Appendix B

Cell-Wide Monitoring & Mitigation Plans

Table of Contents

APPENDIX B-1

Hardbottom Monitoring Plan

1.0 Introduction

Implementation of the BMA (Agreement No. 0328802-001-BMA) will include a comprehensive, cell-wide approach to monitor the effects of beach projects on the environment, which includes and exceeds the standard regulatory requirements for hardbottom monitoring of beach projects. The BMA will offer a unique opportunity to acquire long-term data sets within the coastal cell, expanding the limits of project-by-project monitoring requirements. This opportunity will enable the Department to progress its science-based knowledge of hardbottom communities that exist within the dynamic coastal system. Understanding how these communities naturally respond to the surrounding coastal processes without project influence (i.e., in areas without projects, or areas prior to a project occurring) will further the Department's ability to estimate project induced impacts and to offset them through mitigation.

1.1 Cell-Wide Hardbottom Classifications System and Definitions

1.1.1 Hardbottom Classification System

Between 171 to 266 acres of hardbottom, comprised of exposed limestone bedrock, exists within the boundaries of this BMA[1]. This hardbottom provides substrate for attached and motile benthic species, such as algae, sponges, corals, and sea urchins, and benthic communities formed by these species provide shelter and food sources for fish, marine turtles, and countless other marine organisms. The composition of each hardbottom community varies based on several key factors, such as hardbottom relief, water depth, distance from shore, and persistence of hardbottom exposure.

A consistent, repeatable method for collecting, interpreting, and evaluating hardbottom data will be established for the cell-wide monitoring program. As part of this effort, a hardbottom classification system based on factors that drive community composition has been developed to identify specific hardbottom habitats so they can be tracked over time and changes in them can be objectively documented. The following two parameters, which can be grouped into six combinations, will be used to identify hardbottom habitat types: 1) proximity to shore - expressed by distance from the shoreline and water depth; and, 2) duration of hardbottom exposure – largely

[1] Based on analysis of aerial photographs from 2000 through 2012. See Section 1.2.3.1 and Appendix B-5 for details.

influenced by relief. The six combinations are as follows: Nearshore-High Exposure (less than 3 m depth and greater than 60% exposure), Nearshore-Medium Exposure (less than 3 m depth and between 40% and 60% exposure), Nearshore-Low Exposure (less than 3 m depth and less than 40% exposure), Offshore-High Exposure (greater than 3 m depth (3-8 m) and greater than 60% exposure), Offshore-Medium Exposure (greater than 3 m depth and between 40% and 60% exposure), and Offshore-Low Exposure (greater than 3 m depth and less than 40% exposure). Subcategories for distances (nearshore, offshore) and degrees of exposure (low, medium, high) are based on historical analyses of historical aerial photographs and in-situ data described in **Section 1.2.3.1**. Hardbottom within the BMA cell will initially be characterized and identified using the above classification system during the cell-wide Habitat Mapping effort (see **Section 1.2.3.2**) conducted the first summer the BMA agreement goes into effect.

1.1.2 Definitions for Classification Parameters and Types of Impacts

The following sections provide definitions for each of the hardbottom classification factors as well as the types of impacts that can occur in hardbottom habitats as a result of beach management activities. Many impacts to hardbottom can be predicted before a project occurs, though a full understanding typically requires post-construction measurement of project related changes via the hardbottom monitoring program. Any impact can be temporary or permanent in nature. Regulatory required hardbottom monitoring is included in the BMA cell-wide plan, in order to provide reasonable assurance of predicted impacts.

1.1.2.1 Distance from Shore/Water Depth

Nearshore Hardbottom: Nearshore hardbottom is typically exposed as a 200-400-meter-wide strip from the shoreline offshore to a depth of -4 meters. This area can be divided into 3 zones: 1) Supralittoral (slightly above tidal line); 2) Littoral (intertidal area between high spring tide and low spring tide marks; and, 3) Upper Sublittoral (from the low spring tide mark to the depths of -4 meters). For the purposes of the BMA, nearshore hardbottom shall be defined as hardbottom habitat occurring between the mean high-water line (MHW) and a depth of -3 meters[2]. This area is influenced by waves, the longshore and cross-shore currents and suspended sediments. Typical communities are adapted to stresses associated with the pounding surf, scour from mobilized sand and naturally elevated turbidity levels. Low relief hardbottom in this area is generally ephemeral and benthic communities exhibit rapid recolonization by new growth.

Offshore Hardbottom: For the purposes of the BMA, offshore hardbottom shall be defined as exposed hardbottom existing between the depth of -3 meters and the depth of closure

[2] Definition based on analysis of historical aerial photographs (Section 1.2.3.1) and data collected during the initial in situ habitat mapping effort (Section 1.2.3.2).

(approximately -8 meters). The hardbottom in this area is typically more persistent, with a more diverse and stable benthic community, depending on the relief. Benthic communities can often be older and contain larger sized sessile species and fish. Note that some hardbottom areas are located in water depths greater than -8 meters (-8 meters to -12 meters). These "far offshore" hardbottom areas fall outside the classification scheme and are monitored using a separate, station-based protocol. beyond the depth of closure (-12 meters).

1.1.2.2 Persistence of Hardbottom Exposure

High Exposure Hardbottom: These habitats are exposed 60% or more of the time[3] and are typically formed of high (> 1m) (0.3 to 1.0 m) relief hardbottom. They typically contain stable biological features such as older age classes of benthic species (e.g. corals, algae and sponges) as well as benthic communities in sub-climax/climax status. Burial can occur within persistent habitats, but the time of exposure is sufficient to allow for occupancy by benthic and demersal organisms and associated production functions.

Due to the more stable environmental conditions of persistent hardbottom, most macroalgae in these habitats are perennial species, and in some cases, may live up to 20 years. Larger sponges, scleractinian corals, and octocorals may also be present. Some fish species reside for an entire life cycle. Transient larval and juvenile stages of many species occur year-round with peaks corresponding to species-specific seasons of larval recruitment.

Medium Exposure Hardbottom: These habitats are exposed between 40% and 60% of the time[2] and are typically formed of intermediate (0.3 m to 1.0 m) relief hardbottom. Burial occurs with varying degrees of frequency leading to intermediate levels of disturbance. As such, medium exposure habitats can contain stable biological features, but often display more varied size and age groups of benthic species (e.g. corals, algae and sponges) and sub-climax communities.

Low Exposure Hardbottom: These habitats are exposed less than 60% of the time[2] and are typically formed of intermediate (0.3 to 1.0 m) to low (< 0.3 m) relief hardbottom. Burial and exposure of these habitats occur with a frequency that promotes new growth, inhibits colonization and growth of the benthic invertebrate community, and, along with scouring effect of sediment transport by wave generated currents, reduces macroalgal cover and herbivore abundance. Benthic community structure is driven by dynamic physical conditions associated with wave activity and sediment scour. Epibiota may persist

[3] Based on analysis of aerial photographs from 2000 through 2012. See Section 1.2.3.1 and Appendix B-5 for details.

temporarily under the sand or through the sand. Algal species that persist in this habitat typically are forms with high reproduction rates due to continuous spore release events and are very resilient to environmental disturbances (FDEP NHB Study; Eriksson and Johansson, 2005;).

Communities typically present in ephemeral hardbottom habitats include fast-growing macroalgae (e.g. C*haetomorpha* spp. and *Ceramium* spp.), filamentous turf, *Padina*, *Gracilaria*, opportunistic green and brown sheet form algae (e.g. *Ulva*, *Dictyota*), and other early succession species with a short life cycle. The annual algal biomass production in these species is highly variable since they allocate much of their resources for speedy reproduction typical for r-strategic species. The diversity of algal species is an indicator of the duration of exposure; low diversity is characteristic for ephemeral communities. Benthic forms typical for persistent communities can be present in the ephemeral communities, but normally only as recruits and juvenile forms.

1.1.2.3 Direct impacts

Impacts to hardbottom occurring from burial by sediments from beach nourishment and restoration projects, recorded as a seaward shift of hardbottom edge.

1.1.2.4 Secondary impacts

Secondary impacts (often used interchangeably with "indirect") to hardbottom occur outside of the direct impacts (ETOF measured in situ), from an increased sediment load in the system, which causes increased turbidity and sediment movement over hardbottom, as well as accumulation of sediments as interrupted thin layers and patches of deeper sand accumulation over hardbottom. It is expressed through degradation of the previously existing hardbottom community, or noticeable changes in community structure—such as a macroalgae community replaced with a turf algae community.

