Ecosystem History of South Florida:

Biscayne Bay Sediment Core Descriptions

by

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TABLE OF CONTENTS

TABLES

FIGURES

Ecosystem History of South Florida:

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Abstract

The "Ecosystem History of Biscayne Bay and the southeast Coast" project of the U.S. Geological Survey is part of a multi-disciplinary effort that includes Florida Bay and the Everglades to provide paleoecologic reconstructions for the south Florida region. Reconstructions of past salinity, nutrients, substrate, and water quality are needed to determine ecosystem variability due to both natural and human-induced causes. Our understanding of the relations between the south Florida ecosystem and introduced forces will allow managers to make informed decisions regarding the south Florida ecosystem restoration and monitoring. The record of past ecosystem conditions can be found in shallow sediment cores. This U.S. Geological Survey Open-File Report describes six shallow sediment cores collected from Biscayne Bay. The cores described herein are being processed for a variety of analytical procedures, and this provides the descriptive framework for future analyses of the included cores.

Introduction

The Everglades Forever Act was passed in 1994 in order to address the increasing signs of stress in the ecosystems of the Everglades, Florida and Biscayne Bays: natural vegetation patterns are changing, fisheries are declining, and industrial pollution is apparent. In response to these signs, Federal, State, and local jurisdictions are faced with water and land-use management decisions related to the restoration, mediation, and monitoring of the South Florida ecosystem. To help make these decisions, the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), National Park Service (NPS), and Army Corps of Engineers (ACOE), among others, have initiated research programs focused on the restoration of a significant portion of the Everglades ecosystem. An integral part of the restoration effort is a comprehensive understanding of the ecosystem dynamics of South Florida, including evaluation of modern biotic distributions within the South Florida ecosystems and determination of natural versus human-induced variability in the South Florida ecosystem.

The Biscayne Bay region of South Florida has been affected by natural events such as steadily increasing sea-level, droughts and hurricanes. In addition, anthropogenic alterations of the South Florida region, urbanization, increased agricultural activity, dredging of natural channels, and water management of the Everglades have changed the setting of South Florida. These events and modification of the South Florida geography have driven the evolution of the Biscayne Bay ecosystem. However, the magnitude at which each of these factors affect the ecosystem remains unknown.

The objective of the "Ecosystem History of Biscayne Bay and the Southeast Coast" project of the USGS is to determine historical changes in the ecosystem of Biscayne Bay and adjacent regions, and to correlate the timing of the changes with natural events and anthropogenic alterations made to the South Florida region. These objectives will be accomplished through the analysis of modern distributions of faunas and floras to determine their environmental preferences throughout the South Florida region

(Everglades, Florida and Biscayne Bays). Results of these analyses will be used to interpret historical changes in the ecosystem by analyzing faunas and floras from sediment cores that date back 150 to 200 years before present. This work presents the sediment descriptions of six cores collected from the Upper Florida Keys and Biscayne Bay (Figure 1; Table 1) during November 1996 and February 1997. This report is produced by the Ecosystem History of South Florida component of the USGS's Ecosystem Program,

Table 1: Cores collected from Biscayne Bay.

Core Number	Latitude	Longitude	Core Length (cm)
SEI1196-MB-1	25 15.69 N	80 24.06 W	120
SEI1196-MB-2	25 15.40 N	80 25.65 W	106
SEI297-CB-1	25 18.37 N	80 20.63 W	146
SEI297-PB-1	25 26.65 N	80 17.22 W	85
SEI297-BP-1	25 32.10 N	80 19.13 W	116
SEI297-FB-1	25 31.31 N	80 15.39 W	225

and is one of a series of USGS Open-File Reports on the ecosystem history of the South Florida region (Wingard and others, 1995; Ishman and others, 1996; Brewster-Wingard and others, 1996).

Acknowledgments

I would like to thank Gene Shinn, Don Hickey, Chris Reich (USGS, St. Petersburg, Florida), and Jill D'Ambrosio (USGS, Reston, Virginia) for their logistical support, and Biscayne National Park for providing us with the permits to collect samples within the Park. Thanks are given to Lucy Edwards and Lynn Brewster-Wingard for their thoughtful and helpful comments on the manuscript.

Methods

Shallow sediment cores were collected using a large diameter (approximately 4 inch) piston core deployed in shallow (less than 2 meters) water from the USGS pontoon barge. The cores are collected by suspending a 4 inch diameter polybutylene core tube from a tripod and through a moon pool in the center of the barge. The core tube is suspended by a piston that is positioned at the bottom of the tube. The core tube is lowered to the sediment-water interface at which point the piston is secured so that it can no longer be lowered. The core tube is then lowered into the sediment as the piston remains stationary and slips within the core tube providing a slight vacuum to prevent compaction of the sediments. The core tube is pushed into the sediment, using handles secured to the top of the core tube, until bedrock is encountered or the surface tension on the outer surface of the core prevents further penetration. The core is then recovered by securing a steel cable to the core head handles and slowly winching the core tube out of the sediment. The top and bottom of the core tube are capped upon recovery and the core is labeled and described.

