	18.53	4	74,988.32	1.00	2.10	0.55	86,611.50
86	424/625	Melaleuca(>75%) / Pine Flatwoods	10.35	3	41,885.00	1.00	1.13	0.55	26,031.53
89	424/625	Melaleuca(>50%) / Pine Flatwoods	15.91	2	64,385.54	1.00	0.49	0.55	17,351.90
90	424/625	Melaleuca(>75%) / Pine Flatwoods	7.73	3	31,282.23	1.00	1.13	0.55	19,441.90
92	424/625	Melaleuca(>25%) / Pine Flatwoods	5.92	3	23,957.41	1.00	1.13	0.55	14,889.53
93	625	Hydric Pine Flatwoods	2.34	3	9,469.65	1.00	1.13	0.55	5,885.39
94	621	Cypress	18.57	5	75,150.19	1.00	2.50	0.55	103,331.51
95	424/624	Melaleuca(>25%)/Cypress/Pine	20.43	3	82,677.35	1.00	1.13	0.55	51,383.97
96	424/625	Melaleuca(>25%) / Pine Flatwoods	5.77	3	23,350.38	1.00	1.13	0.55	14,512.26
97	621	Cypress	0.39	5	1,578.28	1.00	2.50	0.55	2,170.13
99	424/625	Melaleuca(>50%) / Pine Flatwoods	1.93	3	7,810.44	1.00	1.13	0.55	4,854.19
100	424/625	Melaleuca(>75%) / Pine Flatwoods	40.24	3	162,845.65	1.00	1.13	0.55	101,208.57
101	424/625	Melaleuca(>50%) / Pine Flatwoods	22.84	3	92,430.28	1.00	1.13	0.55	57,445.42
102	424/625	Melaleuca(>75%) / Pine Flatwoods	8.27	3	33,467.53	1.00	1.13	0.55	20,800.07
105	424/625	Melaleuca(>75%) / Pine Flatwoods	7.55	4	30,553.79	1.00	2.10	0.55	35,289.63
106	424/625	Melaleuca(>25%) / Pine Flatwoods	1.41	4	5,706.07	1.00	2.10	0.55	6,590.51
107	424/625	Melaleuca(>50%) / Pine Flatwoods	21.33	4	86,319.52	1.00	2.10	0.55	99,699.05
108	424/625	Melaleuca(>75%) / Pine Flatwoods	2.85	4	11,533.55	1.00	2.10	0.55	13,321.25
109	540	Cattle Pond	0.19	6	768.90	1.00	2.90	0.55	1,226.40

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
114	621	Cypress	21.11	4	85,429.21	1.00	2.10	0.55	98,670.74
115	424/625	Melaleuca(>75%) / Pine Flatwoods	6.59	3	26,668.81	1.00	1.13	0.55	16,574.66
118	424	Melaleuca	107.97	3	436,939.47	1.00	1.13	0.55	271,557.88
119	424/625	Melaleuca(>25%) / Pine Flatwoods	12.63	4	51,111.84	1.00	2.10	0.55	59,034.18
124	424/624	Melaleuca(>50%)/Cypress/Pine	9.14	3	36,988.30	1.00	1.13	0.55	22,988.23
125	424/625	Melaleuca(>50%)/ Pine Flatwoods	6.37	3	25,778.50	1.00	1.13	0.55	16,021.34
126	621	Cypress	1.16	4	4,694.36	1.00	2.10	0.55	5,421.98
127	424/624	Melaleuca(>50%)/Cypress/Pine	1.29	3	5,220.45	1.00	1.13	0.55	3,244.51
129	424/621	Melaleuca(>25%)/Cypress	3.46	4	14,002.14	1.00	2.10	0.55	16,172.47
131	424	Melaleuca	2.71	4	10,966.99	1.00	2.10	0.55	12,666.87
132	424/621	Melaleuca(>25%)/Cypress	3.67	5	14,851.98	1.00	2.50	0.55	20,421.47
134	424/625	Melaleuca(>75%) / Pine Flatwoods	62.54	3	253,090.62	1.00	1.13	0.55	157,295.82
135	424	Melaleuca	42.41	4	171,627.33	1.00	2.10	0.55	198,229.57
137	424/625	Melaleuca(>75%) / Pine Flatwoods	32.88	3	133,060.76	1.00	1.13	0.55	82,697.26
138	424/625	Melaleuca(>50%)/ Pine Flatwoods	11.67	3	47,226.86	1.00	1.13	0.55	29,351.49
143	422	Brazilian Pepper	3.59	3	14,528.23	1.00	1.13	0.55	9,029.29
144	621	Cypress	9.11	5	36,866.89	1.00	2.50	0.55	50,691.98
145	424	Melaleuca	5.34	4	21,610.23	1.00	2.10	0.55	24,959.82
146	424	Melaleuca	19.58	4	79,237.52	1.00	2.10	0.55	91,519.33
147	424/624	Melaleuca(>50%)/ Pine / Cypress	2.53	4	10,238.56	1.00	2.10	0.55	11,825.53
148	424/621	Melaleuca(>25%)/Cypress	15.38	5	62,240.71	1.00	2.50	0.55	85,580.97
149	424/625	Melaleuca(>25%) / Pine Flatwoods	9.28	4	37,554.86	1.00	2.10	0.55	43,375.86
150	424/625	Melaleuca(>75%) / Pine Flatwoods	25.99	3	105,177.89	1.00	1.13	0.55	65,368.06
153	424/625	Melaleuca(>50%)/ Pine Flatwoods	12.43	3	50,302.47	1.00	1.13	0.55	31,262.98
156	424/625	Melaleuca(>50%)/ Pine Flatwoods	3.91	3	15,823.22	1.00	1.13	0.55	9,834.13
157	424	Melaleuca	15.47	4	62,604.92	1.00	2.10	0.55	72,308.69
158	424/625	Melaleuca(>50%)/ Pine Flatwoods	7.29	3	29,501.61	1.00	1.13	0.55	18,335.25
159	424/625	Melaleuca(>25%) / Pine Flatwoods	0.70	3	2,832.80	1.00	1.13	0.55	1,760.59
160	621	Cypress	9.58	5	38,768.92	1.00	2.50	0.55	53,307.26
161	640	Flag Pond	1.43	5	5,787.01	1.00	2.50	0.55	7,957.14
162	424/621	Melaleuca(>50%)/Cypress/Pine	7.42	5	30,027.70	1.00	2.50	0.55	41,288.09
163	424	Melaleuca	4.34	4	17,563.37	1.00	2.10	0.55	20,285.70
165	424/624	Melaleuca(>50%)/Cypress/Pine	0.89	4	3,601.71	1.00	2.10	0.55	4,159.97
166	621	Cypress	3.05	5	12,342.92	1.00	2.50	0.55	16,971.52
167	424/624	Melaleuca(>50%)/Cypress/Pine	2.25	3	9,105.44	1.00	1.13	0.55	5,659.03
168	424/625	Melaleuca(>75%)/Cypress/Pine	38.94	3	157,584.73	1.00	1.13	0.55	97,938.91
169	424/624	Melaleuca(>50%)/Cypress/Pine	3.07	4	12,423.86	1.00	2.10	0.55	14,349.56
170	424/624	Melaleuca(>50%)/Cypress/Pine	0.79	4	3,197.02	1.00	2.10	0.55	3,692.56
172	621	Cypress	2.12	5	8,579.34	1.00	2.50	0.55	11,796.60
174	424	Melaleuca	11.86	4	47,995.76	1.00	2.10	0.55	55,435.10
175	424/624	Melaleuca(>25%)/Cypress/Pine	6.67	4	26,992.56	1.00	2.10	0.55	31,176.40
177	621	Cypress	5.49	5	22,217.26	1.00	2.50	0.55	30,548.73
178	621	Cypress	0.89	5	3,601.71	1.00	2.50	0.55	4,952.34

ACOE AREA	FLUCCS CODE	DESCRIPTION	Project Wetland Acreage	Hydroperiod Class	Wetlands (m^2)	Habitat Suitability Value	Grams / m^2 / Hydroperiod Class	Wood Stork Consumption Percentage	Grams of Fish Biomass
179	625	Hydric Pine Flatwoods	12.78	3	51,718.87	1.00	1.13	0.55	32,143.28
TOTALS									**2,842,045.92**

Table 23. Mirasol Consultation Area Project List - Wood Stork

Project Name	Wetland Acreage SUM	Project Acreage SUM	Percent Wetlands	Permit Date (Final Agency Action)
PINE FOREST SUBDIVISION	.48	10	4.95%	6/30/2006
PREMIER AIRPORT PARK, LLP (FKA AIRPORT EXCHANGE PARK)	46.08	962	4.79%	4/12/2006
FOREST RIDGE F.K.A. COBBLESTONE	25.80	546	4.73%	10/12/2006
SANIBEL WAY TOWNHOMES	.93	20	4.61%	9/17/2004
STRATFORD DOWNS	2.62	59	4.43%	12/14/2006
MAJESTIC FOUNTAINS	1.78	43	4.11%	12/8/2004
PUEBLO BONITO PHASE 3	1.31	35	3.70%	12/14/2005
BERKSHIRE TOWNHOMES	2.87	83	3.47%	4/13/2005
WATERFORD LANDING	2.87	83	3.47%	8/15/2006
THREE OAKS PARKWAY WIDENING FROM CORKSCREW RD TO ALICO RD	6.36	198	3.21%	4/12/2006
TORTUGA PRESERVE	7.20	241	2.99%	10/12/2005
ECO PUBLIC PARK	.07	3	2.67%	6/1/2006
LEE CO HIGH SCHOOL FFF / PLANTATION HIGH SCHOOL IMPROVEMENTS	1.00	39	2.57%	9/14/2005
PELICAN LANDING GOLF RESORT VENTURES	16.47	665	2.48%	10/11/2005
SUNSET FALLS (F.K.A. WATERSTONE)	23.98	981	2.44%	6/14/2006
COLONIAL PLAZA	9.22	388	2.38%	12/6/2005
BURNT STORE ACRES	8.07	370	2.18%	10/13/2004
BURNT STORE ACRES	2.69	123	2.18%	5/8/2006
WESTGATE REGIONAL CENTRE CPD	.53	26	2.04%	3/23/2005
ALICO LAKES VILLAGE	.61	31	1.97%	12/22/2005
BAINBRIDGE COLONIAL AND WINKLER	.67	39	1.72%	6/19/2006
COVE AT CYPRESS RESERVE THE	.32	20	1.59%	10/3/2005
MAJORCA PALMS ESTATES PUD	.40	25	1.58%	7/29/2005
SANIBEL BRIDGE TOLL PLAZA RECONSTRUCTION	.62	45	1.36%	7/18/2005
CYPRESS RIDGE	.47	35	1.33%	4/19/2005
MARBELLA ON CYPRESS CONDOMINIUMS	.47	35	1.33%	4/3/2006
MAGNOLIA LAKES	.74	57	1.30%	10/28/2004
SHOPPES AT NORTH CAPE THE	.28	22	1.28%	7/7/2006

