Final Lake Apopka Natural Resource Damage Assessment and Restoration Plan

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List of Acronyms

BSAF	Biota-Sediment Accumulation Factor
CBC	Christmas Bird Count of the National Audubon Society
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DARP	Damage Assessment and Restoration Plan
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
District	St. Johns River Water Management District
DOI	United States Department of the Interior
EPA	United States Environmental Protection Agency
F1	Fledglings born to adult birds exposed directly to NSRA contamination
F2	Fledglings born to birds in the F1 generation
FDEP	Florida Department of Environmental Protection
FDOF	Florida Department of Forestry
FNAI	Florida Natural Areas Inventory
NRDA	Natural Resource Damage Assessment
NSRA	North Shore Restoration Area
OCP	Organochlorine pesticide
PCB	Polychlorinated biphenyls
ppm	parts per million
PRP	Potentially Responsible Party
Service	United States Fish and Wildlife Service
TIITF	Board of Trustees of the Internal Improvement Trust Fund of the State of Florida
USC	United States Code
ww	wet weight

1.0 Introduction

In late 1998 and early 1999, a large-scale bird kill occurred in areas north of Lake Apopka, Florida, specifically in the North Shore Restoration Area (NSRA). The United States Fish and Wildlife Service (the Service) has conducted a natural resource damage assessment (NRDA) for this event. This Damage Assessment and Restoration Plan (DARP) documents both the injuries sustained by avian resources as a result of this event, and the restoration actions determined to be appropriate and adequate compensation to the public for these injuries.

1.1 Overview of This DARP

This DARP is organized as follows:

- Section 1 describes the NSRA and Lake Apopka in terms of their history, human use, and ecological attributes. In addition, it summarizes the incident (i.e., flooding of agricultural lands and subsequent exposure of birds to pesticides), discusses the authority under which this assessment was conducted, describes the cooperative nature of this assessment, and summarizes the findings.

- Section 2 describes the natural resources of concern and contaminants of concern at the site.

- Section 3 outlines the determination of injury at the site, explains the assumptions and methodologies used to quantify those injuries, and provides the results of that quantification.

- Section 4 describes the Service's restoration objectives, discusses the criteria that need to be met by any restoration alternative, and outlines the preferred option for restoration.

1.2 Overview of North Shore Restoration Area and Lake Apopka

Lake Apopka is a large (currently almost 30,800 acres), shallow (mean depth is 5.4 feet) lake located about 15 miles northwest of Orlando, Florida (See Figure 1). Historically characterized by clear water and a highly prized sports fishery, it served as a popular destination for boaters, swimmers, and fishermen for decades.

In the past, Lake Apopka was the second largest lake in the state. In the 1940s, however, the northern third (mostly sawgrass marsh with rich peat soil), now called the North Shore Restoration Area, was isolated from the remainder of the water body by levees and drained for rowcrop, or "muck" farming (See Figure 1). Drawing water from the main body of Lake Apopka for irrigation, the farms pumped excess irrigation water and rainfall to the lake as wastewater. This wastewater contained high levels of phosphorus, and when combined with other point and non-point sources of pollution, it caused a dramatic change in the ecology of the lake. In March of 1947, the first algal bloom was observed and a continuous bloom has persisted to date, eliminating larger biota in the lake by shading and degrading benthic habitat through high rates of sedimentation. For example, by 1950, much of the rooted aquatic vegetation in the lake had disappeared. These changes led to the demise of the sport fishery and dominance of the fish fauna by gizzard shad.

In the ensuing decades, the muck farms worked over 18,000 acres for agricultural production of multiple crops per year. Pesticides were used extensively both through aerial and ground application during the period of agricultural production. Wastewater contaminated by agricultural compounds was discharged from the farms at an estimated 20 billion gallons annually (approximately one third of the lake's total volume). Consequently, by the mid-1960s Lake Apopka was known as Florida's most polluted large lake.

The biota of the both Lake Apopka itself and the NSRA reflect the stressed environment. In the lake, blue-green algae dominate the water column throughout the year. Benthic invertebrate populations in the lake are low in diversity and density, and are composed of pollution-tolerant taxa that can endure high levels of organic enrichment. Gizzard shad and blue tilapia dominate the fish community. In the NSRA, the canals in-between fields support some aquatic vegetation and fish populations that include brown bullhead, blue tilapia, and mosquito fish. During late summer and early fall some farmers flooded their fields to minimize soil subsidence and erosion and to control nematodes; these shallow-water habitats attracted large numbers of shorebirds, wading birds and other aquatic species (Pranty and Basili 1998).

1.3 Farm Buy-out and Bird Mortality Event

The Lake Apopka Restoration Act of 1985 (Chapter 85-147, Laws of Florida) and Florida's Surface Water Improvement and Management Act of 1987 (Chapter 85-97, Laws of Florida) paved the way for restoration work at Lake Apopka to begin. However, it was the 1996 Lake Apopka Improvement and Management Act (Section 373.461, Florida Statutes 1996) that determined it was in the public interest to pursue a buy-out of all the farms on the north shore of Lake Apopka and eliminate the major source of phosphorus pollution to the Lake. The Florida Legislature appointed the St. Johns River Water Management District (the District) as the agency responsible for implementing the buy-out program. The plan for restoration after the buy-out focused on re-flooding the farm fields and elimination or breaching of the levees that separated the fields from the main body of the lake, allowing Lake Apopka to return to its historic size.

As part of the acquisition process, an Environmental Site Assessment was conducted on all former farm properties. These multi-phase assessments resulted in the identification and removal of over 20,000 tons of soils contaminated mainly with pesticides. To examine the risk to wildlife posed by restoration of the former agricultural areas, an environmental risk assessment was also completed (ATRA 1997, 1998). Results indicated that soil pesticide residues did not present an acute toxicity risk to wetland fish and some wildlife. Elevated hazard quotients for DDT and its metabolites, however, identified concerns for piscivorous[1] birds.

By August 1998, the District, in partnership with the Wetlands Reserve Program of the United States Department of Agriculture, had purchased most of the farms on the north shore of Lake Apopka (See Figure 1). The farmers in Unit 2, a 6,000 acre area on the northeast side of the lake, were asked to leave their fields shallowly flooded following their final crop harvest in the summer of 1998, where flooding began as early as June of that year. Short-term shallow flooding before pumping wastewater back into the lake was standard farming practice at the end of each year's growing season. This pumping covered the area with approximately 18 inches of water for up to six weeks. By eliminating the post-season pumping, the influx of phosphorous to the lake would be reduced, and the growth of terrestrial vegetation on the farm fields would be inhibited. The fields were to be drained during the winter and treated with a soil amendment (alum residual) to prevent phosphorus release when restoration flooding commenced.

The late summer weather and farming conditions of 1998 were similar to previous years. However, as water levels began to rise with seepage and rainfall, and as fields remained flooded into late fall and early winter, more and more birds arrived. In December, the Audubon Christmas Bird Count (CBC) documented 174 species, the highest recorded species diversity at an inland site in North America in the 100-year history of the CBC (NAS 1999). Although small flocks of 20-30 American white pelicans were seen on the lake during winter months in previous years, the more than 3,500 American white pelicans recorded on a single day in December 1998 in the former farming area were unprecedented.

However, the excitement over the bird response was soon tempered by the first reported mortalities of American white pelicans in November, 1998. Over the next four months, 441 American white pelicans, 58 great blue herons, 43 wood storks, 34 great egrets and smaller numbers of 20 other bird species died on-site. The Service attributed the deaths to organochlorine pesticide poisoning. At the onset of the bird deaths in the fall of 1998, the District began draining the site. Pumping accelerated in January 1999, and by mid-February 1999, the entire north shore farming area had been drained. Since then, the fields have been kept dry and have become vegetated with upland grasses, herbs, and shrubs.

1.4 Authority

This DARP has been prepared by the Service on behalf of the United States Department of the Interior (DOI). The Service is acting under its authority as the designated representative of the Secretary of the Interior, a natural resource Trustee under

[1] Piscivorous means fish-eating.

the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended, 42 U.S.C. Section 9601 et seq., CERCLA 43 CFR Part 11. The Service is authorized to act on behalf of the public under Federal law to assess and recover natural resource damages, and to plan and implement actions to restore natural resources injured or lost as a result of incidents involving the release of a hazardous substance.

The Service is the principal Federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million-acre National Wildlife Refuge System comprised of more than 500 national wildlife refuges, thousands of small wetlands, and other special management areas. It also operates 66 national fish hatcheries and 78 ecological service field stations. The agency enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts (USFWS 1999).

1.5 Coordination with Potentially Responsible Party

Under CERCLA, the party potentially responsible for the release of a hazardous substance ("potentially responsible party" or PRP), such as the incident that occurred at the NSRA of Lake Apopka, is liable for any resulting injuries to natural resources. Although the final authority regarding determinations of injury and restoration rests solely with the Trustee, the PRP may participate in the natural resource damage assessment process, as described in 43 CFR Part 11.

In the case of the NSRA, the PRP (i.e., the District) has been actively involved in the damage assessment process.[2] The District has provided site-specific information such as bird counts, soil and fish contamination data, a contaminant exposure model for birds recorded on-site, and information on proposed restoration options. The Service considered this information in the development of this DARP. The District has reviewed data provided by the Service, and has provided comments on injury assessment assumptions and methodologies. In addition, the District has participated in meetings and conference calls with the Service to discuss both technical and legal issues. Coordination between the Service and the District helped reduce duplication of effort and expedited the assessment process.

[2] The District is interested in assessing the extent of natural resource losses associated with the event at the NSRA of Lake Apopka, and in taking appropriate measures to compensate for these losses. Although the District has cooperated with the Service throughout this process, it does not admit any liability for these losses.

1.6 Public Participation

This DARP was provided to the public for a 30-day review and comment period. In addition to news releases regarding the availability of the draft DARP to several news media in Florida, letters announcing the availability of the draft document were sent to interested agencies, organizations, and public representatives. Following the public review period, the Service considered all comments and finalized the draft DARP. A summary of public comments and the Service's responses is provided in Appendix E. The Final DARP is available:

On-line at:

- The US Fish and Wildlife Service webpage (http://southeast.fws.gov/es/)

- The St. Johns River Water Management District webpage (http://www.sjrwmd.com/programs/acq_restoration/s_water/lapopka/)

Or in hard-copy by request at:

- Jay Herrington
  US Fish and Wildlife Service
  Jacksonville Ecological Services Office
  6620 Southpoint Drive South, Suite 310
  Jacksonville, FL 32216-0712

- Office of Communications and Governmental Affairs
  The St. Johns River Water Management District
  4049 Reid Street
  Palatka, FL 32177

1.7 Summary of Natural Resource Injuries

Natural resources at the Lake Apopka assessment area were injured due to their exposure to contaminants as a result of the flooding of fields historically treated with organochlorine pesticides (OCPs). This DARP focuses on injuries and associated service losses to avian resources connected to the site. Avian injuries determined by the Service include both lethal effects in the form of mortality (i.e., birds found dead on-site[3]), and sub-lethal losses based on adverse reproductive effects of on-site exposure to organochlorines for two generations. Note that these sub-lethal effects could be experienced by the birds after they have left the NSRA and Lake Apopka area. Total

[3] It is possible that birds that were exposed to contaminants from the NSRA died off-site. Birds that died off-site, however, are not included in this analysis due to the uncertainty of their numbers, exact cause of death, and association with the NSRA.

losses sustained by the birds at the NSRA are estimated to be 5,213 "bird-years", a measure that incorporates the losses sustained by both adult birds and their progeny over time.

Why does this Valuation Use "Bird-Years" as a Measure of Loss?

This assessment considers the number of "bird-years" lost as a result of the Lake Apopka NSRA bird kill event, rather that just the number of individual birds affected. In this analysis, each bird-year represents the existence of one bird for one year. The concept of a bird-year allows the analysis to consider not only the number of birds killed as a result of the event, but also the fact that these birds will be missing from the population for some period of time. For example, if a bird that would have lived to be ten years old is killed when it is two years old, approximately eight bird-years are lost. In this analysis, bird-years lost in the past (i.e., 1998-2002) are compounded to present value (2003), and future bird-years (i.e., 2004 and on) are discounted to present value (2003), following the conventions of natural resource damage assessment (Sperduto et al. 1999, Unsworth and Bishop 1994).

1.8 Summary of Preferred Restoration Alternative

The preferred restoration alternative is the acquisition and appropriate management of the Matanzas Marsh Property located in St. Johns County, Florida (See Figure 2). This highly developable, 8,465-acre property includes five miles of frontage along the Matanzas River and is home to the second largest breeding colony of wood storks in northeast Florida (120-150 nests in 2002; Meyer and Fredrick 2002). This property is the last remaining large and relatively undisturbed marsh-front area within the Guana-Tolomato-Matanzas National Estuarine Research Reserve and its acquisition will create a nearly contiguous, 16,000-acre conservation area.

This property will provide multiple restoration benefits, including protection for a breeding colony of the endangered wood stork, and habitat for a myriad of other bird species such as American white pelican and great blue heron. Matanzas Marsh will be managed pursuant to a management plan that will be developed by the State of Florida and the District in accordance with the "Acquisition and Ownership Agreement" between the District and the Board of Trustees of the Internal Improvement Trust Fund of the State (TIITF) and the requirements of Federal and state law. The Service will also participate in management plan development. The Matanzas Marsh property will generally be managed to accomplish natural resource-oriented objectives, with special priority given to the perpetual protection and preservation of the wood stork colony, including adjacent areas. In addition, the management plan will be developed under a public process that involves, at a minimum, participation in the management advisory group by the lead managing entity and all co-managing entities, the local soil and water conservation district, a local conservation organization and local and elected leaders.

2.0 Natural Resources and Contaminants of Concern

This section describes the natural resources and contaminants of concern for this assessment.

2.1 Natural Resources of Concern

Historically, Lake Apopka and its surrounding shores provided multiple habitats for a rich variety of species. These habitats included shoreline wetlands, marshy fields, shallow water and deep water. Together, these Lake Apopka environments sustained a complex food chain that supported fish, reptiles, amphibians, and their predators. Fish species found in the lake included largemouth bass, black crappie, bluegill, and other sportfish. Reptiles (e.g., alligators, red-belly turtles) and amphibians (e.g., various frog species) lived in and around Lake Apopka. Today, both the ecosystem of the lake itself and the habitats that comprise the NSRA are degraded: the lake due to nutrient loading, algal blooms and toxic substance contamination, and the NSRA due to decades of farming, hydrological disruptions, and toxic substance contamination.

Despite the ecological decline of the area, a myriad of bird species still use the habitats of the lake, especially as a feeding ground, including herons, egrets, ibis, pelicans, storks, cormorants, ducks, gulls, eagles, owls, and many others. The lake also serves as a wintering area for waterfowl, shorebirds, and other migratory bird species. When the NSRA was flooded, these species took advantage of the newly-re-created shallows and began feeding along the lake's north shore as well (Robinson 1999, NAS 1999).

The wood stork, a federally listed endangered species, also utilizes the resources of Lake Apopka and the NSRA. Since the 1960s, the wood stork population has been declining, most probably due to scarcity of food resources, which is directly related to habitat loss, as well as adverse effects of contaminants on reproduction. Listed by the Service in 1984 as an endangered species, the population of wood storks has been slowly recovering, but its endangered status has not changed. While flooded, the NSRA provided feeding and resting site for at least 1,200 wood storks, or approximately six percent of the total population of wood storks (20,000) in the United States today (USFWS 1999, Coulter et al. 1999).

Due to the nature of the incident as described above, the Service focuses this evaluation on natural resource losses sustained by avian resources in the flooded areas (the "assessment area") of Lake Apopka's northern shore. This focus is established for four main reasons:

- The flooded fields are the main source of hazardous substances to resident and migratory birds.

- Birds are the only recorded resource that exhibited acute effects (i.e., mortality) due to exposure to on-site contamination.

- Site specific data regarding losses sustained by avian resources is available.

- Piscivorous birds are top predators in many aquatic food chains and therefore are considered in this case to be representative of the health of the entire ecosystem.

2.2 Contaminants of Concern

Due to the incident at the North Shore Restoration Area, the Service, the District, and the US Environmental Protection Agency (EPA) analyzed soils and birds for multiple compounds. Results showed that these resources were mainly contaminated by a group of compounds called organochlorine pesticides (OCPs). Commonly applied to agricultural lands for decades, such as those on the north shore of Lake Apopka, OCPs include chemicals such as DDT (dichlorodiphenyltrichloroethane), toxaphene, dieldrin, and chlordane. Flooding the fields caused these contaminants to become available for accelerated bioaccumulation to piscivorous birds which, the Service maintains, constitutes a release that is not exempt under the pesticide provisions of CERCLA (42 USC Section 9603). Documented effects of these compounds on avian species include behavioral changes, reproductive impacts, and death. Although other compounds such as PCBs (polychlorinated biphenyls) and heavy metals (e.g., cadmium, copper, and lead) were also detected, concentrations were low and any adverse effects sustained by birds due to exposure to these other chemicals were considered small compared to the effects of OCPs. Therefore, service losses are assumed to be due to the exposure of avian resources to OCPs in the assessment area.

3.0 Injury Determination and Quantification

This section discusses the injury criteria, as defined in the US Department of the Interior's damage assessment regulations, that are applicable to this incident and resources of concern (43 CFR Part 11). It describes the determination of injury at the NSRA, and the assumptions and methodologies used to quantify injury to avian resources. This discussion includes an evaluation of the losses that are expected to occur due to exposure of birds to elevated levels of contaminants. In addition, this section discusses injuries determined but not quantified.

3.1 Definition of Injury

Because this assessment focuses on injuries to avian resources, injury will be determined and quantified based on the following definition:

> An injury to a biological resource has resulted from the discharge of oil or the release of a hazardous substance if concentration of the substance is sufficient to: (i) Cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations (43 CFR 11.62 (f)(1)(i)).

3.2 Determination of Injury

Within the DOI regulations, injury is determined in two phases: 1) confirmation of the pathway of contaminants from the source to the natural resource, and 2) documentation of adverse effects experienced by the resource due to exposure to those contaminants (43 CFR Part 11).

Pathway

OCPs of the same type were found in the soils, sediments, plankton, fish, and birds of the NSRA of Lake Apopka (SJRWMD and USFWS unpublished data). Although site-specific pathway studies were not conducted, the Service and the District agree that soil OCPs were transferred from soils to fish, and that birds accumulated OCPs by consuming contaminated fish.

Injury

Birds at the NSRA experienced injury due to the lethal (i.e., mortality) effects of exposure to OCPs. In addition, some birds present on-site during the incident may have experienced sub-lethal (i.e., reproductive) effects of exposure to these same contaminants. The lethal effects of OCP exposure are immediately evident in the large avian die-offs that occurred; over 670 birds were found dead on-site between November 1998 and April 1999. These counts were compiled and reviewed jointly by the Service and the District (See Table 1). Chemical analyses of a sub-set of birds that died during the event showed that most individuals had concentrations of OCPs in their tissues that have been documented, in published studies, to be lethal to other avian species (e.g., Call et al. 1976, Blus et al. 1977, Blus et al. 1979). OCPs therefore are considered to be the primary causative factor in, or the cause of, death for many of the birds found in the NSRA. Losses due to all bird deaths are evaluated based on the life history information of American white pelican, wood stork, and great blue heron, as described in the next section.

Table 1 **Birds Found Dead at the Lake Apopka Assessment Area November 1998 – April 1999 (SJRWMD and USFWS 2003)**	
Species	**Number Recorded**
Herons, Egrets (Ardeidae)	
Great Blue Heron	58
Black-crowned Night-Heron	15
Yellow-crowned Night-Heron	3
Night-heron species	2
Green Heron	1
Little Blue Heron	2
Heron species	1
Great Egret	35
Snowy Egret	3
Egret species	15
Ibis (Threskiornithidae)	
Glossy Ibis	3
White Ibis	4
Storks (Ciconiidae)	
Wood Stork	43
Pelicans (Pelecanidae)	
American White Pelican	441
Sandpiper (Scolopacidae)	
Long-billed Curlew	1
Short-billed Dowitcher	1
Dowitcher species	1
Ducks (Anatidae)	
Blue-winged Teal	3
Lesser Scaup	1
Northern Pintail	1
Cormorants (Phalacrocoracidae)	
Double-crested Cormorant	6
Gulls (Laridae)	
Ring-billed Gull	19
Gull species	4
Blackbirds (Icteridae)	
Boat-tailed Grackle	2
Raptors (Strigidae, Pandionidae, Falconidae)	
Great Horned Owl	1
Osprey	1
Peregrine Falcon	1
Unknown	
Unknown species	8
Total	**676**

In addition to lethal effects, this assessment considers sub-lethal effects that may have resulted from this event; specifically, it considers the potential reproductive effects of the exposure of adult birds to the OCP DDE (dichlorodiphenyldichloroethylene). In general, OCPs can cause a range of adverse effects on birds, including effects on reproduction, eggshell thinning, and physiological function (e.g., Blus et al. 1979, Longcore and Stendell 1977, Hurst et al. 1974). Because reproduction is one of the most biologically relevant and sensitive endpoints for avian exposure to OCPs, this analysis assesses avian injury based on exceedences of relevant and appropriate adverse effects thresholds for reproduction.

This analysis also focuses on avian injury due to DDE exposure, rather than quantifying losses caused by the entire suite of OCPs found at the NSRA for three reasons. First, the effects of DDE on avian reproduction are better documented in the literature than the effects of other OCPs. Second, the levels at which birds experience adverse reproductive effects are lowest for DDE (i.e., birds are more sensitive to DDE than to other types of OCPs). Third, the literature reports the effects of DDE exposure to some of the most sensitive bird species (e.g., brown pelican; Blus et al. 1974). Therefore, the Service expects that quantifying reproductive effects due to DDE exposure based on adverse effects thresholds derived for sensitive species will capture the majority of avian injury at the NSRA due to the event.

No reproductive effects have been directly observed from this event; that is, no site-specific studies have been completed to demonstrate changes in the reproductive success of birds exposed to DDE at the NSRA. Such studies would take several years and be quite costly. Exposure concentrations, however, were such that adverse effects could reasonably be expected to occur. By using reasonable “worst case” assumptions, available data, and published scientific literature, these effects can be estimated. The Service and the District believe this approach appropriately captures the nature and extent of injury and is more cost-reasonable than pursuing additional studies.

Specifically, in this case, since no case-specific data regarding the sub-lethal effects of OCPs on avian resources are available, sub-lethal effects are determined by comparing (1) the estimated exposure of birds recorded on-site with (2) adverse effects thresholds from the literature. Exceedences of these thresholds are used to indicate the potential for injury. This analysis includes the following steps:

- Estimate each bird’s exposure to DDE (i.e., model the transfer of DDE from fish to birds);
- Estimate the transfer of DDE from avian mother to egg; and
- Compare predicted DDE levels in each avian egg with appropriate and relevant adverse effect levels.

In order to estimate the level of OCP exposure of birds recorded on-site, the District developed a site-specific model that evaluates the transfer of OCPs from soil/sediment and fish to birds, then calculates the subsequent bioaccumulation of these chemicals in each bird's body tissues.[4] This model was developed cooperatively with the Service and the Service has determined that it is a scientifically reliable method to estimate exposure. An overview of the inputs to and results of the model is included below; a more detailed description is included in Appendix A.

Using both site-specific data and information from relevant scientific literature, the model considers exposure of American white pelicans and wood storks to DDE. Impacts to members of these two species are chosen to represent losses to all birds recorded on site. American white pelicans are included in the modeling effort because this species has the highest number of individuals recorded in the assessment area: over 4,700 (Robinson 1999). Wood storks are also included in the modeling effort due to their status as an endangered species. Almost 2,000 wood storks were recorded on-site (Robinson 1999). Great blue herons were not included in the assessment of sub-lethal injury. Details are provided in the following section.

Losses due to sub-lethal effects (i.e., reproductive effects) are determined based solely upon exposure to and accumulation of DDE, the most common and most toxic metabolite of DDT.[5] As noted above, in addition to the large body of scientific, peer-reviewed literature documenting the effects of DDE on birds, avian adverse effects thresholds are lower for DDE than for most other OCPs found on-site. Therefore, it is expected that measuring losses using DDE thresholds will incorporate losses due to other OCP compounds.

Site-specific data are used in the model where available. Data on contaminant concentrations in the top twelve inches of soil are derived from samples collected from within the fields and at the ends of fields in the assessment area. Average DDE concentrations range from 0.23 to 8.23 parts per million (ppm; SJRWMD and USFWS unpublished data). Fish OCP concentrations are calculated by multiplying soil OCP levels with a site-specific Biota-Sediment Accumulation Factor (BSAF) of six (See Appendix A for details on derivation of BSAF).

Assumptions regarding spatial and temporal extent of exposure in the NSRA, rate of bioaccumulation, and other parameters are also incorporated in the model. These include:

> *Spatial Extent of Exposure.* Exposure is evaluated over the area of flooded fields in the NSRA. The flooded extent of each field for each bird

[4] This model was developed to assess the sub-lethal effects of DDE only. Lethal effects were determined using site-specific information on the number of dead birds collected – no modeling was necessary.