Coring Localities

Manatee Bay

Manatee Bay is a region located in the Upper Keys of South Florida on the western margin of Barnes Sound (figure 1), within the Florida Keys National Marine Sanctuary. It is partially enclosed by Short Key and Main Key that extend south from the mainland into Barnes Sound. This region contains some of the most pristine habitat within the Florida Keys. Salinities within Manatee Bay are highly variable, reaching values as high as 45 parts per thousand (ppt) to as low as 14 ppt (Metro-Dade

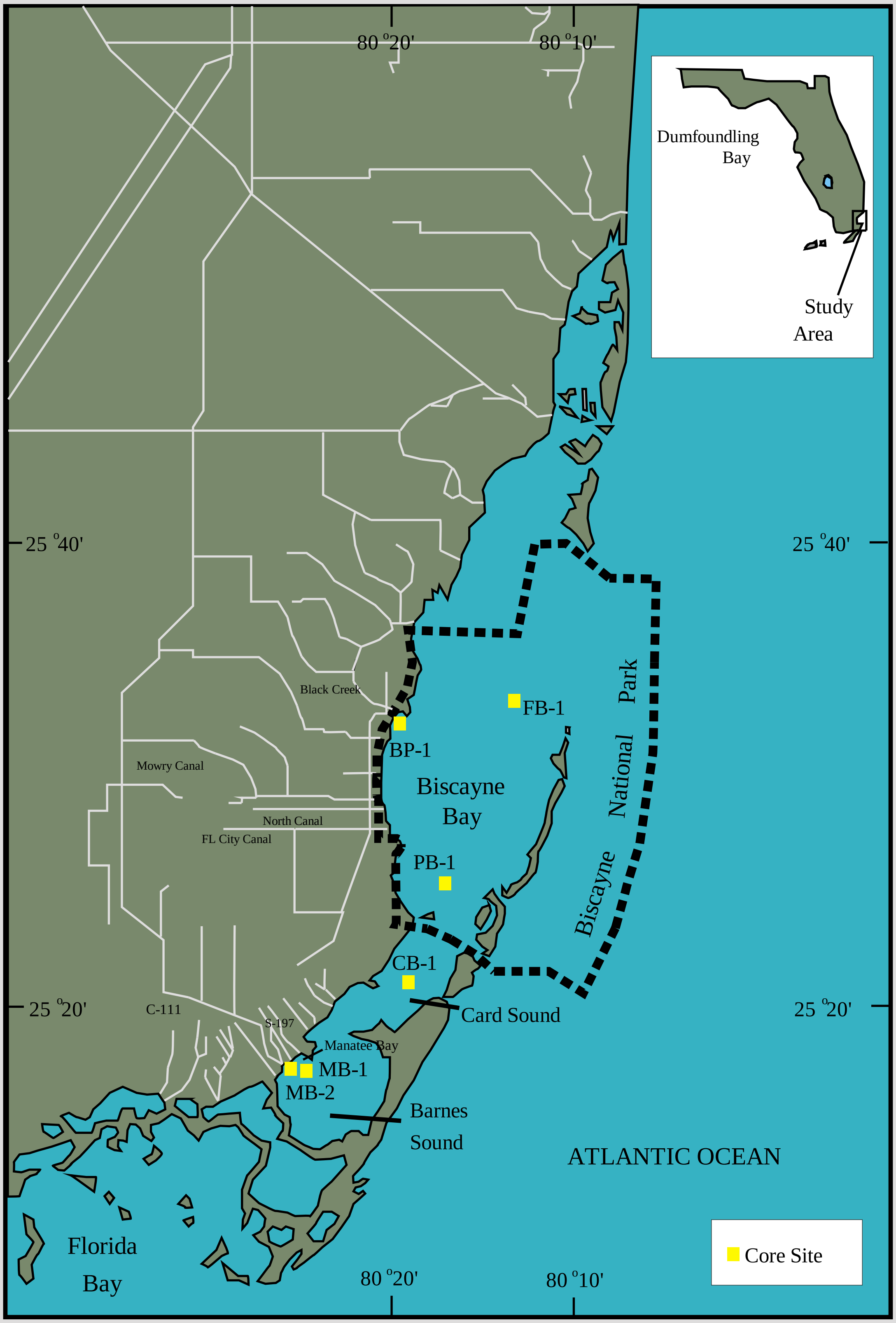
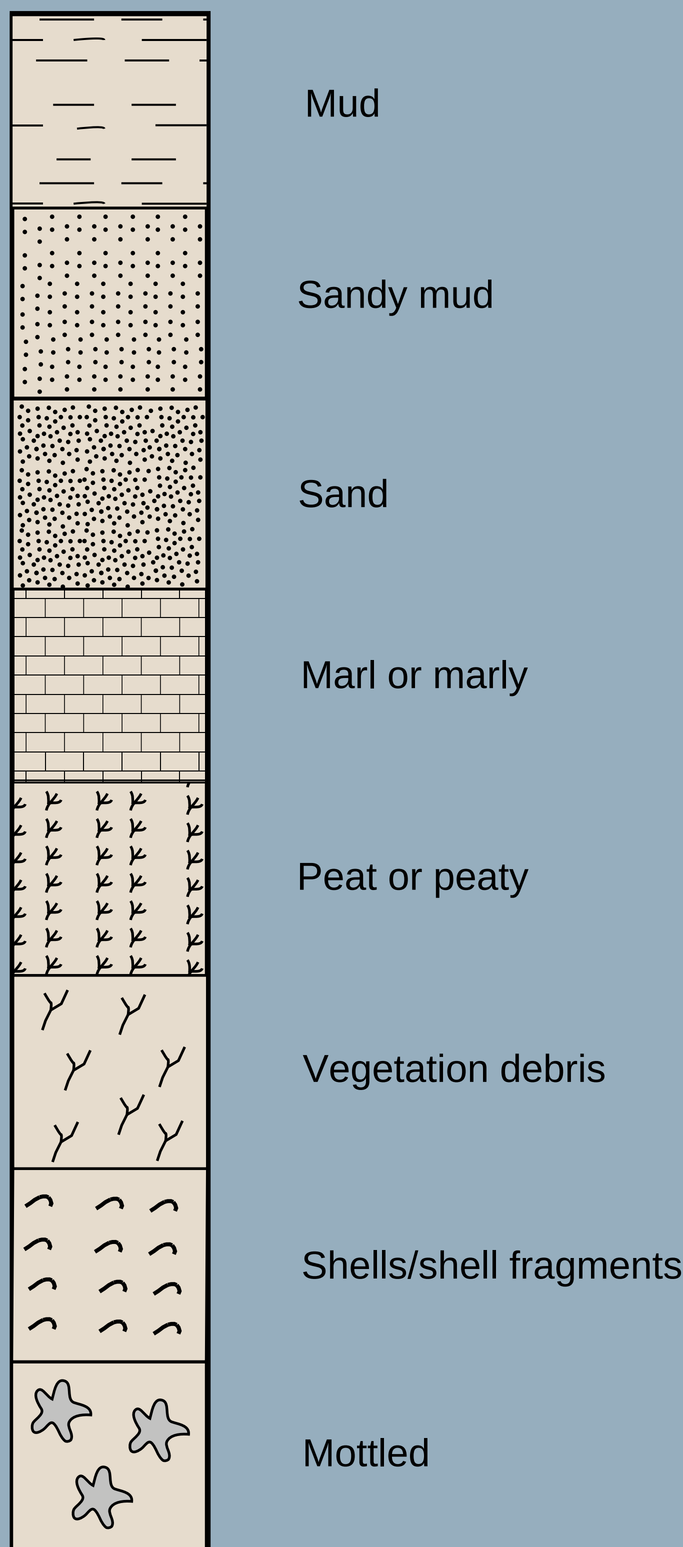