Project Name	Wetland Acreage SUM	Project Acreage SUM	Percent Wetlands	Permit Date (Final Agency Action)
SABAL POINT AND PRAIRIE CREEK AT VERANDAH	.27	22	1.24%	7/18/2005
ISLAND PINES	.38	31	1.22%	1/5/2005
ELDERBERRY LANE EXTENSION	.01	1	1.16%	10/12/2004
CALOOSA FOREST	2.69	239	1.12%	1/15/2004
CHALLENGER-33	1.02	100	1.02%	4/4/2005
RIVER POINTE	.30	40	0.75%	1/12/2006
CENTRAL CAPE BUSINESS PARK	.24	32	0.74%	12/28/2004
GULF COAST CHURCH OF CHRIST	.10	14	0.74%	8/29/2005
LAKE MCGREGOR DRIVE RPD	.57	86	0.66%	1/31/2006
VILLAGE AT ENTRADA	.15	34	0.44%	4/22/2005
MIRADA FKA ASCOT PRESERVE	.25	60	0.42%	1/26/2007
CRANE LANDING FKA FLAGLER 251	7.19	2031	0.35%	8/11/2004
ESTATES AT ENTRADA - THE	13.00	3808	0.34%	1/11/2007
ARROWHEAD RESERVE	.18	54	0.33%	5/11/2005
OASIS COVE FKA REFLECTION COVE	.10	33	0.31%	8/9/2006
LAKE SHALLOWFORD ESTATES	.06	20	0.30%	11/12/2004
JUDD CREEK	.56	193	0.29%	7/12/2006
NORTH OAKS	.42	154	0.27%	8/9/2006
MOODY RANCH	.40	243	0.16%	11/21/2005
EAGLE PRESERVE	.01	16	0.06%	2/7/2005
PELICAN PRESERVE NINE HOLES	.36	678	0.05%	2/8/2006
BUCKINGHAM ESTATES	.03	100	0.03%	12/22/2004
Total	147	12,201		

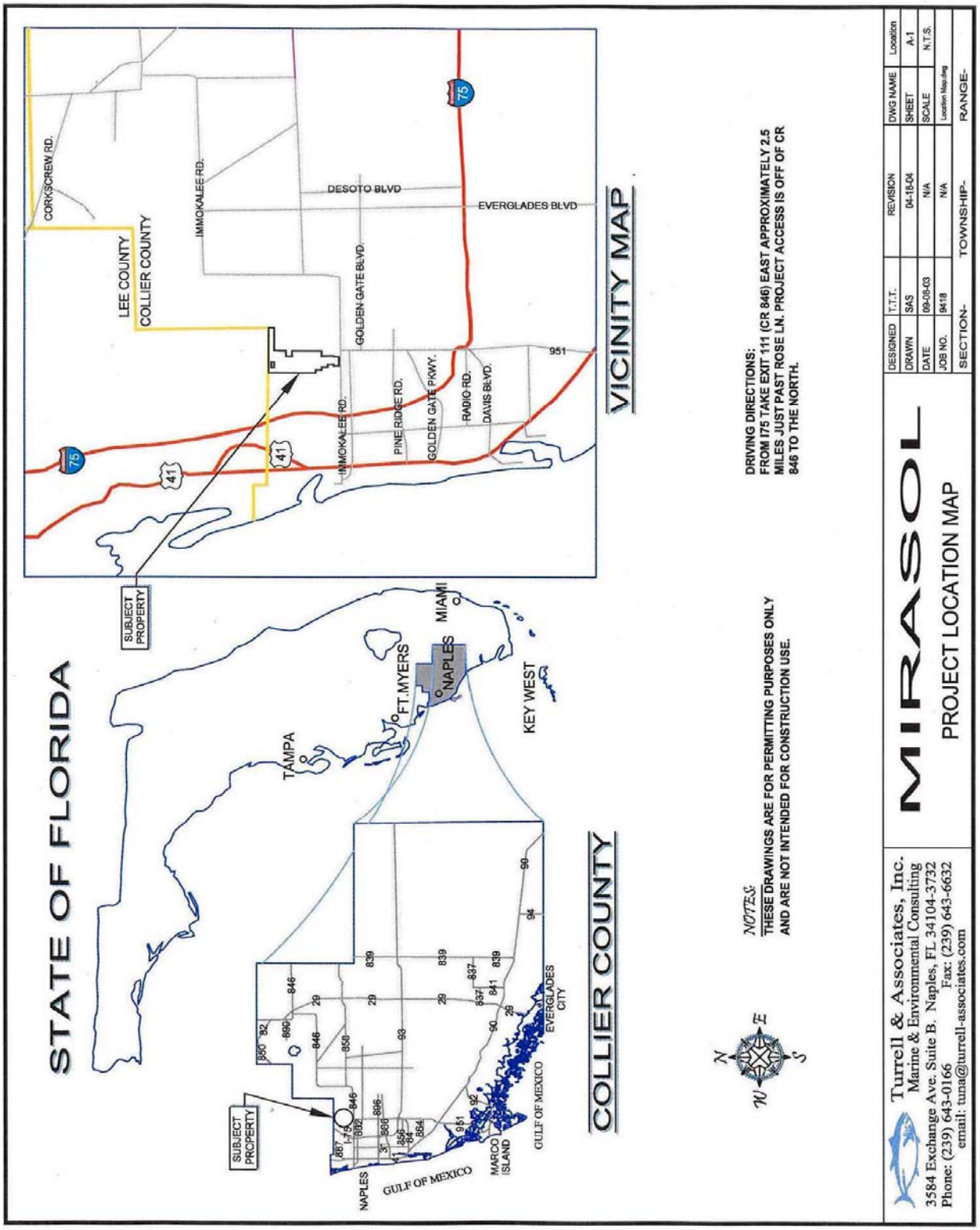


Figure 1. Location of proposed Mirasol project site.

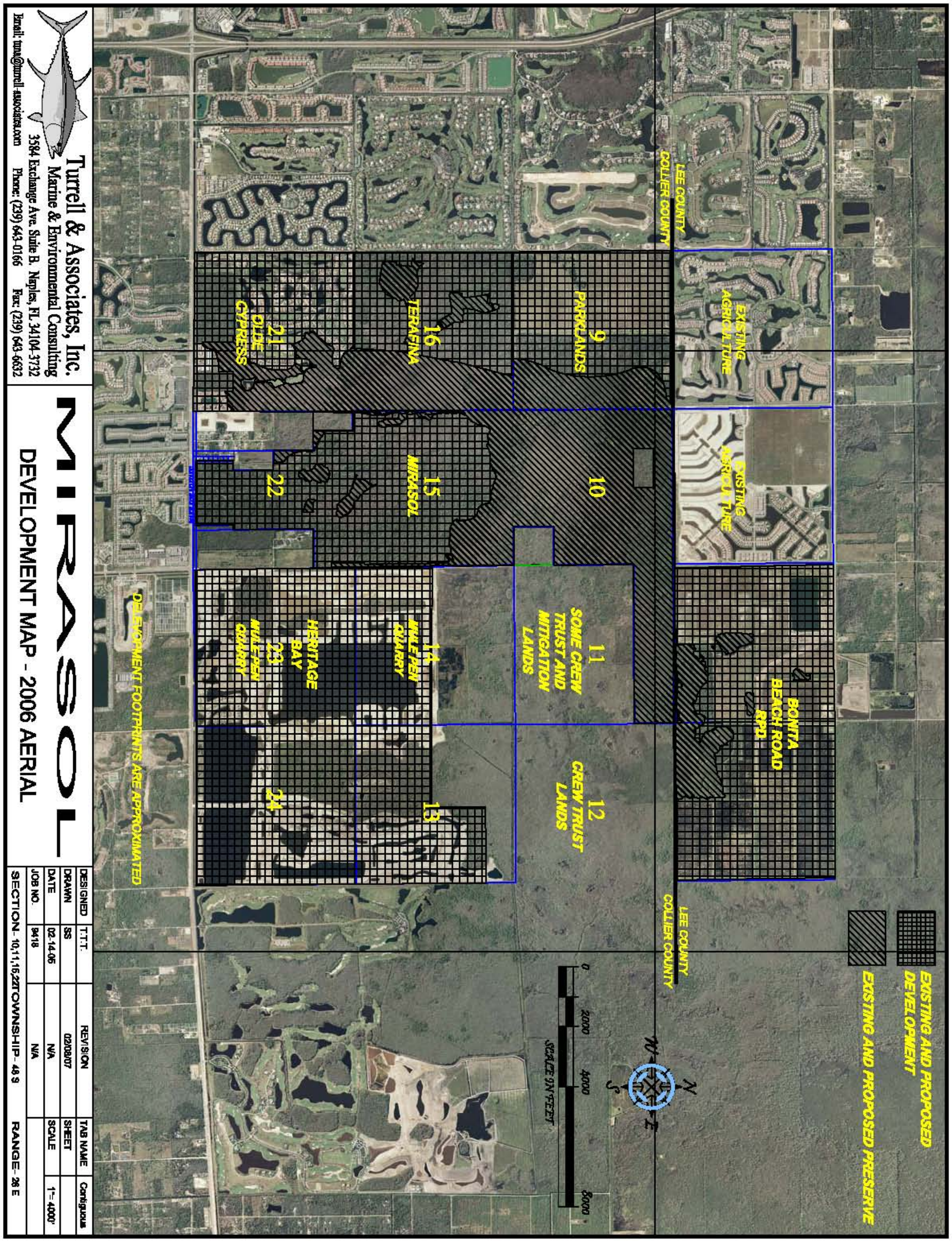


Figure 2. Site plan for Mirasol project.

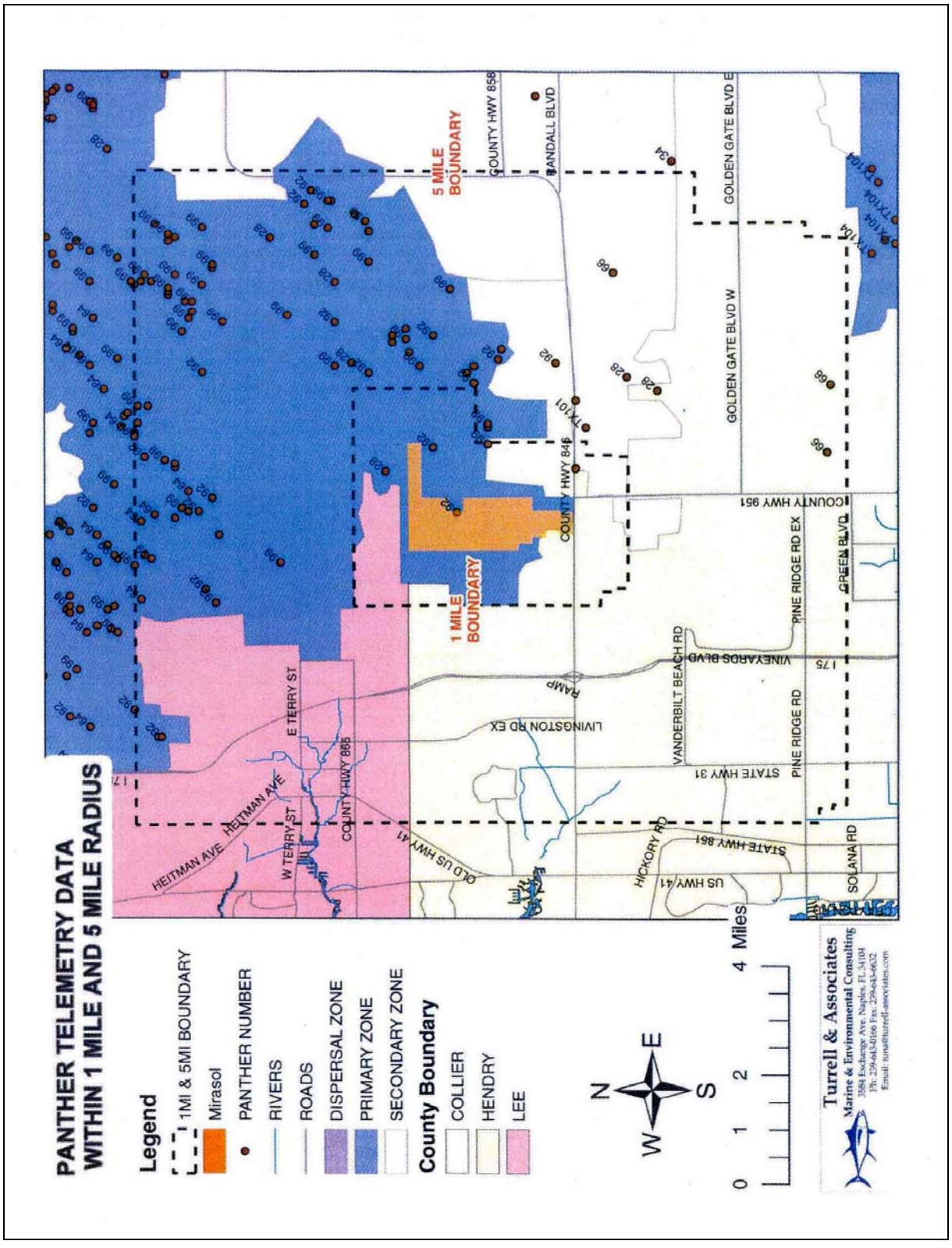


Figure 3. Mirasol project site in relation to panther Primary and Secondary Zones.

