CAPE FLORIDA STATE PARK WETLANDS RESTORATION

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ABSTRACT

During the 1950's, over 80 hectares (200 acres) of wetlands on the south end of Key Biscayne, Florida were destroyed through the placement of over 765,000 cubic meters (one million cubic yards) of dredge fill and approximately 3.2 km (two miles) of bulk-headed shoreline associated with a failed development. Those wetlands, which are essential to the general health of the coastal marine and estuarine ecosystem, were replaced with a dry land forest of invasive exotic Australian pines (*Casuarina equisetifolia*). The passage of the northern eye wall of Hurricane Andrew (1992) over Cape Florida State Recreation Area completely leveled the forest of invasive exotics that dominated the created uplands. In the aftermath of the storm, the Florida Department of Environmental Protection, Division of Parks and Recreation (FDEP) developed a draft conceptual recovery and restoration plan for the park. A major objective of the plan was to restore, to the extent possible, the historic vegetation types present on this portion of Key Biscayne prior to the addition of fill material. The vegetation types included beach dune, coastal strand, maritime hammock, interior isolated freshwater wetlands, and a large tract of tidally connected mangrove wetland in the northwest portion of the park. Thirty- four hectares (85 acres) of historical wetlands are being restored at the park, through cooperative efforts of federal, state, and local agencies. DERM was identified as the lead agency for the implementation and execution of the wetlands restoration plan. The restoration plan has involved the removal of exotics, removal of portions of the bulkhead and fill, placement of a protective lime-rock barrier, elevation grading, creation of isolated freshwater wetlands, tidal pools, flushing channels, and the planting of wetland vegetation.

Key Words: Restoration, creation, wetlands, mangroves, fisheries, Hurricane Andrew

INTRODUCTION

Cape Florida is located sixteen kilometers southeast Miami, Florida, on the southern tip of Key Biscayne, a natural barrier island (Figure 1). During the early 1950's, approximately 152 hectares (380 acres) of natural vegetation on the south end of Key Biscayne were filled with dredged Biscayne Bay bottom for development purposes. The altered site rapidly became populated with a dense forest of invasive exotic Australian pines *(Casuarina equisetifolia),* and numerous other invasive exotic species. In addition, approximately 3.22 km (two miles) of concrete bulkhead was installed to contain approximately 2,295,000 cubic meters (three million cubic yards) of fill, which added up to 1.53 m (five feet) of elevation to the area. In 1966, the State of Florida acquired the 162 hectares (406 acre) tract of land, and in 1969 designated it a State Recreation Area. Upon acquisition, only 11 hectares (27 acres) of the park's uplands supported natural plant communities. The cultural resources of the park included five documented pre-Columbian and historic sites. Most prominent of the historic sites is the Cape Florida Lighthouse, built in 1825.

The passage of the northern eye wall of Hurricane Andrew (1992) destroyed the Australian pine forest that covered approximately 152 hectares (380 acres) of the Park. In the aftermath of the storm, the Florida Department of Environmental Protection, Division of Park and Recreation (FDEP) developed a recovery and restoration plan for the park. A major objective of the plan was to restore, to the extent possible, the historic vegetation types present on this portion of Key Biscayne. The vegetation types included beach dune, coastal strand, maritime hammock, isolated freshwater wetlands, and a large tract of tidally connected mangrove wetland in the northwestern portion of the park (Figure 2). The ecological importance of coastal wetlands as habitat and as a vital link in the main food web has been well documented (Idyll et al., 1968; Odum et al., 1982). Miami-Dade County Environmental Resources Management (DERM) assisted in the development of the restoration plan, and was identified as the lead agency for the design and implementation of the wetlands restoration. The plan called for the creation of 4 hectares (10 acres) of freshwater isolated wetlands and 30 hectares (75 acres) of tidally connected wetlands. This paper presents a review of the elements involved with the design and restoration of the coastal wetlands at the park.

Restoration Plan Development

The restoration plan was developed through the review of historical documents (1926 aerial photograph and personal observations), and field investigations of site characteristics. Field investigations included topographic, biological, geo-technical, hydrological, and archaeological reviews of the site.