Figure 1: Map showing the Biscayne Bay region of southern Florida with core sites labeled with solid squares. MB=Manatee Bay; CB=Card Bank; PB=Pelican Bank; BP=Black Point; FB=Featherbed Banks.

Table 2: Legend showing the symbols used in the core descriptions in figures 2 through 7.

Core Legend



Core MB-1

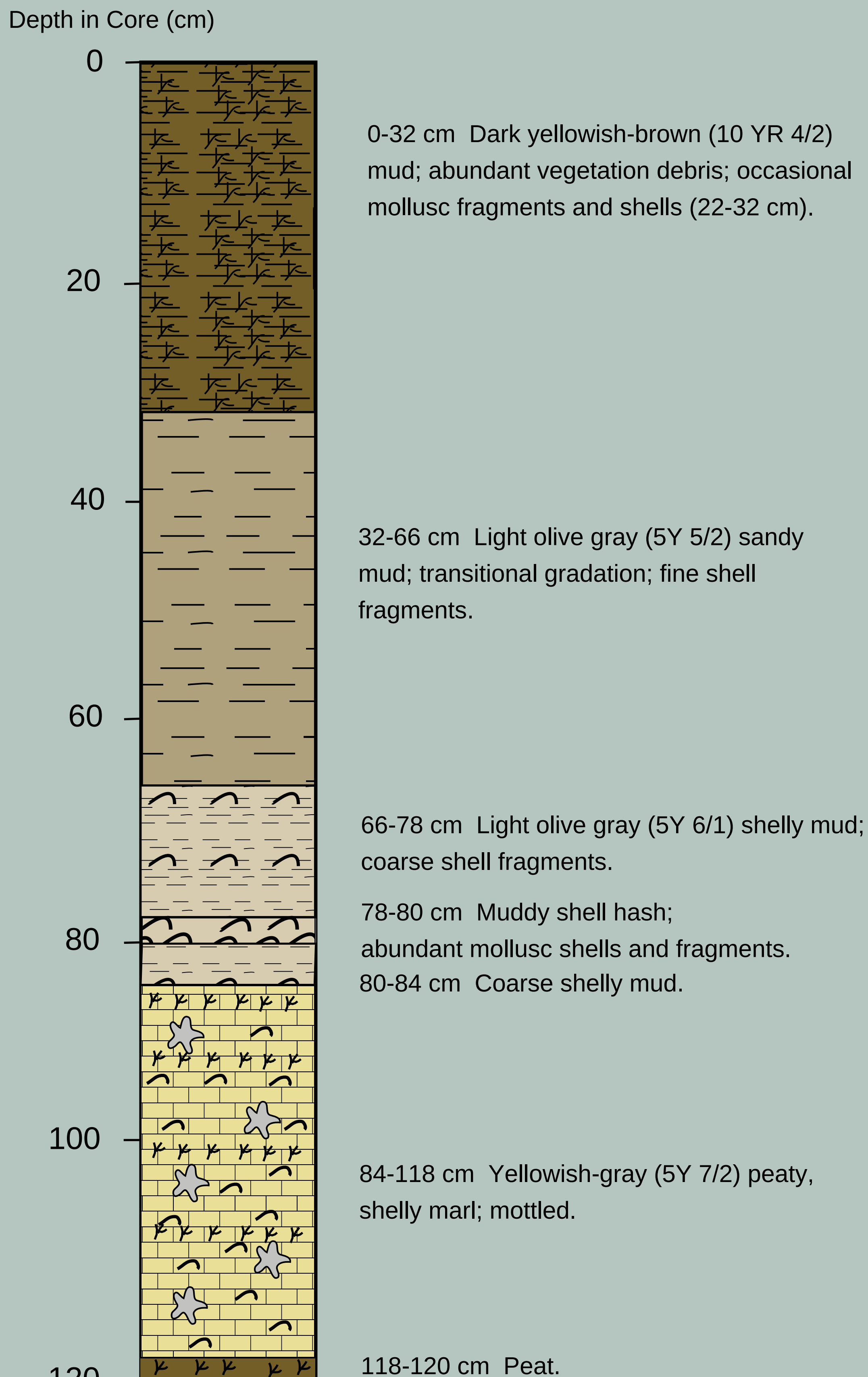


Figure 2: Description of core SEI1197-MB-1 (for symbol descriptions refer to Table 2).