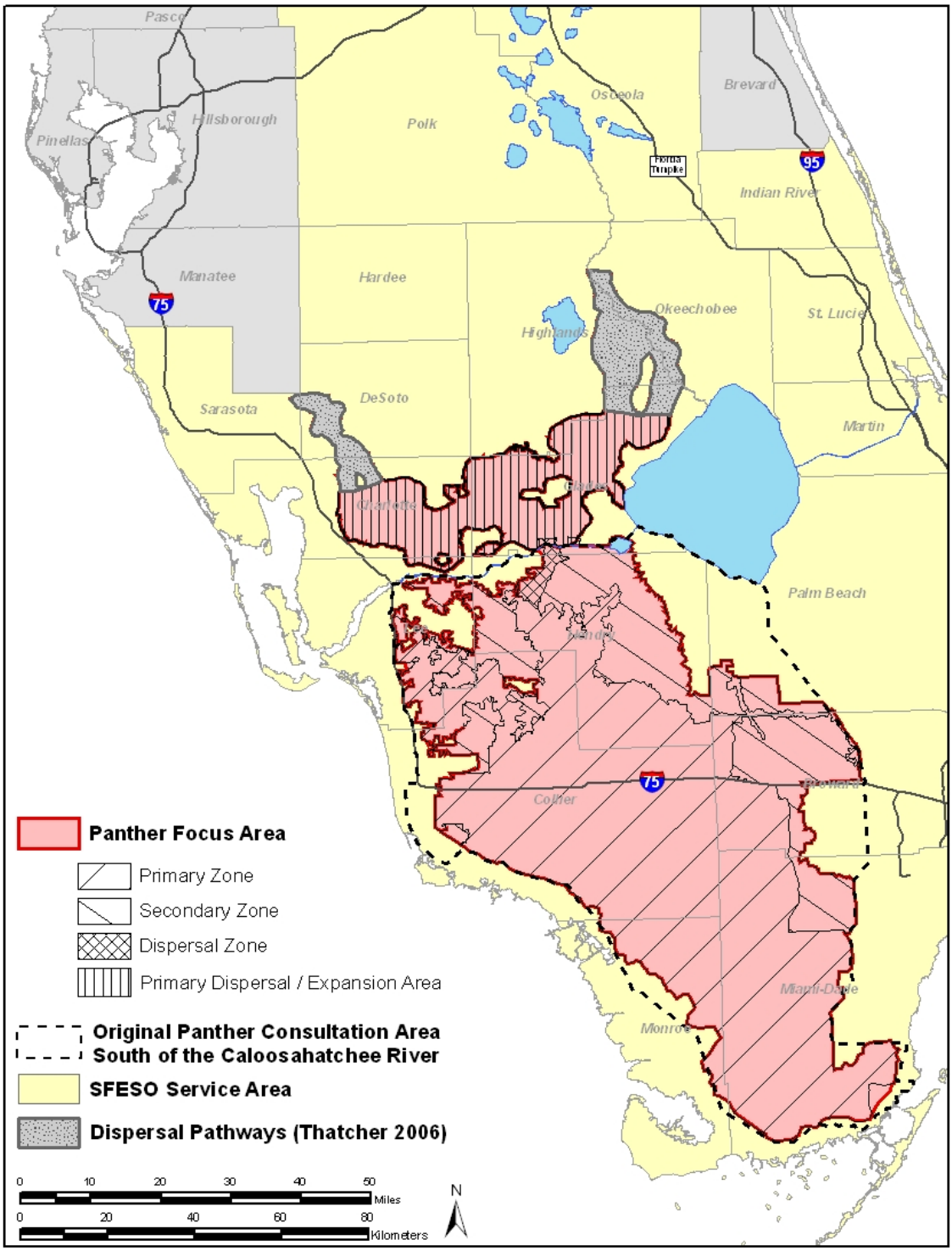


Figure 4. Florida Panther Focus Area.

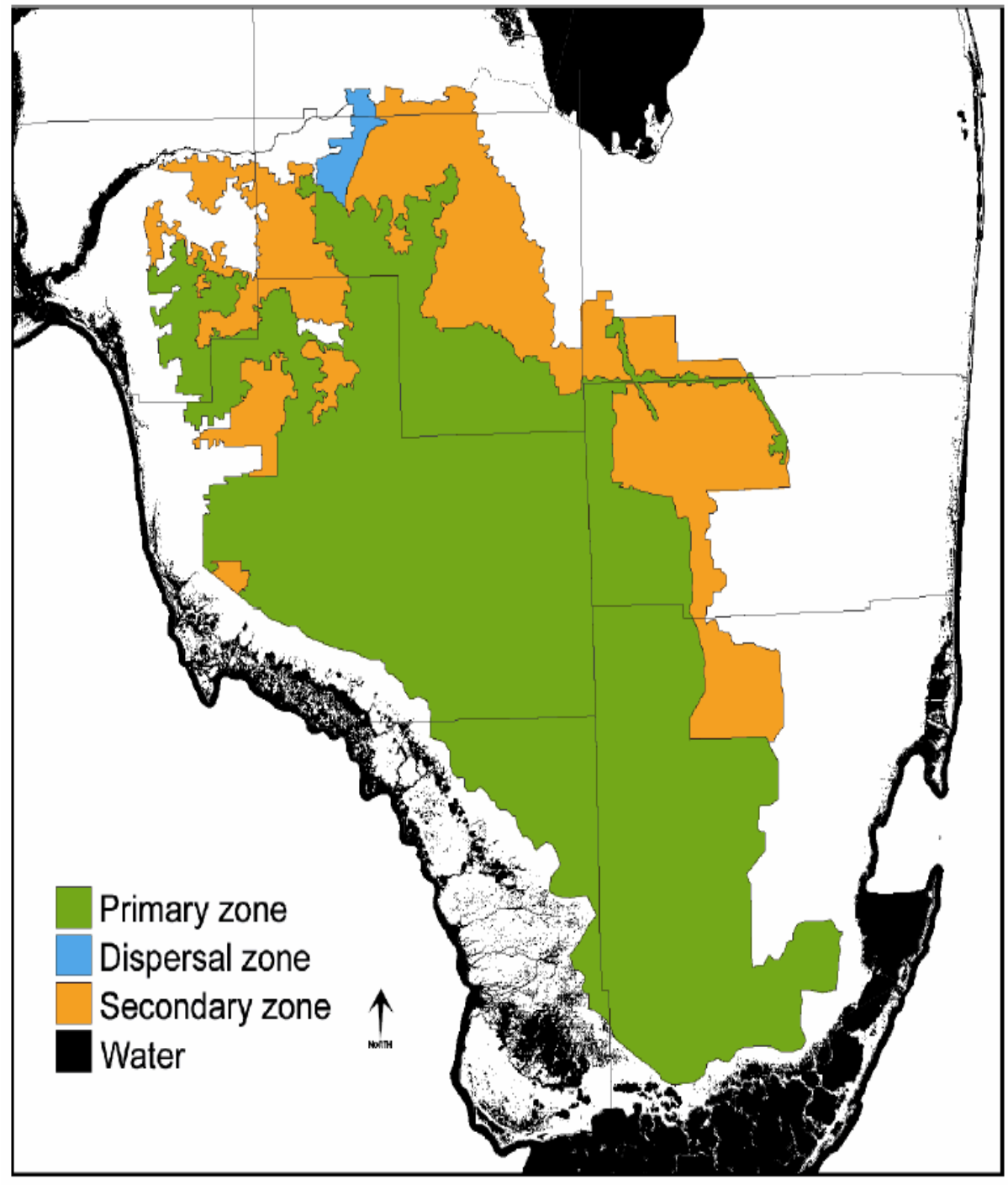


Figure 5: Florida Panther Zones (Kautz et al 2006)

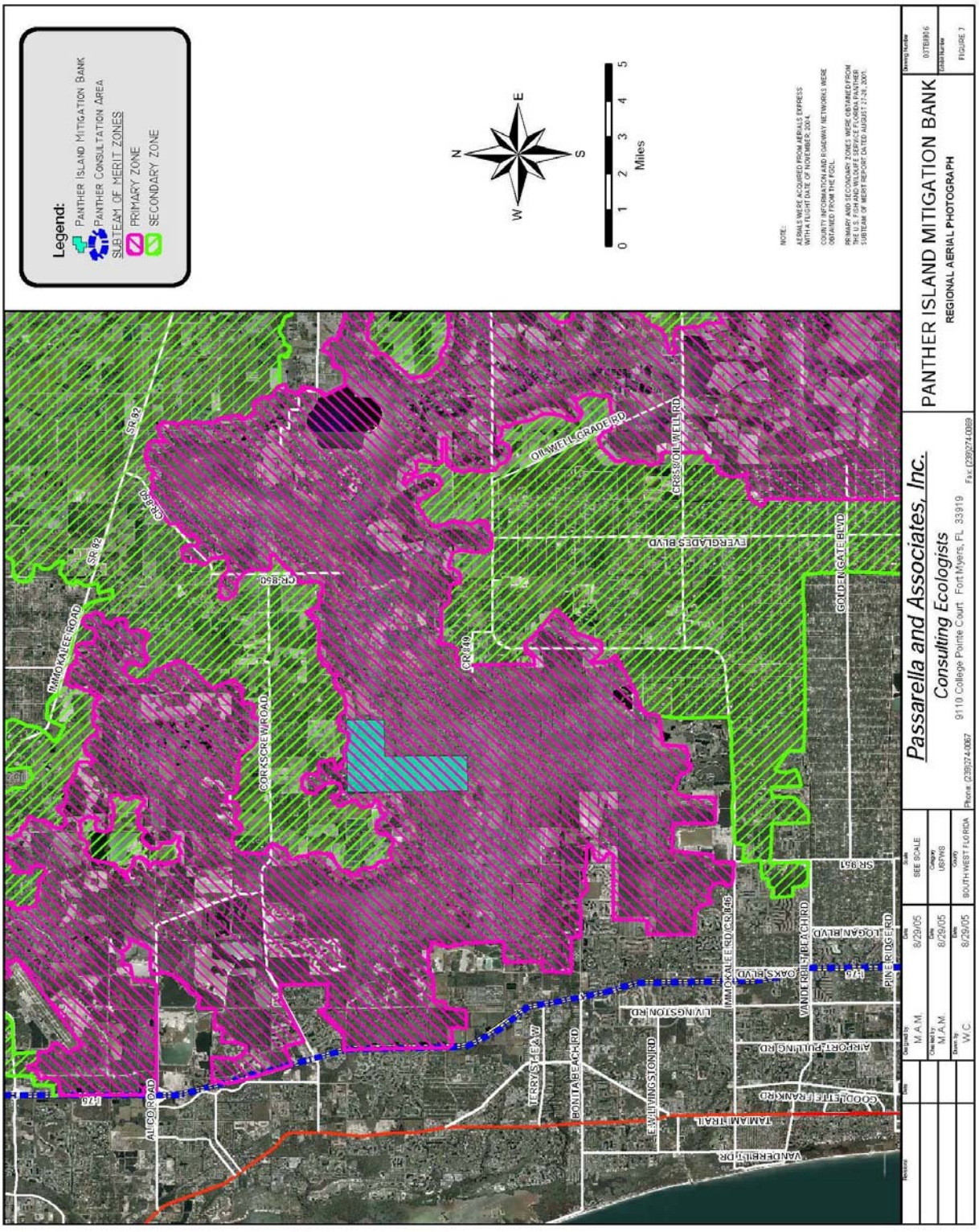


Figure 6. Location of Panther Island Mitigation Bank compensation site.