1.1.2.5 Anticipated impacts

Anticipated impacts are those impacts which are expected to occur during or after construction of a project. Anticipated impacts can include direct impacts (i.e. direct cover of HB through fill, usually within predicted ETOF) and indirect impacts (i.e. expected secondary impacts to communities through increased sediment loading in the area).

1.1.2.6 Unanticipated Impacts

Unanticipated impacts are those resource impacts occurring from a project that are not expected or predicted or accounted for in the approved project. The extent and nature (direct impact versus secondary impacts) as well as duration of these impacts are recorded through the biological monitoring program. Any unanticipated impacts are handled through compliance and enforcement.

1.2 Hardbottom Monitoring Plan

Project-specific hardbottom monitoring protocols typically issued for Joint Coastal Permit (JCP) authorized beach nourishment projects face several challenges, in that the systems in which they occur are open and not contained, and metrics measured may lack the sensitivity and the monitoring effort may lack the longevity necessary to discriminate beach fill sand movement over the hardbottom from the transport of pre-project sediments in the system. Therefore, the BMA cell-wide monitoring plan, as currently designed, will address two goals:

1) provide reasonable assurance under State regulatory requirements (Chapter 161 and part IV of 373, F.S.) that approved projects will have no unanticipated/unpermitted impacts to nearshore hardbottom and their associated benthic communities; and

2) evaluate the variability of sand cover over ephemeral and persistent hardbottom and the resulting functional shifts in habitat within this coastal cell.

None of the currently approved projects in the BMA are anticipated to directly or indirectly (secondarily) impact resources such that compensatory mitigation would be required. If permitted through the traditional JCP permitting process, only the Mid-Town Nourishment Project (Approval No. 0328802-002-BMA) and the Palm Beach Harbor Maintenance Dredging and Bypassing Project[4] (Permit No. 0216012-025-JC) would require project monitoring as regulatory assurance for impact prediction (of no impact) to adjacent hardbottom. Therefore, the typical monitoring transects for these projects (including updrift and downdrift transects) will remain in the cell and, in addition to the two transects in Reach 2 (Maintenance Dredging and Bypassing Project beach placement area), are the only transects that will be used for impact analysis (Goal #1). In order to satisfy the second goal, cell-wide sediment dynamics and changes in habitat function will be monitored on all cell transects. These results will be used to better understand nearshore sediment dynamics and their influence on the persistence of hardbottom habitats which will result in a better understanding and management of these important resources.

[4] Note that the Palm Beach Harbor Maintenance Dredging and Bypassing Project was permitted through the traditional JCP permitting process (see Permit No. 0216012-025-JC).

1.2.1 Overview

The cell-wide hardbottom monitoring plan has been designed using the methodology of the project-specific hardbottom protocol typically required in Joint Coastal Permits, but in an expanded format covering the entire BMA cell. Transects required for regulatory purposes (Mid-Town and Palm Beach Harbor Maintenance Dredging and Bypassing Project) are included in the cell-wide plan but are differentiated from other transects for the purpose of project related impact assessment. The cell-wide hardbottom monitoring plan requires the BMA Participant to conduct Habitat Mapping to initially characterize hardbottom habitat within the BMA (**Section 1.2.3**), followed by transect establishment and annual monitoring of hardbottom for the life of the BMA (**Sections 1.2.4** and **1.2.5**). To achieve Goal #1, the Department will conduct project specific impact analyses for the regulated Mid-Town (within 5 years following each nourishment) and Palm Beach Harbor (within 3 years following each placement) projects. Additionally, to fulfill Goal #2, every 5 years for the life of the BMA, the Department will assess cell-wide dynamics, using the data from all transects and monitoring efforts within the cell. Thus, while cell-wide monitoring data will predominantly be used to document sediment dynamics to be better understand naturally occurring patterns and phenomena, cell-wide monitoring data may also be used to aid assessment of potential impacts following and attributable to the Mid-Town and Palm Beach Harbor projects.

1.2.2 Monitoring Staff and Positioning System Requirements

In order to adequately collect the required data in a consistent and reliable format, the following three requirements, pertaining to the monitoring staff and positioning systems, shall be met.

1.2.2.1 Monitoring Staff Requirements

The names and qualifications of biologists selected by the BMA Participants to perform the monitoring shall be submitted to the FDEP for review and approval. The biological monitoring survey shall be conducted by scientists having previous experience with monitoring of nearshore hardbottom communities and scientific knowledge of marine benthic ecosystems, local flora and fauna, including algae, octocorals, scleractinian corals, sponges, echinoderms, etc. The BMA Participants or their Agent shall provide resumes for those individuals who comprise the monitoring crew, to the JCP Compliance Officer. Written agency approval of personnel shall be required prior to proceeding with the annual monitoring. Any new crew member or subcontractor's resumes shall be provided for agency approval in advance before the field season commences.

All in-water crew members shall participate in cross training with one another to verify correct species identification practices, and survey consistency using standard Quality `Assurance /

Quality Control (QA/QC) procedures at the beginning and completion of the annual survey. This ensures surveys conducted by separate individuals are consistent. Results of the QA/QC procedure shall reflect consistency of at least 90% and shall be reported to DEP (i.e., data on the QA/QC procedure shall be submitted along with the raw monitoring data following the completion of each monitoring event). Annual cell-wide hardbottom monitoring shall be conducted by the BMA Participant's Agent within a 60-day timeframe (if weather conditions allow for workable conditions), as near to the date of the initial aerial photo as possible (see **Section 1.2.5.1**). All monitoring surveys shall be conducted using SCUBA gear and according to the dive safety program of the contracted firm. Vessel and diver positioning, acquisition of survey coordinates, and all mapping shall employ adequately accurate tools and software (see below).

1.2.2.2 Vessel Positioning System Requirements

The Global Positioning System (GPS) onboard the vessel shall have the capability of sub-meter positional accuracy using Differential GPS (DGPS) / Real-Time Kinematic (RTK). GPS receivers will have 12 or more channels and the GPS system will communicate with the navigation software in real-time.

Navigational control shall be maintained on an IBM compatible PC (or equivalent) running a Hydrographic Data Collection and Processing (HYPACK) program or equivalent software that provides the same state-of-the-art navigation and hydrographic surveying and post processing capabilities. Information provided from the GPS system must allow the navigation/hydrographic software to display vessel location in reference to pre-planned lines, targets or GIS loaded information in real time. All survey data recorded on the computer's hard drive shall be transferred daily to an approved external memory device, providing a raw survey data back-up.

1.2.2.3 Diver Positioning System

When the exact position of a swimming diver needs to be recorded, such as during hardbottom edge mapping (see **Section 1.2.5.2**), the following positioning systems requirements shall be met[5]. The buoy towed by the diver shall have a DGPS antenna mounted on it which is attached by a cable to a positioning system or transmits signals wirelessly to a receiver radio on the survey vessel. The buoy shall be maintained on the shortest possible tether so that it sits directly over the diver. The positioning system used shall be interface to a Data Collection and Processing Program with correction from a U.S. Coast Guard Navigational Beacon. The locator shall automatically acquire and simultaneously track GPS satellites and precisely measure code phase and Doppler phase shifts and then compute time, latitude, longitude, height, and velocity each second. The

[5] Any technological advancement in this area would be accepted as long as it can provide more accurate positioning.

positioning data shall be tracked using the Data Collection and Processing program. All data obtained shall be recorded on the computer and copied to external storage at the end of each day.

1.2.3 Historical Aerial Review and Initial Habitat Mapping

In order to assess both goals of the cell-wide monitoring plan, a hardbottom habitat map of the entire BMA cell must be developed to track both project impacts and cell-wide changes. The map of potential hardbottom distribution developed during the review of historical aerial photographs (**Section 1.2.3.1**) will, along with existing in situ data within the cell, be used to plan for the initial (pre-construction) Habitat Mapping effort (**Section 1.2.3.2**).

1.2.3.1 Historical Aerial Review

Prior to the development of this cell-wide hardbottom monitoring plan, the existing and historical distribution of hardbottom was analyzed using available data provided by the BMA Participants, including aerial photography and post-construction physical and biological monitoring data. Twelve years (2000-2012) of historical aerials were studied by the Town of Palm Beach's Agent, using desktop analysis, in order to determine trends in hardbottom habitat exposure over time. A map of potential hardbottom habitat distribution was developed using Geographic Information System (GIS) for the BMA according to the spatial locations (nearshore, offshore[6]) of the historical hardbottom aerial exposure in the cell. Estimates for the historical ranges of these types of hardbottom are provided by year and reach in graphical form, in **Appendix B-5** (historical hardbottom data and analysis). The map of potential hardbottom distribution, as well as the existing *in situ* data within the cell shall be used to plan for the Habitat Mapping effort, which shall be conducted *in situ* by the Town of Palm Beach's agent the summer after the execution of the BMA.