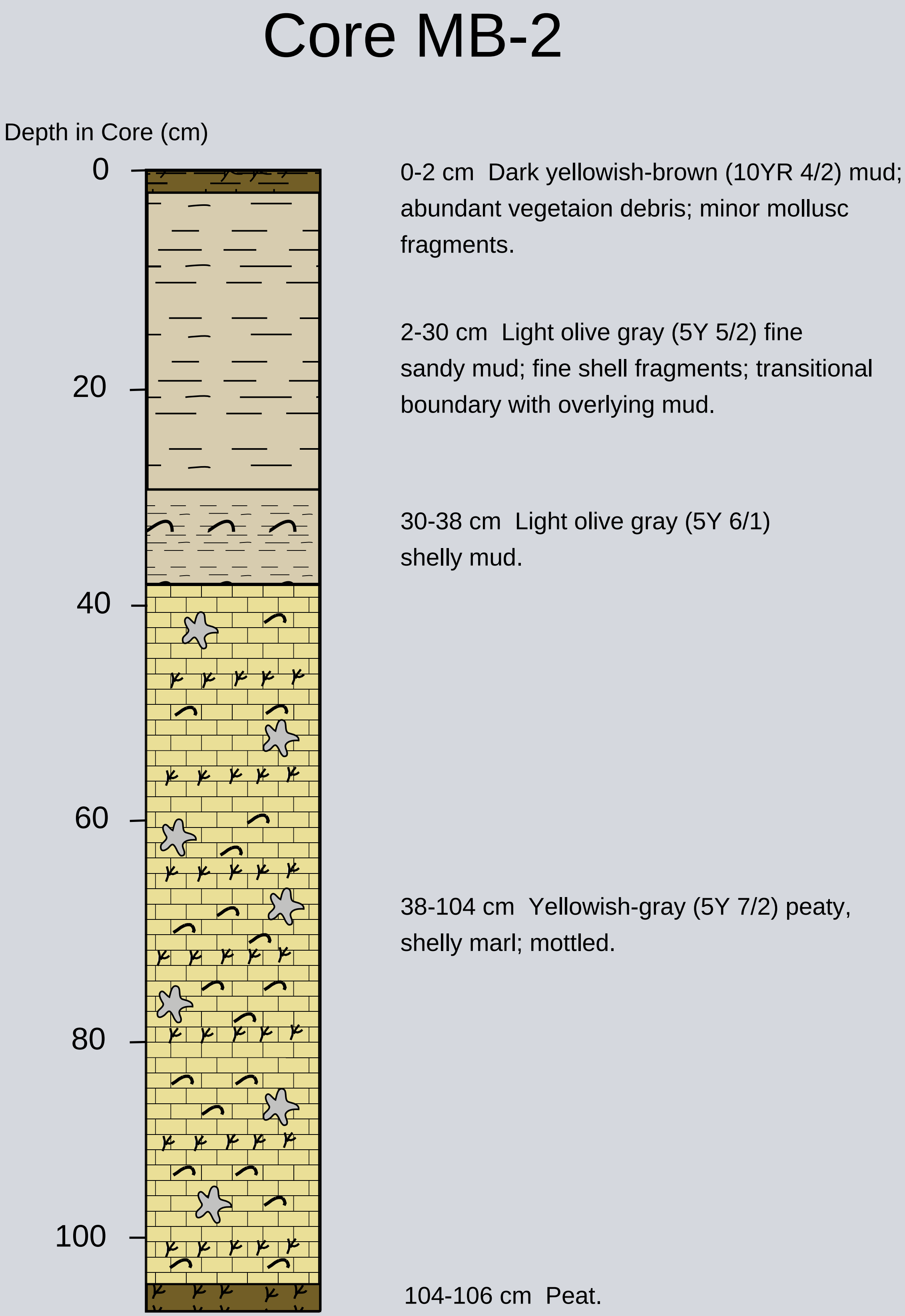


Figure 3: Description of core SEI1197-MB-2 (for symbol descriptions refer to Table 2).

Department of Environmental Resources Management, Bay-Run data, unpublished). Reduced natural flushing results in higher salinities and increased run-off from canal input results in periodic low salinities. Manatee Bay is greatly affected by channelized flow through S-197 canal, which was constructed as part of the C-111 canal system to remedy saltwater intrusion into C-111 and to permit the removal of the earthen plug from C-111 to allow discharge into Barnes Sound through Manatee Bay.

Two sediment cores (SEI1196-MB-1 and SEI1196-MB-2) were collected from Manatee Bay (figures 2 and 3; table 1) to determine the impact of the S-197 discharge on the ecosystem within the bay. Core MB-1 was collected from the interior portion of the Bay, adjacent to the opening between Short and Main Keys. The core was 120 cm in length and bottomed out in limestone bedrock. Seven distinct sedimentologic layers were identified in the core (see figure 2). Core MB-2 was collected in the western part of the Bay, adjacent to the S-197 canal. This core was 106 cm in length and contained 5 distinct sedimentologic units (see figure 3). The MB-1 and MB-2 cores are very similar sedimentologically and should yield records of environmental change within Manatee Bay related to the out-flow from S-197 on both temporal and spatial scales.

Card Sound

Card Sound is located within the Florida Keys National Marine Sanctuary and considered part of the Biscayne Bay Aquatic Preserve and Biscayne National Park in the Upper Florida Keys. Similar to Manatee Bay, Card Sound has not been heavily influenced by development. The greatest impact on the ecosystem of Card Sound is related to freshwater input and recreational use. Freshwater input to Card Sound is primarily surficial sheet flow with additional input coming from groundwater upwelling. How these systems have changed, particularly groundwater outflow, with the introduction of the water management structures remains uncertain. Like Manatee Bay and Barnes Sound, circulation within Card Sound is restricted, which increases residence times of its waters (2.3 months; Lee, 1975). Further restriction would significantly change the physico-chemical characteristics (salinity, dissolved oxygen and redox potential to name a few) of the resident waters.

One core, SEI297-CB-1, was collected from the central region of Card Sound, Card Bank (figure 1; table 1) to recover a record of changing environmental conditions within Card Sound. Core CB-1 was 146 cm long, it bottomed out at limestone bedrock and is composed of three primary sedimentologic units (figure 4).