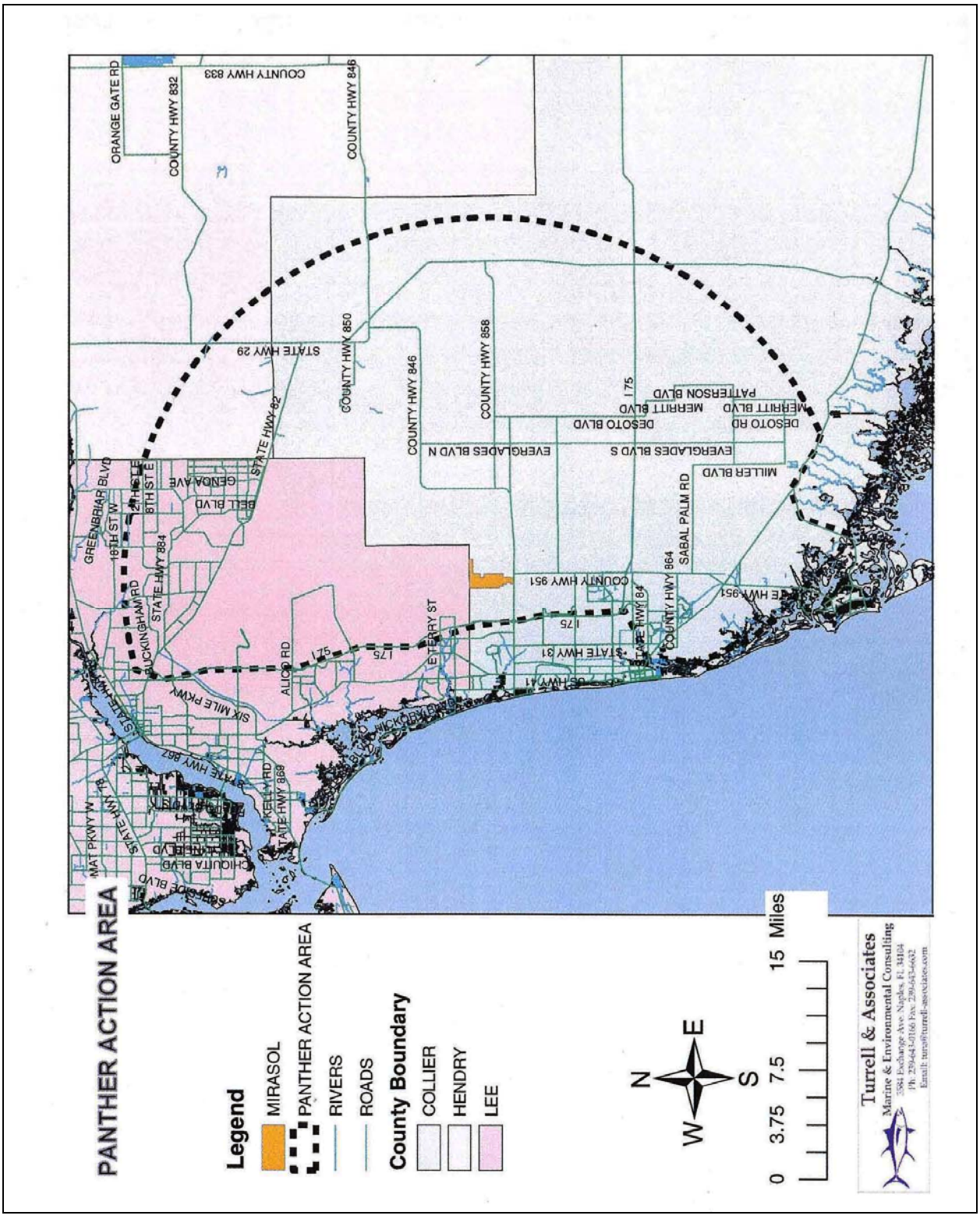


Figure 7. 25-mile Florida Panther Action Area for the Mirasol Project.

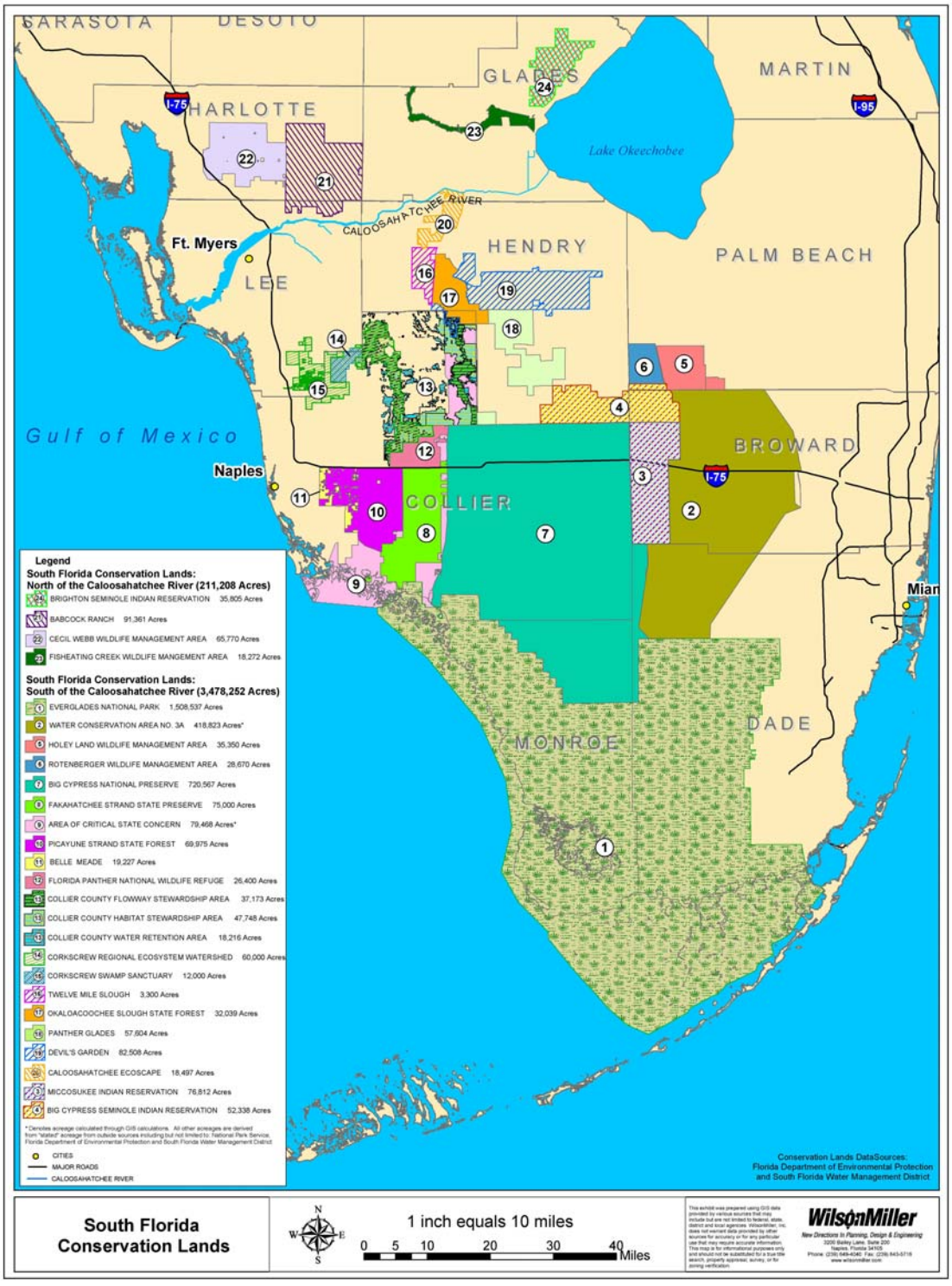


Figure 8. South Florida conservation lands.

