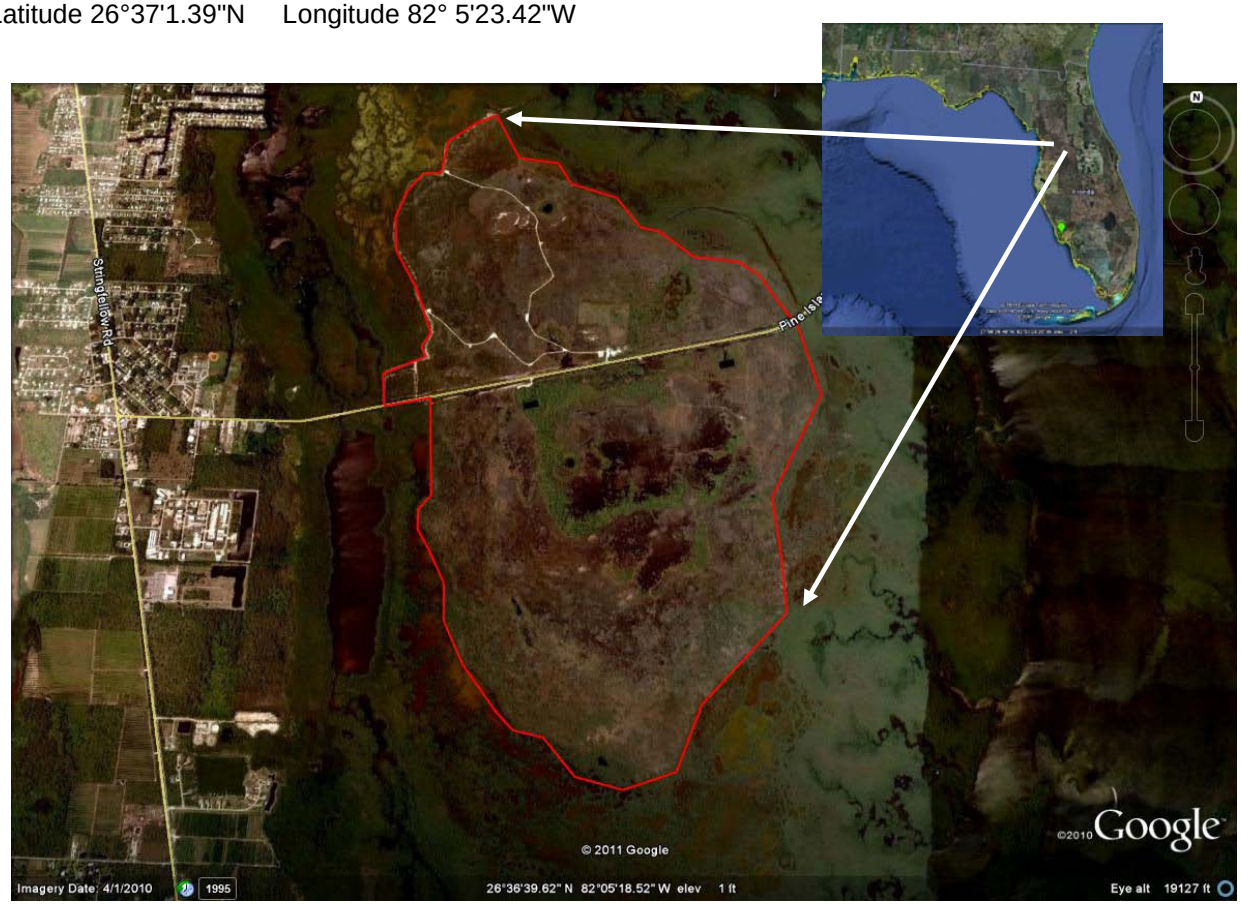
Proposed Wetland Restoration Case Study Submittal

1. **Project Name and Location:**
   Little Pine Island Coastal Habitat Restoration
   Lee County, Florida, USA

   Latitude 26°37'1.39"N Longitude 82° 5'23.42"W



2. **Wetland Hydro-geomorphic Type(s):** Salt water forested; salt water herbaceous; freshwater herbaceous; and freshwater forested

3. **Project size:** 4,670 acres
   Watersheds: Pine Island Sound; Charlotte Harbor Estuary
   Spatial Location: Lee County, Southwest Florida, USA 26^{o} 36'N 82^{o} 05'W

4. **Project sponsor:** Mariner Properties Development, Inc.