Pelican Bank

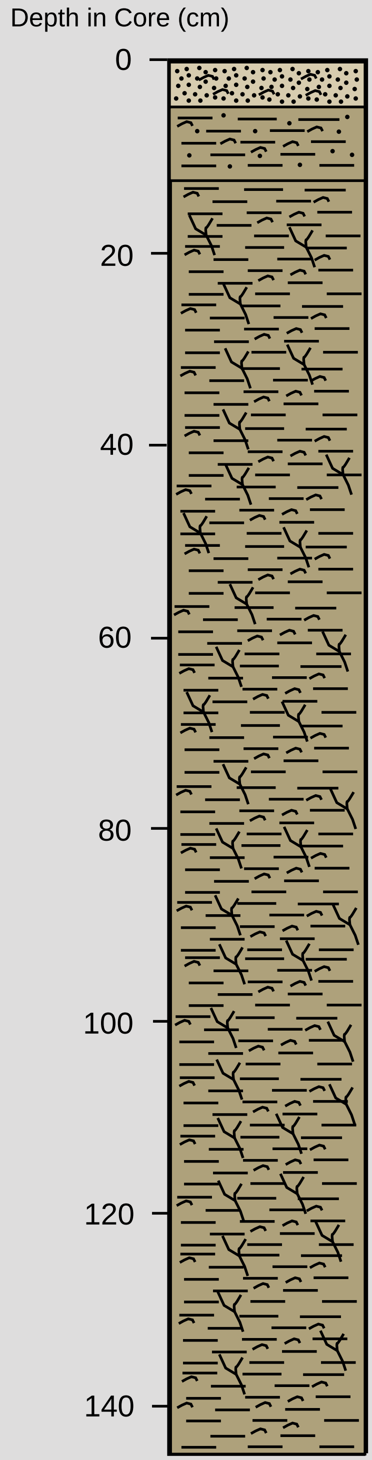
Pelican Bank is a sandy shoal (less than 1 meter water depth) located in the southern portion of Biscayne National Park adjacent Turkey Point (figure 1, PB-1). This region of Biscayne Bay is well circulated resulting in regular flushing with average salinities ranging from 33 to 35 ppt. Turkey Point represents the current southern limit of urban growth, where several canals (Mowry, North and Florida City canals) discharge in excess of up to 20,900 acre-ft./mo. (Mowry Canal average monthly flow for August; South Florida Water Management District, 1994) of water into southern Biscayne Bay. In addition, Turkey Point is the powerplant locality from which effluent flows into Biscayne Bay. Although saltwater wetlands continue to fringe the coastline, a significant portion of the freshwater wetlands has been reduced in this region and further north. The marine habitats in this region include seagrass and hardbottom communities. Pelican Bank contains seagrass cover with patches of bare hardbottom.

Core SEI297-PB-1 was collected from a grassy locality on the edge of Pelican Bank (figure 1; table 1) to recover a record of the impact of southern urban expansion on southern Biscayne Bay. The core recovered 85 cm of sediments composed of four sedimentologic units that range from shelly coarse sand to shelly mud (figure 5).

Black Point

Black Point is located on the western fringe of Biscayne National Park at the mouth of Black Creek (C-1 canal), the major tributary to south Biscayne Bay (figure 1, BP-1). It is in a region affected by

Core CB-1



0-4 cm Light olive gray (5Y 6/1) shelly coarse sand.

4-12 cm Light olive gray (5Y 5/2) shelly sandy mud; visible mollusc fragments.

12-146 cm Light olive gray (5Y 5/2) mud with visible mollusc fragments and vegetation debris. 96-98 cm contains a large articulated bivalve.

Figure 4: Description of core SEI297-CB-1 (for symbol descriptions refer to Table 2).