[5] Although present in commercial DDT preparations, the majority of DDE found in the environment is a result of the metabolism of DDT. That is, DDT was applied to fields in the assessment area and biological and chemical activity over time changed this parent compound into DDE, which has a slightly different chemical composition and structure. This "new" compound is referred to as a metabolite.

survey date is estimated based upon aerial photographs and field notes (SJRWMD unpublished data).

Temporal Extent of Exposure. Exposure is evaluated in two-week increments from July 1998 through March 1999 (the length of time any part of a field in the assessment area was flooded). The model assumes that the first birds arriving on-site were the last to leave, and that birds arriving last were the first to leave. In addition, once an individual bird left the site, it is assumed that it did not return. This allows for a reasonable worst-case estimate of losses by allowing birds to be exposed for the maximum period of time.

Accumulation. The model assumes that all birds entering the site had no pre-existing DDE burden, accumulated DDE only from fish in the flooded portion of a field, and one hundred percent of the DDE consumed by a bird was absorbed and stored within the bird (i.e., no breakdown or elimination of DDE occurred). This provides a reasonable worst-case estimate of losses by allowing birds to accumulate the maximum possible body burden of DDE.

The results of the modeling effort predict DDE body burdens in birds ranging from less than five ppm wet weight (ww) to more than 80 ppm ww for wood storks, and from less than five ppm ww to more than 145 ppm ww for American white pelicans. The results range widely for both species due to the variation in the length of time each bird spent on the site and the different concentrations of DDE to which each bird was exposed during its time on-site (See Appendices A and C for detailed results on a per-bird basis).

In order to estimate incident-related sub-lethal injury to the avian resources of Lake Apopka, model results were compared to published avian adverse effects thresholds for DDE. Literature-based thresholds were chosen based on the following criteria:

- Relevance to the modeled species (i.e., American white pelican and wood stork);
- Use of a biologically-relevant endpoint (i.e., reproduction); and
- Appropriate body tissue; specifically, in an evaluation of the reproductive effects of DDE on birds, the egg is a more sensitive receptor than the adult.

The thresholds shown in Table 2 satisfy these three criteria. Based on concentrations in eggs, chosen thresholds are for reproductive effects in brown pelican, one of the species most sensitive to the effects of DDE. This sensitivity provides for a reasonable worst-case reproductive injury scenario for the birds at Lake Apopka.

Table 2
Reproductive Adverse Effects Thresholds for DDE for the Brown Pelican

Threshold (ppm)	Effect	Service Loss	Source
< 1	Successful nest	0%	Blus 1982, Blus et al. 1979
1 - 1.5	Decrease in young/nest [a]	10%	Blus 1982, Blus et al. 1974
1.5 – 4	Decrease in young/nest [b]	55%	Blus 1982, Blus et al. 1974
4	Total reproductive failure	100%	Blus 1982

Notes
a. As noted in the literature, although most nests with eggs between 1 and 1.5 ppm DDE were successful, unsuccessful hatching was still observed (Blus 1982, Blus et al. 1974).
b. A "normal" brown pelican nest is expected to have 1.36 young/nest; at DDE concentrations between 1.5 and 4 ppm, young/nest is 0.62 (Blus 1982, Blus et al. 1974).

Because the exposure model estimates adult whole body concentrations of DDE and eggs are considered a more sensitive receptor, model results were converted to egg concentrations using a maternal transfer factor (i.e., a ratio of the DDE concentration in the egg to the DDE concentration in the mother). First, the analysis assumes that 50 percent of all exposed birds were female and that all of these females are of breeding age. Then, it assumes that every other bird listed in the exposure model was female, (i.e., females and males were exposed equally).[6] For each female, the analysis estimates that 40 percent of the maternal concentration of DDE is transferred to her eggs (Braune and Norstrom 1989, Norstrom et al. 1986):[7]

$$DDE_{egg} = DDE_{mother} * 0.40$$

Estimated DDE levels in eggs range from 2.58 ppm to 60.13 ppm for American white pelican, and 1.03 ppm to 33.75 ppm for wood stork. Detailed results are provided in Appendix C.

The comparison of predicted DDE concentrations in the eggs of American white pelican and wood stork to the selected adverse effects thresholds provides a measure of the expected reproductive injury. This modeling effort estimates that all female American white pelicans and all female wood storks exposed to DDE would be expected to lay eggs that will suffer adverse effects.

[6] The results of the exposure models list birds in order of decreasing time spent on site (i.e., the first bird spent the most time on-site and the last bird spent the least). Therefore, assuming every other bird in the list is female provides an “equal” exposure pattern over time for males and females.
[7] Forty percent is the average concentration ratio for herring gull mother-to-egg transfer of DDE measured in whole body wet weight units as reported by Braune and Norstrom (1989; 38.5% egg:mother DDE ratio) and Norstrom et al. (1986; 42% egg:mother DDE ratio). Due to the lack of species-specific maternal transfer data for American white pelican and wood stork, for purposes of this assessment the DDE maternal transfer ratio for these two species is assumed to be similar to that for herring gulls.

Table 3 Species-Specific Life History Characteristics			
Characteristic	**American White Pelican** [c]	**Wood Stork** [d]	**Great Blue Heron** [e]
Average life span of species (years) [a]	13	12	14
Average percent of females in population	50%	50%	50%
Average age of first breeding (years)	3	4	2
Probability of adult survival/year [b]	78.7%	80%	78.1%
Broods/year	1	1	1
Eggs/nest	2	3.3	2.9
Young fledged/nest	0.85	1.51	2.3
Probability of fledgling surviving year 1 [b]	59%	60%	31%

Notes
a. Life span for Wood Stork is the maximum (rather than the average) recorded.
b. Probability of survival is 100% minus the probability of mortality.
c. Evans and Knopf 1993
d. Coulter, et al. 1999
e. Butler 1992 and INRIN 2003

3.3 Quantification of Injury: Methodology and Results

Losses to avian resources are quantified through evaluation of lethal (i.e., mortality) and sub-lethal (i.e., reproductive) effects (See Figure 3).

Lethal (Mortality) Effects

Losses due to lethal effects, or mortality, are calculated for all birds found dead on-site and their lost potential progeny. This allows the Service to account for both individual bird losses as well as effects that populations of these birds might suffer as a result of a reduction in the number of birds in the next generation.

What are Service Losses?

In natural resource damage assessment, the term "service loss" is commonly used to refer to the services provided by a natural resource that have been lost, in whole or in part, due to a contamination event. Such losses can include changes in human use of resources (e.g., fewer or lower quality recreational fishing opportunities), and/or ecological services provided by the resource (e.g., diminished capacity of an oiled wetland to provide healthy habitat to plants and animals). Estimates of service losses are based on available site-specific data, data from similar sites, published literature, and assumptions made by qualified technical experts. In this assessment, a slight decrease in the number of successful fledglings per nest results in a ten percent decrease in services, a larger decrease in fledgling success causes a 55 percent service loss, and total avian reproductive failure is assumed to equal 100 percent service loss. These estimates are based on published literature and the professional judgement of Service biologists.

First, avian resource losses are determined based on the adult birds found dead on-site. The data used for this analysis include the record of birds found dead on-site, as compiled and reviewed by the District and the Service. Although approximately 22 species of birds experienced mortality at the site, three species comprised the majority of dead birds (See Table 1). Sixty-five percent of all dead birds were American white pelicans, nine percent were great blue herons, and six percent were wood storks. Other species each represented less than five percent of the dead birds. Therefore, losses are evaluated on a species-specific basis for American white pelican, wood stork, and great blue heron. Losses to all other birds are evaluated based on the life history information of the American white pelican (i.e., losses to American white pelicans and all other birds not reported to be wood stork or great blue heron are evaluated together using information for the American white pelican), and henceforth are referred to as American white pelicans. Although some bird species have different life history characteristics than the American white pelican, use of the American white pelican as a surrogate for these species results in a potential overstatement of losses due to the longevity, breeding habits, and average adult mortality of the American white pelican. Life history characteristics for American white pelican, wood stork, and great blue heron are summarized in Table 3.

Losses due to adult mortality are determined on a per species basis for American white pelican, wood stork, and great blue heron. The analysis assumes that all dead birds were in their first breeding year, and that each bird may have lived to the average age of the species based on the average probability of yearly survival. Sufficient site-specific age data or life history information are not available for NSRA birds; however, these assumptions are considered to provide a reasonable worst-case scenario of losses. The measure of mortality losses is the estimated number of years each bird would have lived but for the incident. Losses are then summed across all modeled years to provide an estimate of bird-years lost per species.

For example, a wood stork found dead on-site is assumed to be four years old. The probability of it surviving to each consecutive year is 80 percent (e.g., a four year old bird has an 80 percent chance of surviving to be five years old, and a 64 percent[8] chance of surviving to its sixth year, etc.), and the maximum age the wood stork could reach is 12 years. Therefore, because each dead bird no longer exists to function within the ecosystem, all the years it would have lived but for the incident are considered "lost." This calculation is repeated with species-specific information for each species.[9]

Because the incident occurred in 1998-1999, the present value (2003) of those losses is calculated using a standard discount rate of three percent.[10] Compounding of past losses and discounting of future losses to generate a present value loss is a well-accepted practice in natural resource damage evaluation (Unsworth and Bishop 1994).

Losses are summed across species, resulting in a total of 2,441 adult bird-years lost due to mortality. A summary of results is provided in Table 4, and detailed results are provided in Appendix B.

Table 4
Injury Quantification for Bird Mortality

Species	**Present Value Adult Bird Years Lost Due to Mortality**
American White Pelican	2,076
Wood Stork	155
Great Blue Heron	210
Total	**2,441**

Next, losses of fledglings the dead adult birds would have produced but for the incident at Lake Apopka are estimated. Losses to this generation of fledglings, the "F1" generation, are evaluated by estimating the number of fledglings the female adults of each species would have produced in the years following the incident.[11] The number of potential year-old fledges accounts for the number of young fledged per nest in a given year and the probability that each of those fledglings would survive their first year.

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[8] Each bird has an 80 percent chance of surviving to the next year. Therefore, the probability of surviving the first year is (80 percent in year 1). The probability of surviving the second year is [(80 percent in year 1) * (80 percent in year 2) = 64 percent], and so on.

[9] All observed bird deaths that are not categorized as wood stork or great blue heron are included in the American white pelican calculations (i.e., 576 birds are evaluated based on American white pelican life history data but only 441 of those bird deaths were actually white pelicans).

[10] Present Value (PV) = [Birds lost in Year X * ((1 + Discount Rate)$^{\text{Present Year} - \text{Year X}}$)]. For example, PV losses for adult American white pelican in 1998 = [Lost Adult Birds in 1998 * $1.03^{2003-1998}$]. The result is that bird years lost in the past are compounded forward, and bird years lost in the future are discounted back.

[11] The analysis assumes that 50 percent of the dead adult birds were female and that all of these individual birds would have been able to reproduce.

Losses are summed across all modeled years to provide an estimate of bird-years lost per species.

For example, a wood stork female found dead on-site is assumed to be four years old and therefore capable of reproducing. From her one brood per year, the wood stork produces an average of 1.51 fledglings (from a clutch of 3.3 eggs per nest). Each of these fledglings has a 60 percent chance of surviving its first year (See Table 3). These fledglings would have existed but for the death of the parent, and are therefore considered "lost." This calculation is repeated with species-specific information for each species.

The total number of lost potential fledglings is determined by calculating the present value (2003) of lost bird-years (i.e., fledgling-years) per species. Again, this analysis applies a discount rate of three percent.[10]

Note that the expected life span of each fledgling (i.e., the number of years each fledgling would have lived) is not included in the quantification of losses, nor are impacts to the F2 generation.[12] One of the main determinants of fledgling success is resource (e.g., food, nesting sites) availability. Assuming food is a finite resource, all fledglings must compete for this resource, with only a fraction able to consume enough to survive. In the NSRA, fledglings that would have been born but for the death of their parents due to contamination are removed from the competition for resources. Therefore, fledglings from areas outside the NSRA have less competition for food and a correspondingly higher chance of survival than they would otherwise. The higher survival rate for off-site fledglings compensates for the loss of fledglings on-site. Thus, the population is expected to recover within the life span of the first generation, and no fledgling losses due to adult mortality are incurred beyond the first year of the F1 generation.

Losses are summed across species, resulting in a total of 646 bird-years forgone. A summary of results is provided in Table 5, and detailed results are provided in Appendix B.

Table 5
Injury Quantification for Lost Fledglings (F1) due to Mortality

Species	**Present Value Fledgling Bird Years Lost Due to Mortality**
American White Pelican	506
Wood Stork	68
Great Blue Heron	72
Total	**646**

[12] The F2 generation consists of the progeny of the F1 generation.

Sub-lethal (Reproductive) Losses

Sub-lethal, or reproductive losses are determined for American white pelicans and wood storks that visited the NSRA but did not die during the period when the assessment area was flooded, and who therefore may have consumed contaminated prey. Losses are calculated for the lost potential progeny of these two species due to exposure to DDE (See Figure 3). Although there were numerous species that utilized the resources of Lake Apopka during the flooding, the majority of these birds were American white pelicans (4,719 individuals), and thus the analysis of potential reproductive effects focuses on this species. In addition, although there were fewer wood storks than white pelicans exposed during the incident (1,991 individuals), wood storks are included in this analysis due to their status as an endangered species.

Although quantified in the assessment of lethal effects, great blue herons were not included in the evaluation of sub-lethal impacts due to DDE exposure at the NSRA. There is no clear evidence of the adverse effects of organochlorines on the reproductive success of this species (Blus 1980). First, although eggshells broken during incubation average 14-17 percent thinner than those from the pre-organochlorine pesticide era (1947), this difference does not appear to significantly affect reproductive success (Blus 1980). Secondly, based on daily bird counts at the NSRA, there were far fewer great blue herons on-site (peak of 395) than American white pelicans (peak of 4370) or wood storks (peak of 1130; Robinson 1999), so inclusion would not materially change the results of this assessment. Finally, great blue heron populations are considered more robust than those of American white pelicans and wood storks, and due to specific life history characteristics great blues herons are expected to recover more quickly from adverse impacts (Butler 1992). For example, the average age of first breeding is two years old (i.e., younger than other similar species), and the average number of young fledged from nests is 2.3 (i.e., greater than other similar species; Butler 1992; See Table 3).

As described above, reproductive losses are based on a model of potential exposure to DDE. The physical and chemical properties of DDE allow it to bioaccumulate, transfer from mother to egg, and resist degradation. Since the effects of DDE exposure may be felt for several generations, this analysis considers potential reproductive impacts on both the F1 and F2 generations.[12] Losses are assumed to be negligible at the population level for the F3 generation, due to the increased survival of other, unexposed fledglings. As noted previously regarding the lost potential progeny of birds that died on site, this assumption is based on the principle of resource-dependent (e.g., food availability) reproductive success.

As described in the Injury Determination section above, avian egg DDE concentrations are determined based on transfer of DDE from mother to egg. The resultant concentrations are then compared to appropriate and relevant adverse effect thresholds noted in scientific literature.

Exceedences of these thresholds indicate that injury has occurred, but not the level of injury. In order to quantify injury, this analysis considers the extent to which bird resources can no longer provide the ecological services that would be provided in the absence of the incident. If a bird is eliminated from the population (i.e., mortality) due to the incident, the bird no longer provides any services and thus the service loss is considered to be 100 percent. In the case of exposed birds that did not suffer acute mortality, this analysis assumes that reproductive impairment could occur. In this case service losses are measured based on the decrease in hatching success associated with a modeled DDE level in each egg (See Table 2).

Lost bird-years, by species, are calculated based on reproductive service losses for each female adult bird, which, in turn, are based on the success or non-success of her fledglings. Using species-specific life history information regarding the expected number of fledges per nest and the probability that each fledgling will survive one year, the number of lost bird years per adult female is calculated. Life history information for the American white pelican and the wood stork is provided in Table 3.

For example, an adult female wood stork is expected to lay an average of 3.3 eggs. Based on the transfer of DDE from mother to egg, each egg is expected to have accumulated a certain concentration (e.g., 3.5 ppm) of DDE. This level of DDE is compared to the adverse effects thresholds, and is expected to cause a 55 percent decrease in hatching success. This is equivalent to a 55 percent loss in reproductive services (i.e., reproductive potential that would have existed but for the mother's exposure to DDE). That loss is calculated in bird-years based on the difference between the fledglings that would have survived for one year without exposure to DDE and the fledglings that are expected to survive given exposure to DDE. This calculation is repeated with species-specific information for each species.

The total lost bird-years for the F1 generation are determined by calculating the present value (2003) of lost fledglings, per species, for the first year the exposed adults bred.[10] Clutches in subsequent years are not included in this analysis because it is expected that, after the mother depurates a significant portion of her DDE burden into her first clutch, following clutches will not receive sufficient DDE to cause significant adverse effects. Again, a discount rate of three percent is applied to this analysis.

Losses are summed across species, resulting in a total of 2,087 bird-years for American white pelican and wood stork fledglings forgone due to reproductive impairment of adult birds. A summary of results is provided in Table 6, and detailed results are provided in Appendix C.

Table 6
Injury Quantification for Lost F1 Generation Bird-Years due to Reproductive Effects

Species	**F1 Generation (bird-years)**
American White Pelican	1,197
Wood Stork	890
Total	**2,087**

In addition to losses in the F1 generation, it is expected that the progeny of the exposed female F1 birds, the F2 fledglings, may themselves experience reproductive impairment. Because of the specific physical and chemical properties (e.g., long half life, affinity for fat) of DDE (ATSDR 2002), the DDE in F1 fledglings is assumed to be eliminated only through maternal transfer into next generation (i.e., F2) eggs. Due to this DDE exposure, the F2 generation of American white pelicans and wood storks may also to suffer a decrease in reproductive (i.e., hatching) success. All female F1 fledglings (i.e., 50 percent of the total fledglings) that survived DDE exposure (i.e., service losses *remaining* after DDE exposure) are assumed to produce their own progeny according to the same species-specific life history data (e.g., young fledged per nest, etc.) used in the evaluations above. Each modeled F2 fledgling is then expected to incur the same service losses due to DDE transferred from its F1 generation-mother as the F1 fledgling incurred from DDE transfer from its original adult female parent. Although this service loss estimate for the F2 fledglings may overstate losses, lack of site-specific studies regarding the generational effects of DDE and the need to estimate losses under a reasonable worst-case scenario allows for the fact that losses to progeny are at least no worse than those of its parent.

For example, the wood stork described in the example above produced fledglings that survived DDE exposure, but suffered a 55 percent reduction in hatching success. That is, only 45 percent of the F1 generation wood stork's potential reproductive services remained to produce F2 progeny (assuming the surviving F1 fledgling is female).[13] Each of the F2 wood stork fledglings is exposed to maternally-transferred DDE from the F1 mother, and each may also suffer a 55 percent service loss. Again, losses are calculated in bird-years based on the difference between the fledglings that would have survived for one year without exposure to DDE and the fledglings that survived with exposure to DDE. This calculation is repeated with species-specific information for American white pelicans as well.

The total lost bird years for the F2 generation are determined by calculating the present value (2003) of the lost fledglings, per species, for the first year the F1 generation was able to breed.[10] For American white pelican this would have been 2002 and for wood stork the first breeding year of the F1 generation would have been 2003. A discount rate of three percent was applied for this analysis.

Losses are summed across species, resulting in a total of 39 bird-years for American white pelican and wood stork fledglings forgone due to reproductive impairment of adult birds. A summary of results is provided in Table 7, and detailed results are included in Appendix C.

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[13] Of course, "0.45" of a wood stork does not exist. This estimate is applied probabilistically; for example, if applied to 100 wood storks, then 45 birds would be estimated to remain in the population to reproduce.

Table 7 **Injury Quantification for Lost F2 Generation Bird-Years due to Reproductive Effects**	
Species	**F2 Generation (bird-years)**
American White Pelican	17
Wood Stork	22
Total	**39**

Summary of Losses

Total losses are the sum of lethal and sub-lethal losses. For the NSRA, these losses total 5,213 bird-years. Summarized in Table 8, they include:

- Losses due to mortality of all adult birds based on the life history characteristics of American white pelican, wood stork, and great blue heron;
- F1 losses incurred due to mortality of adults and based on the life history characteristics of American white pelican, wood stork, and great blue heron; and
- Losses due to reproductive effects of DDE on the F1 and F2 generations of American white pelican and wood stork.

Table 8
Total Quantified Bird-Years Lost due to Lethal (Mortality) and Sub-lethal (Reproductive) Effects at the NSRA of Lake Apopka

	Mortality		**Reproductive Effects**		**Total**
Species	**Adults**	**Potential F1**	**F1**	**F2**	
American White Pelican	2,076	506	1,197	17	3,796
Wood Stork	155	68	890	22	1,135
Great Blue Heron	210	72	NA	NA	282
Total (Bird-Years)					**5,213**

3.4 Other Avian Injuries

In addition to the avian losses that were quantified, the potential for sub-lethal effects on other species exists. Available data show that individual birds from over 20 species were found dead on-site; it is expected that other individuals from those species were exposed to toxic contaminants at the NSRA and therefore may have experienced sub-lethal effects (e.g., reproductive impairment). These birds include night herons, green herons, egrets, gulls, ibis, dowitchers, and teal.

Having quantified the losses attributable to the species that comprise more than two thirds of all birds affected, the Service believes it would not be a prudent use of its resources to quantify losses for each of the 20 other species involved in the event. To quantify such injuries would require additional time, money, and effort on the part of the Service, and would greatly extend the time to complete this assessment. In addition, the Service believes that restoration objectives for injuries to species other than American white pelican, wood stork, or great blue heron can be addressed through restoration actions focused on compensating for losses due to mortality of all avian species and reproductive impairment of American white pelican and wood stork. Specifically, the acquisition of the Matanzas Marsh property will benefit all species involved in the incident (as discussed below). Therefore, while it is clear that injury to these other species did occur, quantification of such losses is not necessary under these circumstances.

4.0 Restoration and Scaling

This section reviews the Service's restoration objectives, outlines the criteria against which restoration options were evaluated, and discusses various proposed restoration alternatives. It then discusses the restoration option preferred for compensation of avian resource losses at the NSRA of Lake Apopka, based on provision of appropriate and sufficient habitat for relevant avian species.

4.1 Restoration Objectives

The Service's overall restoration objective, as stated in CERCLA, includes the restoration, rehabilitation, replacement, and/or the acquisition of the equivalent of the injured natural resources and the services those resources provide (43 CFR 11.82 (a)). Specifically, the Service requires restoration that will compensate the public for the loss of approximately 4,000 bird-years as a result of the incident at the NSRA. Natural recovery, in which no human intervention is taken to directly restore the injured natural resources or services to their baseline condition, is expected to occur with sufficient rapidity (e.g., a few breeding seasons) that no direct primary restoration is required. In addition, the District is currently keeping the fields unflooded to minimize continued exposure of birds to contaminants in that area. The public, however, has experienced interim losses caused by the deaths and reproductive impairment of birds at the NSRA as a result of this incident. Therefore, the Service requires compensatory restoration for avian service losses, with emphasis on the compensation for the loss of the Federally-listed endangered species, the wood stork.

4.2 Evaluation Criteria

In order to assure the appropriateness and acceptability of restoration options for avian losses incurred at Lake Apopka, the Service evaluated each option against site-specific restoration requirements determined by the Service at the beginning of this process. A project that satisfied these site-specific criteria was then reviewed based on restoration factors listed in the DOI damage assessment regulations (43 CFR 11.82 (d)). The criteria specific to compensatory restoration for the incident at Lake Apopka include:

- Provision of projects of sufficient scale to compensate for the total estimated loss.

- Provision of restoration actions specifically focused on protection and enhancement of impacted endangered species populations. In the case of the NSRA, the Service must give special consideration to restoration actions that address losses sustained by the wood stork population.

- Provision of restoration actions that address non-quantified bird losses. The Service recognizes that avian species other than American white pelican and wood stork may have experienced sub-lethal exposure to contaminants at the NSRA, and therefore may have experienced corresponding adverse effects. Although these losses are not quantified, the selected restoration option should consider these losses.

- Provision of actions that will encourage sustainable bird populations. That is, actions that would result in long-term protection of habitat to support bird populations are preferred over actions that might result in short-term, non-sustainable increases in these populations.

4.3 Restoration Alternatives

Several types of projects were considered as potential restoration alternatives for natural resource damages sustained due to the incident at Lake Apopka. These alternatives included:

> Habitat preservation. Preservation efforts would involve acquisition of lands considered at-risk for development or other degradation. The District would target private lands with important habitat for the species affected by the incident at Lake Apopka, but the success of a preservation project would hinge on whether the District could successfully enter into a purchase and sale agreement with the landowner. Specifics of relevant properties are not included in this document due to the sensitive nature of real estate transactions.
>
> Habitat restoration. Habitat restoration alternatives could be accomplished on lands already in public ownership, reducing the uncertainty of success. For example, degraded properties owned by the District for the purpose of

rehabilitation may be restored to benefit the bird species affected by the incident at the NSRA. One District-owned property that requires restoration is the Berry Groves property in Indian River County, Florida. The 1,900 acre property provides an opportunity to restore a complex mosaic of prior converted wetlands, depressional wetlands and upland habitat. Restoration would create habitat for endangered snail kites and wood storks, and numerous other waterbirds and waterfowl.