1.2.3.2 Habitat Mapping

To determine the type and distribution of hardbottom within the cell prior to any BMA authorized projects occurring, BMA Participants shall prepare an initial habitat map of hardbottom the summer immediately following the execution of the BMA. The desktop-created map of historical hardbottom distribution described above (**Section 1.2.3.1**) will be used to plan for the Habitat Mapping effort, which shall include *in situ* verification of hardbottom areas and borders within the

[6] Spatial locations were separated in GIS according to water depth, using survey profile data of the cell. Acreages were determined by clipping of Palm Beach County Aerials, according to the BMA reach and zone information provided by DEP. Accurate estimates of offshore data were not possible due to clipping of aerial photography data. See Section 1.7 for background information and revisions to aspects of the biological monitoring plan which include changes to zone information and acreages.

BMA cell in order to qualitatively and quantitatively characterize, classify, and map hardbottom communities according to the defined BMA classification scheme (see **Section 1.1.1**).

Following *in-situ* mapping/verification/characterization, a Habitat Map of Hardbottom shall be generated in ArcGIS to show the current distribution and location of the various types of hardbottom habitat throughout the BMA cell. The map shall be used to develop the monitoring grid, consisting of final transects and sampling stations (as described in **Section 1.2.4**), prior to the collection of the first year of hardbottom monitoring data.

1.2.4 Monitoring Grid Establishment

In order to assess both goals of the cell-wide monitoring plan, a hardbottom monitoring grid must be established. As described in the following subsections (see **1.2.4.1 – 1.2.4.4**), strategically plotted permanent transects and quadrats (to provide high repeatability in surveys) shall form the monitoring grid. Stations formed of belt transects in areas far offshore are also included in the grid. Monitoring conducted within the grid (see **Section 1.2.5**) will document physical and biological conditions during each monitoring event and enable changes in the hardbottom communities and habitats to be tracked over time.

1.2.4.1 Transect Establishment (General)

Different types of permanent transects will be employed in the monitoring grid, with type determined by where transects are located (within vs. outside project areas) and what data are collected along their length (sediment only vs. sediment and biological data). Transects located in areas where hardbottom seaward of the equilibrium toe of fill (ETOF) is potentially under the influence of the project shall be monitored using regulatory transects (**Section 1.2.4.3**); nonregulatory transects shall be employed in all other hardbottom areas within the BMA cell (**Section 1.2.4.2**). Transects along which information on the physical environment is the only data to be collected (e.g., the position and depth of sediment) are sediment only transects; in addition to information on the physical environment, data on benthic organisms and assemblages are collected along biological transects. Note that regulatory transects may either be sediment only or biological, but that all nonregulatory transects are biological transects (as are belts at the two far offshore monitoring stations [**Section 1.2.4.2**]).

With respect to installation, all transects shall extend seaward (east) from their point of origin, which shall either be the ETOF or the most nearshore (western most) hardbottom edge located outside (seaward) of the ETOF. Areas of particular BMA projects, or areas of higher potential of sediment transport shall include transects spaced at a higher density[7]. The positions of transects

[7] The number of monitoring transects for existing projects will not be reduced.

are permanent once established and permanent markers (pins, steel rods, etc.) shall be installed at set points along the length of all transects to ensure repeatability in transect placement during monitoring events. Note: projects included in the initial BMA have already included mitigation for impacts landward of the ETOF and are not anticipated to further impact hardbottom. Differences between cell-wide transects and stations (nonregulatory) and specific project area transects (regulatory) are described in the following subsections. The establishment of permanent sampling quadrats along all biological transects is also described below (**Section 1.2.4.4**).

1.2.4.2 Establishment of BMA Cell-Wide Transects and Stations (Nonregulatory)

For nonregulatory BMA monitoring transects positioned throughout the cell, preliminary locations were plotted based on aerial photograph analysis. These transects shall be used to primarily track sediment dynamics and their final locations shall be determined following Habitat Mapping and creation of the Habitat Map of Hardbottom. Given the variability of the hardbottom landscape, transects shall be positioned to ensure hardbottom habitat variability (as determined by the classification scheme) is adequately captured and that areas between transects can be evaluated by the interpolation of data between adjacent transects. **Table 1.2.1** lists all transects and **Figures 1.1 – 1.5** depict the locations of all monitoring transects. The length of these transects shall typically vary from approximately 150 m to 400 m, depending on the width of exposed hardbottom during installation. Note that portions of regulatory transects (**Section 1.2.4.3**) beyond 150 m shall be treated as nonregulatory transects. To ensure repeatability in transect placement during successive monitoring events, permanent markers (e.g., nails, eye- bolts, pins) will be installed during the baseline monitoring event to indicate the locations of multiple predetermined points along each transect. The permanent location of each transect (and marker points) shall be recorded (DGPS) and reported for the baseline monitoring event.

Offshore sampling stations may also be used for nonregulatory monitoring in areas farther offshore of the MidTown project area where hardbottom occurs in water depths of -8 to -12 meters. The monitoring grid for "offshore stations" shall consist of three, shore-parallel permanent transects.. A total of three permanent photo-image transects (22 m in length each) will be established at each offshore station; one of these transects shall also function as a belt transect (1 meter wide). The same transect (and transect side) shall be used as a belt in each survey. Transect ends shall be marked as described above, and the location of each and the belt shall be recorded and reported for the baseline monitoring event. Monitoring of the offshore stations is intended to follow the protocol employed by the Southeast Coral Reef Evaluation and Monitoring Project (SECREMP) (see **Section 1.2.5.4**) so data can be compared to monitoring data collected outside the BMA cell.

1.2.4.3 Establishment of Mid-Town and Palm Beach Harbor Transects (Regulatory)

Although not anticipated to have direct or secondary impacts, biological monitoring shall be conducted in association with specific projects in the BMA cell to provide the Department with reasonable assurance that such impacts would be documented and offset, should they occur. As such, regulatory transects shall be established in hardbottom areas updrift, adjacent to, and downdrift of the Mid-Town Nourishment Project (Approval No. 0328802-002-BMA) fill placement area. Regulatory transects shall also be established in hardbottom downdrift of the Reach 2 fill placement area for the Palm Beach Harbor Maintenance Dredging and Bypassing Project (Permit No. 0216012-025-JC). These regulatory transects, along with the associated edges of nearshore hardbottom in these areas, shall be monitored annually for the life of the BMA. **Table 1.2.1** lists all transects and **Figures 1.1 – 1.5** depict the locations of all monitoring transects. Unlike cell-wide transects, transects established for regulatory impact analysis shall extend no more than 150 meters offshore. Portions of these transects extending beyond 150 m will be treated as nonregulatory transects and monitored as part of the cell-wide effort (see **Section 1.2.4.2**). Due to previous project data, the locations of Mid-Town regulatory transects were known prior to the Habitat Mapping effort and the positions of transects will not change.

Table 1.2.1. Transect information including name, type, project area (nearest R-monument), length, and date installed.