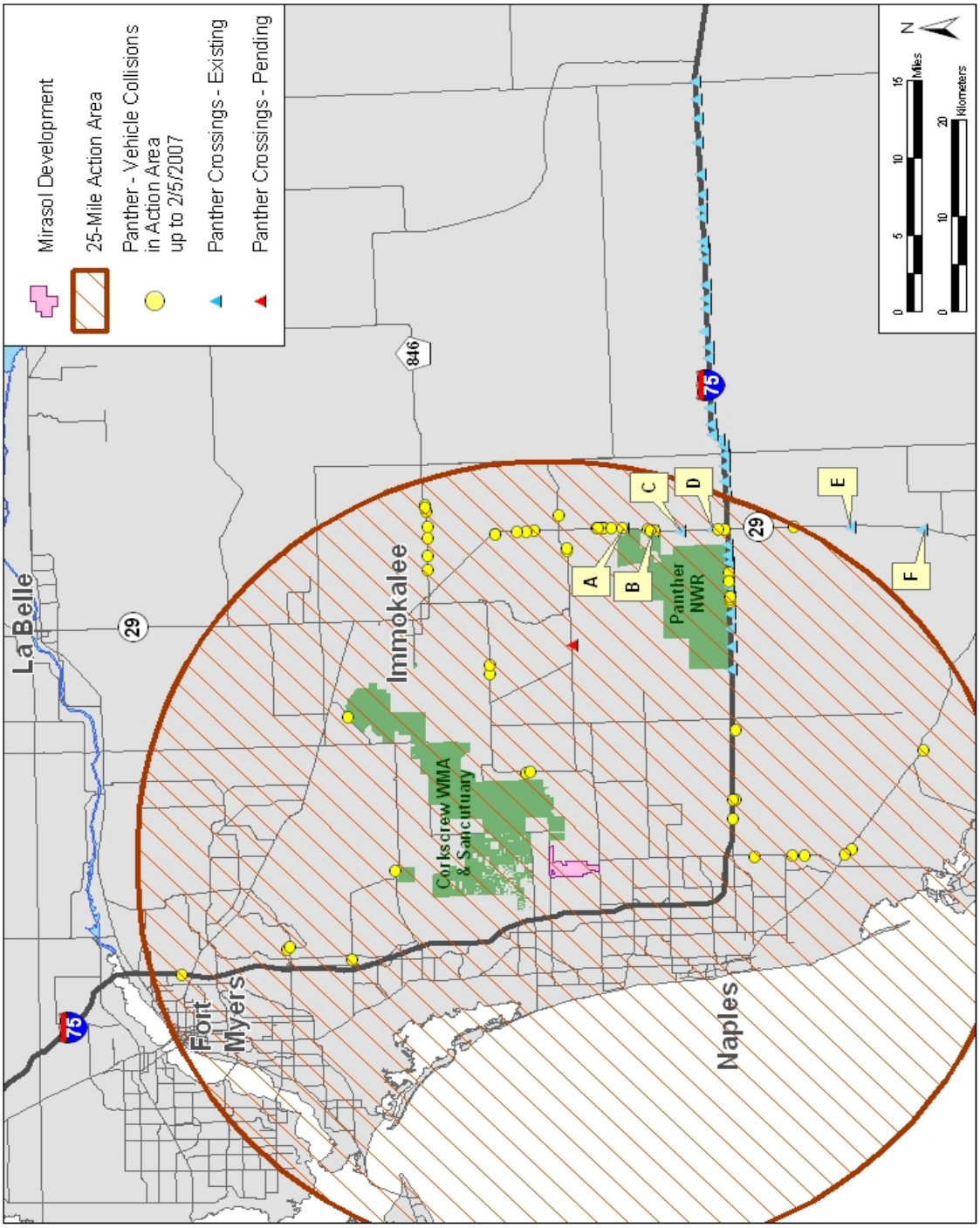


Figure 9. Panther-vehicle collisions and wildlife crossings within panther action area as of February 5, 2007.

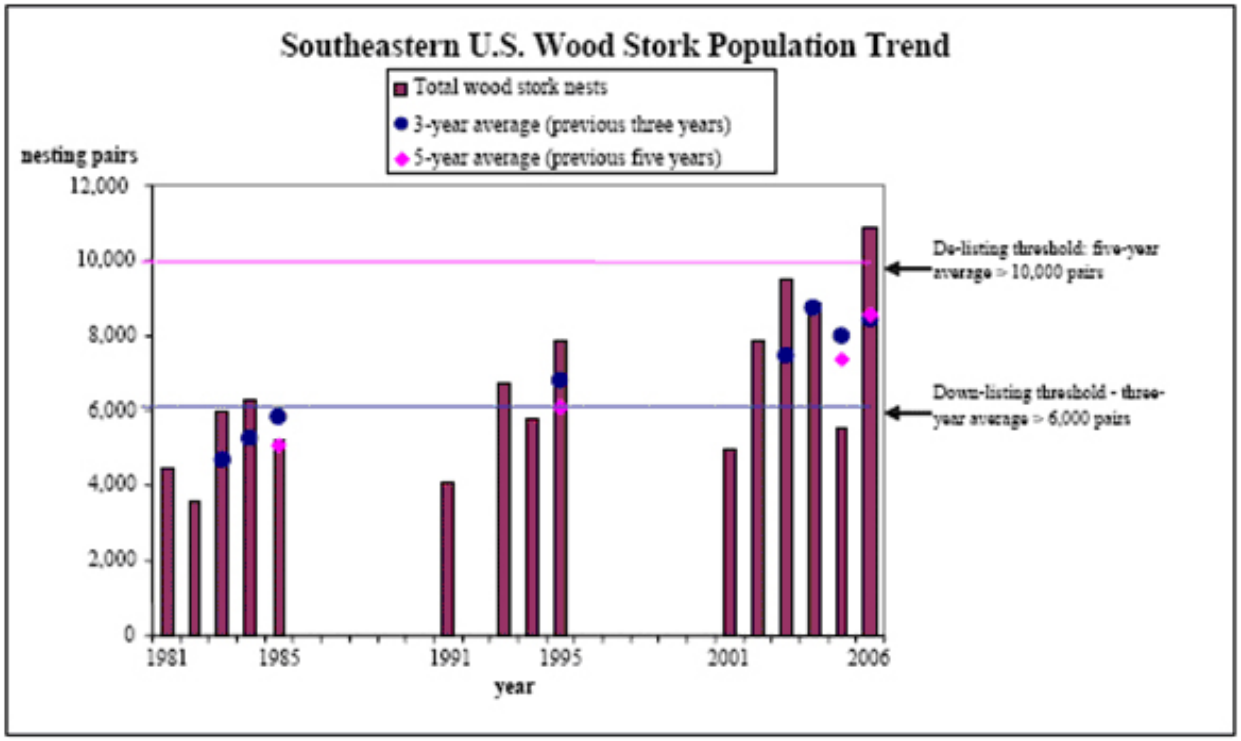


Figure 10. Total Wood Stork Nesting in the Southeastern U.S. in Relation to Recovery Criteria

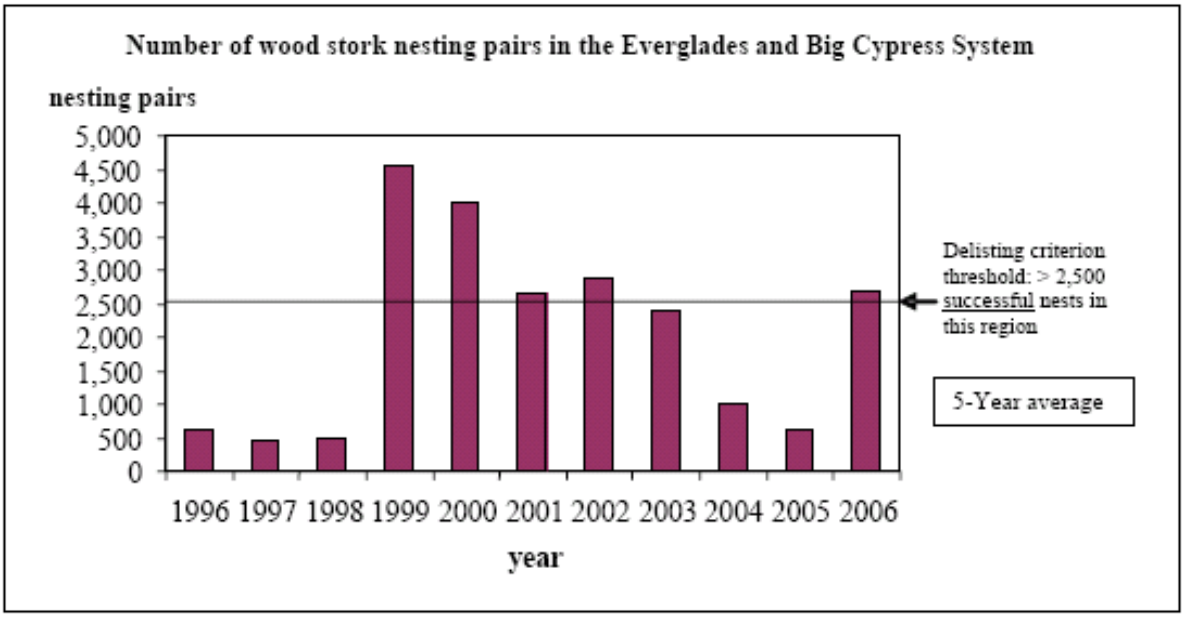


Figure 11. Graph of Wood Stork Nesting in Everglades and Big Cypress System

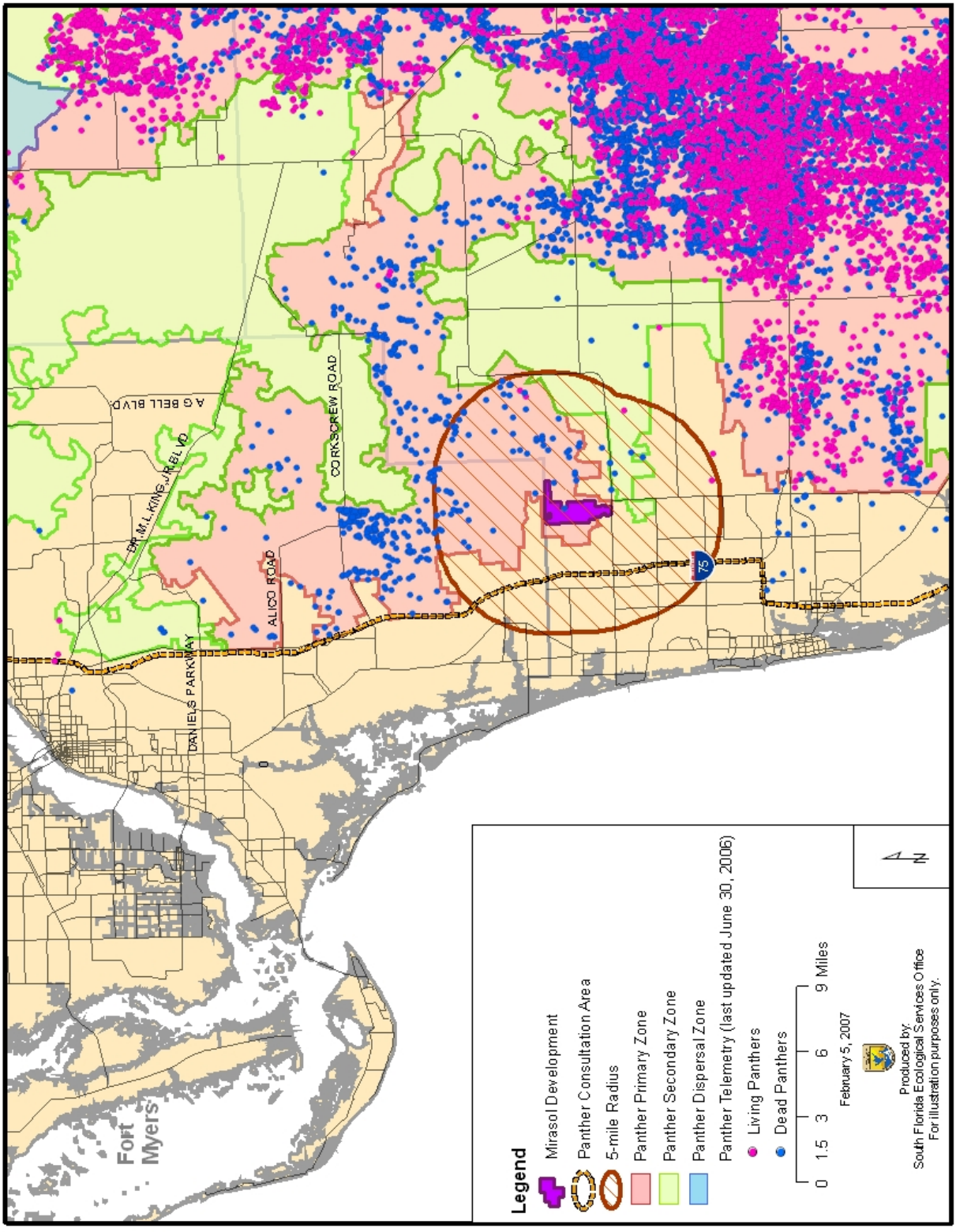


Figure 12. Telemetry showing panther activity within 5-mile radius of Mirasol project.