A topographic survey of the restoration area was conducted for the planning, design, and

construction phases of the project. The restoration area was surveyed topographically using the photogrammetric mapping method (Coastal Technology Corp., 1994). This cost-effective method was employed after the site was cleared of all exotic vegetation. The resulting topographic map, with contours at 0.15 m intervals was super-imposed on a 2.54 cm = 61 m scale aerial photograph of the restoration site.

A comprehensive biological assessment was conducted, to document on-site and surrounding biological communities, to define biological goals and objectives, to identify environmental concerns, and to make specific recommendations concerning construction activities associated with the restoration.

Soil characteristics within the restoration area were determined by excavating 28 test pits at selected locations. A 152.5 m rectangular grid system was established in the footprint of the 30 hectares (75 acre) tidally connected wetlands in the northwest portion of the park. Test pits excavated by backhoe, located at each node of the grid, were sampled to analyze trends in vertical and horizontal distribution of soil strata. A soil-classification report for the site was developed to detail soil characteristics (e.g. type, grain size distribution, and color) and provide information applicable to developing marketing and spoil disposal strategies. In addition, ground penetrating radar and electronic surveying were used to provide data on subsurface conditions (Technos, Inc. 1994). These evaluations were used to locate the five historical isolated wetlands that had been filled to +1.98 m (+6.5 ft) in the early 1950's.

Wave energy, tidal regime, current velocity and bathymetry surveys were conducted to assist in the development of design components such as flushing canals (number, size, and depth), culverts (number, size, and elevation) and open water areas within the tidally connected wetlands. The final design was developed using the Dynamic Estuary Hydrodynamic Model, developed by the Environmental Protection Agency. Groundwater monitoring wells were installed one-year prior to the restoration, and were equipped with recorders to monitor seasonal fluctuations of groundwater. This was used to design elevations and contours of the five isolated freshwater wetlands which were restored in the park.

A two-phase archaeological monitoring plan, was conducted at the restoration site by a qualified archaeologist. Phase I included the evaluation of a series of trenches throughout the restoration area, and Phase II consisted of daily observations of the excavation work during the restoration process. Archaeological evaluation during the excavation phase of the project revealed a 1,000 year-old (B.P.) Human jawbone, along with an assortment of primitive conch shell tools. This is the oldest evidence of human habitation in this area (Zaminillo, 1997).

Restoration Implementation

The wetlands restoration plan was implemented via two separate Miami-Dade County construction contracts and three privately funded efforts. Federal, state, and local environmental resource permits were obtained for all restoration work. The first element of the plan was to stabilize approximately 0.8 km, of high-energy shoreline on the western boundary of the restoration area. This was accomplished through the first construction contract, which was executed in December 1993 and consisted of the installation of 16,535 metric tons of natural lime-rock boulders 30.5 cm to 76.2 cm in diameter to create a 3.6 m wide x 1.22 m high rip rap revetment along the western boundary. The existing remnant concrete bulkhead along this shoreline was reduced to 0.0 m National Geodetic Vertical Datum (NGVD) and utilized as additional material at the toe of the rip rap revetment. Lime-rock boulders were also placed along the seaward base of the concrete bulkhead for habitat and structural purposes. At 30.5 m intervals along the bulkhead, a 1.53 m wide notch was cut to -0.3 m NGVD to enhance flushing along the stabilizing structure. A 7.63 m wide red mangrove (*Rhizophora mangle*) planter was installed at 0.4 m NGVD elevation along the length of the rip-rap revetment. A temporary lime-rock/filter fabric containment wall was installed on the landside edge of the mangrove planter to contain the upland fill. The back wall was eventually recycled and utilized in the second construction contract to stabilize three flushing channels and two overlooks. The total cost of the first contract was $650,000, and was funded by the Florida Inland Navigation District and the Miami-Dade County Biscayne Bay Environmental Enhancement Trust Fund.

The second construction contract was executed in January 1996 and was completed in January 1999. The contract was subdivided into eight wetland components: Five 0.8 hectares freshwater isolated wetlands and three unequal areas (16 hectares, 6.4 hectares, and 7.6 hectares) of tidally connected wetlands. The completed contract resulted in the:

- Removal of 7,650 cubic meters (10,000 cubic yards) of solid waste
- Removal of 344,250 cubic meters (450,000 cubic yards) of dredge material
- Creation of a 30 hectares (75 acre) red mangrove (*Rhizophora mangle*) forest
- Creation of a 0.4 hectare tern nesting island (1.4 m elevation)
- Creation of 1.6 hectares of open water area (-0.9' m NGVD)
- Installation of three floating water-craft barriers at flushing connections
- Installation of network of inter-tidal flushing creeks
- Creation of freshwater isolated wetlands (4 hectares)

The total cost of the second contract was 1.9 million and was funded by the following

agencies: USDA Forest Service, South Florida Water Management District, Miami-Dade County Environmental Resources Management (DERM), Miami-Dade Water and Sewer Department, and the Village of Key Biscayne.