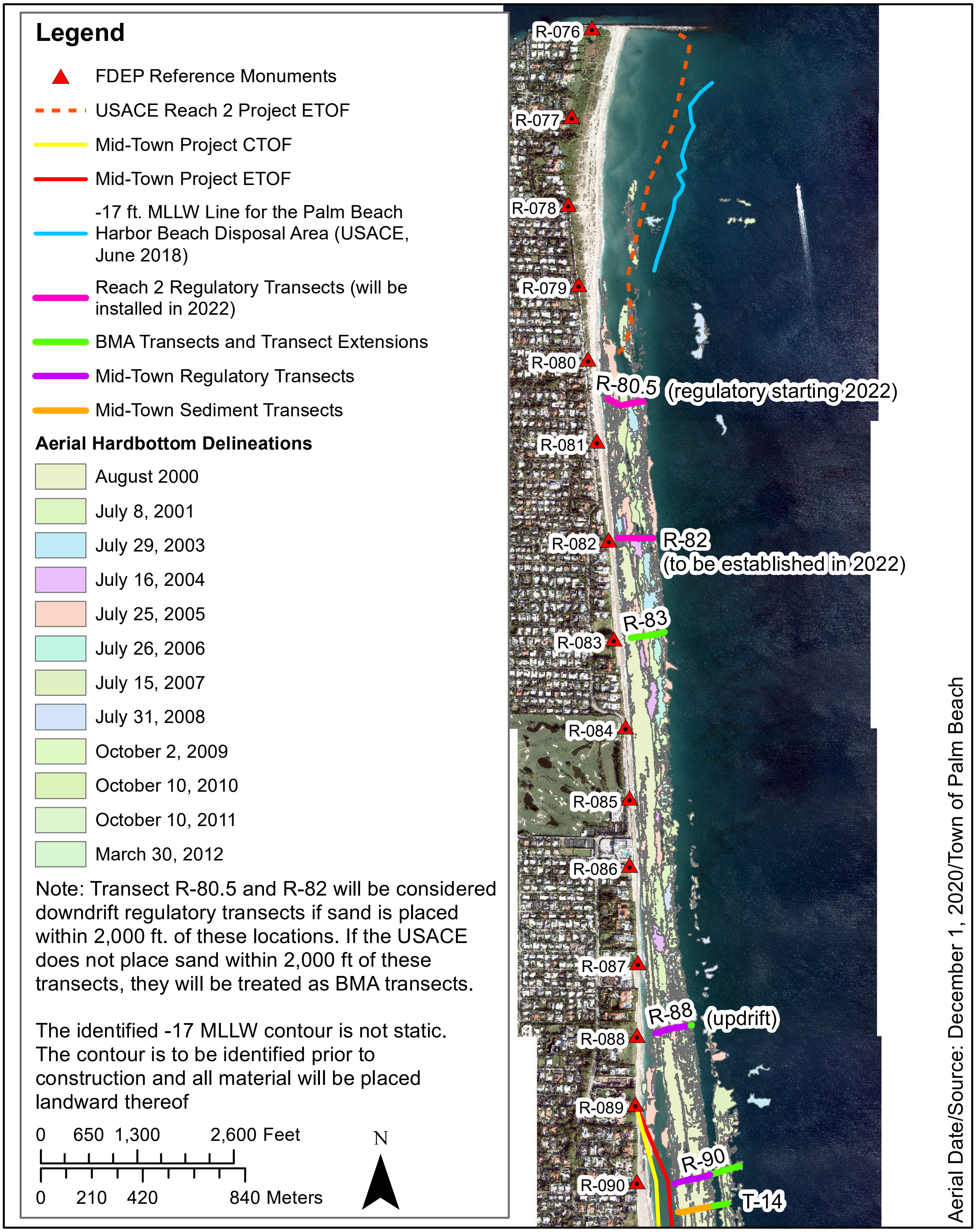
Name	Type		Location	Length	Installed
	(Reg / Nonreg)	(Sed Only/ Bio)	(R#)	(m)	(mm/yy)
R-80.5	Reg	Bio	R-80+500'	150	6/22/2015
R-82	Reg	Bio	R-82	NA	NA
R-83	Nonreg	Bio	R-83	156.8	6/22/2015
R-88	Reg	Bio	R-88	150	10/30/2014
R-88 ext	Nonreg	Bio	R-88	22	10/30/2014
R-90	Reg	Bio	R-90	150	10/20/2014
R-90 ext	Nonreg	Bio	R-90	132	10/20/2014
T-14	Reg	Sed Only	R-90+400'	150	10/3/2014
T-14 ext	Nonreg	Sed Only	R-90+400'	50	10/3/2014
T-13	Reg	Sed Only	R-91+340'	150	10/2/2014
T-13 ext	Nonreg	Sed Only	R-91+340'	50	10/2/2014
R-91	Reg	Bio	R-91+850'	150	10/3/2014
R-91 ext	Nonreg	Bio	R-91+850'	158	10/3/2014
R-92	Reg	Bio	R-92+280'	150	10/17/2014
R-92 ext	Nonreg	Bio	R-92+280'	175.6	10/17/2014
R-92 Offshore Station	Nonreg	Bio	R-92	22	6/22/2015
R-93	Reg	Bio	R-93	150	10/17/2014
R-93 ext	Nonreg	Bio	R-93	53	10/17/2014
R-94	Reg	Bio	R-94	150	10/29/2014
R-94 ext	Nonreg	Bio	R-94	131	10/29/2014
R-94 Offshore Station	Nonreg	Bio	R-94	22	6/22/2015

R-95 Breakers Rockpile	Reg	Bio	R-94+685'	185	10/22/2014
R-95 Breakers Natural	Reg	Bio	R-94+685'	60	10/22/2014
T-9	Reg	Sed Only	R-94+1,140'	150	10/2/2014
T-9 ext	Nonreg	Sed Only	R-94+1,140'	44	10/2/2014
T-8	Reg	Sed Only	R-95	56	10/1/2014
T-7	Reg	Sed Only	R-96+740'	62	10/1/2014
R-97	Reg	Bio	R-97	62	10/22/2014
T-6	Reg	Sed Only	R-98	75.2	10/1/2014
R-98	Reg	Bio	R-98+600'	94	10/20/2014
T-5	Reg	Sed Only	R-98+700'	78	9/30/2014
R-99	Reg	Bio	R-99	95	10/20/2014
T-4	Reg	Sed Only	R-99+300'	90	9/30/2014
R-100	Reg	Bio	R-100+230'	117	10/22/2014
R-101	Reg	Bio	R-101	107.3	10/22/2014
R-103	Reg	Bio	R-103	150	10/29/2014
R-103 ext	Nonreg	Bio	R-103	1	10/29/2014
R-113	Nonreg	Bio	R-113+380'	2.2	10/30/2014
R-115	Nonreg	Bio	R-115+340'	15.5	10/30/2014
R-116	Nonreg	Bio	R-116+560'	29.5	10/30/2014
R-132	Nonreg	Bio	R-132+260'	117	10/30/2014
R-133	Nonreg	Bio	R-133+180'	143	10/30/2014
R-136	Nonreg	Bio	R-136	137	6/19/2015
R-139	Nonreg	Bio	R-139+110'	67	6/19/2015
R-142	Nonreg	Bio	R-142	125.5	6/19/2015
R-145	Nonreg	Bio	R-145	157.4	6/19/2015

Note: Transects R-88, R-94, R-95 (Breakers Natural), and R-103 were originally classified as non-regulatory BMA transects. Due to their location within and immediately adjacent to the Mid-Town Beach Nourishment Project area, these four transects have been reclassified as regulatory transects for the 2020 Mid-Town Beach Nourishment Project. Additionally, the BMA non-regulatory Transect R-80.5 has been reclassified as a regulatory transect in Reach 2. Transect R-82 is a new regulatory transect that will be installed for the Reach 2 Project.

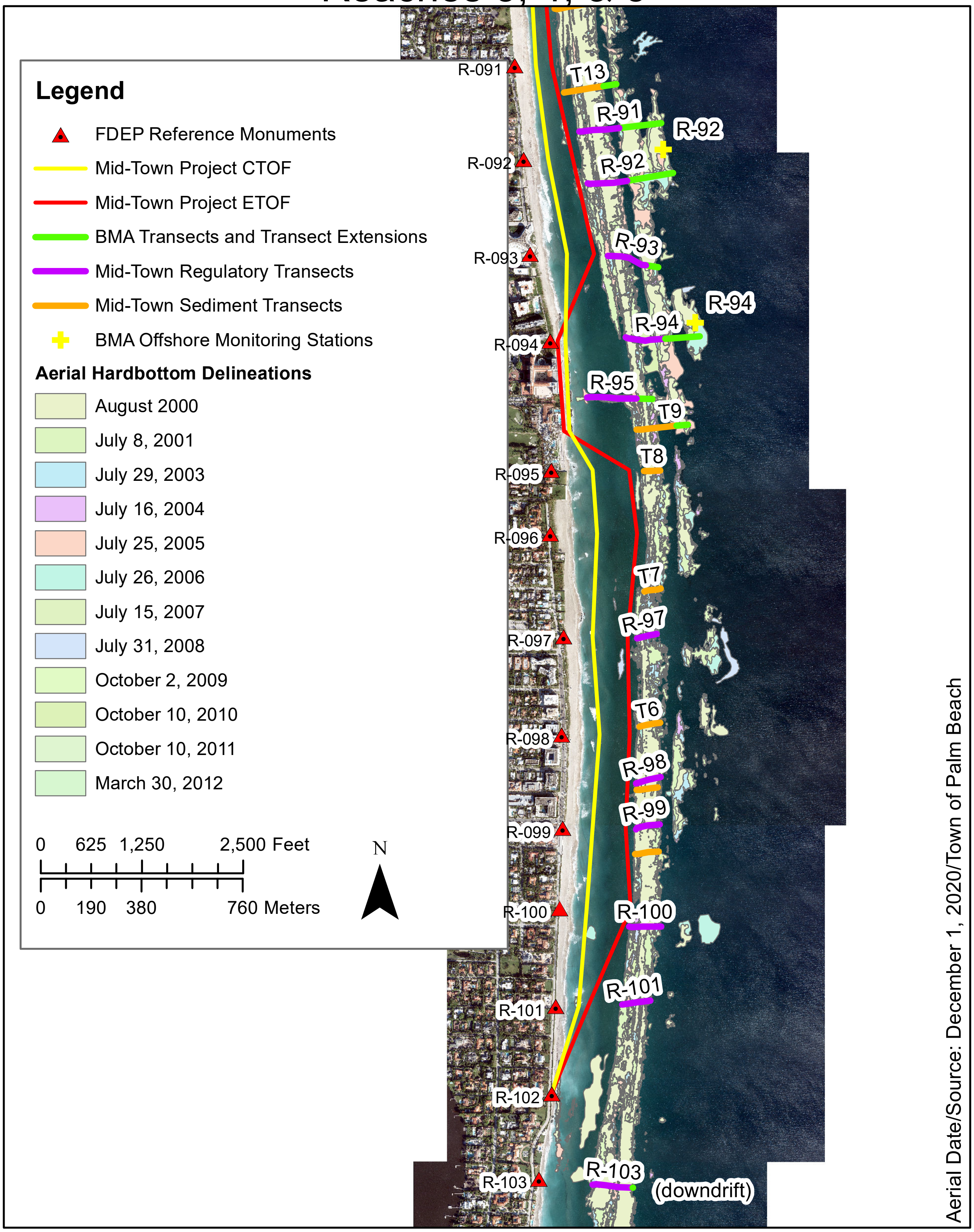
Beach Management Agreement (BMA) and Mid-Town Regulatory Transect Locations with Historic Hardbottom Aerial Delineations