Scientific research. Scientific endeavors were evaluated as a possible restoration alternative because the knowledge generated from these studies would assist resource managers in predicting the bioaccumulation of organochlorines in wetland systems. Results would not only help the District manage wetlands at Lake Apopka, but would have broad applicability to other efforts aimed at restoring ecosystems damaged by agriculture. For example, the District is involved in a bioaccumulation study that is expected to: 1) reduce uncertainty in predicting OCP bioaccumulation in organisms living on highly organic soils, and 2) develop Biota-Sediment Accumulation Factors.

4.4 Evaluation of Selected Restoration Alternative

The District proposed multiple restoration alternatives as appropriate compensation for natural resource damages at Lake Apopka. The Service reviewed these proposals and determined that purchase and subsequent management of the Matanzas Marsh property was preferred based on its provision of in-kind services (i.e., bird-years), and specifically, wood stork services. The Service then evaluated this option in light of the evaluation criteria described above.

Overview of the Matanzas Marsh Property

The Matanzas Marsh property is approximately 8,465 acres in size and is located within the District's Northern Coastal Basin in St. Johns County, Florida. South of the City of St. Augustine and north of Palm Coast, the property is bordered on the south by Faver-Dykes State Park and the Pellicer Creek State Aquatic Preserve. State Road 206 and the Moses Creek Conservation Area lie to the north. US Highway 1 forms the western boundary and the Matanzas River is east of the property (See Figure 2).

Matanzas Marsh provides important habitat for fish and wildlife, especially birds. The property is approximately 78 percent (6,600 acres) uplands and 22 percent (1,800 acres) wetlands, and data from the Federal Emergency Management Agency indicate that more than 20 percent of the parcel is below the 100-year floodplain. Marshes support large numbers of waterbirds, shorebirds take advantage of the oyster bars and tidal flats of the Matanzas River, a cypress dome provides habitat for a wood stork colony, and the proximity of uplands to aquatic habitat is utilized by the inhabitants of two bald eagle nests. In addition, a highly diverse group of neotropical migratory songbirds stopover at the property during spring and fall migration.

Most of the uplands at Matanzas Marsh have been subjected to silvicultural forest management practices since the mid 1940's. Although the number of listed species protected on silvicultural lands may be relatively low, these forest areas often serve vital functions when viewed from a regional perspective. As is the case with the Matanzas Marsh Property, they help to buffer more pristine natural areas from encroaching urban and residential development. These forest lands also help to link Faver-Dykes State Park and the Moses Creek Conservation Area. This continuous landscape of natural areas provides a corridor for the movement of individual organisms and an avenue for the spread of genes and ecological processes, all of which are important for the long-term conservation of biodiversity (Noss 1991).

Attributes of the Matanzas Marsh property that make it appealing from a conservation standpoint also make it highly desirable and uniquely situated for large-scale development. For example, the property boasts over five miles of frontage along the Intracoastal Waterway (Matanzas River), is adjacent to approximately 8,000 acres of conservation land, and supports upland communities on almost 80 percent of the property. In addition, much of the transportation access essential to any development already exists, such as proximity to two interstate interchanges and road access to the Atlantic Ocean in nearby Crescent Beach (See Appendix D for more details).

Evaluation Based on Criteria

In order to determine the appropriateness and sufficiency of the preferred restoration alternative, the characteristics of the Matanzas Marsh property and the proposal for its acquisition and management were evaluated based on the criteria listed above. In addition to these site-specific criteria, the general criteria listed in the Department of the Interior regulations for damage assessment (43 CFR 11.82 (d)) were also considered. Details regarding these criteria are provided below.

> *Provision of projects of sufficient scale to compensate for the total estimated loss (Site-specific criterion).* Trustee analysis indicates that the proposed project is sufficient in scale to compensate for estimated losses. Specifically, the Matanzas property consists of a variety of habitats that support many of the bird species that were directly affected by the incident, including a cypress dome that provides nesting habitat for a colony of 120 to 150 nests of endangered wood storks (Meyer and Frederick 2002). Acquisition and management of this 8,465-acre property will provide protection (e.g., from development) for essential nesting and foraging habitats into the future.
>
> *Provision of restoration actions specifically focused on protection and enhancement of impacted endangered species populations (Site-specific criterion).* As noted above, the Matanzas Marsh property supports a

breeding colony of wood storks. Located in large cypress trees in the northwest quadrant of the property, the wood stork colony in 2002 was one of the two largest wood stork colonies in northeast Florida. Acquisition of the Matanzas Marsh property would provide long-term protection for the colony.

Provision of restoration actions that address non-quantified bird losses (Site-specific criterion). Impacts were quantified for American white pelican, wood stork, and great blue heron. Available information suggests that several other species likely were affected by the incident, including egrets, ibis, teal, and gulls. As described below, many of these species are present in the Matanzas Marsh property, and would likely benefit from long-term management efforts. For example, a survey by the Florida Natural Areas Inventory (FNAI) and the Department of Environmental Protection, Bureau of Recreation and Parks (FDEP) revealed large numbers of waterbirds foraging in the openings of the high marsh. Species of particular interest (e.g., those species directly impacted at the NSRA) included wood stork, great egret, and great blue heron. Small numbers of great blue, little blue, and green herons also nest within the wood stork colony, and there are two known bald eagle nests on the property. In addition, a biodiversity analysis by the Florida Fish and Wildlife Conservation Commission resulted in parts of the Matanzas Marsh property being designated Class 2 or Class 3 biodiversity hotspots (Cox et al. 1994).[14]

Provision of actions that will encourage sustainable bird populations (Site-specific criterion). Acquisition of this parcel will provide protection to the last remaining large and relatively undisturbed marshfront area within the Guana-Tolomato-Matanzas National Estuarine Research Reserve and the District's Northern Coastal Basin. The acquisition will create approximately 16,000 acres of contiguous conservation land that include Faver-Dykes State Park, Pellicer Creek Conservation Area, the Florida State Agriculture Museum, and Princess Place Reserve. This contiguous habitat is essential for the long term persistence of numerous avian species in Florida, and for this reason Audubon of Florida designated this site as an Important Bird Area (Pranty 2002).

Technical feasibility (43 CFR 11.82 (d)(1)). Purchase and management of the Matanzas Marsh property is technically feasible. The purchase was completed on April 14, 2003 with monies from the District and the TIITF, and a management plan for the protection of the wood stork colony will be created and implemented by the District and other relevant agencies, including the Service.

[14] A "Class 2" biodiversity hotspot represents important habitat for three to four species, while a "Class 3" hotspot represents important habitat for five to six species.

The relationship of the expected costs of the proposed actions to the expected benefits from the restoration, rehabilitation, replacement, and/or acquisition of equivalent resources (43 CFR 11.82 (d)(2)). The Service believes the expense of purchasing and managing the Matanzas Marsh property to be reasonable based on the compensation required for avian losses, including losses incurred by the endangered wood stork. The criterion applied by the Service for determination of the appropriateness and sufficiency of a restoration option is whether the project provides habitat that supports the avian population affected by the incident. The Matanzas property is the only restoration option that provides feeding *and* nesting sites for the endangered wood stork, a benefit that is highly valued by the Service and the public and is therefore appropriate to address the specific impacts caused by this incident.

Cost-effectiveness (43 CFR 11.82 (d)(3)). The acquisition and management of the Matanzas Marsh property is cost-effective. The Trustees attempted but were unable to identify other, lower cost projects that adequately addressed restoration needs.

Results of any actual or planned response actions (43 CFR 11.82 (d)(4)). The response actions taken by the District due to the incident (i.e., pumping the NSRA fields) effectively ended the incident and are expected to minimize further injury to the avian resources in the Lake Apopka area. The restoration actions being implemented are intended to address compensatory, or interim losses, and are accounted for in loss calculations, but do not directly affect the Matanzas Marsh property, as no response actions have occurred or will occur on that property.

Potential for additional injury resulting from the proposed actions, including long-term and indirect impacts, to the injured resources or other resources (43 CFR 11.82 (d)(5)). Acquisition and long term management the Matanzas Marsh property is specifically designed to improve the condition of associated resources; the potential for causing additional direct or indirect injury through this project is very low.

The natural recovery period and the ability of the resources to recover with or without alternative actions (43 CFR 11.82 (d)(6-7)). The potential for natural recovery of the injured avian resource was explicitly incorporated when scaling the preferred restoration option. Specifically, injured bird populations are expected to recover within a generation due to increased reproductive success by birds unaffected by the incident. That recovery was expected to begin with the first generation of birds born after the incident (i.e., in the 1999 breeding season) due to the response actions completed by the District. This DARP shows that the Matanzas Marsh property provides sufficient avian services to compensate for avian losses through complete recovery.

Potential effects of action on human health and safety (43 CFR 11.82 (d)(8)). Acquisition and management of the Matanzas Marsh property is expected to have a negligible effect on human health and safety, given non-invasive management programs likely to be implemented. Because the preferred restoration option involves acquisition of property, risks to human health and safety are less than if restoration or enhancement activities were required (e.g., use of large machinery, stirring up contaminated soil, etc.).

Consistency and compliance with relevant Federal, state, and tribal laws and policies (43 CFR 11.82 (d)(9-10)). The Service's consideration of this criterion is discussed in detail below in Section 4.5.

Purchase and Management of the Matanzas Marsh Property

The District has purchased the Matanzas Marsh property with a combination of its own funds and monies contributed by the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida. The total purchase price for the property is $39,912,475, or $4,715 per acre. On December 11, 2002, the District's Governing Board approved and signed the purchase and sale agreement, and on February 11, 2003, the TIITF–Governor and Cabinet approved and signed the purchase and sale agreement. The closing of the real estate transaction occurred on April 14, 2003. The District obtained the property with the understanding that the Service was not obligated and had not yet determined that protection of the property would be the preferred restoration option for avian losses due to the avian mortality event at the NSRA.

The District expects to manage the Matanzas Marsh property for conservation purposes in perpetuity, with assistance from other agencies, including the Service. The "Acquisition and Ownership Agreement" between the District and the Board of Trustees of TIITF *requires* that all lands necessary to the protection of this wood stork colony, including all adjacent areas, be preserved in perpetuity. It is anticipated that the Florida Division of Forestry (FDOF) will manage the northern portion of the property and the FDEP will manage the southern portion as an addition to Faver-Dykes State Park. Details of the development and implementation of this management plan will be determined in the future with input from the Service as to the management plan for the protection of the wood stork colony. In addition, as part of the restoration effort the District will: 1) monitor the success of the colony, and 2) fund the cost of updating the US Fish and Wildlife Service Habitat Management Guidelines for the Wood Stork in the Southeast Region (Prepared by John C. Ogden, January 1990).

4.5 Compliance with the National Environmental Policy Act and Other Potentially Applicable Laws

The preferred restoration alternative is categorically excluded under the National Environmental Policy Act, 42 USC Section 4321 *et seq*., as provided under DOI's Department Manual. See generally 516 DM 2, including Appendix 1, and specifically 516 DM 6, Appendix 1 Sections B(1) and B(11). Section B(1) exempts research, inventory, and information collection activities directly related to the conservation of fish and wildlife resources and that involve negligible animal mortality or habitat destruction, no introduction of contaminants, and no introduction of non-indigenous organisms. This exception, therefore, covers the monitoring component of the preferred restoration alternative. Section B(11) covers implementation of natural resource damage assessment and restoration plans under CERCLA when there are only minor or negligible changes in the use of the affected restoration area. In this case, where the preferred restoration alternative provides for the preservation of wood stork habitat in its current state, there will be no change in the use of the affected property due to implementation of the preferred restoration alternative. Compliance with any of the following laws will be addressed during management planning or permitting processes if the laws are found to be applicable at that time, or, if during implementation of the management of the Matanzas property they become applicable: Section 7 of the Endangered Species Act, 42 USC Section 1536, the National Historic Preservation Act of 1966, 16 USC Section 470 *et seq*., the Fish and Wildlife Coordination Act, 16 USC Section 661 *et seq*., the Rivers and Harbors Act of 1899, 33 USC Section 403 *et seq*., and the Federal Water Pollution Control Act, 33 USC Section 1251 *et seq*.

The preferred restoration alternative is consistent with considerations mandated by applicable executive orders. These include Executive Order Number 11990, 42 Fed. Reg. 26961, mandating protection of wetlands. The preferred restoration alternative will not adversely affect wetlands or the services they provide; instead it will result in the preservation of wetlands. Executive Order Number 12898, 59 Fed. Reg. 7629, requires each Federal agency to identify and address any policy or planning impacts that disproportionately affect the health and environment in low income and minority populations. Since the restoration alternative will result in a negligible change in current land use in the Matanzas property area, the Service has concluded that there would be no adverse impacts on low-income or minority communities due to implementation of the restoration alternative.

5.0 Conclusion

Based on the avian services provided, and its satisfaction of all criteria listed above, the Service believes that purchase and management of the Matanzas Marsh property is an appropriate and sufficient restoration option for natural resource damages incurred at the Lake Apopka North Shore Restoration Area.

UNITED STATES FISH AND WILDLIFE SERVICE

Environmental Action Statement

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and have determined that the action of (describe):

(1) land acquisition and protection; (2) revise wood stork management plan; and (3) monitor the wood stork colony, at lands acquired in association with the Lake Apopka Bird Mortality Event in Florida.

_X_ is a categorical exclusion (1.4 A(3), B(1), B(10), and B(11)) as provided by 516 DM 6, Appendix 1, or has been adequately addressed in previous Environmental Assessments on file.

____ is found not to have significant environmental effects as determined by the attached Environmental Assessment and Finding of No Significant Impact.

____ is found to have special environmental conditions as described in the attached Environmental Assessment. The attached Finding of No Significant Impact will not be final nor any actions taken pending a 30-day period for public review (40 CFR 1501.4(e)(2)).

____ is found to have significant effects, and therefore a "Notice of Intent" will be published in the Federal Register to prepare an Environmental Impact Statement before the project is considered further.

____ is denied because of environmental damage, Service policy, or mandate.

____ is an emergency situation. Only those actions necessary to control the immediate impacts of the emergency will be taken. Other related actions remain subject to NEPA review.

Regional Director/Authorized Official 2/20/08
Date

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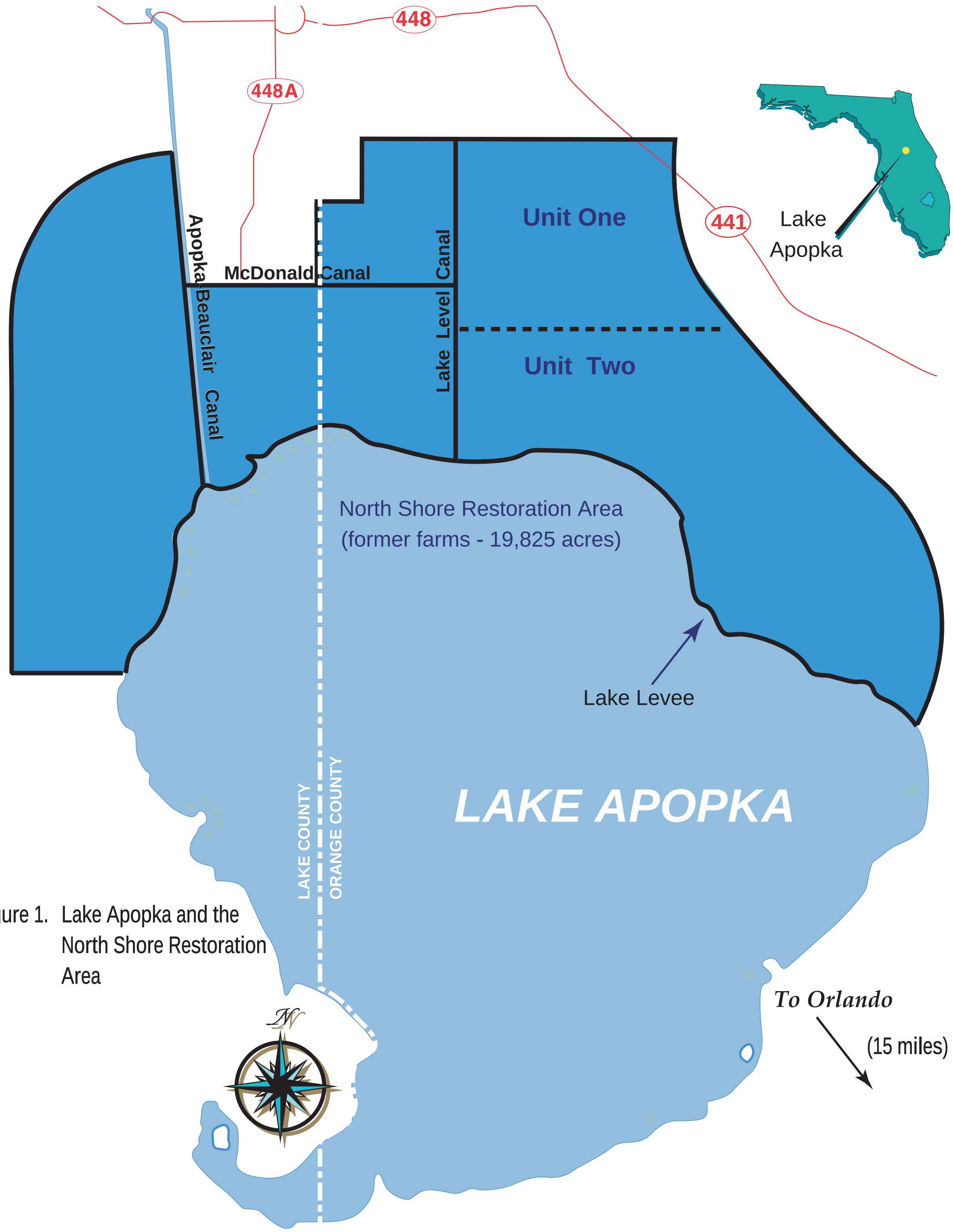


Figure 1. Lake Apopka and the North Shore Restoration Area

Figure 2. Matanzas Marsh Property

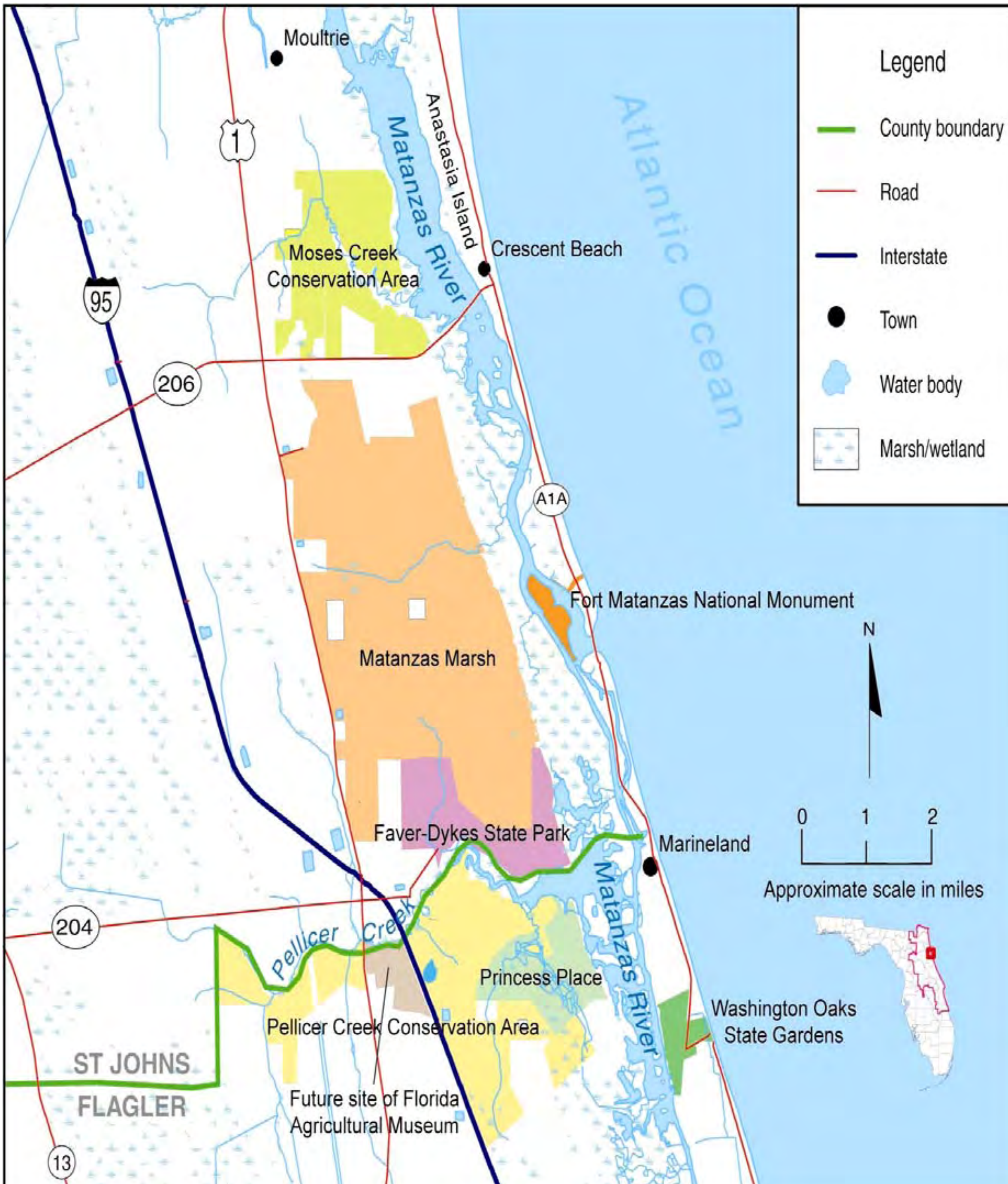
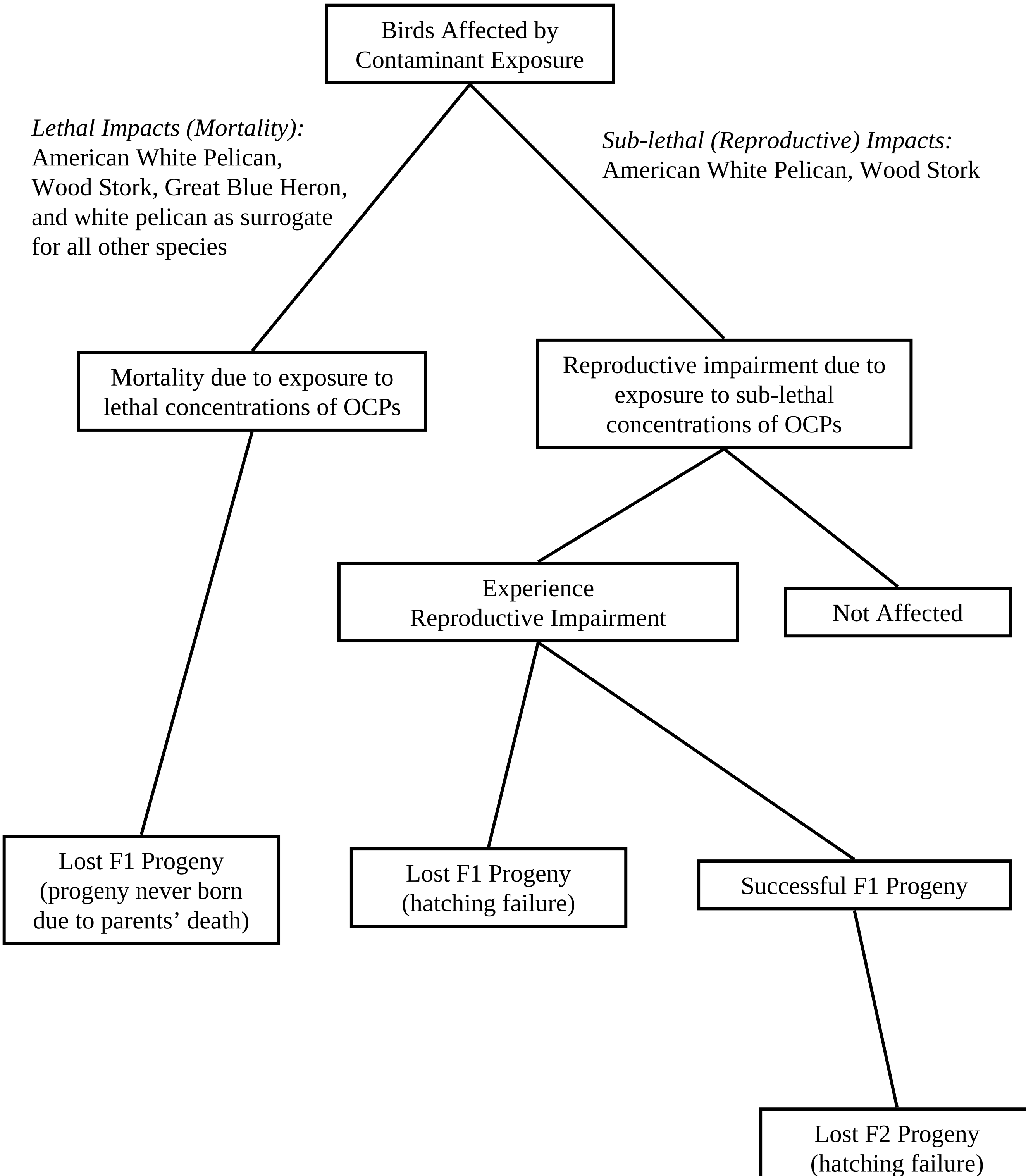


Figure 3. Summary of Injury Quantification for Lake Apopka Avian Resources



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Appendix A

Model of Avian Exposure to DDE at Lake Apopka

Estimation of DDE accumulation in American white pelicans and wood storks on the Lake Apopka North Shore Restoration Area - Unit 2 from July 1998 through March 1999

Methods

A series of linked MS Excel files was created to estimate the DDE burden accumulated from July 1998 through March 1999 in wood storks and American white pelicans on the Lake Apopka North Shore Restoration Area (NSRA) Unit 2. DDE accumulation was modeled in two-week intervals using the maximum number of birds observed during the interval by Harry Robinson (Table 1; Robinson 1999). Below is a list of the assumptions that were used in the analysis.