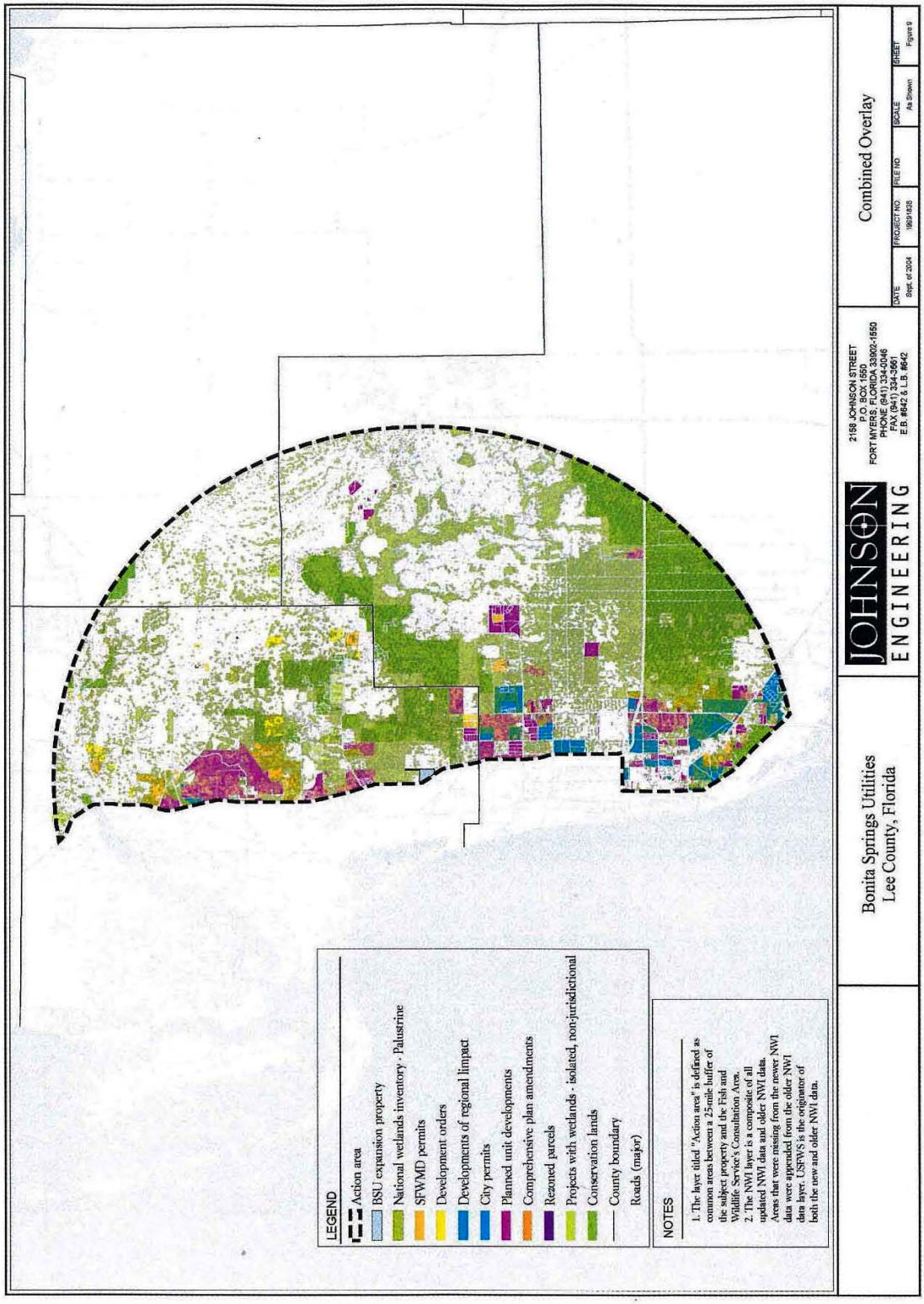


Figure 13. Projects in cumulative impact analysis

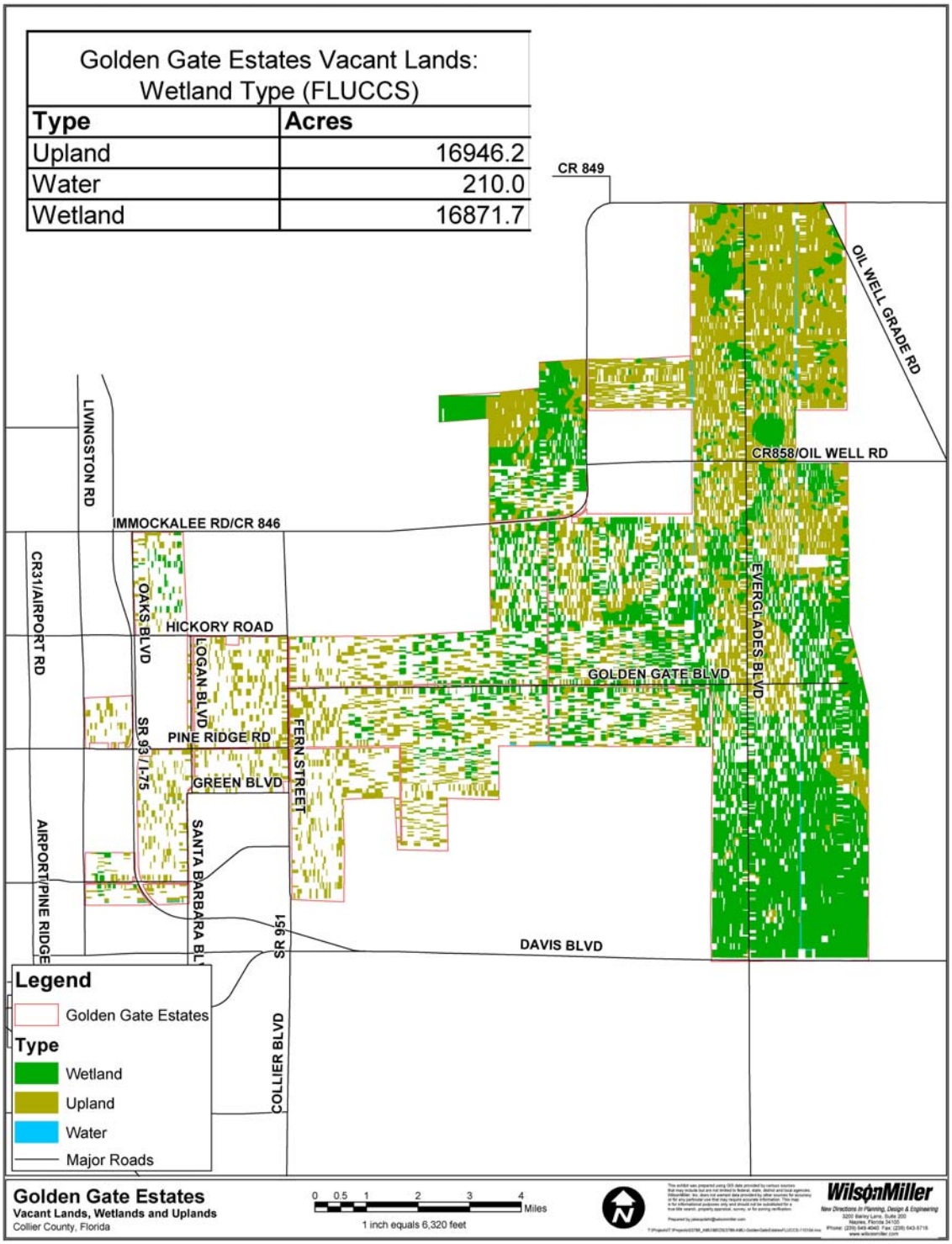


Figure 14. Northern Golden Gates Estates vacant lands.