Reach 2



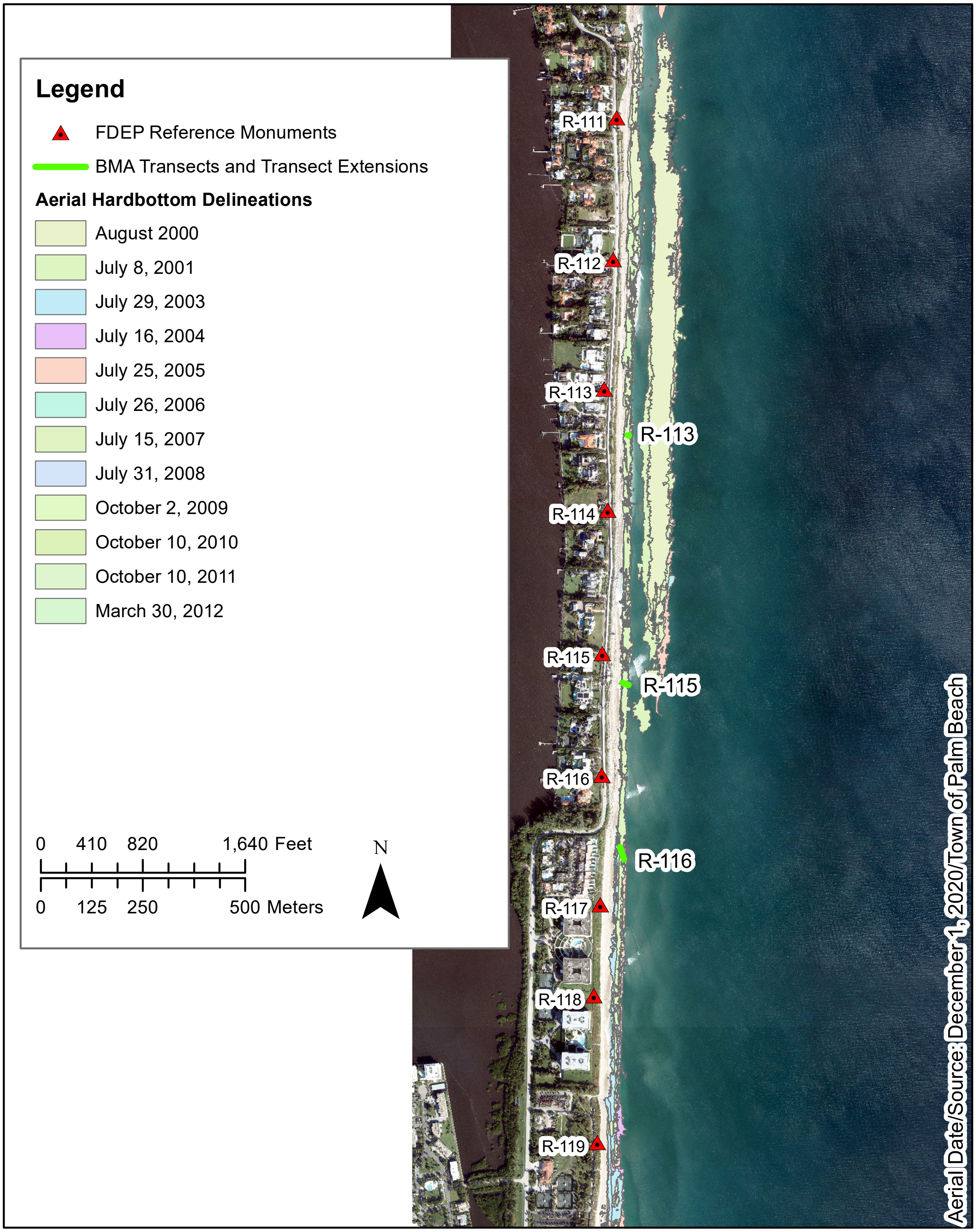
Beach Management Agreement (BMA) and Mid-Town Regulatory Transect Locations with Historic Hardbottom Aerial Delineations

Reaches 3, 4, & 5



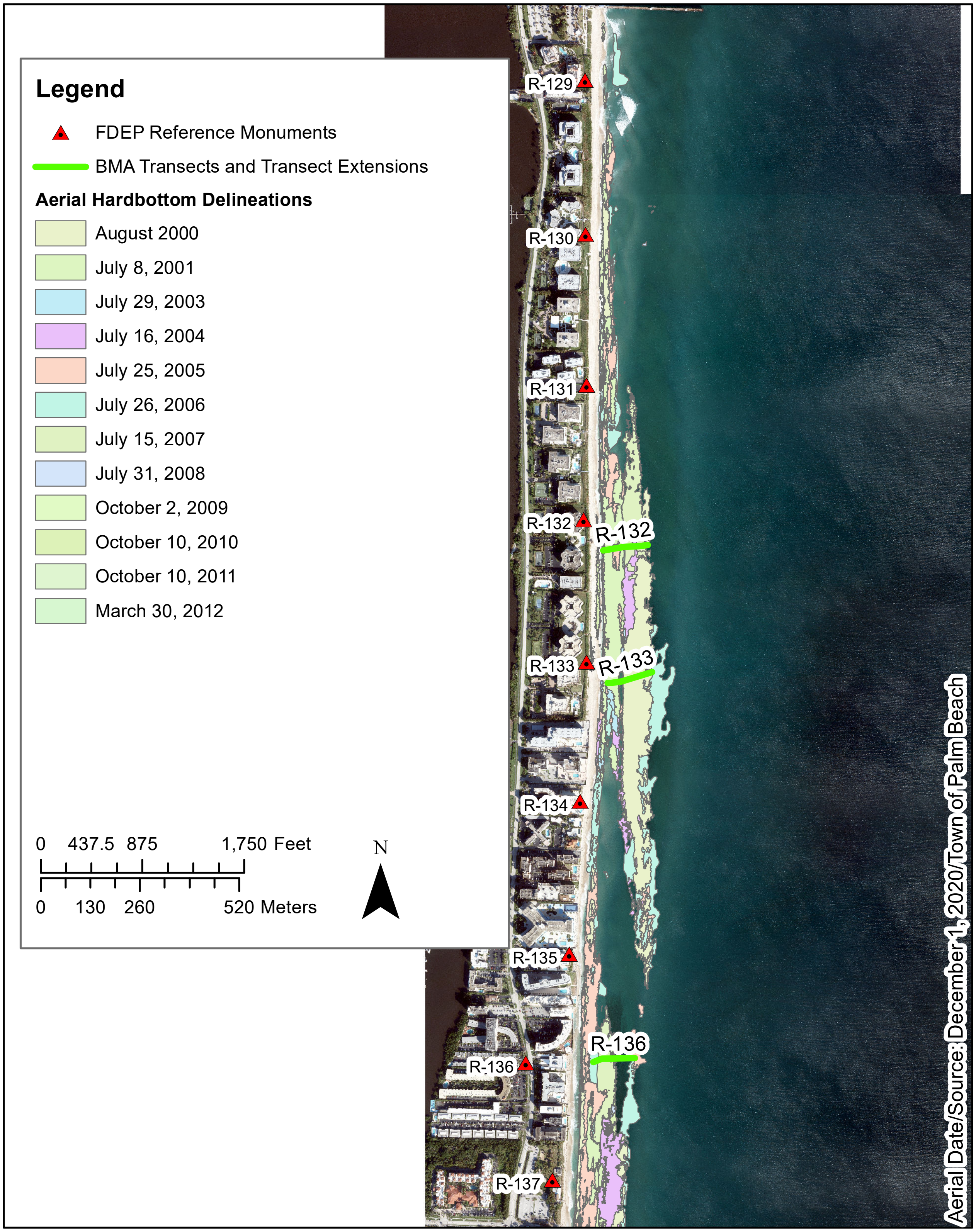
Beach Management Agreement (BMA) and Mid-Town Regulatory Transect Locations with Historic Hardbottom Aerial Delineations