1. The first birds arriving on-site were the last to leave, and birds arriving last, were the first to leave. Once an individual bird left the site, it did not return.
2. All birds entering the site had no pre-existing DDE burden.
3. Birds were randomly distributed among fields, relative to the extent of flooding on each field to the entire flooded area.
4. Birds accumulated DDE only on the flooded portion of a field.
5. Pelicans weighed 5.4 kg and consumed 83.3 g fish (dry weight) per day per kg body weight (Evans and Knopf 1993). Wood storks weighed 2.4 kg (Dunning 1993) and consumed 44 g fish (dry weight) per day per kg body weight (Kushlan 1978).
6. Birds fed only on fish from the fields to which they were assigned during each time interval.
7. There was no limit to the number of birds feeding within any one acre.
8. Fish were in sufficient abundance to accommodate all birds feeding within the field. The birds were not food limited.
9. Fish in the flooded fields were instantaneously at steady-state with the DDE within the soils.
10. One-hundred percent of the DDE consumed by a bird was absorbed and stored within the bird and no breakdown or elimination of DDE occurred.
11. The BSAF for DDE was six. This BSAF was used to estimate fish DDE concentrations from soil DDE concentrations. It was derived from experimental data using NSRA soils (Appendix 1) rounded up to the next integer (6).
12. The fish had 6% lipid.
13. The fish were 75% water by weight.
14. DDE and total organic carbon (TOC) levels within each field were uniform.

For each field, DDE in fish was estimated using the BSAF approach (Appendix 1) and the assumptions above. The soil dataset was restricted to the ambient and field end samples. The average total organic carbon (TOC) content of the soils within fields ranged from 6 to 52 percent and average DDE concentrations ranged from 225 to 8,233 µg/kg (Table 2). (See below for further information on soil data included in the analysis.)

The flooded extent of each field for each bird survey date was estimated based upon aerial photographs and field notes (SJRWMD unpublished data). The flooding extent was intersected with the field data to provide the number of flooded acres within each field for each date.

Birds were randomly distributed over the flooded area during each time period. A grid of one-acre blocks was created over the flooded area. The number of blocks per field was equal to the number of acres flooded within a field. One-acre grids were associated with fields, relative to the number of flooded acres per field. The total number of flooded acres was calculated for each date. Each bird was assigned to an acre using the random number generator in Excel (set to provide an integer between 1 and the total number of flooded acres, inclusive).

Once a bird was assigned to an acre and field it consumed the specified amount of fish per day, for the number of days in the time interval. The time interval was determined by the interval between bird counts (usually 14 days).

For the next bird survey date, a new file was created and the number of birds on-site was either increased or decreased from the bottom of the list. Removing and adding from the bottom ensured that the assumption was met that birds first on-site were the last to leave. The random number generator range was reset to the total number of flooded acres, and each bird was randomly reassigned to an acre and field.

The accumulated DDE in each individual bird, during each time interval was compiled and totaled to give the total burden, assuming no elimination, in each modeled bird. This burden was normalized by the average weight of the bird species to provide results per kilogram of wet body mass.

Accumulation of DDE ended when the fields were dry and the fish food source in the fields no longer existed. This was assumed to occur during the first two weeks of March. The March 13 bird survey found only 40 pelicans and 3 wood storks. Therefore, the final time interval was assumed to be the period from March 13 to March 27. This period was included within the file for March 13. This likely led to an overestimate of exposure since the extent of flooding for this time interval was assumed to be the Feb 9 estimate, which was too great for this entire period.

Data

The soil data used for the model were derived from ambient and field end samples from the top twelve inches of soil (SJRWMD unpublished data). Previous analyses showed that there was no significant difference in organochlorine pesticide (OCP) concentrations between these two sample types, therefore they were combined to describe the OCP concentrations of the farmed soils of the NSRA. Ambient sites were located using a stratified random grid approach. Using this method each ambient site was given an equal spatial weighting. All OCP analyses were conducted by En Chem, Inc., Madison WI.

Analysis of these data showed there was no spatial correlation between sites, therefore concentration contouring was deemed an inappropriate way to describe patterns in OCP concentration (Rouhani and Wild 2000). In contrast, there were often significant differences in OCP concentration that followed previous ownership boundaries (Figure 1). Upon reflection, this seems reasonable since different owners likely had differing farm practices, which might have included different crops and/or different OCP usage practices and years of use. To further delineate what we suspected were "field" level differences, we intersected the previous ownership map with a map of the individual fields. The result was our current estimate of fields which had similar OCP usage (Table 2; Figures 2 and 3). We found that a great deal of the overall variation in OCP concentrations throughout Unit 2 could be described by this variation among fields. Therefore in this model, the OCP concentration for each field was the mean of all the ambient and field end sites which were collected within that field. Variation in OCP concentrations within the fields was not incorporated in this modeling.

Small portions of two fields on Unit 2 (the Lust farm field ZSE-A and the field south of the Crakes airstrip, ZNE-A) were intensively sampled in order to delineate small areas with unusually high pesticide concentrations. These data were not included in this analysis because they were not spatially weighted in a uniform manner. The original ambient sites were included so that the area weighted average would accurately represent the higher concentration found at these locations. No airstrip, canal sediment, canal bank or deeper (below 12") soil profile data were used in this analysis.

<u>Results</u>

There were a total of 4,719 American white pelicans and 1,991 wood storks exposed in the model. Exposure duration ranged from 2 weeks to 271 and 210 days for wood storks and pelicans, respectively (Figures 3 & 4). The average DDE concentration in soils was below 3,000 ppb dry weight for most fields (Figure 5). Modeled body burdens in birds ranged from less than 5 ppm wet weight to more than 80 ppm ww for wood storks and from less than 5 ppm ww to more than 145 ppm ww for pelicans (Figures 6–7). Approximately 95% of the wood storks had body burdens $\leq$ 35 ppm w.w. (Figure 8), while approximately 90% of pelicans had burdens $\leq$ 65 ppm ww (Figure 9).

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Table 1. Abundance of wood storks and American white pelicans on Unit 2 (Robinson 1999).

Date	American white pelican	wood stork
8/15/98	0	30
8/29/98	0	45
9/12/98	216	546
9/26/98	190	395
10/10/98	140	590
10/24/98	186	1,030
11/7/98	920	1,130
11/21/98	1,350	1,115
12/5/98	1,440	105
12/19/98	3,550	550
1/2/99	3,310	627
1/16/99	4,370	815
1/30/99	2,610	730
2/13/99	2,190	620
2/27/99	7	10
3/13/99	40	3

Table 2. Ownership X Field means for DDE and TOC used in the modeling.

Owner X Alum	**TOC (%)**	**4,4'-DDE (µg/kg)**
Clarence Beall X ZNC-B	38.59	1,915.38
Clarence Beall X ZNW-B	26.98	2,677.50
Clarence Beall X ZSC-A	46.55	1,900.00
Clonts Farm X ZSE-B	38.63	1,712.63
Clonts Farm X ZSE-C	33.56	1,282.00
Clonts Farm X ZSE-G	31.76	1,488.67
Clonts Farm X ZSE-H	6.17	225.00
Crakes & Son, Inc. X ZNC-B	39.9	1,534.3
Crakes & Son, Inc. X ZNE-A1	38.15	2,266.67
Crakes & Son, Inc. X ZNE-A2	47.74	8,233.33
Crakes & Son, Inc. X ZNE-C	39.33	2,075.00
Crakes & Son, Inc. X ZNE-D	48.43	4,916.67
Crakes & Son, Inc. X ZSW-B	30.80	1,163.08
Long Farms, Inc. X ZNE-A1	39.58	3,225.00
Long Farms, Inc. X ZNE-A2	48.32	2,427.60
Long Farms, Inc. X ZNE-D1	30.84	1,611.43
Long Farms, Inc. X ZNE-D2	43.49	2,666.67
Long Farms, Inc. X ZNE-E	44.25	2,487.50
Long Farms, Inc. X ZNE-F	35.88	2,325.00
Long Farms, Inc. X ZSE-A	47.84	1,379.17
Lust & Long Precooler X ZNE-F	0.59	5.20
Lust Farms X ZNE-A	52.58	2,900.00
Lust Farms X ZNE-B	45.43	2,842.31
Lust Farms X ZNE-C	38.84	1,935.00
Lust Farms X ZNE-D	41.81	1,270.00
Lust Farms X ZSC-C	44.33	1,173.18
Lust Farms X ZSE-A	39.88	1,808.33
Lust Farms X ZSE-D	37.95	1,504.17
Lust Farms X ZSE-F	35.58	1,572.86
Mulford Hickerson c/o Peat Hummus Corp X ZNE-F	2.55	43.00
Smith X none	3.97	14.00
Smith X ZNE-A	34.00	1,400.00
Stroup Farms X ZNE-A	44.71	2,197.60
Stroup Farms X ZSC-B	39.73	1,950.00
Stroup Farms X ZSE-E	36.85	2,235.71
Stroup Farms X ZSW-C	38.10	1,680.25
Zellwin Farms X	16.01	860.00
Zellwin Farms X ZNC-A	36.36	1,247.58
Zellwin Farms X ZNW-A	37.95	928.16
Zellwin Farms X ZNW-B	34.63	1,137.40
Zellwin Farms X ZNW-C	25.03	808.50

Owner X Alum	TOC (%)	4,4'-DDE (µg/kg)
Zellwin Farms X ZSE-I	31.99	1,967.52
Zellwin Farms X ZSE-J	40.28	2,016.67
Zellwin Farms X ZSW-A	29.73	1,009.14
Zellwood Drainage District X ZSW-C	22.95	1,203.10

Figure 1. Map of fields colored by previous ownership.

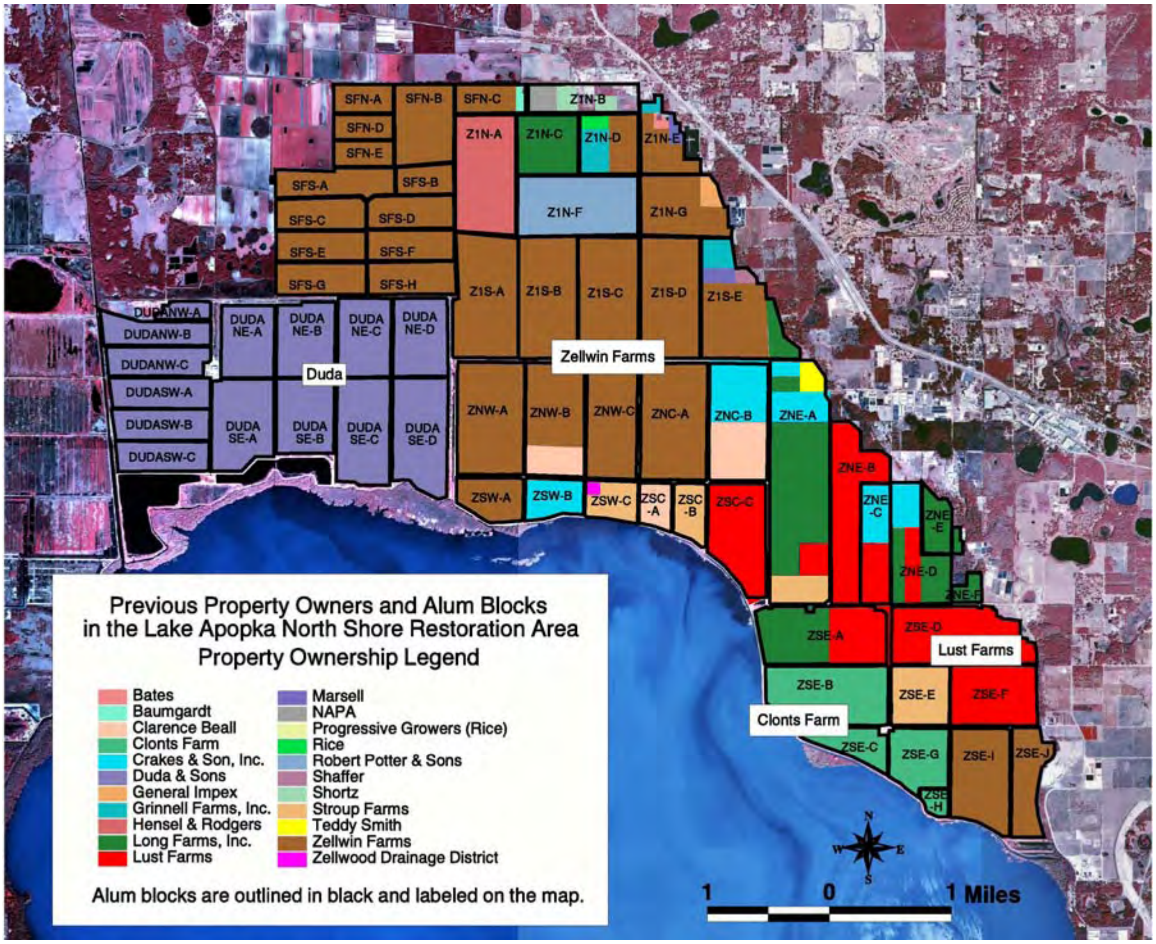


Figure 2. Map of average field DDE concentrations.

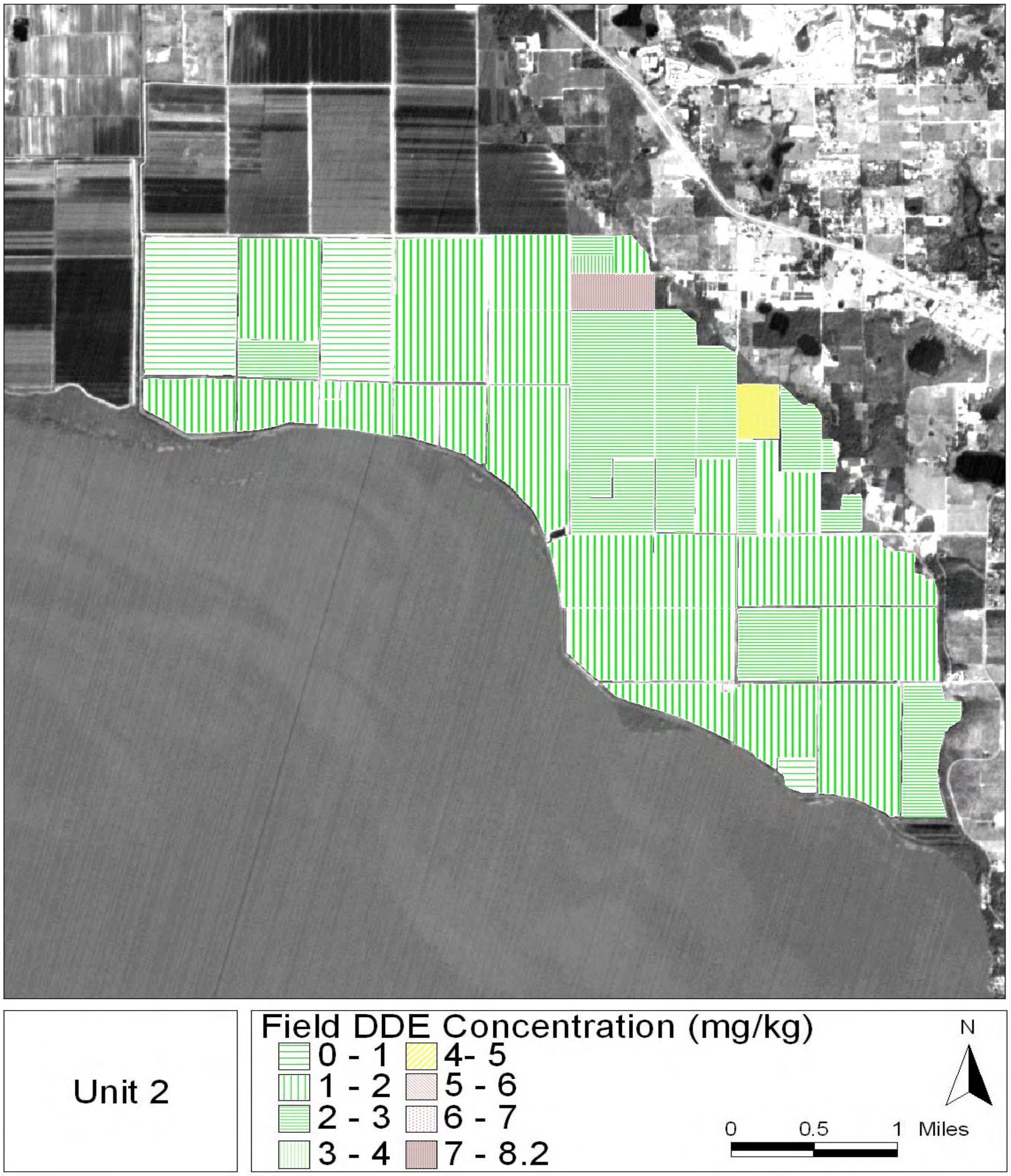


Figure 3. Average DDE concentrations in fields of Unit 2.

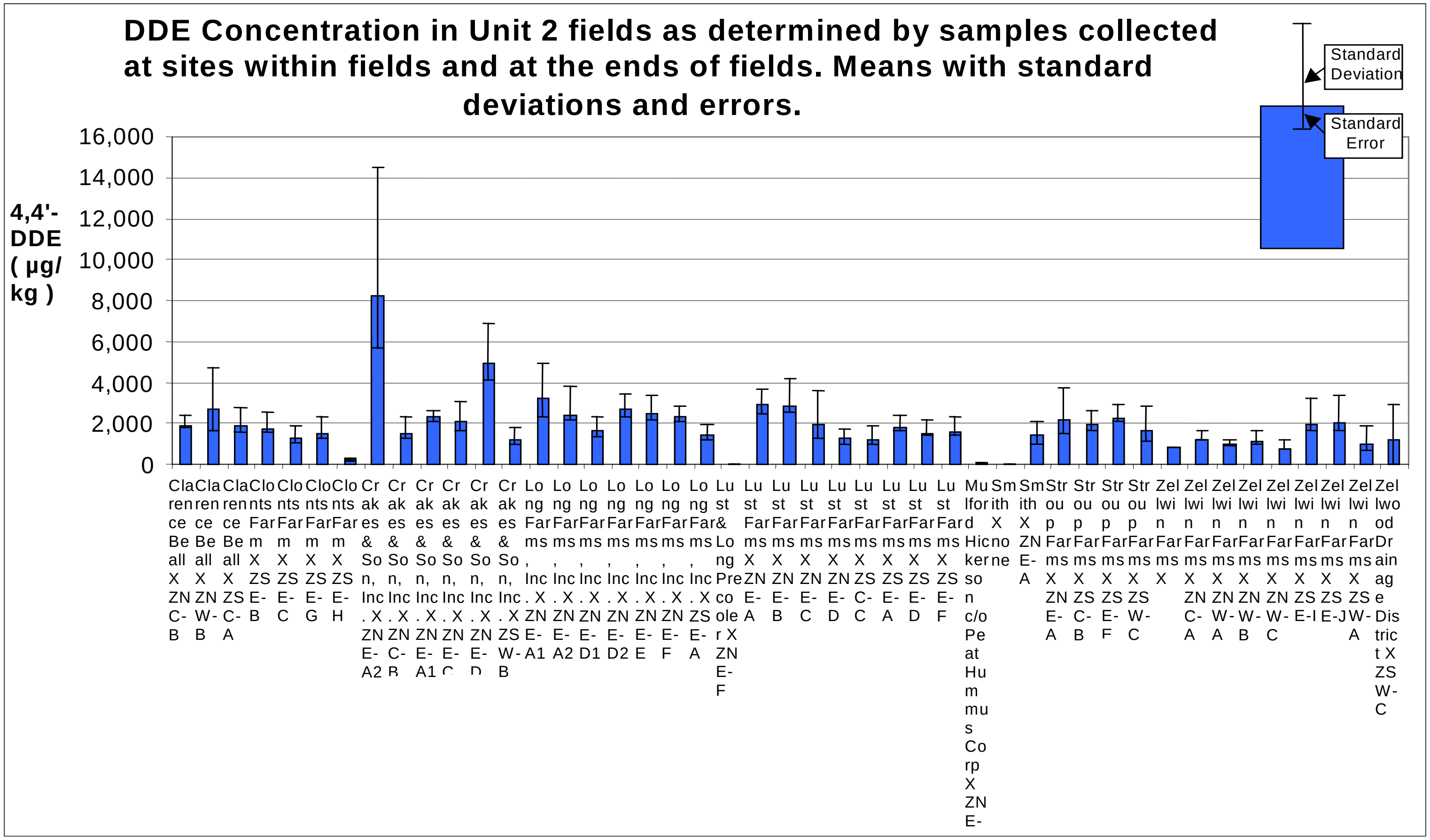


Figure 4. Frequency of duration for wood storks on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999.

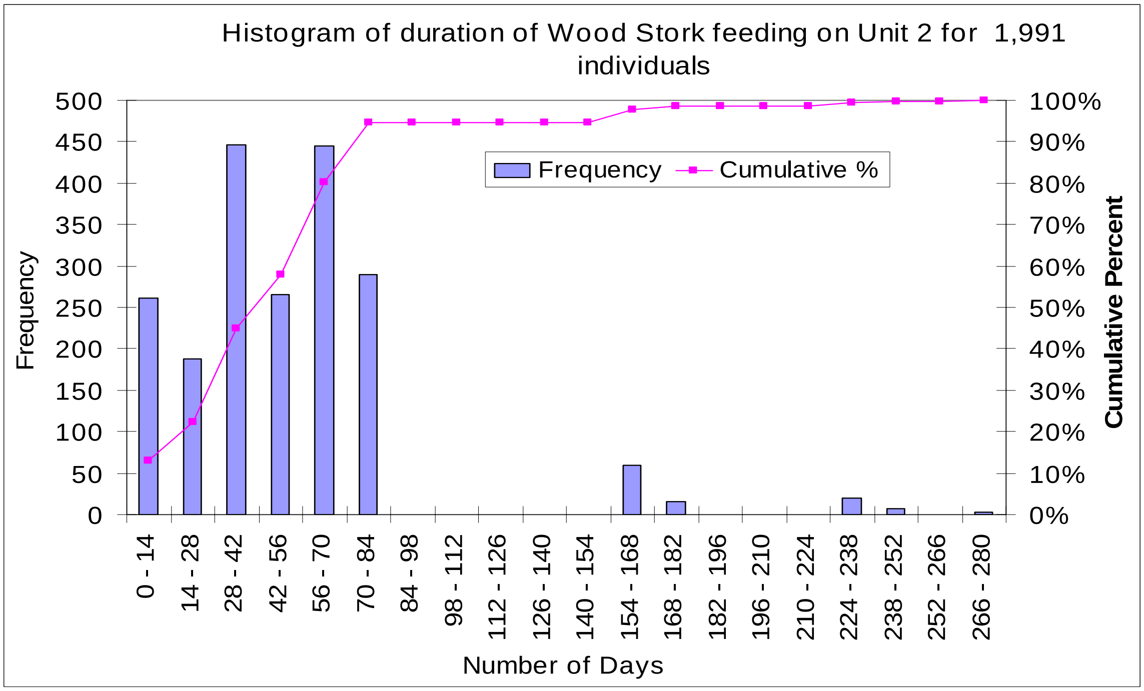


Figure 5. Frequency of duration for American white pelicans on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999.