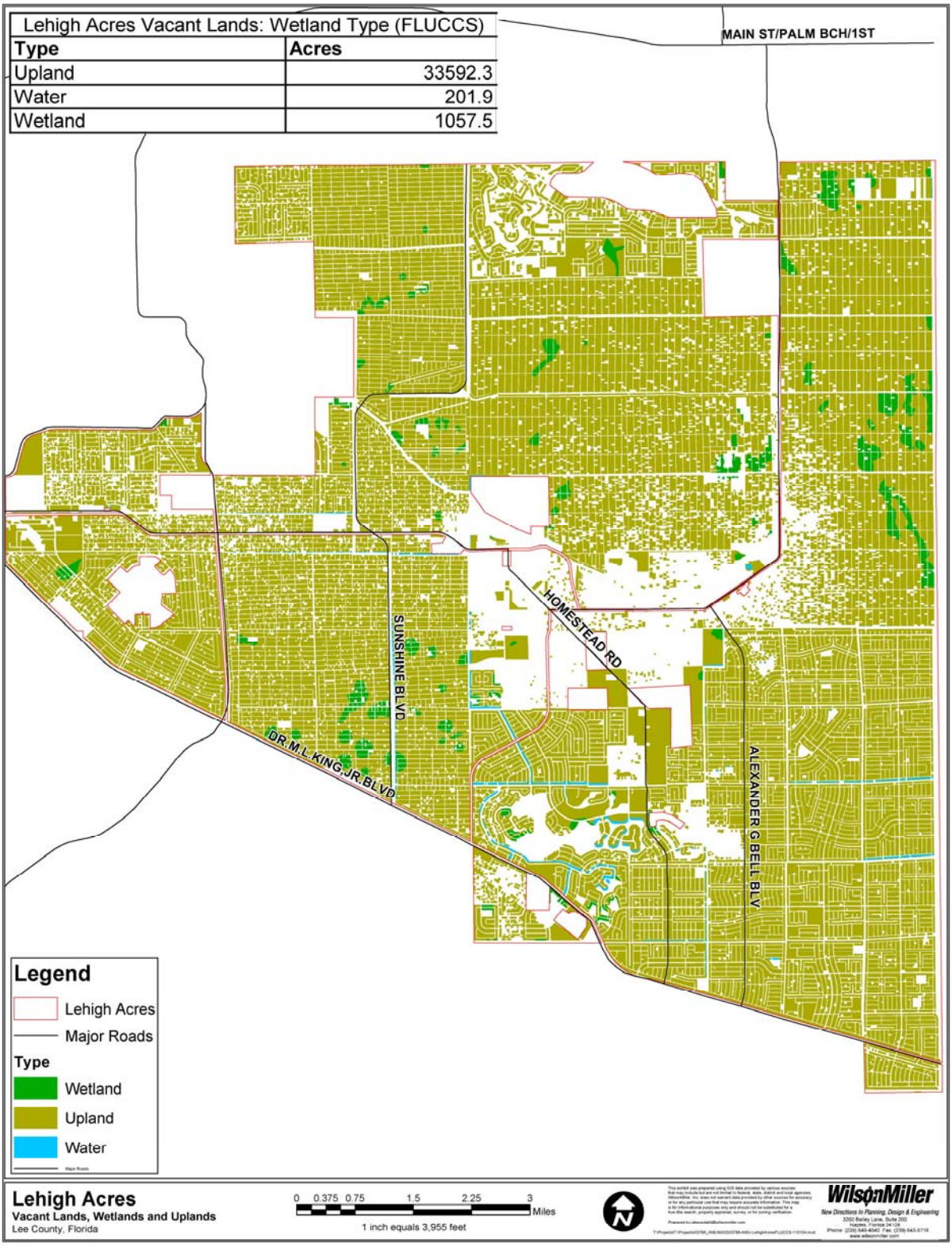


Figure 15. Lehigh Acres vacant lands

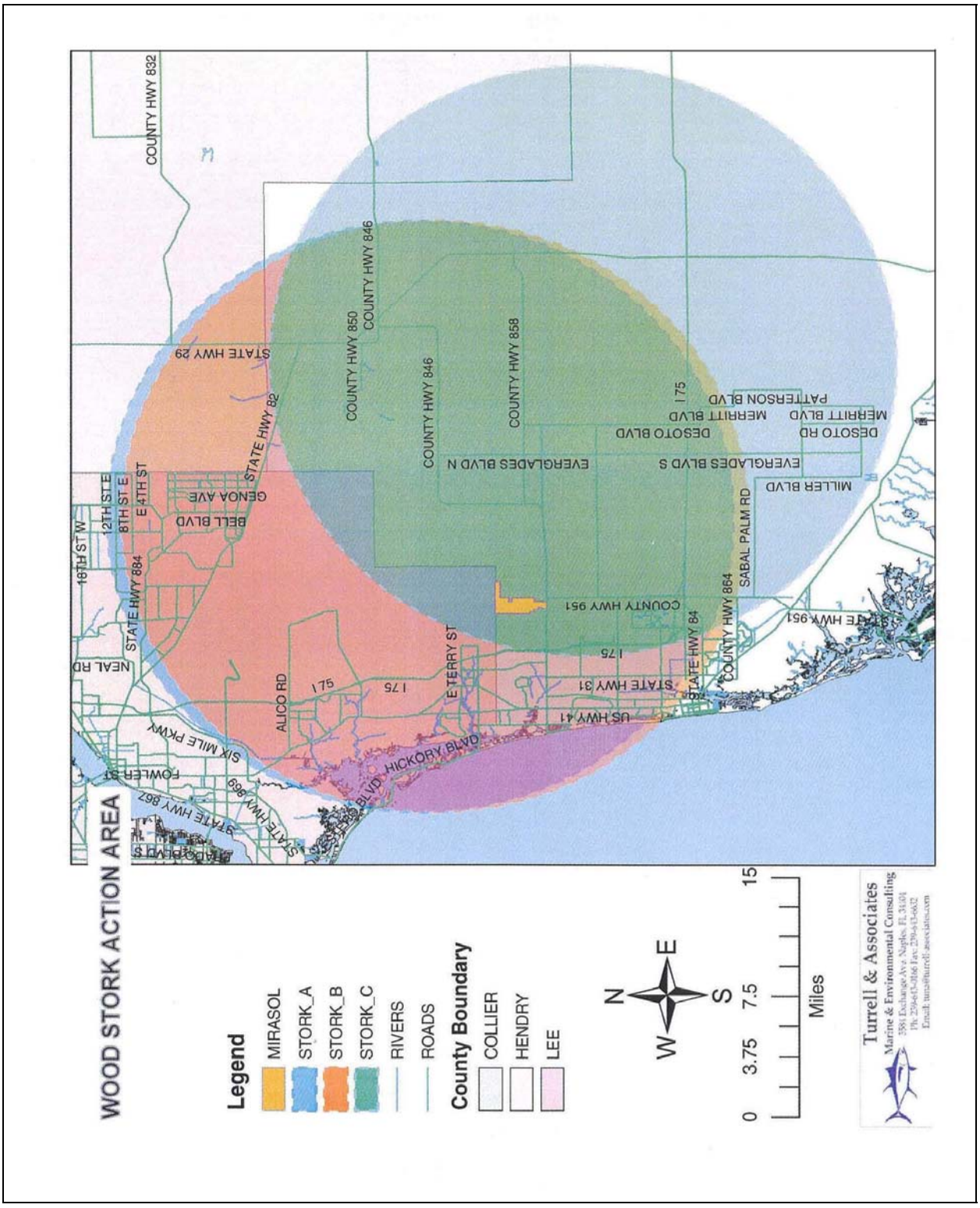


Figure 16. Action Area for the Wood Stork

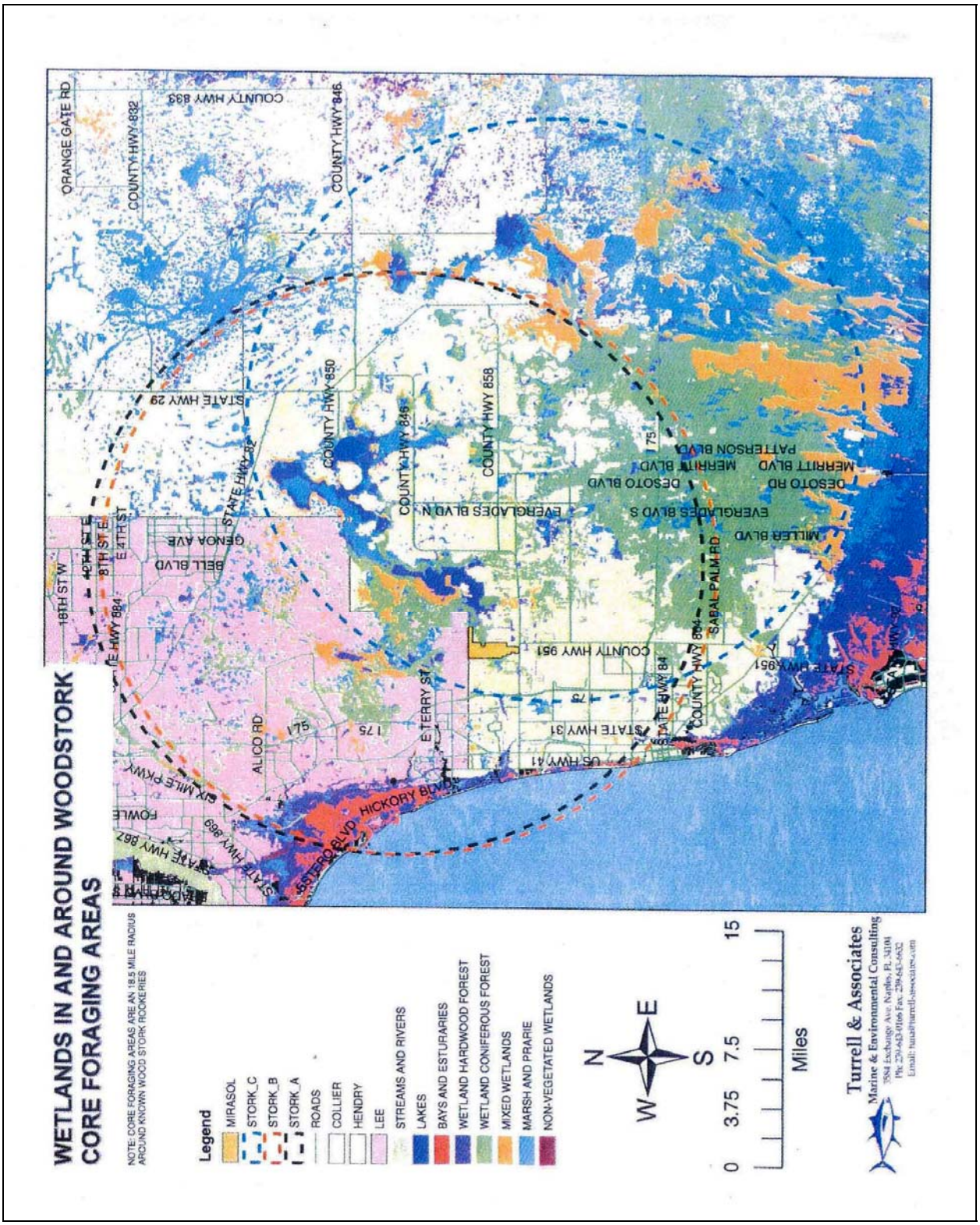


Figure 17. Wetlands in and Around Wood Stork Action Area

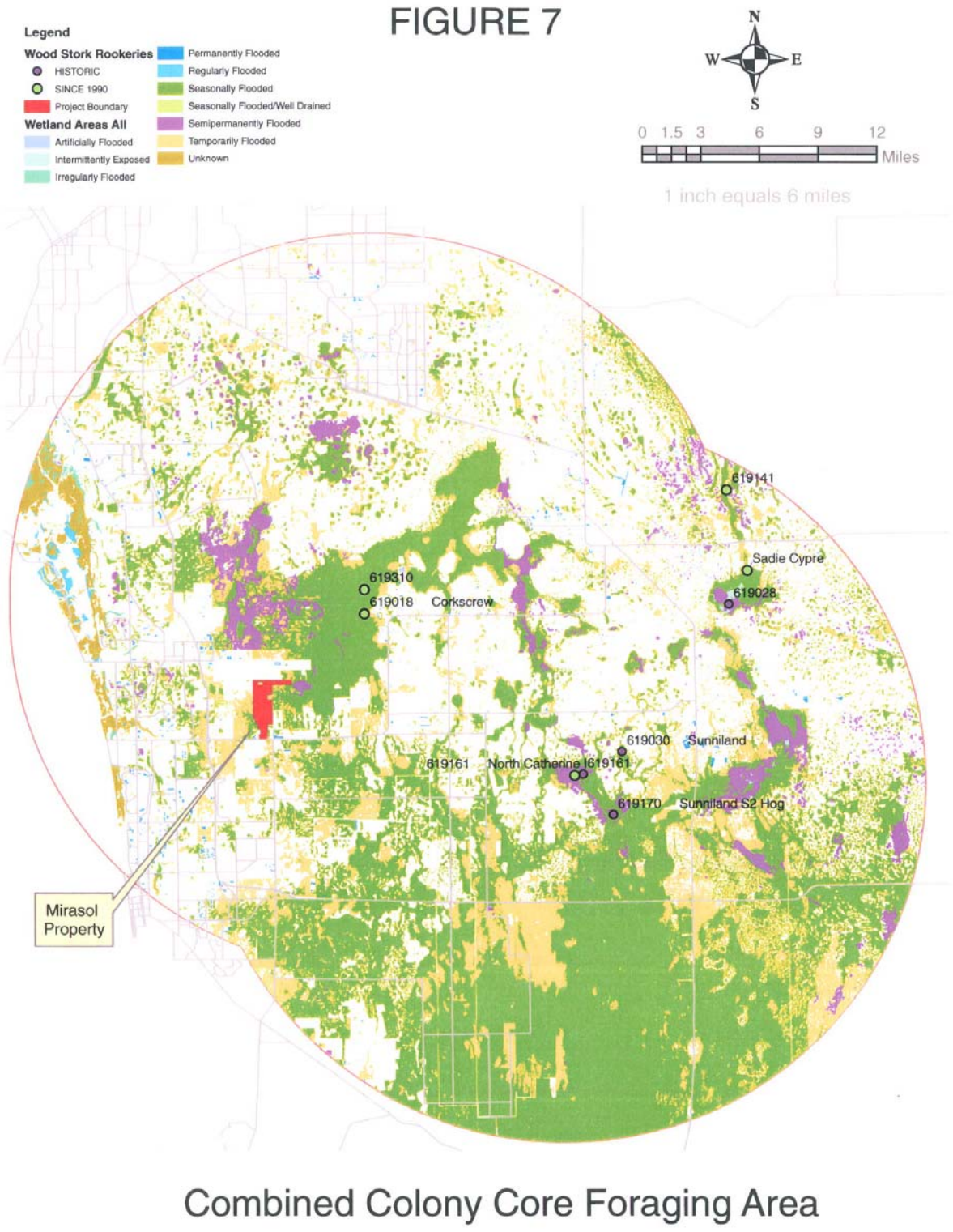


Figure 18. Hydroperiods of Core Foraging Areas of Affected Rookeries