Reaches 6 & 7



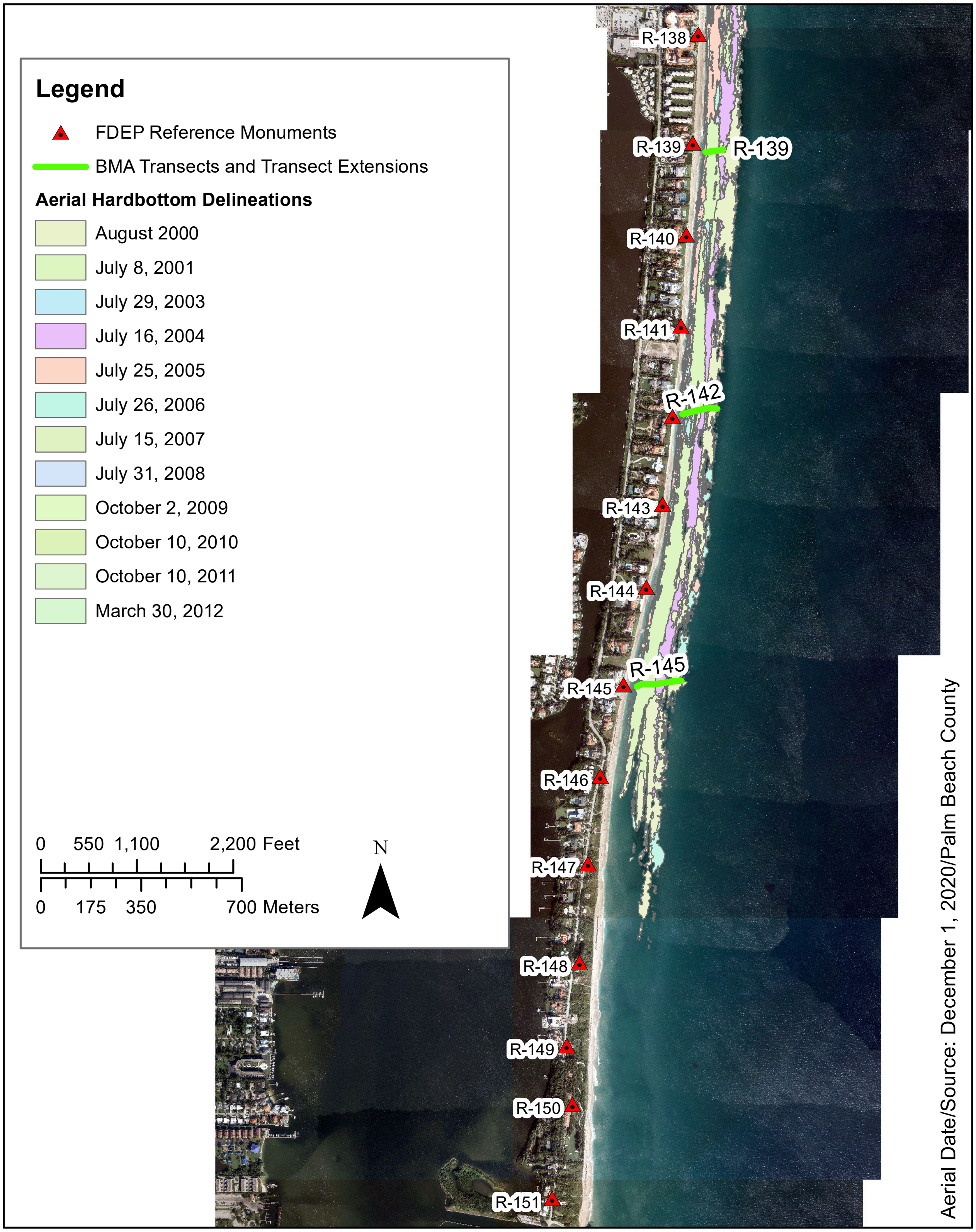
Beach Management Agreement (BMA) and Mid-Town Regulatory Transect Locations with Historic Hardbottom Aerial Delineations

Reaches 8 & 9



Beach Management Agreement (BMA) and Mid-Town Regulatory Transect Locations with Historic Hardbottom Aerial Delineations

Reaches 10 & 11



1.2.4.4 Quadrat Establishment

Quadrats shall be plotted avoiding areas of sand cover. Permanent quadrats shall be established and monitored along all nonregulatory transects and along each biological regulatory transect in the BMA cell. All quadrats shall measure 0.5 m^2 (0.7 m x 0.7 m) in area and shall be employed at a ratio of 0.13 quadrats per meter of transect such that a total of 10 m^2 of area (N=20 quadrats) is sampled along each 150 m long transect. The final number of quadrats along each transect shall be based on the length of each transect as established at baseline. The first permanent quadrat along each transect shall be installed at meter zero (0) (nearshore hardbottom edge or ETOF). The remaining quadrats shall be distributed along the length of each transect such that at least 2.5 to 3.5 m^2 of area is sampled within the following zones: 0-30m; 30m-60m; 60m- 100m; 100m to 150m. During establishment, quadrats shall be positioned such that areas covered by sand are avoided (i.e., quadrat placement during establishment will be biased to include hardbottom). The distribution of hardbottom along each transect during the baseline monitoring event will therefore influence the total number of quadrats installed and the positions at which they are established. All quadrats are permanent once established and post-construction monitoring events shall use the same quadrat locations as the pre-construction event, regardless of the exposure or burial condition of each location after initial quadrat establishment. The northeast corner of each quadrat shall align with a particular meter mark along the transect and a permanent marker (e.g., nail, eye- bolt, pin, etc.) shall be installed to indicate the location of the meter mark to ensure repeatability in quadrat placement during successive monitoring events. The permanent location of each quadrat shall be recorded and reported for each survey.

1.2.5 Annual Monitoring Survey Methods

To track changes to hardbottom throughout the cell and to verify that unanticipated impacts to nearshore hardbottom have not occurred as a result of the Mid-Town and/or the Palm Beach Harbor Maintenance Dredging and Bypassing projects, annual monitoring shall be conducted by the BMA Participants' Agent during summer/fall months every year throughout the life of the BMA. This annual cell-wide monitoring replaces the need for the individual project pre and post construction monitoring typically required for JCP authorized projects.

Annual monitoring shall be conducted once per year within a 60-day time frame during the summer/fall as close as possible to the time frame during which baseline data were collected (month of year/season of year). Each monitoring event will include the following four (4) types of surveys: aerial photography, nearshore hardbottom edge mapping, transect surveys, and offshore station surveys. Annual aerial photographs (**Section 1.2.5.1**) will document the amount of exposed hardbottom within the cell at a large scale. Annual *in situ* delineation of the nearshore hardbottom edge (**Section 1.2.5.2**) will provide detailed information on hardbottom exposure within the project area and allow for determination of direct impacts, when occurring, due to hardbottom burial by project fill. Additionally, annual surveys along permanent monitoring transects (**Section 1.2.5.3**) and within offshore monitoring stations (**Section 1.2.5.4**) will document sediment depth, cover, and distribution as well as the abundance, distribution, condition, and function of hardbottom resources (biotic assemblages). Collectively and over time, these data will make it possible to assess impacts for projects with regulatory requirements.

Following each annual monitoring event, a statistical analysis of the monitoring data is required to be completed by the Participant (**Section 1.5**), and a monitoring report is required to be submitted to the Department (**Section 1.6.3**). Monitoring results will be analyzed annually, and an analysis of cell-wide trends will be conducted every 5 years by the Department (**Section 1.3**). Additionally, an impact analysis of the Mid-Town project will be conducted by the Department within 5 years following each nourishment (**Section 1.4**). Impact assessments for the Mid-Town project shall be based solely on the project required regulatory transects and adjacent hardbottom edge mapping effort. The same shall be true for all impact assessments for the Palm Beach Harbor project, which shall be based solely on the two regulatory transects and hardbottom edge mapping effort in the area.