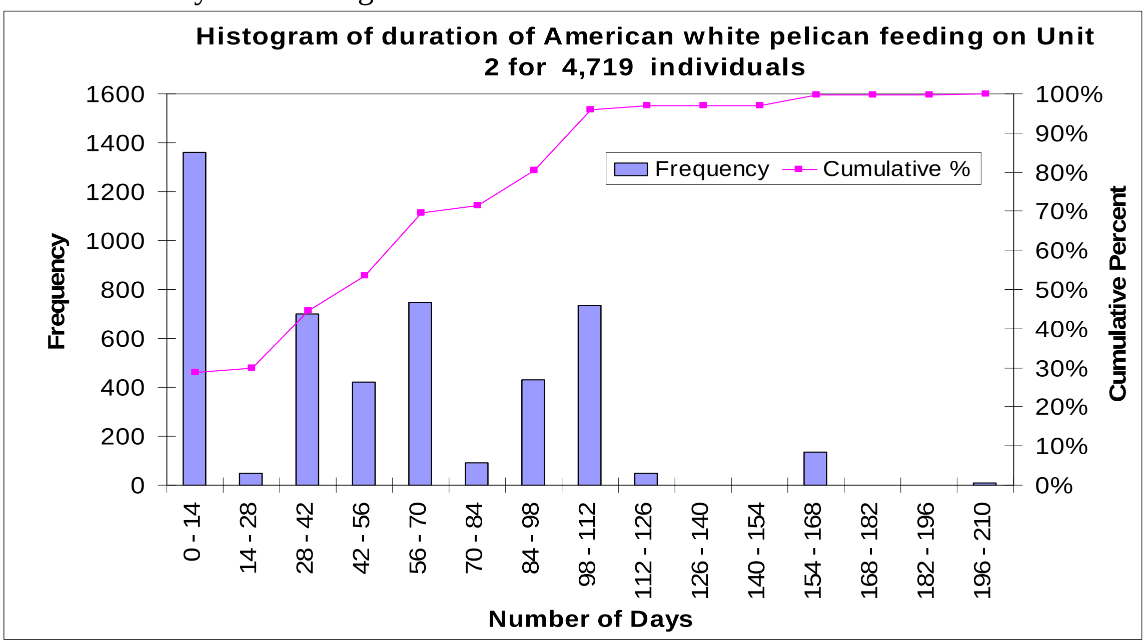


Figure 6. Estimated wood stork (WS) body burden on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999 (mg DDE/kg body mass).

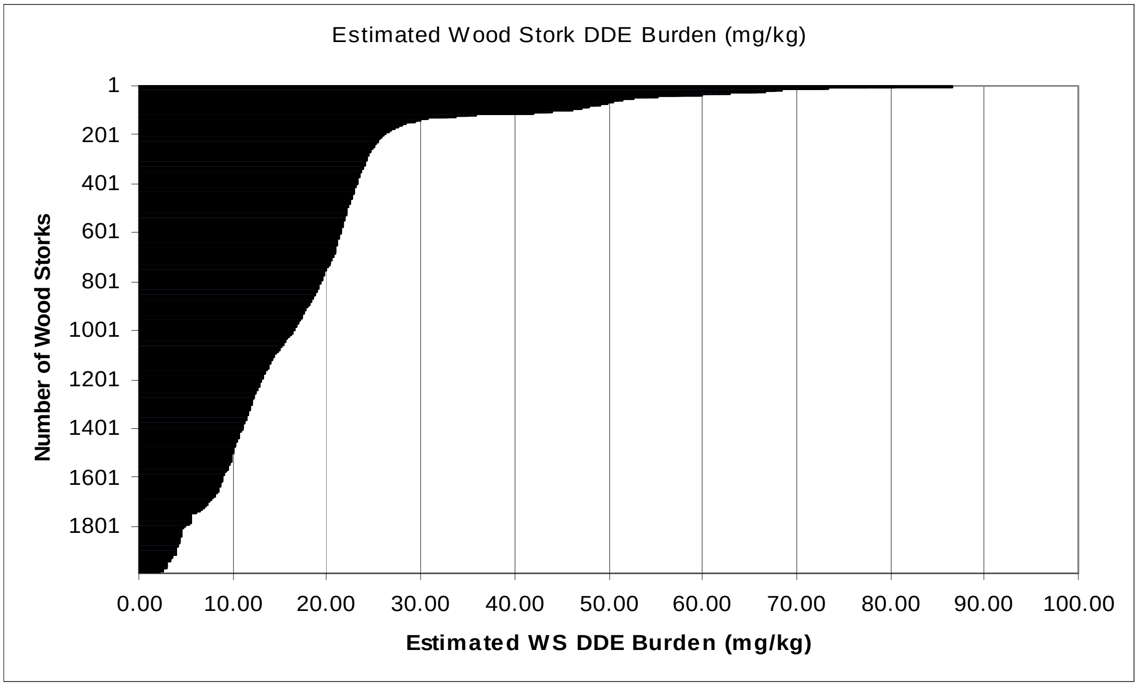


Figure 7. Estimated American white pelican (AWP) body burden on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999 (mg DDE/kg body mass).

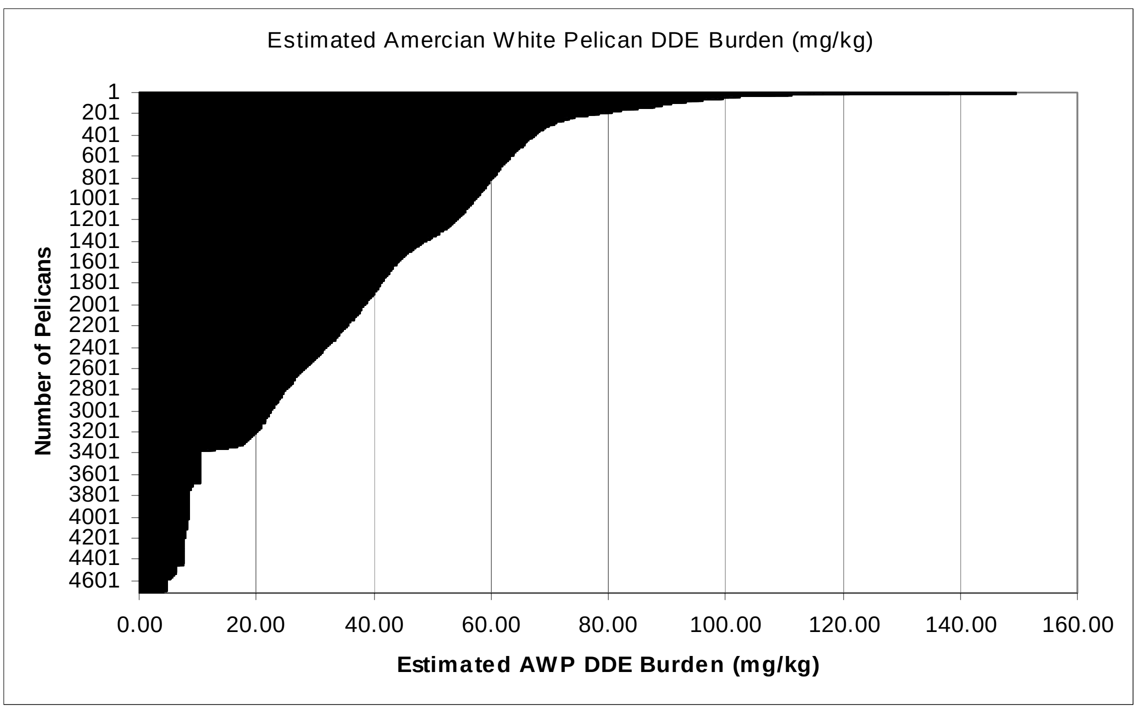


Figure 8. Estimated wood stork (WS) body burden on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999 (mg DDE/kg body mass).

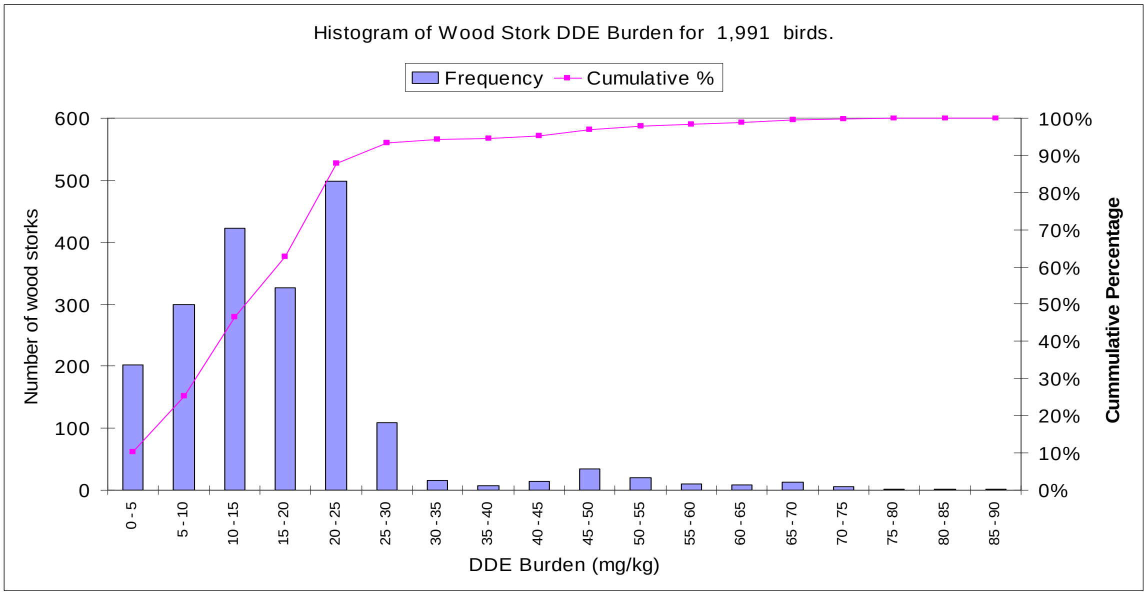
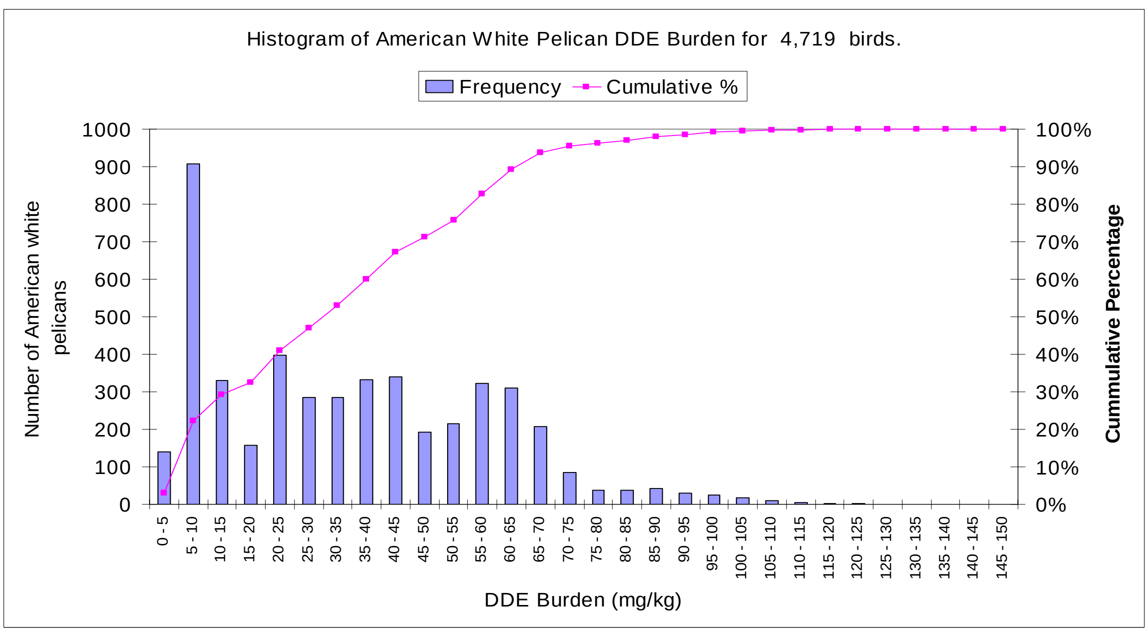


Figure 9. Estimated American white pelican (AWP) body burden on the Lake Apopka NSRA Unit 2 from July 1998 through March 1999 (mg DDE/kg body mass).



Appendix 1. Calculation of BSAFs for DDE from the Microcosm Experiment of the SJRWMD/USGS Bioaccumulation Study

Introduction

Following mortality of birds on flooded farm fields adjacent to Lake Apopka (the North Shore Restoration Area or NSRA), the St. Johns River Water Management District (District) initiated a major research program designed to guide future management of the NSRA. At its conclusion, this research will have had several major phases: 1) an extensive survey of organochlorine pesticide (OCP) levels in the soils of the NSRA, 2) analyses of tissue levels of OCPs in fish collected from flooded former farms and from canals, 3) analyses of tissue levels of OCPs in birds that died on the NSRA and other former farming areas of the Upper Ocklawaha River, 4) measurement of tissue levels in fish and crayfish cultured in aquaria (microcosms) over soils collected from the NSRA, 5) measurement of tissue levels in birds fed fish grown in ponds constructed over former farm fields in the NSRA, and 6) measurement of tissue levels in fish and invertebrates within 0.25 acre wetlands (mesocosms) created on fields of the NSRA. The latter three studies are collaborative efforts with Dr. Timothy S. Gross and his colleagues from the University of Florida and the U.S. Geological Survey's Florida Caribbean Science Center. This report is a preliminary analysis of biota-sediment accumulation factors (BSAFs) for DDE derived from phase 4 of the research program. The BSAFs derived in this preliminary analysis will be close to, but may not be identical to, those derived in the final analysis of these data.

The microcosm research was designed to provide more reliable estimates of BSAFs than could be derived from limited field samples of fish and to elucidate the effect of varying levels of OCPs and of total organic carbon (TOC) on the BSAF. In field sampling, there is typically a large degree of uncertainty regarding the levels of OCPs to which the fish have been exposed and the duration of that exposure. In the microcosm study, exposure was controlled. Furthermore, fish could be exposed to 3 levels of OCPs (high, medium, and low) and to 3 levels of TOC (high, medium, and low).

Methods

Experimental Design - Soils were collected from various locations within the NSRA in order to test the effect of the complete range of OCPs and TOC content. Because not all conditions represented by the 3X3 design could be found within the NSRA (e.g. low TOC but high OCP), some test soils were composited from NSRA soils mixed with clean sand or peat, as necessary. Three soils, representing low, medium and high TOC with non-detectable OCPs, were mixed from sand and peat and utilized as controls. Additional microcosms were included to test soils from a site (Lust farm) with extremely high OCP concentrations (the "hot-spot")[1]. In all, 9 NSRA soils, the hot-spot soil, and 3 control soils were tested in triplicate microcosms (total 39 microcosms).

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[1] This site is currently undergoing remediation.

Soils were collected and mixed in the field and transferred to the USGS facility in Gainesville, Florida. Soils were thoroughly mixed again and placed into tanks measuring 120 cm (4 ft.) in diameter by 65 cm (26 in.) deep (volume of approximately 735 L). Soil was added to a depth of about 20 cm (8 in.). Pond water (with inoculum of algae and zooplankton) was placed into each tank at a depth of 45 cm (1.5 ft), and this level was maintained throughout the experiment. Tanks were equilibrated for 4 weeks prior to the introduction of test species.

Following equilibration, tanks were stocked with 150 adult mosquitofish (Gambusia holbrooki). This species will be abundant in flooded fields, is consumed by many species, and had some of the highest tissue levels in field-collected fish. Ten crayfish (Procambarus paeninsulanus) were also stocked in each tank. (Data indicate that BSAFs for crayfish were much lower than for mosquitofish and, consequently, only the fish were considered in this analysis.) Five samples of mosquitofish were collected at the time of stocking. Subsequently, attempts were made to sample mosquitofish (n ~ 18, target 5 g total wet weight) from each tank at 2, 4, 8, 12 and 16 weeks; however, capture attempts from the tanks were not always successful. All samples were frozen (-80ºC) as single composites for each tank at each sampling time and shipped to En Chem Inc., Madison, WI, for OCP analyses. In addition, soil samples were collected from each tank for OCP analyses at the initiation and completion of the study.

Data Analysis

In order to ensure that exposure time had been sufficient for accumulation of OCPs only data from the latter time periods were used (weeks 8, 12, and 16). Because the time period of maximum tissue levels varied in the different treatments, we considered each time period to be an estimate of the maximum tissue level of OCP. At most, this approach resulted in 9 replicate accumulation values to average for each soil type. In some cases, organisms did not survive or were not caught at each sampling occasion, so several data sets were smaller. The soil and fish data used in this analysis are listed in Table 1.

From these data, we calculated a BSAF (as the ratio of the lipid normalized concentration of DDE in fish to the TOC normalized concentration of DDE in the soil; Table 2) for each treatment at each sampling period (8, 12, and 16 weeks) for which fish were collected. The control treatments were excluded from the BSAF calculations as the OCP concentrations were below the level of detection. In addition, the hot spot treatment was excluded because the test organisms died before the first sampling date.

The BSAF data were plotted against the soil concentrations of TOC and of DDE and linear regressions were fit to each plot (Figures 1 and 2).

Results and Discussion

The BSAF for DDE declined with increasing soil TOC (Figure 1) and with soil DDE (Figure 2). Most of Unit 2 of the NSRA had TOC concentrations exceeding 30 % (Figure 3) and DDE levels ≤ 3 ppm dry weight (Figure 4). Examination of the regressions of BSAF on [TOC] and [DDE], shows that the average BSAF would be below 6 for these conditions.

Summary statistics for all treatments, and for all treatments with soil [TOC] greater than 20 %, support this conclusion (Table 3). These data indicate that a BSAF of 6 would be a reasonable estimate for the average BSAF within the NSRA.

Table 1. Percent total organic carbon (TOC) in soils, percent lipid in fish, and concentration of DDE in soils and fish from weeks 8, 12, and 16. Soil treatment assignments represent soil sites with different TOC and OCP levels, respectively.

Soil Treatment Assignment (TOC/DDE)	Event (week)	Soil TOC (%)	Soil DDE (µg/kg dry weight)	Carbon-Normalized DDE	Gambusia Lipid (%)	Gambusia DDE (µg/kg wet weight)	Lipid-Normalized Gambusia DDE	BSAF DDE
L/L	**8**	10.13	190	1,876	1.05	70	6,646	3.5
L/L	**12**	10.13	190	1,876	1.39	89	6,394	3.4
L/L	**16**	10.13	190	1,876	1.66	107	6,479	3.5
L/M	**8**	2.20	297	13,485	1.15	910	78,902	5.9
L/M	**12**	2.20	297	13,485	1.56	1,867	119,914	8.9
L/M	**16**	2.20	297	13,485	3.80	2,143	56,354	4.2
L/H	**12**	1.59	40	2,526	1.35	6	407	0.2
L/H	**16**	1.59	40	2,526	5.17	1,077	20,839	8.2
M/L	**8**	9.27	240	2,589	0.86	270	31,518	12.2
M/L	**12**	9.27	240	2,589	1.40	280	20,048	7.7
M/L	**16**	9.27	240	2,589	1.39	367	26,316	10.2
M/M	**8**	17.08	3,433	20,098	0.99	1,633	164,430	8.2
M/M	**12**	17.08	3,433	20,098	1.33	2,200	165,000	8.2
M/M	**16**	17.08	3,433	20,098	2.22	3,467	155,922	7.8
M/H	**8**	23.20	1,492	6,430	1.16	410	35,447	5.5
M/H	**12**	23.20	1,492	6,430	1.16	483	41,523	6.5
M/H	**16**	23.20	1,492	6,430	2.08	593	28,526	4.4
H/L	**8**	44.12	423	960	0.96	39	4,097	4.3
H/L	**12**	44.12	423	960	1.21	69	5,691	5.9
H/L	**16**	44.12	423	960	1.79	64	3,601	3.8
H/M	**8**	39.62	3,117	7,867	1.32	617	46,717	5.9
H/M	**12**	39.62	3,117	7,867	1.66	803	48,491	6.2
H/M	**16**	39.62	3,117	7,867	3.48	850	24,425	3.1
H/H	**8**	48.12	14,267	29,650	3.29	2,600	79,148	2.7
H/H	**12**	48.12	14,267	29,650	2.41	2,950	122,661	4.1
H/H	**16**	48.12	14,267	29,650	3.33	2,700	81,081	2.7

Table 2. Calculation Example for Daily Bird Accumulation

For this example, the field DDE concentration is 2,000 µg/kg_{dw} and TOC is 40%. The BSAF is 6. Fish contain 6% lipids and 25% solids. Wood storks were assumed to each weigh 2.4 kg and consume 44 g $fish_{dw}$ / kg day.

1. Carbon Normalize Soil

   2,000 DDE µg / kg_{dw} / 0.4 kg_{TOC} / kg_{dw} = 5,000 µg DDE / kg_{TOC}

2. Convert Carbon-Normalized Soil to Lipid-Normalized Fish

   5,000 µg DDE / kg_{TOC} X BSAF 6 = 30,000 µg DDE / kg_{lipid}

3. Convert Lipid-Normalized Fish to wet weight fish

   30,000 µg DDE / kg_{lipid} X 0.06 kg_{lipid} / kg ww = 1,800 µg DDE / kg_{ww}

4. Convert wet weight concentration in fish to dry weight concentration in fish

   1,800 µg DDE / kg_{ww} / 0.25 kg_{dw} / kg_{ww} = 7,200 µg DDE / kg_{dw}

5. Convert dry weight concentration in fish to daily bird intake

   7,200 µg DDE / kg_{dw} X 44 g_{dw}/day $kg_{body\ weight}$ / 1000 g / kg X 2.4 $kg_{body\ weight}$ /wood stork = 760.32 µg DDE / bird day

   For pelicans, the daily fish consumption and body weight are changed.

   7,200 µg DDE / kg_{dw} X 83.3 g_{dw}/day $kg_{body\ weight}$ / 1000 g / kg X 5.4 $kg_{body\ weight}$ /pelican = 3,238.70 µg DDE / bird day

Table 3. Summary statistics for all the BSAFs and for only those treatments with a soil TOC greater than 20% and therefore most likely to represent the NSRA.

	BSAF				
	Average	**Median**	**Max**	**Min**	**Standard Error**
For all non-control treatments	5.66	5.68	12.18	0.16	0.53
For all non-control treatments with soil TOC > 20%	5.28	5.51	8.21	2.67	0.49

Figure 1. Plot of BSAFs vs. soil carbon content (TOC) for the 8, 12 and 16 week sampling periods.

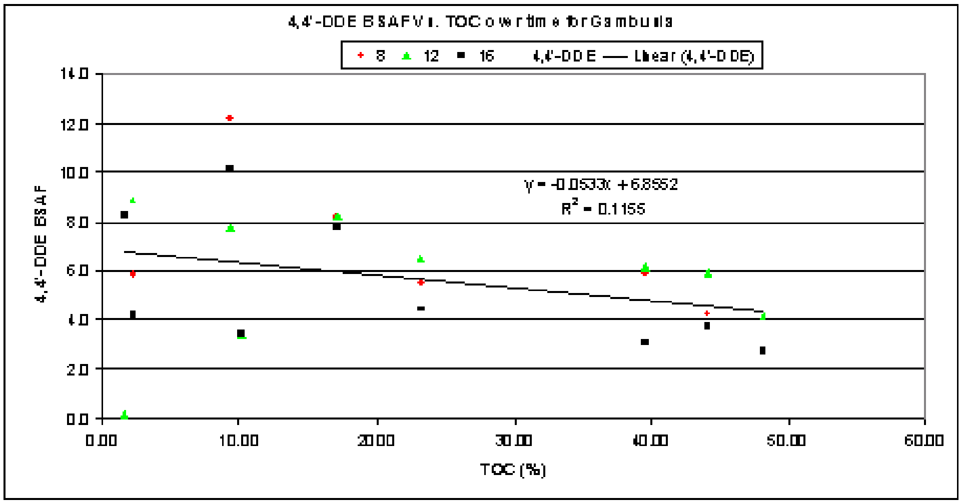


Figure 2. Plot of BSAFs vs. soil DDE for the 8, 12 and 16 week sampling periods.

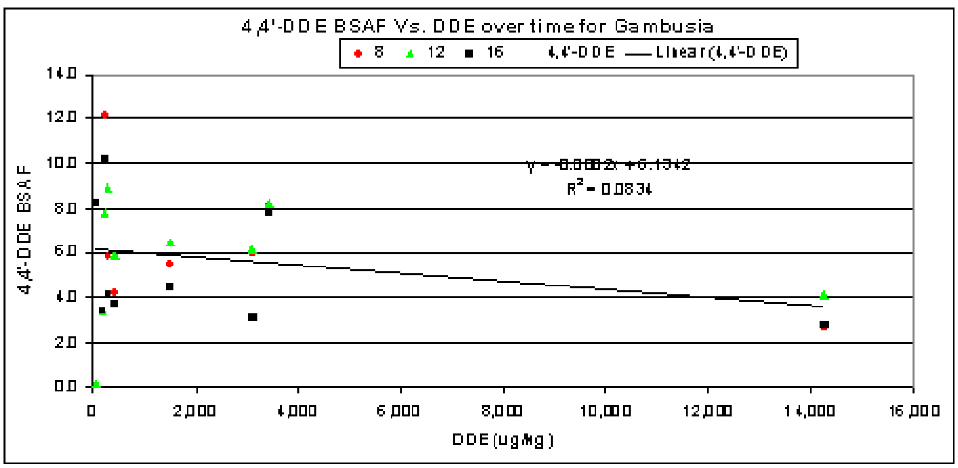


Figure 3. Frequency distribution of total organic carbon (TOC) in the soils of Unit 2.