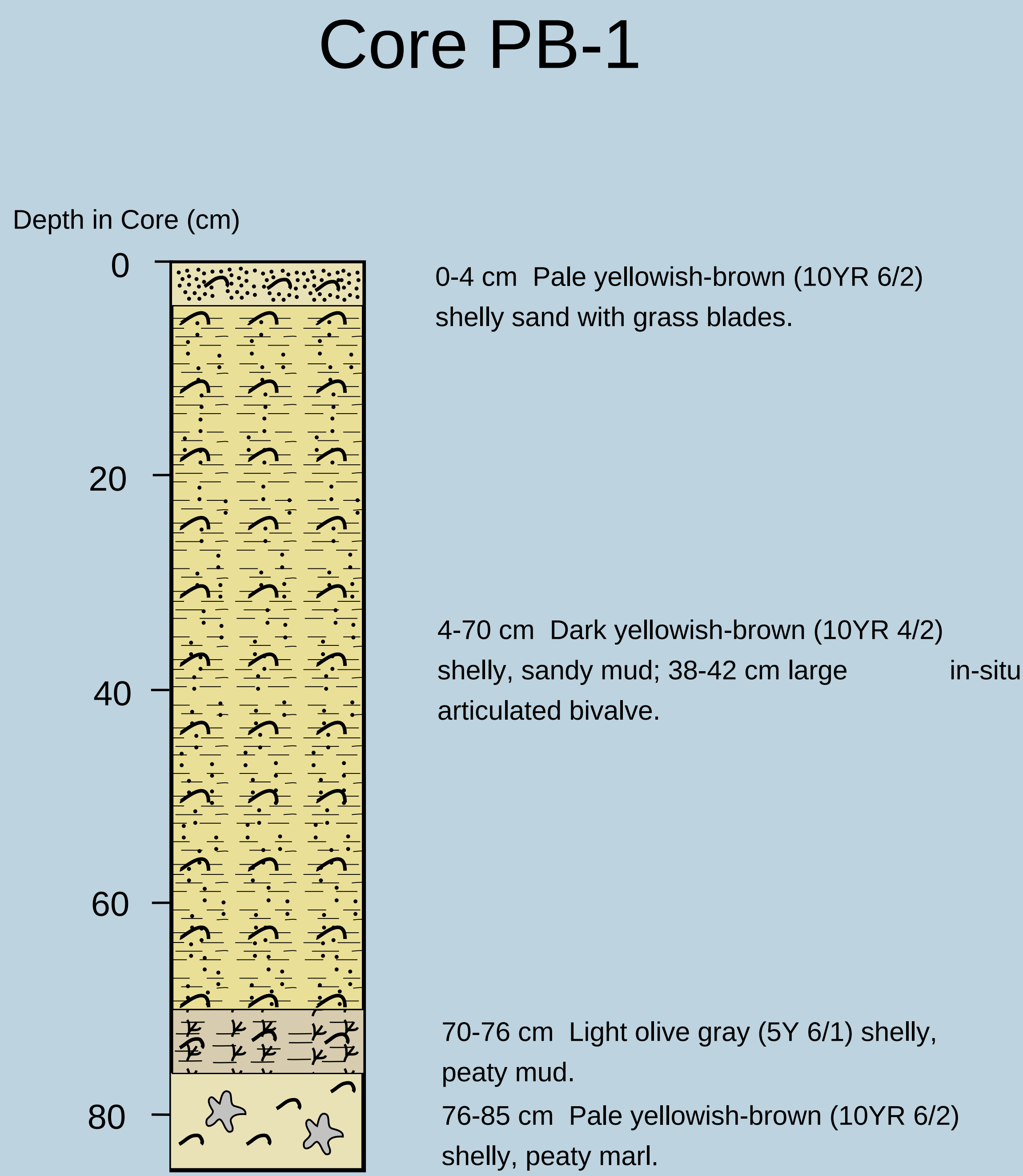


Figure 5: Description of core SEI297-PB-1 (for symbol descriptions refer to Table 2).