1.2.5.1 Aerial Photograph Survey

Annual aerial photography shall be used to map hardbottom within the BMA cell each year and will serve as a comparative dataset for *in situ* nearshore hardbottom edge mapping. Department approved aerial photographic methods shall be employed during the collection of aerial photographs to ensure photographs are of sufficient quality for analysis (i.e., delineation of hardbottom within the cell). Following collection, photographs shall be analyzed and hardbottom delineated to estimate the acreage of exposed hardbottom in each of the cross-shore zones and eleven (11) shoreline reaches. Though delineation and estimation of hardbottom acreage will primarily be based on the analysis of aerial imagery, hardbottom delineation and acreage estimation may be adjusted based on the results of the annual in water hardbottom edge mapping. In addition to the abundance and distribution of hardbottom, analysis of annual aerial photographs will provide valuable data on the dynamics of sand in nearshore areas of the cell.

1.2.5.2 Hardbottom Edge Survey

Delineation of the nearshore hardbottom edge will provide information on sediment dynamics and hardbottom exposure within the BMA cell and allow for determination of direct impacts, when occurring, due to the burial of hardbottom by project fill. The entire length of each portion of the nearshore hardbottom edge within the BMA cell shall be mapped in situ during each monitoring event. The nearshore hardbottom edge is defined as the visible border between sand and hardbottom. Bounce dives shall not be used to delineate the hardbottom edge unless authorization is granted by FDEP staff. If necessary, requests will be submitted to resource review staff in the Department's Beaches, Inlets, and Ports program.

For in situ hardbottom edge mapping, at least two divers shall, together, swim the entire length of the hardbottom edge. One diver shall tow a DGPS antenna transmitting continuous positions to hydrographic survey software on board a survey vessel (see **Sections 1.2.2.2** and **1.2.2.3** for requirements). To accurately map the edge, the towing-diver shall swim at a speed conducive to maintaining the buoy on as short a tether as possible. Positions of breaks (sand gaps) in the hardbottom edge greater than 5 meters in length shall be noted during the survey. The non-towing diver shall record relief characteristics of the edge and note dominant benthic communities during the survey to qualitatively document the edge for descriptive analysis. If preferred, qualitative video may be collected instead of notes. If employed and if possible, qualitative video shall be georeferenced

1.2.5.3 Transect Surveys

Cell-wide hardbottom monitoring shall occur along non-regulatory biological transects (and, when occurring, along sections of regulatory transects beyond 150 m [see **Section 1.2.4.3**]). Monitoring of specific projects within the BMA shall occur along regulatory transects of two types — biological and sediment only. All survey methods described below apply to biological transects while only line-intercept, interval sediment depth, and video collection apply to sediment only transects. To obtain the most accurate information on sediment depth and the location of sediment and hardbottom, line-intercept and interval sediment depth shall be the first surveys conducted along each transect. For biological transects, initial surveys (line-intercept, interval sediment depth, video) shall be followed by benthic quadrat and belt transect sampling.

1.2.5.3.1 Line Intercept Survey

In order to document larger areas of uninterrupted sand (physical transitions along the monitoring transects between sand and hardbottom) and to track changes in sediment cover on the hardbottom, line-intercept surveys shall be conducted along all permanent transects. During each monitoring event, the landward and seaward position of each sand patch / trough at least 0.5 m in length shall be recorded along each transect by reference to transect tape meter marks. Meter mark references will be to one decimal place (e.g., patch from 2.4 to 3.2 m).

1.2.5.3.2 Interval Sediment Depth Measurements

In order to track changes in sediment depth associated with changes in sediment cover, each monitoring event will include collection of interval sediment depth measurements along each permanent transect. Sediment depth shall be measured and recorded to the nearest centimeter at two (2) meter intervals (e.g., 0m, 2m, 4m, etc) along the length of each transect. For each measurement, a ruler graduated in centimeters (0 to 30 cm) shall be pressed through the sediment until the ruler reaches the surface of hard substrata or is totally immersed in sand. Depth measurements shall be rounded to the nearest cm (i.e., sediment thickness of less than 0.5 cm will be recorded as "0 cm", while thickness greater than 0.5 cm but equal or less than 1 cm shall be recorded as "1 cm", etc.). Measurements greater than 30 cm will be recorded as ">30 cm". Measurements may be truncated to the first and last few meters of each trough in areas of Mid-Town known to contain large, deep sand troughs.

1.2.5.3.3 Video Survey

Video survey data collected as part of required biological monitoring functions as an archival data set that can be used for general reference purposes or to help resolve potential impacts suggested by quadrat and sediment survey data. As such, video data could be reviewed and compared between surveys and must be of a quality sufficient to allow for post-collection quantitative image analysis using point count procedures.

Video surveys shall be conducted along all permanent monitoring transects using a digital video camera. Video of the seafloor along each transect shall progress no faster than 5 meters per minute over hardbottom and 10 m per minute over large sand patches (troughs). A convergent laser guidance system shall be used to indicate the precise height of the camera at 40 cm from the bottom. The transect line shall be clearly visible in all video so that locations may be accurately referenced. A 360° panoramic view at an angle of roughly 30° to the horizon shall be recorded both at the beginning and end of each transect from an elevation of roughly 1 m above the bottom. At the beginning and end of each transect, a standard underwater display shall also be recorded and integrated directly onto the digital video track. The standard display shall report: 1) the BMA transect number; 2) the survey date (e.g., 06/25/2021); 3) the water depth in meters for both the beginning (transect meter 0) and end (final meter) of the transect (e.g., start depth = 2 m, end depth = 4.5 m); and 4) any pertinent notes (e.g., poor visibility, large swell, etc.). Video data (files) will be supplied to FEDP during raw data submittal. Video shall be reviewed at the end of each transect surveyed to ensure the quality is acceptable for general characterization of the benthos; poor quality video shall be re-filmed.

1.2.5.3.4 Quadrat Sampling

Benthic communities and their habitats will be characterized quantitatively using the quadrat method, which samples benthic habitat and assemblages within permanently positioned quadrats along all nonregulatory transects and along each biological regulatory transect[8]. This method

[8] Benthic quadrat surveys are subject to revision and development of finer details prior to implementation.

ensures the same quadrats (same location, same size) are sampled in each monitoring event in order to document changes in hardbottom/sediment and benthic communities over time. The sampling protocol is similar to that used in the Benthic Ecological Assessment for Marginal Reefs (BEAMR) (Lybolt and Baron, 2006). Similar to all other non-invasive and non-consumptive methods of sampling, the quadrat method is limited to physical characteristics and organisms that can be visually recorded and identified in the field. As described below, three (3) main benthic characteristics will be assessed in each quadrat during sampling: physical structure, planar percent cover of sessile benthos, and coral (scleractinian and octocoral) size and density.

Physical structure

Maximum topographic relief and mean sediment depth (average of five [5] depth measurements) shall be measured (in centimeters) within each quadrat to document physical structure.

Cover (Percent) of Functional Groups

The distribution of substrata and composition of the benthic community within each quadrat shall be documented by estimating the planar cover (percent) of functional groups. Specifically, the following 15 major functional groups shall be assessed: sediments[9], bare hardbottom, macroalgae[10], turf algae[11], encrusting red algae[12], sponges, scleractinian corals, , octocorals, zoanthids , hydroids, hydrocorals *Millepora* sp., sessile worms (including wormrock, *Phragmatopoma* spp.), bivalves, bryozoans, and tunicates. Each functional group shall be assigned a cover value (percent) from 0%-100%, with the total of all functional groups in each quadrat equaling 100%. Macroalgae with at least 1% cover shall be identified to genus and the cover (percent) of each genus shall be recorded. Unattached or floating macroalgae shall be disregarded and shall be removed from quadrats prior to sampling. The cover (percent) of cyanobacteria shall also be assessed but will be recorded separately from other cover estimates (i.e., not included with the main 15 functional groups).

Coral Size and Density

Monitoring staff shall also measure and record to the nearest centimeter (cm) the maximum dimension (height or width) of each scleractinian coral and octocoral colony within each quadrat. The smallest size recorded shall be one (1) cm; for colonies less than one (1) cm in

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[9] Sediments characterized by circling of the descriptor, or giving short additional characterization (e.g., rubble, or circled descriptor sand and then + shell hash, mud, etc.).
[10] Macroalgae include fleshy macroalgae and geniculate calcareous algae, e.g. *Halimeda*); non-geniculate calcareous branching red algae write separately.
[11] Turf algae include all algae with thallium less than 10mm and forming dense cover.
[12] Encrusting red algae recorded separately for non-calcareous and calcareous (% + %).

size, the measurement recorded shall be “< 1 cm”. Each colony within each quadrat shall also be enumerated and identified (by species for scleractinians, by genus for octocorals) to determine coral density and composition. Abnormal colony conditions shall also be recorded (e.g., bleaching, disease, predation, etc) when encountered.