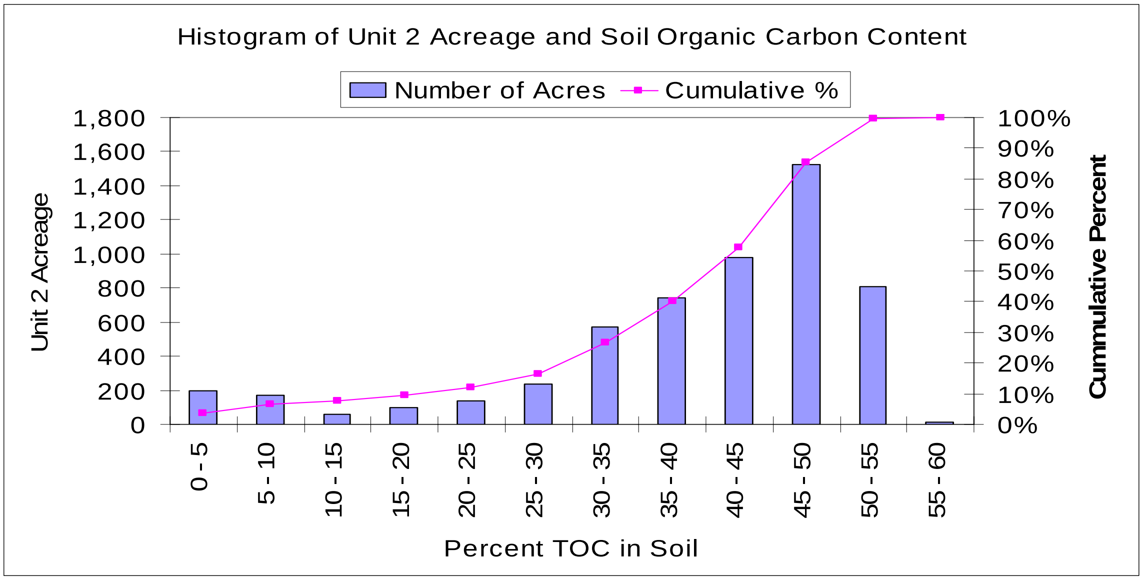
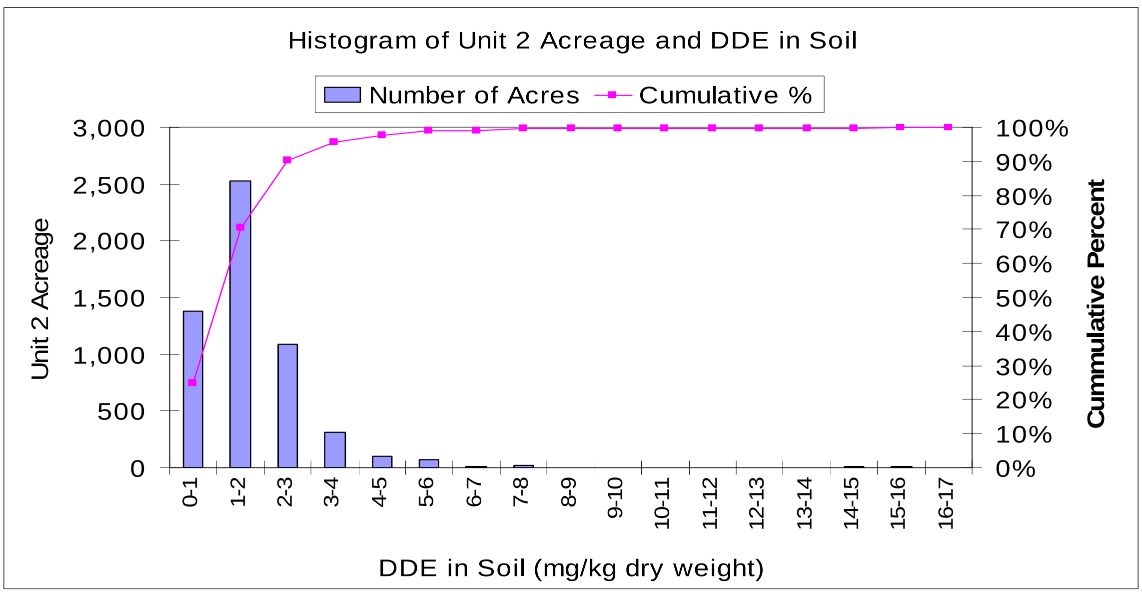


Figure 4. Frequency distribution of DDE in the soils of Unit 2.



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Appendix B

Calculations of Lost Bird-Years Due to Avian Mortality

Summary Lost Present Value Bird Years Due to Mortality			
	Adults	**Potential Fledglings**	**Total**
Species			
American White Pelican	2,076	506	2,582
Wood Stork	155	68	223
Great Blue Heron	210	72	282
Total			**3,088**

American White Pelican

	Adults								F1 Generation					
Year	Number of birds died (A)	Number of female birds died (A/2) = (B)	Average age of dead birds (years; assumed first breeding year) (C)	Average life span of species (years) (D)	Additional years each bird would have lived (D-C, then -1 each additional year) = (E)	Probability of survival/ year (F)	Lost birds per year (F*A) = (G)	Present value of lost adult bird years (PV (G))	Average age of breeding (years) (C)	Broods/year (H)	Young fledged/nest (I)	Probability of fledgling surviving year 1 (J)	Lost fledglings per year (G/2*I*J) = (K)	Present value of lost fledglings (PV (K))
1998	576	288	3	13	10	78.7%	453	526	3	1	NO FLEDGLINGS BORN IN 1998			
1999					9	78.7%	357	402			0.85	59%	114	128
2000					8	78.7%	281	307			0.85	59%	89	98
2001					7	78.7%	221	234			0.85	59%	70	75
2002					6	78.7%	174	179			0.85	59%	55	57
2003					5	78.7%	137	137			0.85	59%	44	44
2004					4	78.7%	108	105			0.85	59%	34	33
2005					3	78.7%	85	80			0.85	59%	27	25
2006					2	78.7%	67	61			0.85	59%	21	19
2007					1	78.7%	53	47			0.85	59%	17	15
2008											0.85	59%	13	11
					Total Present Value lost adult bird-years			2076			Total present value lost fledgling-years			506

Wood stork

	Adults								F1 Generation					
Year	Number of birds died (A)	Number of female birds died (A/2) = (B)	Average age of dead birds (years; assumed first breeding year) (C)	Average life span of species (years) (D)	Additional years each bird would have lived (D-C, then -1 each additional year) = (E)	Probability of survival/ year (F)	Lost birds per year (F*A) = (G)	Present value of lost adult bird years (PV (G))	Average age of breeding (years) (C)	Broods/year (H)	Young fledged/nest (I)	Probability of fledgling surviving year 1 (J)	Lost fledglings per year (G/2*I*J) = (K)	Present value of lost fledglings (PV (K))
1998	43	21.5	4	12	8	80%	34	40	4	1	NO FLEDGLINGS BORN IN 1998			
1999					7	80%	28	31			1.51	60%	16	18
2000					6	80%	22	24			1.51	60%	12	14
2001					5	80%	18	19			1.51	60%	10	11
2002					4	80%	14	15			1.51	60%	8	8
2003					3	80%	11	11			1.51	60%	6	6
2004					2	80%	9	9			1.51	60%	5	5
2005					1	80%	7	7			1.51	60%	4	4
2006											1.51	60%	3	3

Total present value lost adult bird-years	155
Total present value lost fledgling-years	68

Great Blue Heron

Year	Adults								F1 Generation					
	Number of birds died (A)	Number of female birds died (A/2) = (B)	Average age of dead birds (years; assumed first breeding year) (C)	Average life span of species (years) (D)	Additional years each bird would have lived (D-C, then -1 each additional year) = (E)	Probability of survival/ year (F)	Lost birds per year (F*A) = (G)	Present value of lost adult bird years (PV (G))	Average age of breeding (years) (C)	Broods/yea r (H)	Young fledged/nest (I)	Probability of fledgling surviving year 1 (J)	Lost fledglings per year (G/2*I*J) = (K)	Present value of lost fledglings (PV (K))
1998	58	29	2	14	12	78.1%	45	53	2	1	NO FLEDGLINGS BORN IN 1998			
1999					11	78.1%	35	40			2.3	31%	16	18
2000					10	78.1%	28	30			2.3	31%	13	14
2001					9	78.1%	22	23			2.3	31%	10	10
2002					8	78.1%	17	17			2.3	31%	8	8
2003					7	78.1%	13	13			2.3	31%	6	6
2004					6	78.1%	10	10			2.3	31%	5	5
2005					5	78.1%	8	8			2.3	31%	4	3
2006					4	78.1%	6	6			2.3	31%	3	3
2007					3	78.1%	5	4			2.3	31%	2	2
2008					2	78.1%	4	3			2.3	31%	2	2
2009					1	78.1%	3	3			2.3	31%	1	1
2010											2.3	31%	1	1

Total present value lost adult bird-years	209

Total present value lost fledgling-years	72

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Appendix C

Calculations of Lost-Bird Years Due to Reproductive Impairment

Adverse Effect Thresholds			
Effect	**Lower Threshold (mg/kg)**	**Upper Threshold (mg/kg)**	**Assumed Percentage Service Loss**
Total reproductive failure	>	4	100%
Decrease in young/nest	1.5	4	55%
Decrease in young/nest	1	1.5	10%
Successful nest	<	1	0%

Lost Bird Years Due to Sub-lethal Effects			
	F1	F2	Total
Species			
American White Pelican	1,197	17	1,214
Wood Stork	890	22	912
Total			**2,126**

Example Calculation of Sub-lethal (Reproductive) Losses Expected to Result from Wood Stork Exposure to DDE at Lake Apopka

Estimation of potential bird-years lost due to exposure of avian resources to sub-lethal concentrations of DDE was conducted for each individual American white pelican and wood stork that the Service believes may have been exposed to this contaminant during the Lake Apopka NSRA incident. As described in Section 3.0, the adverse effects of DDE are expected to occur to both the children (F1 generation) and grandchildren (F2 generation) of each bird, in the form of reproductive failure. The following outlines the calculations performed for one female wood stork, reported as “WS141” in the attached table. **Bold letters** below each equation (e.g., **(C)**) refer to the table’s column headers.

The analysis of lost bird-years due to DDE exposure requires a “receptor” and a sub-lethal endpoint against which to measure avian service losses. The most sensitive avian receptor with regards to DDE exposure is an avian egg, thus WS141’s predicted body burden is converted to an estimated DDE concentration in her eggs. The District’s exposure model predicts a body burden of 25.1 ppm DDE for WS141 (See Appendix A for more details regarding the model). Assuming 20 percent of WS141’s maternal body burden of DDE is transferred to her clutch, with each egg receiving an equal portion of this burden (Bargar et al. 2001, Blus et al. 1974), and assuming WS141 lays an average clutch of 3.3 eggs (Coulter et al. 1999), each of WS141’s eggs is expected to receive 1.52 ppm DDE from its mother.

DDE_{egg} = (DDE_{WS141} * 20%) / Number of eggs per clutch

1.52 ppm DDE = (25.1 ppm DDE * 20%) / 3.3 eggs per clutch

(D) = (A*B)/(C)

The analysis evaluates the expected adverse effects of DDE exposure in terms of reproductive impairment, specifically, hatching success. Literature-based adverse effects thresholds defining levels of hatching success are assigned a corresponding percentage service loss, which is defined as the percentage reduction in the number of successful hatchlings. In this example, predicted DDE concentrations in WS141’s eggs are compared to selected adverse effects thresholds. A DDE level of 1.52 ppm falls within the threshold range of 1.5-4.0 ppm DDE, which is assumed to be associated with a service loss of 55 percent (i.e., WS141 is expected to incur a 55 percent decrease in the hatching success of her clutch).

To evaluate the number of bird-years lost (in this case the number of lost bird-years is measured in terms of the reduction in successful first year fledges), the analysis considers the number of WS141 fledglings that would have survived their first year but for the incident. Assuming WS141 produced an average of 1.51 fledglings, and that each of those fledglings had a 60 percent chance of surviving its first year (Coulter et al.

1999), WS141 would have had 0.91 successful year-old fledglings in 1999 (the first breeding season after exposure).[1]

0.91 Expected Year-Old Fledglings = 1.51 Fledglings/Nest * 60% Probability of Survival to Year 1
(H) = (F*G)

Due to DDE exposure of 1.52 ppm, however, the analysis estimates that 55 percent of year-old fledglings would not survive. That is, 0.91 fledges would be expected to survive to their first year (as calculated above), but given contaminant exposure in the mother 0.5 fledges were lost; only 0.41 fledges survive the first year.

0.5 Lost Fledgling-years = 0.91 Expected fledglings * 55% Service Loss
(I) = (E*H)

Because WS141 was exposed in 1998-1999, before the 1999 breeding season, the analysis assumes that her fledglings also were lost in 1999. The present value (2003) of those losses is estimated using a three percent discount rate, with a resulting loss of 0.56 present value bird-years.

0.56 Lost Bird-Years (2003) = ((0.5 Lost Bird-Years) * $((1 + .03)^{2003-1999})$)
0.56 Lost Bird-Years (2003) **= PV (I)**

Those lost bird-years, however, only reflect adverse effects to WS141's children, or the F1 generation. Due to the physical and chemical properties of DDE, WS141's 0.41 fledglings that did survive past year one may be carrying a body burden of DDE that also affects the next generation (i.e., the F2 generation) of fledglings. Due to the lack of site-specific or literature-based information on the generational effects of DDE, this analysis assumes that the F2 generation suffers the same percent service loss as the F1 generation (i.e., the effects on the F2 generation are at least no worse than the effects on the F1 generation). In WS141's case, the F1 fledglings and therefore the F2 fledglings experienced a 55 percent service loss.

Again, lost F2 bird-years (expressed as the number of lost year-old fledglings) are estimated based on the fledglings that would have survived but for the incident. Each wood stork is expected to produce 0.91 successful year-old fledglings. The 0.41 F1 fledglings from WS141 would therefore be expected to produce 0.37 year-old fledglings.

[1] Of course, no bird produces "0.91" fledglings. All calculations performed for this analysis are based on a probabilistic model, and thus equal expected values, which can be expressed as non-integers.

0.37 Fledgling-Years = 0.91 Expected Year-old Fledglings * 0.41 F1 Fledglings Survived to Reproduce

0.37 Fledgling-Years = **(H*J)**

DDE, however, may have caused the F2 fledglings to experience a decrease in hatching success. Assuming a 55 percent service loss, surviving F1 fledglings only would have produced 0.27 successful F2 year-old fledglings (i.e., 0.2 fledges were lost).

0.20 Lost year-old F2 fledglings = 0.37 Expected F2 fledglings * 55% Service Loss

(L) = (H*J) * (K)

One additional issue is the fact that only females reproduce. The evaluation of F2 losses initially assumes that all surviving F1 fledglings lay clutches. Assuming half of each generation is female, only 50 percent of the surviving F1 fledglings reproduce, and therefore only half of the predicted F2 losses, or 0.10 lost fledgling-years would have occurred.

0.10 Lost F2 Bird-Years = 0.20 Lost F2 Year-Old Fledglings * 50% Female Population

(N) = (L*M)

Finally, wood storks are not mature enough to breed until they are four years old. The F1 generation born in 1999 would have been expected to breed in 2003. Because 2003 is the same as the present year, no present value calculation in necessary.

In summary, due to the exposure of WS141 to sub-lethal concentrations of DDE at Lake Apopka, 0.56 F1 and 0.10 F2 present-value bird-years were lost, for **a total of 0.66 lost bird-years**.

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Exposure Data		Egg DDE Levels		Estimation of F1 Losses						Estimation of F2 Losses					
Bird #	Estimated Wood Stork DDE Burden (mg/kg) (A)	Maternal Transfer (B)	DDE Concentration in Egg (A*B) = (C)	Fledgling/ Nest (D)	Percent Probability of Survival to Year 1 (E)	Bird Services Lost (compare C to threholds) = (F)	Number of Fledglings Survive > 1 yr (D*E) = (G)	Lost Birds F1 (F*G) = (H)	Present Value Lost Birds F1 (PV (H))	Number of fledglings Assumed to Survive to Reproduce ((1-F)*G) = (I)	Percent Service Loss (based on parent in F1) (J)	Individual Bird-Years Lost F2 (I*J*G) = (K)	Percent Female (L)	Bird-Years Lost F2 (K*L) = (M)	Present Value Bird-Years Lost F2 (PV (M))
WS103	53.48	40%	21.50	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS105	46.14	40%	18.55	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS107	22.91	40%	9.21	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS109	34.70	40%	13.95	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS111	24.48	40%	9.84	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS113	20.96	40%	8.43	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS115	25.85	40%	10.39	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS117	22.86	40%	9.19	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS119	26.37	40%	10.60	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS121	20.97	40%	8.43	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS123	21.85	40%	8.78	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS125	19.29	40%	7.75	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS127	39.22	40%	15.77	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS129	27.81	40%	11.18	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS131	21.49	40%	8.64	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS133	20.81	40%	8.37	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS135	29.67	40%	11.93	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS137	24.86	40%	9.99	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS139	20.41	40%	8.21	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS141	25.10	40%	10.09	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS143	23.97	40%	9.64	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS145	21.53	40%	8.66	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS147	22.26	40%	8.95	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS149	26.12	40%	10.50	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS151	21.50	40%	8.64	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS153	22.59	40%	9.08	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS155	21.54	40%	8.66	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS157	20.78	40%	8.35	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS159	17.28	40%	6.95	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS161	21.58	40%	8.68	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS163	24.47	40%	9.84	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS165	19.26	40%	7.74	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS167	22.23	40%	8.94	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS169	28.78	40%	11.57	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS171	22.53	40%	9.06	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS173	22.34	40%	8.98	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS175	22.80	40%	9.16	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS177	20.21	40%	8.12	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS179	24.90	40%	10.01	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS181	28.70	40%	11.54	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS183	27.97	40%	11.24	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS185	25.09	40%	10.09	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS187	27.69	40%	11.13	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS189	22.39	40%	9.00	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS191	21.65	40%	8.70	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS193	19.21	40%	7.72	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS195	22.94	40%	9.22	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS197	24.21	40%	9.73	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS199	25.54	40%	10.27	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--

Exposure Data		Egg DDE Levels		Estimation of F1 Losses						Estimation of F2 Losses					
Bird #	**Estimated Wood Stork DDE Burden (mg/kg) (A)**	**Maternal Transfer (B)**	**DDE Concentration in Egg (A*B) = (C)**	**Fledgling/ Nest (D)**	**Percent Probability of Survival to Year 1 (E)**	**Bird Services Lost (compare C to threholds) = (F)**	**Number of Fledglings Survive > 1 yr (D*E) = (G)**	**Lost Birds F1 (F*G) = (H)**	**Present Value Lost Birds F1 (PV (H))**	**Number of fledglings Assumed to Survive to Reproduce ((1-F)*G) = (I)**	**Percent Service Loss (based on parent in F1) (J)**	**Individual Bird-Years Lost F2 (I*J*G) = (K)**	**Percent Female (L)**	**Bird-Years Lost F2 (K*L) = (M)**	**Present Value Bird-Years Lost F2 (PV (M))**
WS201	18.91	40%	7.60	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--
WS203	22.94	40%	9.22	1.51	60%	100%	0.91	0.91	1.02	--	100%	--	50%	--	--

Appendix C: Data Availability

Due to the volume of data used in this analysis, this version of Appendix C provides only an example of the data used for determination and quantification of sub-lethal losses for wood storks. The complete version of Appendix C, which includes all data for American white pelican and wood stork, is available for public review.

On-line at:

- The US Fish and Wildlife Service webpage (http://southeast.fws.gov/es/)
- The St. Johns River Water Management District webpage (http://www.sjrwmd.com/programs/acq_restoration/s_water/lapopka/)

Or on CD by request from:

- Jay Herrington
  US Fish and Wildlife Service
  Jacksonville Ecological Services Office
  6620 Southpoint Drive South, Suite 310
  Jacksonville, FL 32216-0712
- Office of Communications and Governmental Affairs
  The St. Johns River Water Management District
  4049 Reid Street
  Palatka, FL 32177

Appendix D

Characteristics of the Matanzas Marsh Property

Development Potential and Ecological Characteristics of the Matanzas Marsh (Rayonier) Property, St. Johns County, Florida

Prepared by

St. Johns River Water Management District
Palatka, Florida

April 15, 2003

Appendix D

Characteristics of the Matanzas Marsh Property

Development Potential and Ecological Characteristics of the Matanzas Marsh (Rayonier) Property, St. Johns County, Florida

Prepared by

St. Johns River Water Management District
Palatka, Florida

April 15, 2003

Background

The Matanzas Marsh Property (a.k.a. Rayonier/St. Johns) is approximately 8,465 acres in size and is located within the District's Northern Coastal Basin in St. Johns County, Florida. The property is south of the City of St. Augustine and north of Palm Coast, and is bordered on the south by Faver-Dykes State Park and the Pellicer Creek State Aquatic Preserve. State Road 206 and the Moses Creek Conservation Area lie to the north. U.S. Highway 1 forms the western boundary and the Matanzas River is east of the property (Figure 1).

The total purchase price for the property is $39,912,475 or $4,715 per acre. The St. Johns River Water Management District (District) is purchasing a 25 percent undivided interest in the 8,465 acres for $9,978,119. The Board of Trustees of the Internal Improvement Trust Fund of the State of Florida (TIITF) is purchasing a 75 percent undivided interest in the 8,465 acres for approximately $29,934,356. On December 11, 2002, the District's Governing Board approved and signed the purchase and sale agreement. On February 11, 2003, the TIITF–Governor and Cabinet–approved and signed the purchase and sale agreement. The real estate transaction closed on April 14, 2003.

It is anticipated that the Division of Forestry (DOF) will manage the northern portion and the Department of Environmental Protection, Bureau of Recreation and Parks (FDEP) will manage the southern portion as an addition to Faver-Dykes State Park. The District retains the right to approve the management plans for the property, and therefore will work with the United States Fish and Wildlife Service (Service), DOF and FDEP to ensure appropriate management of the known wood stork colony on site.

Development Potential

The District contracted with a group of highly competent development consultants to assess the development potential of the property. Their analysis revealed that the property is uniquely situated for large-scale development; nothing like it exists from North Carolina to Miami. Some of the of the property's attributes include:

- Five miles of frontage along the Intracoastal Waterway (Matanzas River),
- Almost 80% uplands,
- Available transportation infrastructure including two I-95 interchanges,
- Positioned between the rapidly growing areas of Jacksonville and Palm Coast (Figure 2),
- Adjacent to 8,000 acres of conservation lands, an amenity for a recreation community, and
- Road access to the Atlantic Ocean in nearby Crescent Beach.

Their conclusion, without hesitation, was that the Matanzas Marsh Property could support large-scale development.

The development consultants have indicated that there are three levels of buyers who could be interested in this property. They are: individual buyers; consortiums, and publicly traded corporate developers. We have been advised that there are three to five individual buyers in the North Florida area who would be capable and motivated to purchase this tract to hold as an investment for a two to three year period. The motivation of these individuals seems to be a desire to invest funds in real estate as opposed to the stock market at this time. The consortiums consist of groups of builders who need two to six hundred units per year for new home construction. These builders would group together to form a consortium to acquire a large tract such as the subject property. We have been advised that there are two to three consortiums in the North Florida area that are capable of acquiring this tract. The corporate developers are those large publicly traded companies that need eight hundred to one thousand units per year for residential construction. We have been advised that there are six to ten of those type companies in the market now looking for sites like the Matanzas Marsh property. They need to be acquiring tracts like this to provide the necessary inventory of units two to five years in the future.

Land Use and Zoning

The Matanzas Marsh Property has a land use designation as R/S (Rural/Silviculture). This land use is primarily intended for agriculture, forestry, and other uses typical of rural areas. The property immediately to the north of the subject property is primarily Residential B, which allows for a maximum density of two units per upland acre. The land immediately east of the subject property is CSV (Conservation), and consists of the Matanzas River and the adjacent marsh. At the southern border, the adjacent property is primarily P/OS (Parks and Open Space), which is Faver Dykes State Park. Adjacent to the southwest corner is a Mixed Use District, located at the interchange of I-95 and US 1. The Mixed Use District allows for a mix of uses, including industrial, office, commercial, residential and recreation. The land to the west of the subject property is R/S.

If the land use designation is not changed, there are two development options that are feasible. First, the land could be developed as residential lots with a minimum of 100 acres each. Second, the land could be rezoned to Planned Rural Development (PRD), as further described below. To develop the land at other than the current land use designations would require a change in land use designation to Residential B or Residential A. Residential A limits development to approximately one unit per acre, while Residential B allows up to two units per acre. A change in land use designation requires that St. Johns County amend their Future Land Use Map and submit the proposed changes to the Department of Community Affairs. The land use amendment application must demonstrate that there is a need for a land use change, and that there would be adequate infrastructure to serve the proposed development.