5. **Role:** Kevin L. Erwin Consulting Ecologist, Inc. lead consultant for the design and environmental permitting; conducted wildlife surveys; mapped historic and current vegetation communities; conducted soils evaluations; designed a hydrologic monitoring well network; conducted hydrologic monitoring; developed, tested and applied low-impact exotic plant removal techniques; provided oversight for the restoration construction, planting, and maintenance; conducted habitat monitoring; recommended and implemented adaptive management techniques; compiled annual monitoring reports.

6. **Purpose/drivers:** The Little Pine Island Mitigation Bank is a 4,670± acre wetland restoration project by Mariner Properties Development, Inc. in conjunction with the Florida Department of Environmental Protection (DEP). Exotic species had heavily infested Little Pine Island and were present in approximately 1,598 acres of the island in 1995. In addition to the infestation, Little Pine Island's hydrology was significantly impacted by 48.3± acres of mosquito ditches which destroyed the freshwater lens on the center of the island. The purpose of the Little Pine Island Mitigation Bank is to restore the wetland ecosystem through removal of exotic species, re-establishment of native vegetation, and hydrologic restoration.

7. **Project goals and degree of goal attainment:**

- A phased enhancement and restoration of include forested freshwater coastal fringe, forested saltwater coastal fringe, herbaceous freshwater/brackish coastal fringe, and herbaceous saltwater coastal fringe habitats – Goal achieved except for completing the removal of temporary road within Phase III.

- Restore natural grade of temporary roads, filled ditches and removed berm areas appropriate for the target habitat – Goal fully achieved.

- The following criteria as described by "An Assessment Procedure for Wetland Mitigation Banks" (Kevin L. Erwin Consulting Ecologist, Inc., 1995b) have been met in each of the hydro-geomorphic wetland types identified above:

    1. Vertebrate Criteria:

        a) Wildlife utilization will at a minimum include two native wetland dependent mammal species – Goal exceeded.

        b) Wildlife utilization will at a minimum include three wetland dependent wading bird species – Goal exceeded.

        c) Wildlife utilization will at a minimum include three wetland dependent bird species other than wading birds – Goal exceeded.

        d) Wildlife utilization will at a minimum include two native wetland dependent reptile species – Goal exceeded.

        e) When water is present, fish assemblage at a minimum will include three native species of fish, or, in the case of extremely harsh environments (with respect to water temperatures, salinities, etc.) one abundant species of fish – Goal achieved.

        f) Native amphibians (anurans) include a minimum of two species – Goal achieved.

Note: To date, wildlife monitoring has documented utilization by at least 9 species of native mammals, 110 bird species, including 53 wetland-dependent bird species, 21 species of native reptiles, 7 species of native amphibians, and 13 species of native fish. [It should be noted that during the pre-restoration Little Pine Island assessment in 1995, wildlife utilization included only 4 mammal species, 43 bird species, including 20 wetland-dependent bird species, and 5 species of native reptiles.] When water is present, it is common to observe large numbers of wading birds foraging in the restored areas. Many wildlife species have been observed nesting and/or reproducing on-site, including a pair of bald eagles, eastern indigo snakes, box turtles, green treefrogs, green herons, anhingas, killdeer, northern mockingbirds, mourning doves, mottled ducks, great horned owls, red-tailed hawks, and red-shouldered hawks.

2. Vegetative Criteria:

    a) A minimum of 15 non-nuisance, native wetland plant species are present, contribute to a minimum of 60 percent total cover, and remains the same or is increasing in percent total cover – Goal exceeded.

    b) All native wetland ground cover species and existing wetlands trees are reproducing naturally, via seeding establishment, growth and survival or normal, healthy vegetative spread in ways that would be normal for each species – Goal achieved.

    c) A viable seed bank of non-nuisance native wetland species has been established, as demonstrated by germination experiments – Goal achieved.

    d) Percent cover of exotic species (melaleuca, Brazilian pepper, and Australian pine) is maintained at or below one percent of the total cover without physical maintenance for one growing season – Goal achieved.

    e) A minimum of three plant communities are established within each hydrogeomorphic wetland type – Goal achieved.