DISCUSSION

A total of 497,250 cubic meters (650,000 cubic yards) of fill material was excavated and transported to various locations in close proximity to the restoration site. The fill material was subdivided into three classifications. Type A consisted of approximately 229,500 cubic meters (300,000 cubic yards) of beach quality material. Approximately 76,500 cubic meters (100,000 cubic yards) of Type A material was recycled onto public beaches on Key Biscayne and Virginia Key, Florida. Private developers were responsible for the excavation and removal of approximately 153,000 cubic meters (200,000 cubic yards) of Type A material, at no cost to the public. Type B, consisted of approximately 153, 000 cubic meters (200, 000 cubic yards) of high quality sand fill which was suitable for dune restoration or construction fill. Type C consisted of approximately 114,750 cubic meters (150,000 cubic yards) of material mixed with mulch, sandy humus, peat, and silt, which was unsuitable for construction fill unless mixed with Type A or B material.

The 30 hectares (75 acre) marine wetlands are tidally connected to Biscayne Bay through three 3.7 m wide x -0.6 m flushing canals and a series of four (1.2 m diameter) culverts. The main canals (7.9 m wide x -0.9 m NGVD) interconnect with a 2 ha open water area (-0.9 m NGVD) and twenty eight shallow pools (21.3 m diameter x -0.46 m NGVD) via 6.1 m wide "feeder" canals (-0.3 m NGVD). The open water area and shallow pools provide low energy habitat areas for larva, invertebrates, and juvenile fish. Additionally, the open shallow areas provide a sanctuary for wading birds.

The tidally connected wetlands were planted with *Rhizophora mangle* on 0.9 m centers utilizing the construction contract and volunteers. *Avicennia germinans* and *Laguncularia racemosa* were not installed and recruited into the site through the tidal creeks. *Borrichia fructescens* and *Spartina spartinae* were planted around the edges of the wetland site above 0.76 m NGVD. The five 0.8 hectare isolated freshwater wetlands (0.15 m NGVD) were planted with *Acrostichum danaeifolium, Cladium jamaicensis, Eleocharis cellulosa,* and *Spartina spartinae.*

Success criteria of the project are based on planting survivability and information regarding habitat use by fauna. To date, a 100% survival of wetland species is being realized. Wildlife observations conducted by FDEP, and local environmental groups have documented an influx of fish and birds into the restoration area.

To date, 40 species of bird have been recorded using the saltwater wetlands, including 18 species shorebirds 7 species of egrets and herons and 4 species of terns Additionally, 12 species of birds have been documented utilizing the freshwater wetlands. Recently, a 1.2

m crocodile was observed resting on the banks of the restoration area.

Public restoration dollars were maximized in this project through a resourceful spoil disposal plan, which reduced fill disposal distances and marketed fill to local developers. Fill materials of beach quality were recycled back onto local beaches. An estimated 2.8 million dollars were saved utilizing creative and resourceful project implementation strategies (e.g., phasing, spoil disposal strategies and resourceful construction strategies). In addition, it should be noted that over 1,500 volunteers have assisted with re-vegetating portions of the restoration area with native wetlands vegetation, providing a considerable cost savings.

The cost-effective restoration techniques reviewed in this paper have been developed through the DERM Biscayne Bay Coastal Habitat Restoration Program. Since 1985, DERM has restored and enhance approximately 120 hectares (300 acres) of coastal wetlands, created 15.2 hectares (38 acres) of tropical hardwood hammock, created 6 hectares (15 acres) of coastal strand community, created over 1.6 km of dune community, enhanced and restored fourteen islands, and stabilized over seven miles of unstable shoreline. Additional restoration details can be found in Restoration of coastal wetlands in southeastern Florida (Milano, 1999b), and Island Restoration and Enhancement in Biscayne Bay, Florida (Milano, 2000).

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