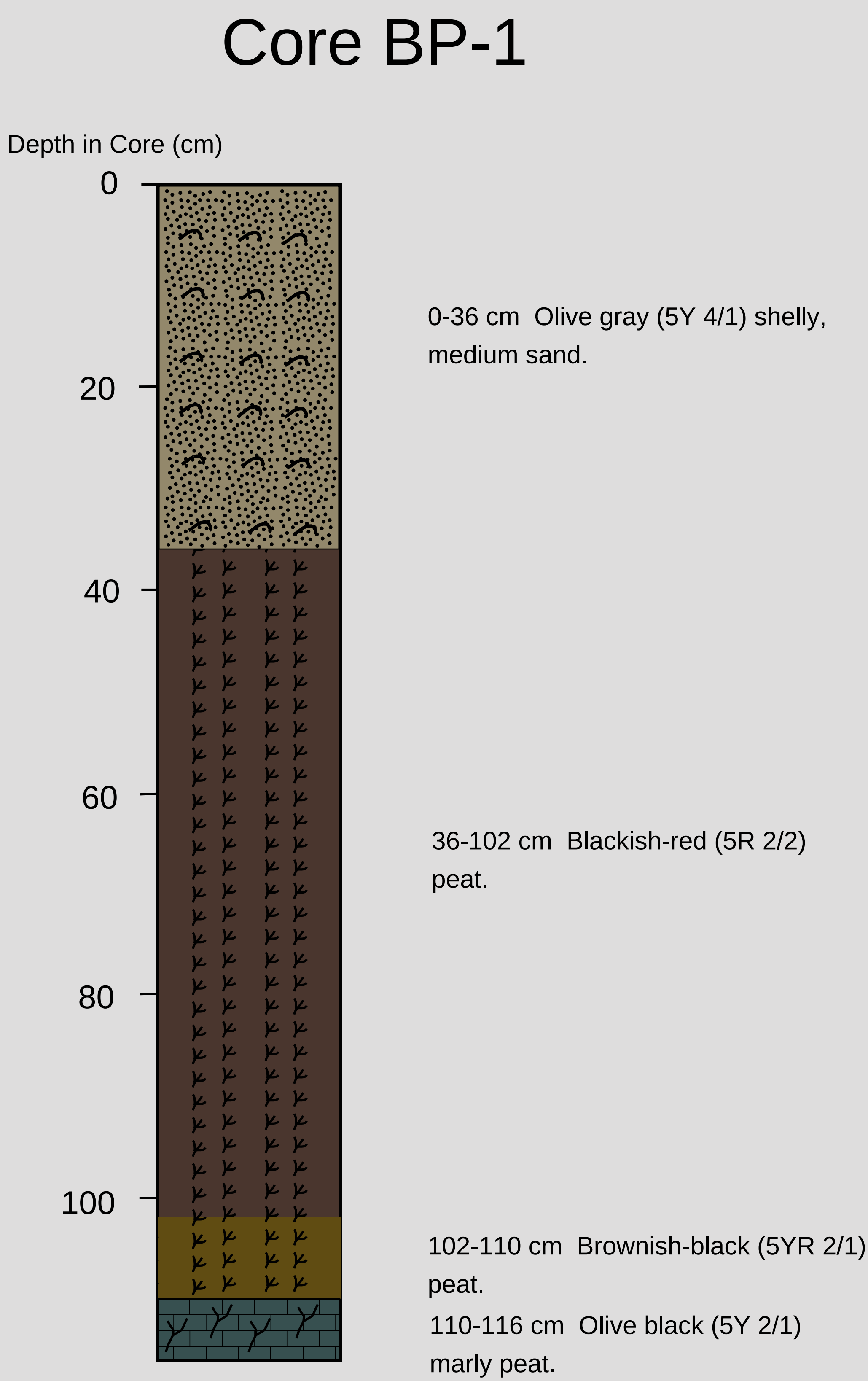


Figure 6: Description of core SEI297-BP-1 (for symbol descriptions refer to Table 2).

Figure 7: Description of core SEI297-FB-1 (for symbol descriptions refer to Table 2).

relatively high tidal pumping that results in frequent flushing that helps maintain the health of the ecosystem. However, Black Point is affected by its close proximity to the South Dade Landfill where ammonia rich leachate enters Black Creek and spills into Biscayne Bay. One core (SEI297-BP-1) was collected to the south of Black Point, between the point and the breakwater to its south (figure 1; table 1). Core BP-1 was collected to determine the impact of the adjacent landfill on its adjacent marine ecosystem. The core bottomed out in limestone bedrock, was 116 cm in length and consisted of four major sedimentologic units (figure 6), a shelly sand, two distinct peat units, and a marly peat.

Featherbed Banks

Featherbed Banks represents thick accumulations (greater than 4 meters) of Holocene (greater than 5000 yrs. BP; Wanless and others, 1995) sediments south of Safety Valve and approximately midway between Sands Key and Black Point, within Biscayne Bay (figure 1, FB-1; table 1). These sand bodies represent "stringer shoals" formed by transport of skeletal carbonate sand, quartz-carbonate aggregates, and quartz sand through natural channel passes through the Key Largo limestone ridge (Wanless, 1976).

Core SEI297-FB-1, collected from North Featherbed Bank, was 225 cm in length and did not bottom out in the limestone bedrock. The core is composed of homogeneous fine sandy mud (figure 7) with shell and plant fragments throughout.

Discussion

The cores collected from Biscayne Bay show a variety of sediments (with the exception of FB-1) that reflect their sedimentologic history. The observations made appear to be consistent with the Holocene sedimentologic history described in Wanless, 1976. The Manatee Bay cores show a history of mangrove peat deposition followed by a progressive increase in marine mud and sands. Card Sound and Pelican Bank show evidence of peat and high vegetation accumulation in their early history followed by an increase in marine and or carbonate clastic deposition. Core BP-1 shows a complex history possibly reflecting an early fresh water environment followed by the transition to a mangrove swamp and capped by deposition of clastic marine sediments. Finally, core FB-1 represents a region of high sediment accumulation, therefore the record contained within the core may represent a much shorter time period than the other cores from Biscayne Bay. However, this also would provide an opportunity to collect a much more detailed record.

Future Work

The interpretations provided above are very preliminary and require more corroborative evidence. The future direction of research on these cores and its success relies on a multidisciplinary approach that includes microfaunal (foraminifera, ostracodes and micro-molluscs), diatom, and palynological analyses to determine salinity, substrate and nutrient histories for Biscayne Bay; radiogenic isotope dating using ^{210}Pb and ^{14}C methods; and shell geochemistry analyses on foraminifers, ostracodes, and molluscs to determine stable isotopic and trace element ratios to quantify paleosalinities for Biscayne Bay. Finally, pore water and sediment geochemistry will be conducted on the cores to determine salinity, nutrients, fire, and pollutant histories within the Bay. The results of these analyses will provide us with the information necessary to make informed decisions on restoration targets, practices and their potential affects on the present ecosystem.

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