Note: The response of the native seed bank and the natural regeneration of native vegetation have been excellent. Multiple macrophyte types exist throughout the island. Plants are healthy, reproducing, and are distributed properly within appropriate zones throughout the island. Exotic species represent less than one percent total vegetative coverage. Native grasses are expanding their distribution and colonizing areas that were formerly sparsely populated or exhibiting low coverage of these species. This is especially true in areas that have recently been burned using controlled fires. Over 150 native plant species have been observed on-site.

3. Invertebrate criteria:

    a) A minimum of three classes (i.e., insecta, mollusca, crustacea, or annelida), four orders (i.e., odonata, coleoptera, hemiptera, diptera, gastropoda, or decapoda), and ten species of aquatic macroinvertebrates are present in each herbaceous wetland type – Goal achieved.

    b) At least two classes, three orders, and six species are present in a forested wetland type – Goal achieved.

Note: A diverse variety of aquatic macroinvertebrates has been collected at the restored wetlands throughout all phases, representing at least 150 species. Wetland vegetation and hydroperiods are appropriate for the hydrogeomorphic wetland types that are found on Little Pine Island. This situation supplies an abundance of natural habitats for aquatic macroinvertebrates, allowing them to reproduce, feed and disperse throughout the island and beyond.

- Soils Criteria – The soils at the restored mosquito ditches and berms have the following characteristics:

    1. Redox potential is within 200 mV and pH within 1 unit of values measured in adjacent wetland soils – Goal achieved or trending toward achieving. *Note: In some cases, the pH values for the ditch and berm soils are slightly higher than the pH values measured in the adjacent wetland soils. In these circumstances, the restored ditch and berm soils are slightly more basic than the adjacent wetland soils that are more*

acidic. This is most likely due to the fact that the adjacent native wetland soils contain more organic matter than the ditch/berm soils, which is apparent upon visual inspection. This organic matter is from dead melaleuca tree material and native vegetation that has accumulated over time in these wetland soils. It is expected that the pH values in the restored ditch/berm soils will decrease over time, and therefore become more acidic, as more organic material accumulates. Where this situation occurs, the pH aspect of this criterion may be considered to be meeting success through trending. Otherwise, the pH aspect of this criterion has been directly achieved.

2. Interstitial salinity is similar to adjacent wetland soils – Goal achieved or trending toward achieving. *Note: soils of the Little Pine Island restored ditches typically have higher average interstitial salinities than those of the adjacent native wetlands. This difference may be attributed to some areas of the restored ditches that have become sun-baked and contain concentrated salts. It is anticipated that, as the restored ditches mature and become more vegetated over time, interstitial salinities will become lower and begin to mirror the interstitial salinities of the adjacent wetlands. It should be noted that some sampling locations of the restored ditches have interstitial salinities that are highly similar to those of the adjacent wetlands.*

- Post-restoration Invasive Exotic Vegetation Management: The percent cover by exotic and nuisance plant species at the site shall be maintained at or below 1% of the total cover – Goal achieved to date; habitat management is ongoing.

8. **Methods of restoration and approximate time to complete:**

The project focused on low-impact methods to conduct the hydrologic restoration and removal of invasive plant species to allow the germination of native plants from the existing seed bank. All restoration activities were overseen by ecologists certified through the Ecological Society of America (www.esa.org).

The restoration was conducted in phases with Phase I being a demonstration phase to document the successes and problems encountered in order to allow adaptive methodologies to insure the least impact on the existing soil, native vegetation, and seed bank. Restoration began in 1997 and was completed in 2006 with management and maintenance of the restored habitats continuing in perpetuity. The major restoration activities were completed within the time periods detailed in Table 1.

Hydrologic restoration included backfilling nearly 50 acres of drainage canals that were excavated in the 1960's as part of a mosquito control program.