Potential Development Scenarios

After examining existing natural conditions, existing infrastructure, land use and zoning, our consultants presented two development scenarios. As noted above, the land use designation of the subject property is Rural/Silvicultural, which limits residential density to no more than one unit per 100 acres, unless a landowner or applicant takes advantage of the Planned Rural Development provision of the St. Johns County Land Development Code. Under the Planned Rural Development regulations, an applicant can achieve an overall residential density of one unit per five acres if 90% of the property is set aside as a reserve area. Given that the subject property contains approximately 8,465 gross acres, the maximum number of residential units which could be constructed on the property would be 1,693 under this scenario.

Scenario 1: Planned Rural Development Proposal

The St. Johns County regulations governing Planned Rural Developments are contained in Part 5.04.00 of the County Land Development Code. Under these regulations, the applicant must divide the subject property into a "development area" and a "reserve area." The smaller the development area, the greater the number of units the applicant is entitled to develop. If the development area is limited to 10% of the total site, then the developer will be entitled to two units per acre of development area. If the development area constitutes 15% of the site, then the developer will be entitled to one unit per acre of the development area. Finally, if the development area is 20% of the total site, then the development will be limited to one unit per 2.5 acres of development.

Our consultants determined it would be most profitable to take advantage of the maximum allowable density by confining the development area to 10% of the site, or 846.5 acres. Using a development area of 846.5 acres, two units per acre would yield a maximum allowable density of 1,693 units. Under Table 2.02.02 of the St. Johns County Land Development Code, the allowable uses within a Planned Rural Development include residential, agricultural, cultural/institutional, neighborhood business, rural commercial, mining and extraction, outdoor passive and neighborhood public service. Neighborhood business use would include low intensity commercial, medical and professional offices, government branch offices and the like. The cultural and institutional use category would allow for schools, etc.

Scenario 2: Planned Unit Development Requiring a Comprehensive Plan Amendment

If the developer is willing to take on the task of pursuing a land use amendment (Comprehensive Plan Amendment), then the developer must decide how many residential units and how much non-residential square footage to request. The intensity of development requested would be determined by a number of factors, including: (1) the physical capacity of the land; (2) the projected absorption in the marketplace or the market demand; (3) political consideration of what the Board of County Commissioners might be willing to approve, and (4) the amount of transportation costs and other similar offsite infrastructure that would be imposed on the project for different levels of development intensity. It is important to note that over the last five years several large-scale developments in St. Johns County successfully changed their Rural/Silviculture land use designation with a Comprehensive Plan Amendment. They include Nocatee

(11,332 acres), St. Johns (5,380 acres), Durbin Crossing (2,066 acres), Marshall Creek (1,343 acres), and Aberdeen (1,316 acres).

In general terms, our consultant indicated that the land could be developed at a gross density of one unit per acre. Based on our consultants' experience, they would propose the land is suitable for 8,000 residential units. Due to the proximity to the interchange of I-95 and US 1, the location near natural areas, the potential hotel development could be up to 1,000 rooms. The potential for commercial development is estimated to be 400,000 square feet, which would primarily support residential development on this property and adjacent properties. Five million square feet of industrial development is suggested because the property is located between the City of St. Augustine and Palm Coast and close to I-95. For this reason, industrial development may be attractive at some point in the future.

In summary, if developed without a land use change, a rezoning to Planned Rural Development (PRD) would be required, and would yield approximately 1,700 units (one lot per five acres). If developed with a land use change, a rezoning to Planned Unit Development (PUD) would be required and the potential yield would increase to 8,000 units (one per acre) plus significant commercial development.

Ecological Characteristics

Acquisition of this parcel will provide protection to the last remaining large and relatively undisturbed marshfront area within the Guana-Tolomato-Matanzas National Estuarine Research Reserve (Figures A1 & A2). The acquisition will create approximately 16,000 acres of nearly contiguous conservation land, including Faver-Dykes State Park, Pellicer Creek Conservation Area, the Florida State Agriculture Museum, Princess Place Reserve, and Moses Creek Conservation Area (Figure 3). The property is comprised of approximately 6,618 acres or 78.1% uplands, 1,825 acres or 21.6% wetlands, and 22 acres or 0.3% sovereign wetlands (Figure 4). FEMA data indicates that more than 20% of the parcel is below the 100-year floodplain.

Most of the uplands have been subjected to silvicultural forest management practices since the mid-1940's (Figure A3). The catastrophic wildfires of the late 1990's altered the harvest schedule for this forest to the extent that the majority of pine plantations are young trees that are currently too young to sell (Figure A4). Over time, these pine plantations will be restored to a more natural condition. Restoration actions would include thinning of the forest canopy and prescribed fire to promote native groundcover growth and re-establishment. Although the number of listed species protected on silvicultural lands may be relatively low, these forest areas often serve vital functions when viewed from a regional perspective. As is the case with the Matanzas Marsh Property, they help to buffer more pristine natural areas from encroaching urban and residential development (Figure A5). These forest lands also serve as dispersal areas between nature preserves or help to maintain air and water quality (Figure A6), provide recreational opportunities (Figure A7) and forest resources, and other functions.

The eastern side of the property has approximately five miles of salt marsh frontage. Approximately 250 acres of maritime hammock occur along this frontage (Figure A8). Most of the hammock and all of the salt marsh are of high quality. There are numerous openings in the high marsh that provide important habitat for fish and wildlife (Figures A9 & A10). A survey with biologists from the Florida Natural Areas Inventory (FNAI) and FDEP revealed large numbers of waterbirds foraging in the openings of the high marsh. Species of particular interest include the wood stork, reddish egret, roseate spoonbill, American oystercatcher, whimbrel, marbled godwit, great egret, little blue heron and least tern.

Wood Stork Rookery

There is one wood stork breeding colony on site. Data from a USFWS census (Meyer and Frederick 2002) indicated that the colony had 120 to 150 nests in 2002 (Figures A11 & A12). The nests were located on the edge of a swamp in large cypress trees in the northwest quadrant of the property (Figure 3). Also nesting in the colony were an unknown number of great blue herons, little blue herons and anhingas. In 2002, the wood stork colony was one of the two largest stork colonies in Northeast Florida.

Important Bird Area Designation

In 2002, Audubon of Florida identified this site and adjacent properties as an Important Bird Area (Pranty 2003). The Important Bird Area Program is a science-based effort to identify those sites that are critical to maintaining healthy bird populations throughout the state. This site was selected because of the wood stork colony, the large numbers of shorebirds that forage on the oyster bars and tidal flats of the Matanzas River, and the diversity and numbers of neotropical migratory songbirds that stopover during spring and fall migration. Data from the Florida Fish and Wildlife Conservation Commission (FFWCC) indicate the site also contains two active bald eagle nest sites (Figure 3).

Strategic Habitat Conservation Area and Biodiversity Hot Spot

A review of databases from the FFWCC shows that all of the wetlands on the property are considered to be part of the Strategic Habitat Conservation Area (SCHA) of the State of Florida. Because of the endangered status of wood storks, the FFWCC designated all wetlands within 15 km of a known wood stork colony as a SHCA. Although wood storks forage over a larger area than 15 km, most of the foraging occurs within this distance from a colony. In addition, wetland areas near nesting colonies play a critical role during the nesting season soon after the young hatch (Cox et al. 1994).

The FFWCC also performed analyses for biodiversity hotspots throughout the state. The results indicate a high degree of overlap for 52 focal species, plus known occurrences of rare flora and natural communities. Some of the property is designated as a Class 2 biodiversity hotspot , representing important habitat for three to four species, and a small portion is a Class 3 hotspot – the second highest category – important for five to six species (Figure 5). The FFWCC performed these analyses to provide detailed information on known locations of focal taxa to help meet the need for conservation information at regional and local levels.

Manatees

According to FNAI, acquiring this tract and preventing it from being developed will help maintain water quality and shoreline plant communities of the Matanzas River, benefiting manatees that spend the warm season in these waters. The Matanzas River, as part of the Intracoastal Waterway, is the primary migration corridor for manatees moving from Duval and Nassau counties to the north and Volusia and Brevard counties to the South. Several hundred manatees move between warm season and cold season habitat each year, and virtually all of them pass through the Matanzas River when migrating in each direction. The abundance of shoreline vegetation, such as smooth cordgrass (*Spartina alterniflora*), near deeper water makes the acquisition of this site significant for the protection of manatee feeding habitat. Shoreline plants are the primary forage for manatees in estuarine waters north of Volusia County on the east coast of Florida, due to the lack of seagrass and other submerged vegetation (ARC and FNAI 2001).

Outstanding Florida Waters, Shellfish Harvesting and other Fisheries

Two areas listed as Outstanding Florida Waters by FDEP are in the vicinity of the subject property; the Pellicer Creek Aquatic Preserve and waters within Faver-Dykes State Park. In addition, one of the last remaining shellfish harvesting areas in St. Johns County lies adjacent to the site. It can be anticipated that preventing private development of this property will be very beneficial in preventing the degradation of these water resources and provide significant fisheries benefits.

A list of marine and estuarine fish and invertebrates for the general area compiled by the University of Florida Whitney Laboratory is comprised of 270 species (GTMNERR 1998). Species of commercial value that use the estuary for part or all of their life cycle include oysters, blue crabs, stone crabs, white shrimp, brown shrimp, striped and white mullet, flounder and menhaden. Recreationally valuable species include tarpon, spotted sea trout, red drum, black drum, snook, sheepshead, jack crevalle and bluefish.

Guana/Tolomato/Matanzas National Estuarine Research Reserve

Much of the area adjacent to the property has received national recognition as a National Estuarine Research Reserve (NEER). This program is designed to sustain the environmental integrity of relatively undisturbed estuarine ecosystems. Reserves are intended to promote, implement and coordinate opportunities for scientific research, environmental education, public stewardship and nature appreciation on uplands and submerged lands. Established in 1999, the Guana/Tolomato/Matanzas NEER was chosen as a national example of the temperate Carolinian biogeographic province. The area's overall quality played a large role in its selection, and conservation of the Matanzas Marsh Property will play a vital role in the success of the NEER.

In summary, the Matanzas Marsh Property is rich in ecological services. It provides habitat for nesting and foraging wood storks and bald eagles. It is important stopover habitat for migratory and wintering songbirds and shorebirds, and provides water quality benefits to manatees and a significant recreational and commercial fishery. This property is considered by many to be one of the natural resource crown jewels that remains in private ownership in Northeast Florida.

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Appendix D

Characteristics of the Matanzas Marsh Property

Development Potential and Ecological Characteristics of the Matanzas Marsh (Rayonier) Property, St. Johns County, Florida

Prepared by

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Palatka, Florida

April 15, 2003

Background

The Matanzas Marsh Property (a.k.a. Rayonier/St. Johns) is approximately 8,465 acres in size and is located within the District's Northern Coastal Basin in St. Johns County, Florida. The property is south of the City of St. Augustine and north of Palm Coast, and is bordered on the south by Faver-Dykes State Park and the Pellicer Creek State Aquatic Preserve. State Road 206 and the Moses Creek Conservation Area lie to the north. U.S. Highway 1 forms the western boundary and the Matanzas River is east of the property (Figure 1).

The total purchase price for the property is $39,912,475 or $4,715 per acre. The St. Johns River Water Management District (District) is purchasing a 25 percent undivided interest in the 8,465 acres for $9,978,119. The Board of Trustees of the Internal Improvement Trust Fund of the State of Florida (TIITF) is purchasing a 75 percent undivided interest in the 8,465 acres for approximately $29,934,356. On December 11, 2002, the District's Governing Board approved and signed the purchase and sale agreement. On February 11, 2003, the TIITF–Governor and Cabinet–approved and signed the purchase and sale agreement. The real estate transaction closed on April 14, 2003.

It is anticipated that the Division of Forestry (DOF) will manage the northern portion and the Department of Environmental Protection, Bureau of Recreation and Parks (FDEP) will manage the southern portion as an addition to Faver-Dykes State Park. The District retains the right to approve the management plans for the property, and therefore will work with the United States Fish and Wildlife Service (Service), DOF and FDEP to ensure appropriate management of the known wood stork colony on site.

Development Potential

The District contracted with a group of highly competent development consultants to assess the development potential of the property. Their analysis revealed that the property is uniquely situated for large-scale development; nothing like it exists from North Carolina to Miami. Some of the of the property's attributes include:

- Five miles of frontage along the Intracoastal Waterway (Matanzas River),
- Almost 80% uplands,
- Available transportation infrastructure including two I-95 interchanges,
- Positioned between the rapidly growing areas of Jacksonville and Palm Coast (Figure 2),
- Adjacent to 8,000 acres of conservation lands, an amenity for a recreation community, and
- Road access to the Atlantic Ocean in nearby Crescent Beach.

Their conclusion, without hesitation, was that the Matanzas Marsh Property could support large-scale development.

The development consultants have indicated that there are three levels of buyers who could be interested in this property. They are: individual buyers; consortiums, and publicly traded corporate developers. We have been advised that there are three to five individual buyers in the North Florida area who would be capable and motivated to purchase this tract to hold as an investment for a two to three year period. The motivation of these individuals seems to be a desire to invest funds in real estate as opposed to the stock market at this time. The consortiums consist of groups of builders who need two to six hundred units per year for new home construction. These builders would group together to form a consortium to acquire a large tract such as the subject property. We have been advised that there are two to three consortiums in the North Florida area that are capable of acquiring this tract. The corporate developers are those large publicly traded companies that need eight hundred to one thousand units per year for residential construction. We have been advised that there are six to ten of those type companies in the market now looking for sites like the Matanzas Marsh property. They need to be acquiring tracts like this to provide the necessary inventory of units two to five years in the future.

Land Use and Zoning

The Matanzas Marsh Property has a land use designation as R/S (Rural/Silviculture). This land use is primarily intended for agriculture, forestry, and other uses typical of rural areas. The property immediately to the north of the subject property is primarily Residential B, which allows for a maximum density of two units per upland acre. The land immediately east of the subject property is CSV (Conservation), and consists of the Matanzas River and the adjacent marsh. At the southern border, the adjacent property is primarily P/OS (Parks and Open Space), which is Faver Dykes State Park. Adjacent to the southwest corner is a Mixed Use District, located at the interchange of I-95 and US 1. The Mixed Use District allows for a mix of uses, including industrial, office, commercial, residential and recreation. The land to the west of the subject property is R/S.

If the land use designation is not changed, there are two development options that are feasible. First, the land could be developed as residential lots with a minimum of 100 acres each. Second, the land could be rezoned to Planned Rural Development (PRD), as further described below. To develop the land at other than the current land use designations would require a change in land use designation to Residential B or Residential A. Residential A limits development to approximately one unit per acre, while Residential B allows up to two units per acre. A change in land use designation requires that St. Johns County amend their Future Land Use Map and submit the proposed changes to the Department of Community Affairs. The land use amendment application must demonstrate that there is a need for a land use change, and that there would be adequate infrastructure to serve the proposed development.

Potential Development Scenarios

After examining existing natural conditions, existing infrastructure, land use and zoning, our consultants presented two development scenarios. As noted above, the land use designation of the subject property is Rural/Silvicultural, which limits residential density to no more than one unit per 100 acres, unless a landowner or applicant takes advantage of the Planned Rural Development provision of the St. Johns County Land Development Code. Under the Planned Rural Development regulations, an applicant can achieve an overall residential density of one unit per five acres if 90% of the property is set aside as a reserve area. Given that the subject property contains approximately 8,465 gross acres, the maximum number of residential units which could be constructed on the property would be 1,693 under this scenario.

Scenario 1: Planned Rural Development Proposal

The St. Johns County regulations governing Planned Rural Developments are contained in Part 5.04.00 of the County Land Development Code. Under these regulations, the applicant must divide the subject property into a "development area" and a "reserve area." The smaller the development area, the greater the number of units the applicant is entitled to develop. If the development area is limited to 10% of the total site, then the developer will be entitled to two units per acre of development area. If the development area constitutes 15% of the site, then the developer will be entitled to one unit per acre of the development area. Finally, if the development area is 20% of the total site, then the development will be limited to one unit per 2.5 acres of development.

Our consultants determined it would be most profitable to take advantage of the maximum allowable density by confining the development area to 10% of the site, or 846.5 acres. Using a development area of 846.5 acres, two units per acre would yield a maximum allowable density of 1,693 units. Under Table 2.02.02 of the St. Johns County Land Development Code, the allowable uses within a Planned Rural Development include residential, agricultural, cultural/institutional, neighborhood business, rural commercial, mining and extraction, outdoor passive and neighborhood public service. Neighborhood business use would include low intensity commercial, medical and professional offices, government branch offices and the like. The cultural and institutional use category would allow for schools, etc.

Scenario 2: Planned Unit Development Requiring a Comprehensive Plan Amendment

If the developer is willing to take on the task of pursuing a land use amendment (Comprehensive Plan Amendment), then the developer must decide how many residential units and how much non-residential square footage to request. The intensity of development requested would be determined by a number of factors, including: (1) the physical capacity of the land; (2) the projected absorption in the marketplace or the market demand; (3) political consideration of what the Board of County Commissioners might be willing to approve, and (4) the amount of transportation costs and other similar offsite infrastructure that would be imposed on the project for different levels of development intensity. It is important to note that over the last five years several large-scale developments in St. Johns County successfully changed their Rural/Silviculture land use designation with a Comprehensive Plan Amendment. They include Nocatee

(11,332 acres), St. Johns (5,380 acres), Durbin Crossing (2,066 acres), Marshall Creek (1,343 acres), and Aberdeen (1,316 acres).

In general terms, our consultant indicated that the land could be developed at a gross density of one unit per acre. Based on our consultants' experience, they would propose the land is suitable for 8,000 residential units. Due to the proximity to the interchange of I-95 and US 1, the location near natural areas, the potential hotel development could be up to 1,000 rooms. The potential for commercial development is estimated to be 400,000 square feet, which would primarily support residential development on this property and adjacent properties. Five million square feet of industrial development is suggested because the property is located between the City of St. Augustine and Palm Coast and close to I-95. For this reason, industrial development may be attractive at some point in the future.

In summary, if developed without a land use change, a rezoning to Planned Rural Development (PRD) would be required, and would yield approximately 1,700 units (one lot per five acres). If developed with a land use change, a rezoning to Planned Unit Development (PUD) would be required and the potential yield would increase to 8,000 units (one per acre) plus significant commercial development.

Ecological Characteristics

Acquisition of this parcel will provide protection to the last remaining large and relatively undisturbed marshfront area within the Guana-Tolomato-Matanzas National Estuarine Research Reserve (Figures A1 & A2). The acquisition will create approximately 16,000 acres of nearly contiguous conservation land, including Faver-Dykes State Park, Pellicer Creek Conservation Area, the Florida State Agriculture Museum, Princess Place Reserve, and Moses Creek Conservation Area (Figure 3). The property is comprised of approximately 6,618 acres or 78.1% uplands, 1,825 acres or 21.6% wetlands, and 22 acres or 0.3% sovereign wetlands (Figure 4). FEMA data indicates that more than 20% of the parcel is below the 100-year floodplain.

Most of the uplands have been subjected to silvicultural forest management practices since the mid-1940's (Figure A3). The catastrophic wildfires of the late 1990's altered the harvest schedule for this forest to the extent that the majority of pine plantations are young trees that are currently too young to sell (Figure A4). Over time, these pine plantations will be restored to a more natural condition. Restoration actions would include thinning of the forest canopy and prescribed fire to promote native groundcover growth and re-establishment. Although the number of listed species protected on silvicultural lands may be relatively low, these forest areas often serve vital functions when viewed from a regional perspective. As is the case with the Matanzas Marsh Property, they help to buffer more pristine natural areas from encroaching urban and residential development (Figure A5). These forest lands also serve as dispersal areas between nature preserves or help to maintain air and water quality (Figure A6), provide recreational opportunities (Figure A7) and forest resources, and other functions.

The eastern side of the property has approximately five miles of salt marsh frontage. Approximately 250 acres of maritime hammock occur along this frontage (Figure A8). Most of the hammock and all of the salt marsh are of high quality. There are numerous openings in the high marsh that provide important habitat for fish and wildlife (Figures A9 & A10). A survey with biologists from the Florida Natural Areas Inventory (FNAI) and FDEP revealed large numbers of waterbirds foraging in the openings of the high marsh. Species of particular interest include the wood stork, reddish egret, roseate spoonbill, American oystercatcher, whimbrel, marbled godwit, great egret, little blue heron and least tern.

Wood Stork Rookery

There is one wood stork breeding colony on site. Data from a USFWS census (Meyer and Frederick 2002) indicated that the colony had 120 to 150 nests in 2002 (Figures A11 & A12). The nests were located on the edge of a swamp in large cypress trees in the northwest quadrant of the property (Figure 3). Also nesting in the colony were an unknown number of great blue herons, little blue herons and anhingas. In 2002, the wood stork colony was one of the two largest stork colonies in Northeast Florida.

Important Bird Area Designation

In 2002, Audubon of Florida identified this site and adjacent properties as an Important Bird Area (Pranty 2003). The Important Bird Area Program is a science-based effort to identify those sites that are critical to maintaining healthy bird populations throughout the state. This site was selected because of the wood stork colony, the large numbers of shorebirds that forage on the oyster bars and tidal flats of the Matanzas River, and the diversity and numbers of neotropical migratory songbirds that stopover during spring and fall migration. Data from the Florida Fish and Wildlife Conservation Commission (FFWCC) indicate the site also contains two active bald eagle nest sites (Figure 3).

Strategic Habitat Conservation Area and Biodiversity Hot Spot

A review of databases from the FFWCC shows that all of the wetlands on the property are considered to be part of the Strategic Habitat Conservation Area (SCHA) of the State of Florida. Because of the endangered status of wood storks, the FFWCC designated all wetlands within 15 km of a known wood stork colony as a SHCA. Although wood storks forage over a larger area than 15 km, most of the foraging occurs within this distance from a colony. In addition, wetland areas near nesting colonies play a critical role during the nesting season soon after the young hatch (Cox et al. 1994).

The FFWCC also performed analyses for biodiversity hotspots throughout the state. The results indicate a high degree of overlap for 52 focal species, plus known occurrences of rare flora and natural communities. Some of the property is designated as a Class 2 biodiversity hotspot , representing important habitat for three to four species, and a small portion is a Class 3 hotspot – the second highest category – important for five to six species (Figure 5). The FFWCC performed these analyses to provide detailed information on known locations of focal taxa to help meet the need for conservation information at regional and local levels.

Manatees

According to FNAI, acquiring this tract and preventing it from being developed will help maintain water quality and shoreline plant communities of the Matanzas River, benefiting manatees that spend the warm season in these waters. The Matanzas River, as part of the Intracoastal Waterway, is the primary migration corridor for manatees moving from Duval and Nassau counties to the north and Volusia and Brevard counties to the South. Several hundred manatees move between warm season and cold season habitat each year, and virtually all of them pass through the Matanzas River when migrating in each direction. The abundance of shoreline vegetation, such as smooth cordgrass (*Spartina alterniflora*), near deeper water makes the acquisition of this site significant for the protection of manatee feeding habitat. Shoreline plants are the primary forage for manatees in estuarine waters north of Volusia County on the east coast of Florida, due to the lack of seagrass and other submerged vegetation (ARC and FNAI 2001).

Outstanding Florida Waters, Shellfish Harvesting and other Fisheries

Two areas listed as Outstanding Florida Waters by FDEP are in the vicinity of the subject property; the Pellicer Creek Aquatic Preserve and waters within Faver-Dykes State Park. In addition, one of the last remaining shellfish harvesting areas in St. Johns County lies adjacent to the site. It can be anticipated that preventing private development of this property will be very beneficial in preventing the degradation of these water resources and provide significant fisheries benefits.

A list of marine and estuarine fish and invertebrates for the general area compiled by the University of Florida Whitney Laboratory is comprised of 270 species (GTMNERR 1998). Species of commercial value that use the estuary for part or all of their life cycle include oysters, blue crabs, stone crabs, white shrimp, brown shrimp, striped and white mullet, flounder and menhaden. Recreationally valuable species include tarpon, spotted sea trout, red drum, black drum, snook, sheepshead, jack crevalle and bluefish.

Guana/Tolomato/Matanzas National Estuarine Research Reserve

Much of the area adjacent to the property has received national recognition as a National Estuarine Research Reserve (NEER). This program is designed to sustain the environmental integrity of relatively undisturbed estuarine ecosystems. Reserves are intended to promote, implement and coordinate opportunities for scientific research, environmental education, public stewardship and nature appreciation on uplands and submerged lands. Established in 1999, the Guana/Tolomato/Matanzas NEER was chosen as a national example of the temperate Carolinian biogeographic province. The area's overall quality played a large role in its selection, and conservation of the Matanzas Marsh Property will play a vital role in the success of the NEER.

In summary, the Matanzas Marsh Property is rich in ecological services. It provides habitat for nesting and foraging wood storks and bald eagles. It is important stopover habitat for migratory and wintering songbirds and shorebirds, and provides water quality benefits to manatees and a significant recreational and commercial fishery. This property is considered by many to be one of the natural resource crown jewels that remains in private ownership in Northeast Florida.