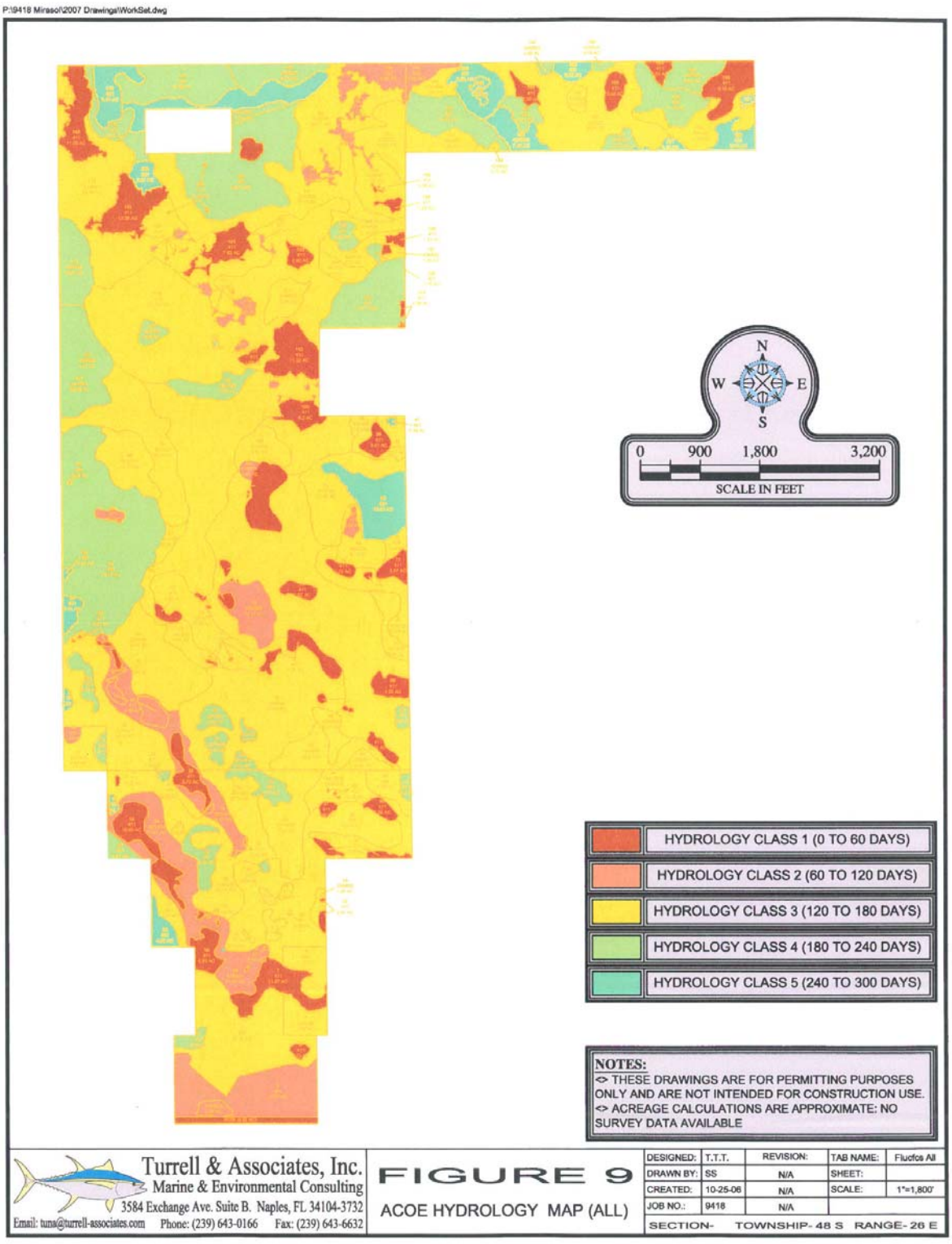


Figure 19. Hydroperiods of Mirasol Project Area

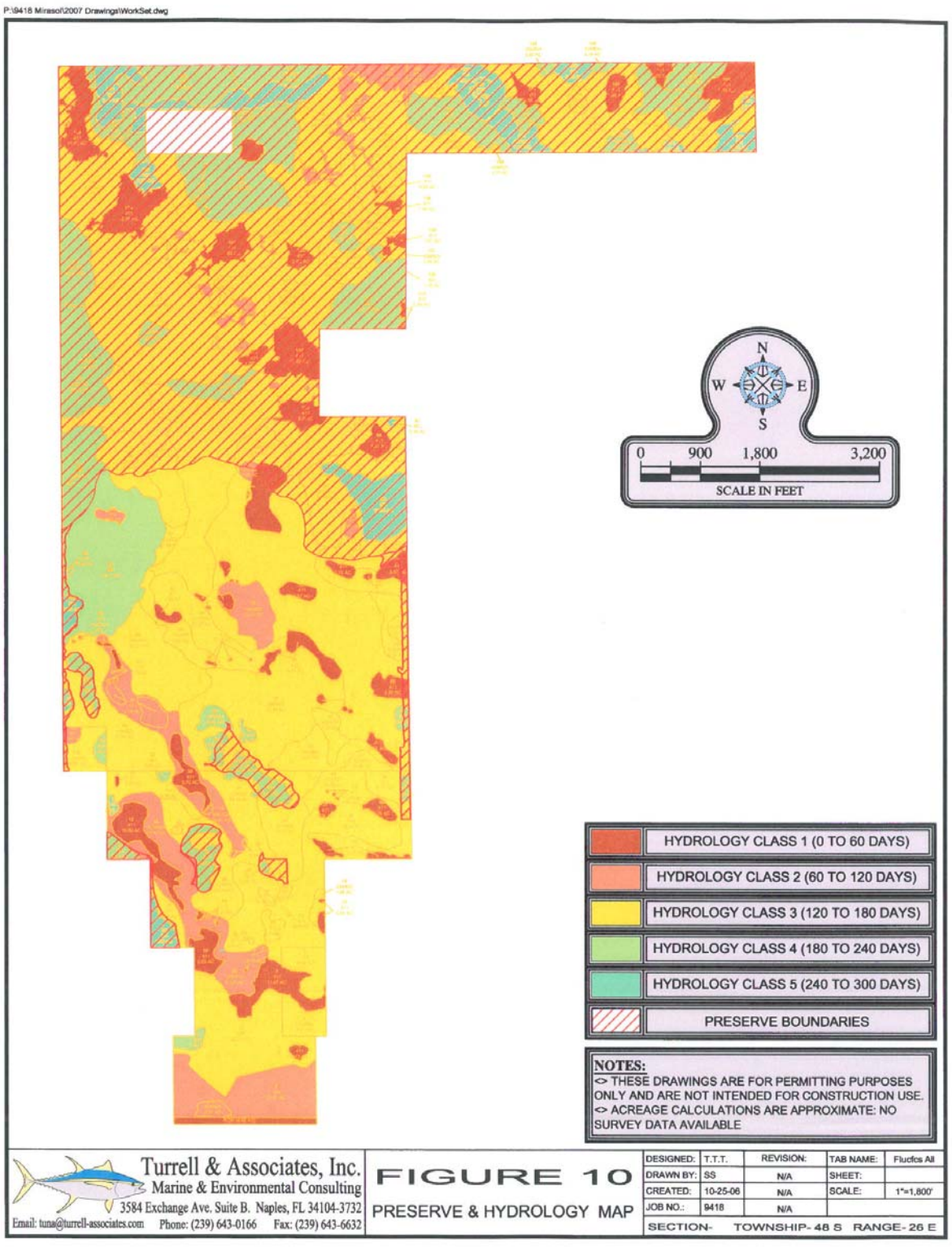
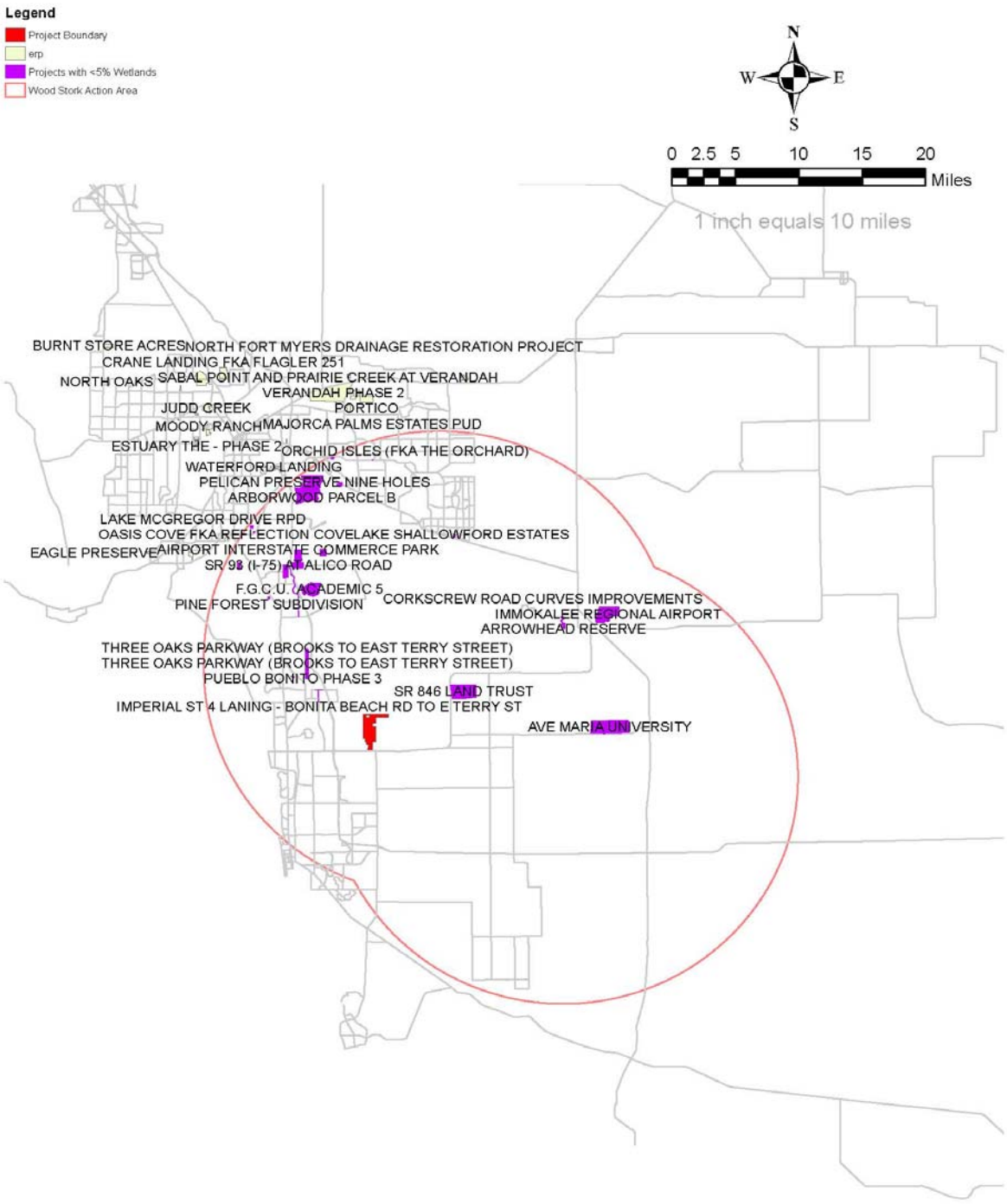


Figure 20. Hydroperiods of Mirasol Project Area Showing Preserve Boundaries.



ERP Projects within Wood Stork Action Area
with <5% Wetlands

Figure 21. Projects in Wood Stork Consultation Area**.**