Removal of exotic plant species mainly from nearly 2,000 acres was conducted utilizing a unique low-impact procedure involving constructing removable roads and conducting much of the tree removal by hand (i.e. chain saws). Melaleuca (*Melaleuca quinquenervia*), Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*) were the main invasive species with an average of 30 tons of exotic biomass per acre removed from the site. After initial removal and treatment of stumps with an appropriate herbicide, regular follow-up herbicide treatments were conducted (i.e. 6 month, 12 month, then annually). Although laborious and time-consuming, hand-removal ensured the least impact to the existing seed bank and reduction in exotic plant regeneration greatly reducing the costs typically associated with repeated exotic plant removal, seeding and planting restoration areas. Supplemental plantings were incorporated into select areas where the seed bank response was low and in filled ditches to speed the restoration process.

Prescribed fires are used as an essential habitat management tool on Little Pine Island because fire plays an important role in Florida's ecosystems**.** The purpose of these prescribed burns is to control undesirable species (especially exotics), promote forest regeneration, perpetuate natural vegetation communities, improve wildlife habitat, cycle nutrients, and reduce accumulated fuel loads. Prescribed fires will continue to be conducted annually over selected portions of the site until a burn cycle is established for the island's habitats.

Table 1: Time frame for completion of major restoration activities by phase.

Restoration Activity	Phase I	Phase II	Phase III	Phase IV	Phase VA	Phase VB	Phase VC	Phase VI	Phase VIIA	Phase VIIB
Road Building	3/97-6/97	3/97-4/98	4/05-5/06	1/05-4/06	9/97-10/97	5/98-6/98	4/98-6/98	6/01 4/03 1/04	4/99-6/99	2/04-3/04
Road Removal	6/97-5/98	4/98-6/99	3/06[1] *[2012[2]]*	3/06[1] *[2012[2]]*	6/01-7/01	6/01-7/01	6/01-7/01	1/04-1/06	4/05	4/04-6/04
Exotic Clearing	3/97-7/97	3/97-5/98	4/05-3/07	1/05-5/06	9/97-11/98	5/98-7/98	4/98-7/98	2/01 4/03 2/04	4/99-10/99	3/01-6/04
Ditch Work	6/97-7/98	6/97-7/98	3/06-4/07	5/06	9/97	n/a	6/98	12/00 - 2/01	n/a	n/a

1. *Activity commenced but not completed*
2. *Projected date of completion*

Mariner Development Properties, Inc. was required to establish the Little Pine Island Preservation Trust Fund. The interest-earning trust fund will pay for the annual costs of maintenance and monitoring of Little Pine Island's habitats. The fund will be managed locally by the Little Pine Island Trustees and not used for any other projects.

9. How was the project monitored? Monitoring was conducted throughout the restoration process to document the restoration success as measured by the twenty-four success criteria given in the State and Federal environmental permits. The success criteria were divided into categories and include (1) **topography** criterion for the temporary roads, ditch and berm areas; (2) **vertebrate** criteria; (3) **vegetation** criteria; (4) **invertebrate** criteria; (5) **soils** criteria; and (6) percentage of **invasive exotic vegetation**. The permit success criteria were used to define the scope of the monitoring as detailed below.

(1) Topography: Topographic surveys were conducted using a survey level, a laser level and a survey grade GPS unit in areas where ditches were filled, berms removed, and temporary roadways removed.

(2) **Vertebrate Community:** The vertebrate criteria examined the following: mammals, birds, reptiles, fish, and amphibians. In general, wildlife monitoring included audible and visual surveys, which were conducted continually during all visits to the project site. Active monitoring was necessary for the more evasive wildlife. A wildlife notebook was kept to record all observations on site. Information that was recorded for any wildlife observations included date, species, number of individuals, and location by phase and wetland type.

Mammal utilization was confirmed through observation of an individual or evidence of habitat utilization (scat, nests, tracks, etc.). During all site visits, the ecologists took time to detect signs of mammal utilization. In addition, Sherman mammal traps were used to

determine habitat utilization by small mammals. The traps were placed along animal trails and in brush piles and were baited with rolled oats. The Sherman traps were run for approximately 52 nights from June through August.