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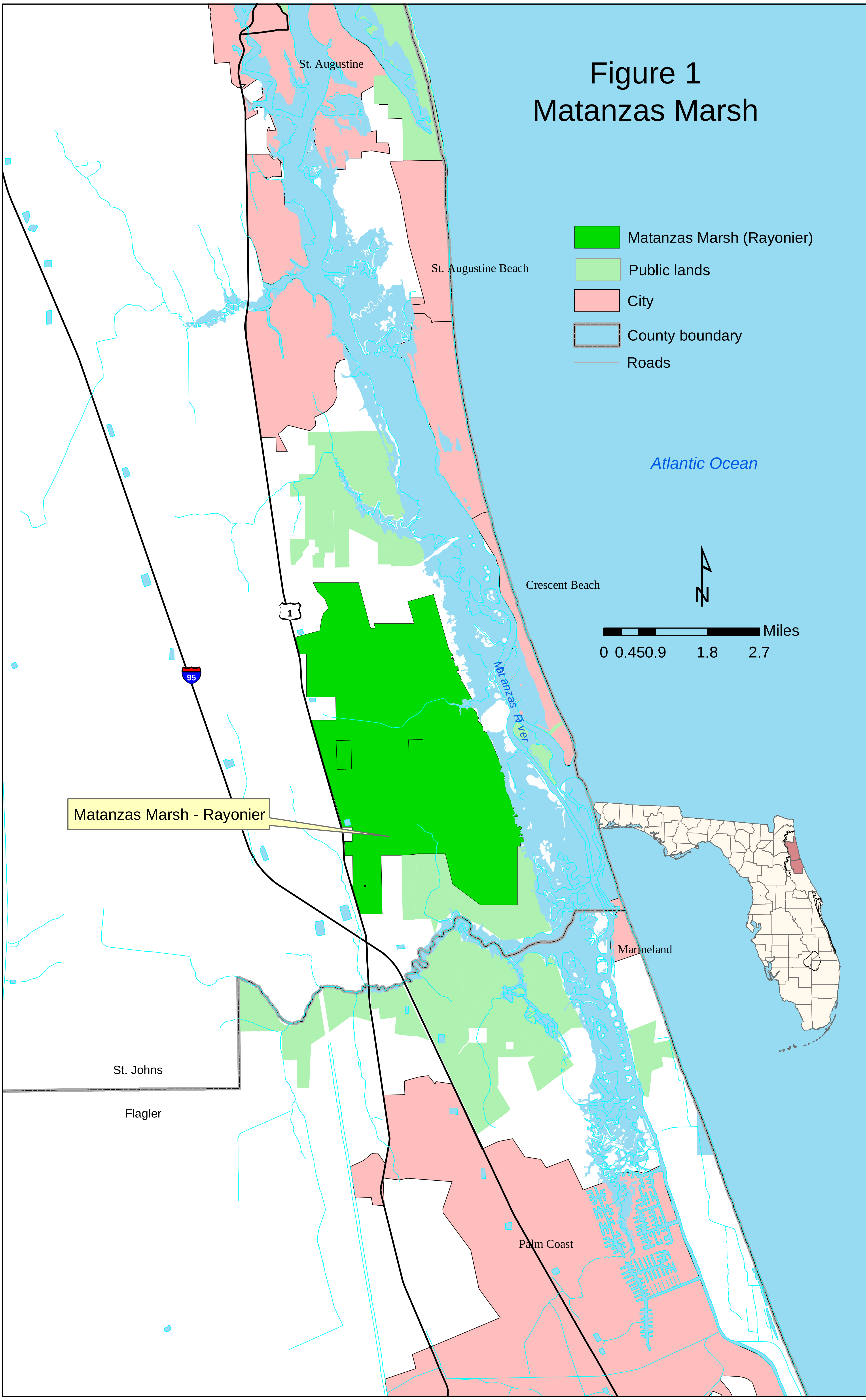

Figure 1
Matanzas Marsh

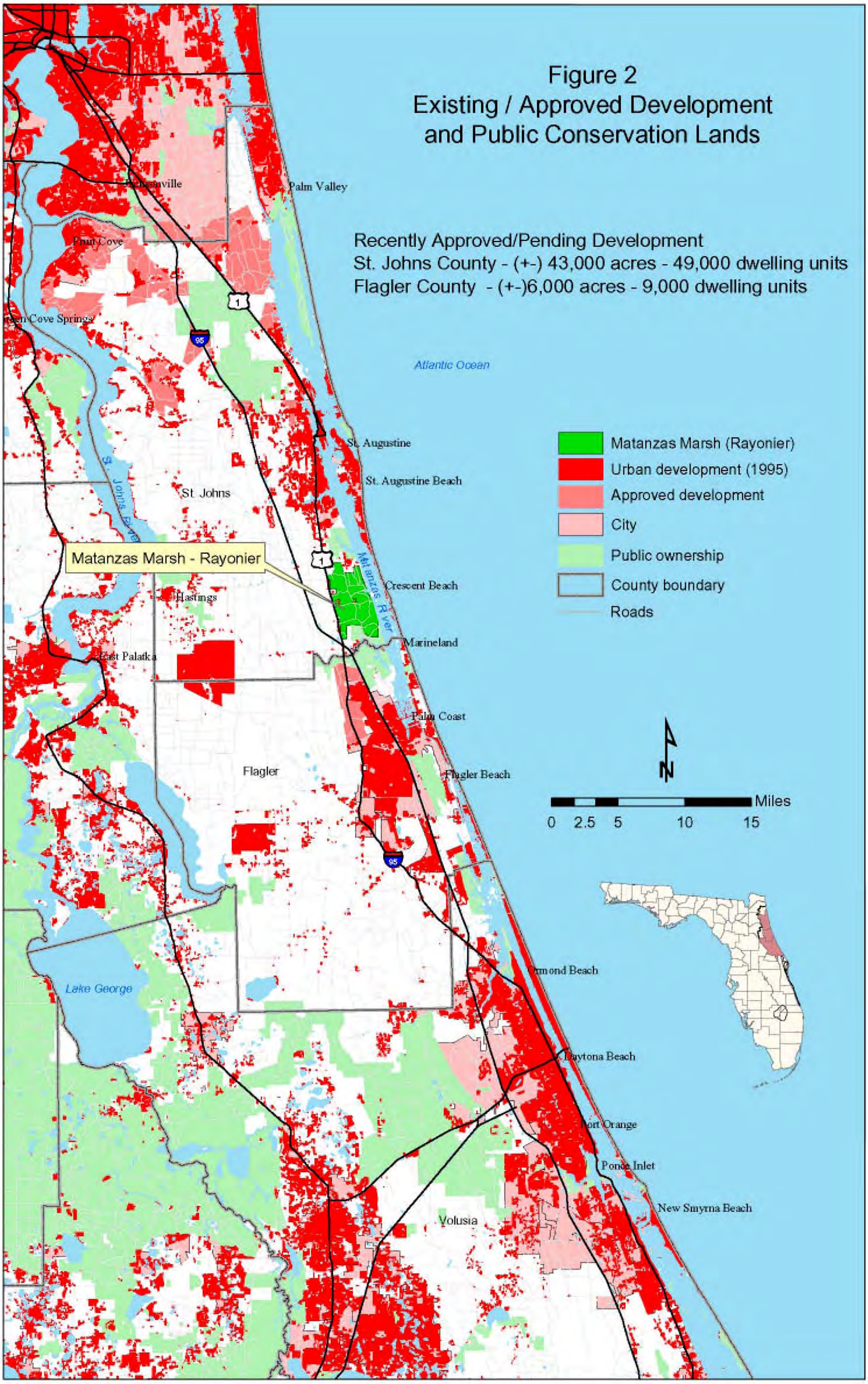

Figure 2
Existing / Approved Development
and Public Conservation Lands

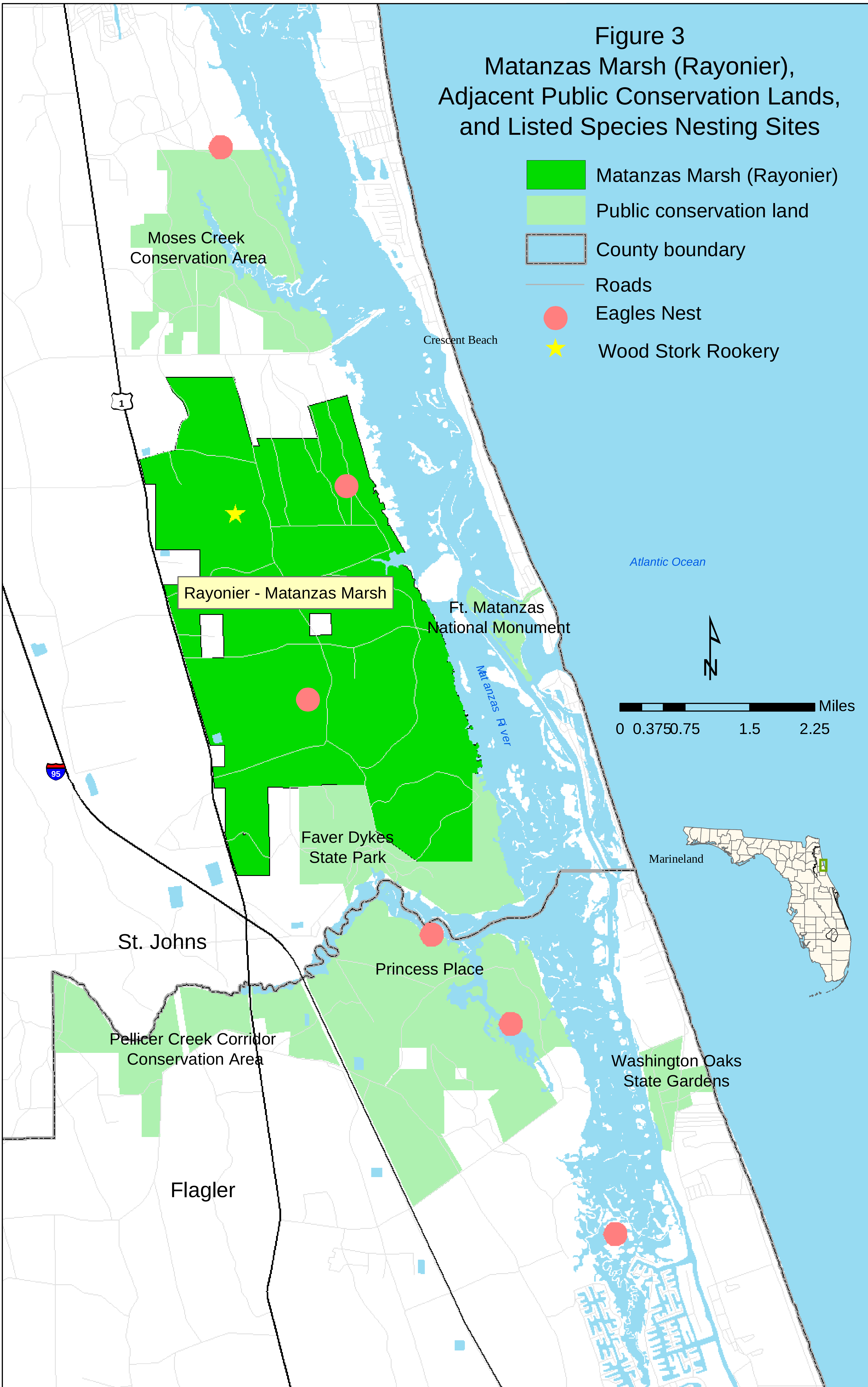
Figure 3
Matanzas Marsh (Rayonier),
Adjacent Public Conservation Lands,
and Listed Species Nesting Sites
Matanzas Marsh (Rayonier)
Public conservation land
County boundary
Roads
Eagles Nest
Wood Stork Rookery
Moses Creek
Conservation Area
Crescent Beach
Atlantic Ocean
Rayonier - Matanzas Marsh
Ft. Matanzas
National Monument
Matanzas River
Miles
0 0.375 0.75 1.5 2.25
Marineland
Faver Dykes
State Park
St. Johns
Princess Place
Pellicer Creek Corridor
Conservation Area
Washington Oaks
State Gardens
Flagler
1
95

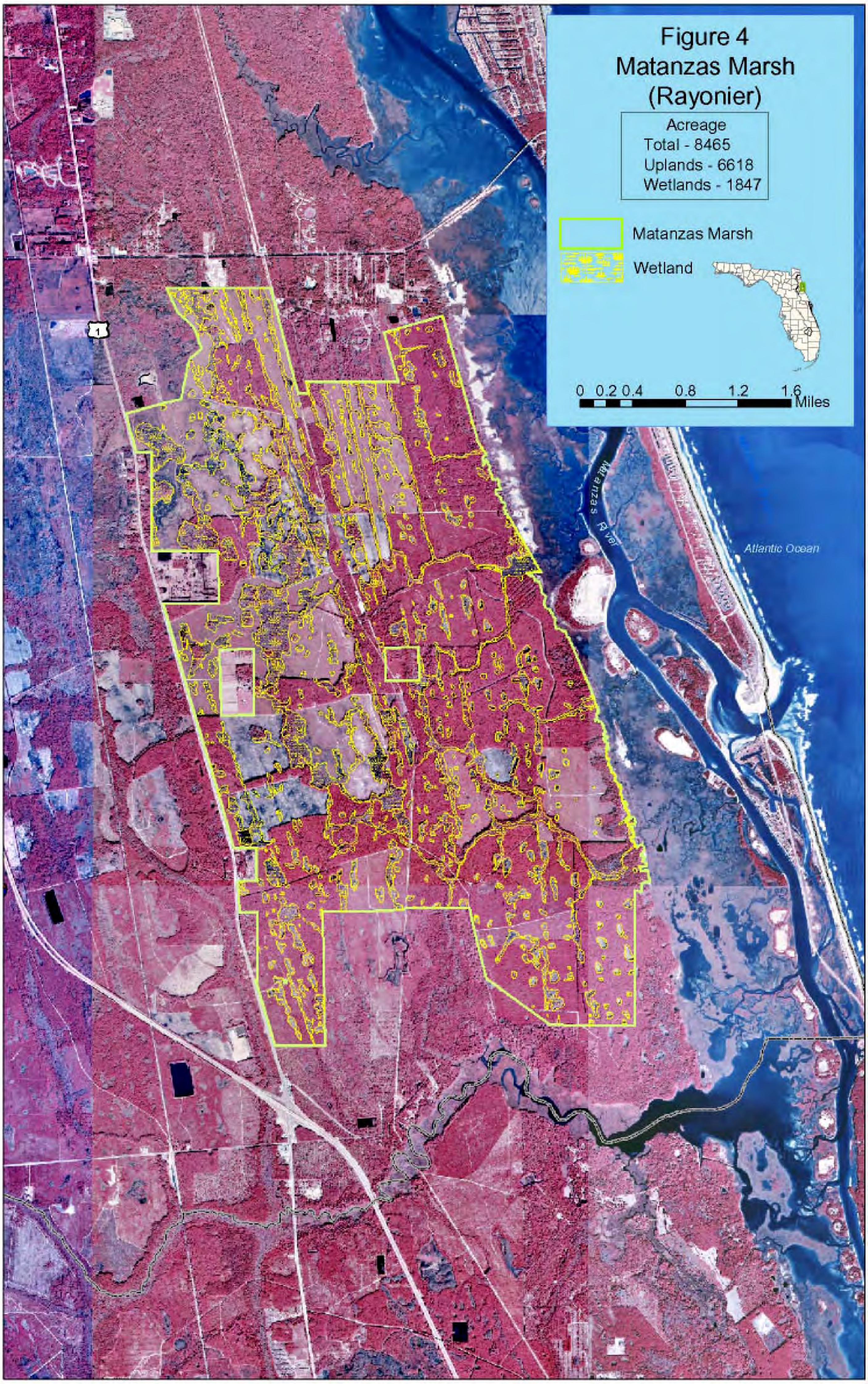

Figure 4
Matanzas Marsh
(Rayonier)
Acreage
Total - 8465
Uplands - 6618
Wetlands - 1847
Matanzas Marsh
Wetland
0 0.2 0.4 0.8 1.2 1.6
Miles
Matanzas River
Atlantic Ocean
1

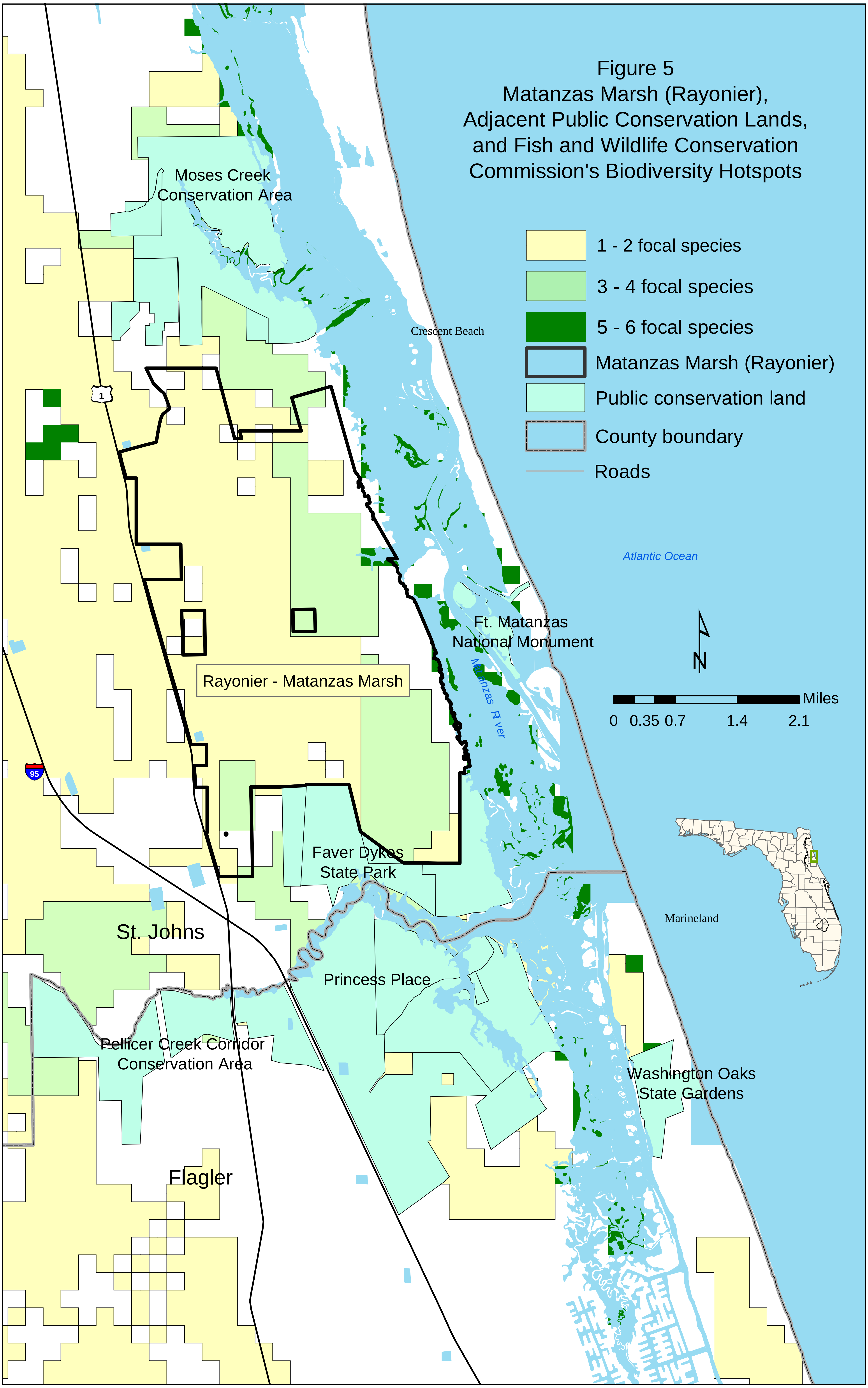
Figure 5
Matanzas Marsh (Rayonier),
Adjacent Public Conservation Lands,
and Fish and Wildlife Conservation
Commission's Biodiversity Hotspots
1 - 2 focal species
3 - 4 focal species
5 - 6 focal species
Matanzas Marsh (Rayonier)
Public conservation land
County boundary
Roads
Moses Creek
Conservation Area
Crescent Beach
Atlantic Ocean
Ft. Matanzas
National Monument
Matanzas River
Rayonier - Matanzas Marsh
Miles
0 0.35 0.7 1.4 2.1
Faver Dykes
State Park
St. Johns
Princess Place
Marineland
Pellicer Creek Corridor
Conservation Area
Washington Oaks
State Gardens
Flagler
1
95

Attachment A. Photos of the Matanzas Marsh Property

Figure A1. Aerial view of saltmarsh adjacent to subject property.

Figure A2. Cordgrass (*spartina*) dominated saltmarsh adjacent to the site.

Attachment A continued.

Figure A3. Mature pine plantation.

Figure A4. Immature slash pines in an area burned by wildfire.

Attachment A continued.

Figure A5. Oysterbar in creek draining from the site.
Note the condominiums across the river (Crescent Beach).

Figure A6. An interior freshwater wetland (wet prairie).

Attachment A continued.

Figure A7. The site contains a network of roads that will provide an exceptional trail system for recreational users.

Figure A8. An oak hammock with salt marsh in background.

Attachment A continued.

Figure A9. Ecotone between high marsh and oak hammocks, with pine plantation in background. The open flats are tidally influenced and provide valuable habitat for fish and wildlife.

Figure A10. A potential tidally-connected fish trap built by native Americans.

Figure A11. Aerial of wood stork colony located on site.

Figure A12. Nestling wood storks in a cypress tree.

Appendix E

Response to Comments on the Draft Lake Apopka Natural Resource Damage Assessment and Restoration Plan

Response to Comments on the Draft Lake Apopka Natural Resource Damage Assessment and Restoration Plan

The Service received one comment letter regarding the Draft Lake Apopka Natural Resource Damages Assessment and Restoration Plan from the Friends of Lake Apopka (FOLA), December 2003. FOLA was supportive of the acquisition and management of the Matanzas Marsh property, but had comments regarding some aspects of the settlement of natural resource damage claims. To the extent these relate to the DARP, the comments and the Service's responses are set forth below.[1]

Comment: FOLA supports the acquisition and management of Matanzas Marsh because of its environmental sensitivity and habitat value but objections must be expressed about the punitive nature of this requirement. The same should be said about the fine to be paid to DOI to fund an update of Management Guidelines ($14,776.30), the funding required for a study of eggshell thinning ($10,450.00), the reimbursement to DOI for costs incurred ($26,868.11) and the overhead charges incurred by USFWS ($1,500.00/year). Bureaucratic processes are typically slow and expensive and these energies and resources could be much better applied to the problem at hand.

Response: The damage assessment and subsequent compensation are not punitive nor part of a criminal case. Instead, these are civil claims, explicitly designed not to be punitive, but to be purely compensatory, making the public whole for the injuries to and the losses of natural resources. The Comprehensive Environmental Compensation, Restoration, and Liability Act, 42 USC Section 9601 et seq. (CERCLA), provides for the recovery of these kinds of damages (42 USC Section 9607(4)(C)). Although denying natural resource damages liability under CERCLA, the District has recognized that these losses did occur in association with the District's restoration activities at Lake Apopka and agreed to restore these injuries as well as compensate the Trustee for damage assessment costs and restoration oversight costs. The $1,500.00 per year compensation is not for overhead but for the costs of the Service to participate in the restoration project, management of the Matanzas Marsh property for wood storks. Trustees, in this case the Service, are entitled to recovery of damage assessment costs and restoration costs pursuant to CERCLA Section 107(4)(C), 42 U.S.C Section 9607(4)(C), and pertinent damage assessment regulations (43 CFR Part 11.15(3)).

Comment: We strongly object, however, to the characterization of the SJRWMD in both documents [MOU and draft DARP]. Both documents state, either implicitly or explicitly, that SJRWMD was solely responsible and negligent in its attempts to restore the north shore. We know this is not the case, as we have worked with the district on many projects. The State of Florida charged SJRWMD with the responsibility of restoring Lake

[1] It should be noted that the majority of comments from FOLA addresses a Memorandum of Understanding between the United State and the District. Comments on the MOU, as opposed to the DARP, were not solicited, and it is therefore not appropriate to address these comments in this response.

Apopka. Agricultural interests flooded the fields and applied organochlorine pesticide (OCP) for many years prior to acquisition by SJRWMD. As stated in the DARP, SJRWMD performed a multi-phase site assessment and environmental risk assessment, removing over 20,000 tons of contaminated soils. We feel the SJRWMD acted in a responsible and cautious manner and should not be persecuted for its efforts. Certainly, these agricultural interests share much of the responsibility for the unfortunate avian mortality (As submitted by Friends of Lake Apopka 12/12/03).

Response: As discussed above, the District agreed to take affirmative steps to offset the losses to the natural resources based upon its recognition that these losses did occur in association with the District's restoration activities at Lake Apopka. This avoided the need for extensive assessment and litigation activities to determine liability under CERCLA, and permitted the District and the Service to move forward in a positive and cooperative manner to benefit the resource, a mutual objective of both agencies. Because the District agreed to fully offset the losses to natural resources, it was not necessary for the Service to initiate formal legal action against the District or any other potentially responsible parties. It is possible that if legal action had been initiated, other potentially responsible parties could have been brought into the matter by USFWS or the defendant(s).