Observations of avian species utilization of the project site were conducted continually during all site visits. The species, number of individuals, and location (phase and wetland type) were recorded.

Herpetofauna drift fences were utilized for the monitoring of reptiles and amphibians. Drift fences were installed in each wetland type and phase where casual observation of species did not meet success criteria. Wire traps and drop buckets were placed along the fence. Vegetation was used to cover the traps and buckets for camouflage and shade. Two to three, 1.25" PVC pipes were also installed in the vicinity of each drift fence for monitoring of tree frogs. The drop buckets were removed when the water table rose to a point where they were under water. The traps were monitored from April to September (i.e. wet season) for approximately four to seventeen weeks.

Fish were sampled with Breder traps (Breder, 1960). The Breder traps were placed in standing water for a minimum of 30 minutes and as long as overnight. Samples were collected by wetland type and phase. The fish were counted and specimens were collected and preserved in 10 percent formalin for identification in the lab. Fish specimens were identified using the taxonomic literature listed in the reference section of this report. Fish samples were collected during other monitoring events when standing water was present.

(3) **Vegetation Community:** The plant communities were mapped through interpretation of aerial photography and ground truthing. A vegetation survey was conducted by walking the phases and mapping the different macrophyte communities on the aerials.

Vegetation monitoring was conducted in October and November. The quantitative vegetation monitoring was conducted with point frames in the herbaceous communities and quadrats in the forested communities. The wetland types and macrophyte communities determined the location of the sampling plots. Areas that were not infested with exotic species were not quantitatively sampled.

Within each sampled plant community in the herbaceous wetland types, a central point was permanently marked with a PVC pipe. From the central point, ten random directions and distances were determined using a random numbers table. At each random direction/distance the vegetation was sampled using a $3.3ft^2$ point frame. The plant species or non-vegetated area (i.e. bare ground) located directly below each of the 25 points within the point frame was recorded and assigned a coverage value of four percent per point for a total of 100 percent (Bonham, 1989). Plant species were identified using the taxonomic literature listed in the reference section of this report.

For the forested wetland types, $33ft^2$ quadrats were used for sampling the vegetation (Bonham, 1989). Three quadrats were permanently installed (i.e. marked with PVC pipes) within each macrophyte community being sampled. Within the quadrats the number of stems were counted and percent canopy cover was estimated for woody species greater than four feet in height. For all other vegetation, percent cover was visually estimated by species.

Panoramic photographs were taken of each sampling area and quadrat. Panoramic photographs were also taken of the macrophyte communities that were not sampled due to those areas not being previously infested with exotic species. The location of the panoramic photographs varied to accurately represent the typical vegetative cover for each macrophyte community.

A vegetation survey was used in order to verify natural reproduction of native wetland species. The survey was conducted by walking the project and noting seed production and young plants nearby a parent plant. These surveys were conducted throughout the year.

Prior to the commencement of restoration, photo stations were established. Panoramic photographs were taken before removal of exotic species and every three months for one year after which annual photographs were taken. These photographs provide a visual record of the progress of the wetland restoration and subsequent changes in the landscape.

(4) **Invertebrate Community:** Qualitative sampling of aquatic macroinvertebrates was conducted using a standard D-frame aquatic dip net. In wetlands that contained a minimum of one inch of standing water, a collector worked the net vigorously within the vegetation, open water, and surficial benthic sediments. The contents of the net were placed in a pan and sorted through with forceps until no new species were found. Sampling with the net and sorting was conducted until no new species were encountered or for a period of 30 minutes. Organisms were preserved in 80 percent ethanol and returned to the laboratory where they were identified with the aid of a stereomicroscope (10x to 30x).

(5) Soils: Soils within the filled ditches and removed berm areas were sampled to document the oxidation reduction potential (ORP), pH and interstitial salinity levels.

(6) Invasive Exotic Vegetation Management: The quantitative vegetation monitoring detailed above was also utilized to determine the percentage of invasive exotic vegetation cover.

10. **Is the project part of a larger initiative at a watershed or regional level?** Yes, the restoration project provides a regional benefit to offset unavoidable impacts to wetlands resulting from development within the mitigation bank service area which covers portions of seven watersheds (Lower Coastal, Alligator Creek, Myakka River, Estero Bay, Tidal Caloosahatchee, North Coastal and Peace River).

11. Is the project considered a success or failure? Please explain why.

Recovery of the restored wetlands throughout the island has been quite remarkable. Following exotic removal, seeds of native wetland vegetation that had been dormant in the soil sprouted to produce appropriate native wetland flora within well-balanced vegetation communities. Supplemental plantings of native species in small areas where the seed bank failed to germinate, and ongoing exotic maintenance, have allowed the restoration areas to reach conditions that are highly comparable to pristine natural systems. In addition, recent prescribed fires have helped to further enhance native vegetation and mimic natural processes that historically evolved on the island over time.

Wildlife monitoring has documented a dramatic increase in wildlife utilization since restoration. Species richness, as well as numbers of individuals using the restored areas, has shown rapid and steady increases following restoration. To date, wildlife monitoring has documented utilization by at least 9 species of native mammals, 110 bird species, including 53 wetland-dependent bird species, 21 species of native reptiles, 7 species of native amphibians, 13 species of native fish, and 150 aquatic macroinvertebrate species. [It should be noted that during the pre-restoration Little Pine Island assessment in 1995, wildlife utilization included only 4 mammal species, 43 bird species, including 20 wetland-dependent bird species, and 5 species of native reptiles.] When water is present, it is common to

observe large numbers of wading birds foraging in the restored areas. Many wildlife species have been observed reproducing on-site, including a pair of bald eagles, eastern indigo snakes, box turtles, green treefrogs, green herons, anhingas, killdeer, northern mockingbirds, mourning doves, mottled ducks, great horned owls, red-tailed hawks, and red-shouldered hawks.

Overall, throughout the entire island, the condition of the restored wetlands is excellent. Vegetation, vertebrate, and aquatic macroinvertebrate communities are well developed throughout all of the restored wetland types. The response of the wetlands to the restoration effort has been exceptionally positive.

12. How could the project have been improved – e.g. location, design, hydrology, construction methods, data collection, etc? N/A

13. Please provide any citations where additional information may be found.

Kevin L. Erwin Consulting Ecologist, Inc. 1995. An Assessment Procedure for Wetland Mitigation Banks.

Kevin L. Erwin Consulting Ecologist, Inc. 1997a. Little Pine Island Mitigation Bank Demonstration Report.

Kevin L. Erwin Consulting Ecologist, Inc. 1997b. Little Pine Island Mitigation Bank Phase I Supplemental Demonstration Report

Kevin L. Erwin Consulting Ecologist, Inc. 1999. Little Pine Island Mitigation Bank First Annual Monitoring Report: Phases I, II, & VA.

Kevin L. Erwin Consulting Ecologist, Inc. 2000. Little Pine Island Mitigation Bank Second Annual Monitoring Report: Phases I, II, VA, VB, VC, and VIIA.

Kevin L. Erwin Consulting Ecologist, Inc. 2001. Little Pine Island Mitigation Bank Third Annual Monitoring Report: Phases I, II, VA, Second Annual Monitoring Report: VB, VC, and VIIA.

Kevin L. Erwin Consulting Ecologist, Inc. 2002. Little Pine Island Mitigation Bank Fourth Annual Monitoring Report: Phases I, II, VA, Third Annual Monitoring Report: VB, VC, and VIIA.

Kevin L. Erwin Consulting Ecologist, Inc. 2003a. Little Pine Island Mitigation Bank Reference Wetlands Monitoring Report: Phases I, II, VA, VB, and VC.

Kevin L. Erwin Consulting Ecologist, Inc. 2003b. Little Pine Island Mitigation Bank Fifth Annual Monitoring Report: Phases I, II, VA, Fourth Annual Monitoring Report: VB, VC, and VIIA.

Kevin L. Erwin Consulting Ecologist, Inc. 2004a. Little Pine Island Mitigation Bank Supplemental Reference Wetlands Monitoring Report: Phases I, II, VA, VB, and VC (Wildlife), Phase VIIA (Vegetation and Wildlife).

Kevin L. Erwin Consulting Ecologist, Inc. 2004b. Little Pine Island Mitigation Bank Sixth Annual Monitoring Report: Phases I, II, VA, Fifth Annual Monitoring Report: VB, VC, and VIIA.

Kevin L. Erwin Consulting Ecologist, Inc. 2005. Little Pine Island Mitigation Bank Seventh Annual Monitoring Report: Phases I, II, VA, Sixth Annual Monitoring Report: VB, VC, and VIIA, First Annual Monitoring Report: VI and VIIB.

Kevin L. Erwin Consulting Ecologist, Inc. 2006. Little Pine Island Mitigation Bank Eighth Annual Monitoring Report: Phases I, II, VA, Seventh Annual Monitoring Report: VB, VC, and VIIA, Second Annual Monitoring Report: VI and VIIB.

Kevin L. Erwin Consulting Ecologist, Inc. 2007. Little Pine Island Mitigation Bank Ninth Annual Monitoring Report: Phases I, II, VA, Eighth Annual Monitoring Report: VB, VC, and VIIA, Third Annual Monitoring Report: VI and VIIB, First Annual Monitoring Report: III and IV.

Kevin L. Erwin Consulting Ecologist, Inc. 2008. Little Pine Island Mitigation Bank Tenth Annual Monitoring Report: Phases I, II, VA, Ninth Annual Monitoring Report: VB, VC, and VIIA, Fourth Annual Monitoring Report: VI and VIIB, Second Annual Monitoring Report: III and IV.

Kevin L. Erwin Consulting Ecologist, Inc. 2009. Little Pine Island Mitigation Bank Eleventh Annual Monitoring Report: Phases I, II, VA, Tenth Annual Monitoring Report: VB, VC, and VIIA, Fifth Annual Monitoring Report: VI and VIIB, Third Annual Monitoring Report: III and IV.

Kevin L. Erwin Consulting Ecologist, Inc. 2010. Little Pine Island Mitigation Bank Twelfth Annual Monitoring Report: Phases I, II, VA, Eleventh Annual Monitoring Report: VB, VC, and VIIA, Sixth Annual Monitoring Report: VI and VIIB, Fourth Annual Monitoring Report: III and IV.

Kevin L. Erwin Consulting Ecologist, Inc. 2011. Little Pine Island Mitigation Bank Thirteenth Annual Monitoring Report: Phases I, II, VA, Twelfth Annual Monitoring Report: VB, VC, and VIIA, Seventh Annual Monitoring Report: VI and VIIB, Fifth Annual Monitoring Report: III and IV.

Little Pine Island Mitigation Bank http://www.littlepineisland.com/begin.html

Nellemann, C., E. Corcoran (eds). 2010. ***Dead Planet, Living Planet: Biodiversity and Ecosystem Restoration for Sustainable Development***. A Rapid Response Assessment. United Nations Environment Programme, GRID-Arendal. p.34

14. Is there any other information on the project you would like to provide?

- This project is an excellent example of a public-private partnership to achieve successful, cost effective, risk free wetland compensation project consisting of regionally significant ecosystem restoration that will be perpetually maintained at a no cost to the public. Not only is the restoration of Little Pine Island occurring at no cost to Florida taxpayers, the sale of mitigation credits returns a significant sum to the Florida Department of Environmental Protection. Every credit sold includes a "7 % use fee." All the "use fees" return to the Charlotte Harbor Buffer Preserve to be used in the acquisition and restoration of yet more wetland habitats.

  Little Pine Island mitigation credits are a high-quality form of wetland replacement for unavoidable wetland impacts. One wetland mitigation credit is equivalent to the ecological value of one acre of wetland creation. Their purchase relieves public and private development interests of the cost and liability associated with on-site wetland compensation.

- The growth of exotic vegetation on Little Pine Island forced the Bald Eagles to abandon their nests and move elsewhere. But within 90 days of restoring their former habitat, the eagles returned to their old nests, rebuilt them, and produced young eaglets since 1997.

- Photos and additional information can be found at http://environment.com/index.php/featured-projects/florida/little-pine-island-regional-wetland-mitigation-bank/