1.2.5.4 Offshore Station Survey

The sampling protocol for stations very far offshore will follow the protocol employed by the Southeast Coral Reef Evaluation and Monitoring Project (SECREMP). The monitoring stations will be established with permanent stainless-steel markers and will include permanent, shore-parallel 22-m long photo-transects (N=3 per station), and a 1-m wide belt transect (N=1 per station) (see **Sections 1.2.4.2** for offshore station monitoring grid configuration). The three photo-transects will be sampled using a digital camera. Non-overlapping consecutive photographs will be taken along the full length of each transect at a distance of 40 cm above the reef substrate to yield images approximately 40 cm wide by 30 cm in height. A constant distance above the substrate will be maintained using an aluminum bar affixed to the bottom of the camera housing or converging lasers which confirm the 40-cm distance. This results in each transect consisting of about 60 images and covering an area of approximately 0.4 m x 22 m; the total number of images at each station is about 180. Percent cover of benthic functional groups is analyzed post-collection by way of image analysis software based on the point-count methodology. A total of 15 random points on each image will be assessed. The following functional groups will be distinguished in the photo image survey: substrate (unconsolidated sediments and consolidated hardbottom), scleractinian corals, octocorals, sponges, zoanthids, hydroids, macroalgae, coralline algae, cyanobacteria. Tape/wand/shadow and unknown categories are used when points cannot be confidently identified in images. . The 1-m wide belt transect will be surveyed in the field to assess stony coral, octocoral and barrel sponge populations. All scleractinian coral colonies greater than 4 cm in maximum dimension will be identified and counted along the entire 22-m belt transect, maximum height and diameter of each colony will be recorded, and each colony will be visually assessed for the presence of diseases, bleaching and other conditions. Where these conditions result in partial mortality, the percentage will be visually estimated. All octocoral colonies will be counted along the first 10 m of the belt transect to provide an estimate of overall density. Following the octocoral colony count, erect octocorals listed as target species will be identified, measured, and their condition (presence of disease/predation) recorded along the first 10 m of the transect. Target octocoral species are *Eunicea calyculata*, *Antillogorgia americana* (formerly *Pseudopterogorgia americana*), *Eunicea flexuosa* (formerly *Plexaura flexuosa*), *Pseudoplexaura porosa*, and *Gorgonia ventalina*. Barrel sponge (*Xestospongia muta)* density will be assessed by counting all sponges within the 1 m x 22 m belt transect. For each sponge colony, maximum diameter, maximum base diameter, and maximum height will be measured, and the sponge will be visually assessed for the presence of disease, bleaching and other conditions (i.e. damage/injury, predation). The percent of the sponge affected by injury, disease, and/or bleaching will be recorded.

1.3 Determination of Cell-Wide Trends

1.3.1 Step 1 – Creation of Habitat Classification Tracking Table

The Habitat Map of Hardbottom will be created by the Participants using the *in situ* Habitat Mapping data collected the summer following the execution of the BMA. Hardbottom in the Map will be classified according to the approved Hardbottom Classification System specified in **Section 1.1.1**. Additionally, the hardbottom within the map will be compared against the historical variability documented in the review of historical aerial photographs (**Section 1.2.3.1**).

The following shall be conducted After the Habitat Mapping is conducted and the Habitat Map of Hardbottom is completed, a table will be created (see **Table 1.3.1**) identifying the acreage of each type of hardbottom habitat. The table and all supporting data will be submitted to the Department within 120 days following the completion of the habitat mapping survey. The acreage of each type of hardbottom habitat will be tracked and updated annually (based on required annual survey data) so that long-term changes in the acreage of hardbottom by habitat type can be tracked through the life of the BMA.

Table 1.3.1. Habitat Classification Tracking Table. Subcategories by distance from shore and persistence of exposure.

Distance (water depth)	Exposure Category (Acreages)			
	Low (<40%)	Medium (40-60%)	High (>60%)	*Total*
Nearshore (0 to 3m)	169.01	60.60	25.33	*254.93*
Offshore (3 to 12m)	194.75	48.69	99.39	*342.83*
Far Offshore (8 to 12)	38.38	2.88	3.41	*44.66*
Total	*433.37*	*115.15*	*128.79*	***677.30***

Note: Using the 2021 MHW line as the landward limit of the nearshore zone removes 34.87 acres from the overall nearshore zone total (31.23 acres of low, 2.98 acres of medium, and 0.66 acres of high exposure) when comparing these acreages to the historic acreage totals in the 2014 BMA monitoring plan.

1.3.2. Step 2 – Annual comparison

Every year following the biological monitoring survey, the resulting data will be compared to the Habitat Map of Hardbottom by the biological monitoring team. Each year, the acreage of each listed habitat (using the habitat classification table) from the yearly survey will be tabulated and compared to previous years, and basic trends and analysis will be reported by the Participants. Reports will be submitted to the Department as required in the cell-wide hardbottom monitoring plan (**Appendix B-1**). This will track habitat types and shifts caused by sediment movement in the cell.

1.3.3 Step 3 – Analysis of habitat changes/cell-wide trends

Every five years following the submittal of the monitoring data, the Department will initiate its review of the data. Changes in communities and hardbottom types as classified shall be compared to the Habitat Map of Hardbottom and yearly updates to the Habitat Classification Tracking Table as well as to the historical variation in the cell. Trends occurring within the cell shall be noted. A community response to an increase in sedimentation (e.g. degradation of community in percent cover and changes in content of the community), provides documentation of sedimentation effects over time. Community response indicators include stress of organism-indicators, reduction of cover by major benthic groups, and loss of a particular type of species, and changes in function.

The following are indicators of sedimentation and changes in habitat/community response that can be seen in monitoring data:

- *Shifts in the Nearshore Hardbottom Edge*: Movement Seaward movement of hardbottom edge, indicative of sand movement, covering different portions of hardbottom the hardbottom.
- *Sedimentation*: this is measured using the interval sediment depth recording and line-intercept sediment patch measurements during the annual biological monitoring. Areas of documented sediment coverage are calculated using sediment coverage along a specific length of a transect, and extrapolation between transects.
- *Species Stress*: Indication of stress by a species or functional group (i.e., partial burial or formation of sediment ridge at the base of the coral, bleaching or paling, excessive mucus production, or expanded polyps by corals).
- *Changes in Functional Group Cover (%)*: documentation of changing coverage of particular species or functional groups documented within quadrats, or elimination of functional groups or species.
- *Changes in Functions of Hardbottom Type*: documentation showing that a hardbottom classified as one type is shifting to another type of hardbottom, reflecting a change in habitat function (i.e., a community typically documented as having provided a persistent sheltering ground is changing to a more ephemeral community providing grazing habitat).

As seen in the 12-year historical aerial analysis **(Appendix B-5** and **Section 1.2.3.1**), there is a considerable fluctuation in this system, and the nature and strength of storms greatly contributes to the variability. Without *in situ* data collection, natural variation is hard to identify. However, annual field data will provide additional information on sediment dynamics within the BMA cell. In the initial phases of BMA monitoring, it is likely that the variability in the system will not be fully documented and understood, and successful correlation on a cell-wide basis may not be immediately feasible. It is anticipated that the upper and lower limits of natural variability throughout the cell will become more apparent with the collection of more consistent *in situ* data.. A better understanding of the variability in the system will allow the Department to more readily tease out project related impacts, if occurring. In the end, this should lead to better resource management strategies by the Department.

1.4 Impact Determination for Unanticipated Impacts

1.4.1 Step 1 - Baseline Establishment

A baseline for the condition of hardbottom shall be established for each specific project area (i.e. Mid-Town and the Reach 2 placement area) prior to the initial construction of each project. If possible, multiple monitoring events prior to the initial construction event will be used to determine the pre-project baseline condition of hardbottom.

1.4.2 Step 2 - Analysis of Impact from a Project

Within 5 years following each fill placement event (nourishment) for the Mid-Town Nourishment Project (Approval No. 0328802-002-BMA) and within 3 years following each fill placement event for the Palm Beach Harbor Maintenance Dredging and Bypassing Project (Permit No. 0216012-025-JC), the Department shall conduct an analysis of to determine whether unanticipated project-related impacts have occurred. Project related impacts shall be determined by analyzing monitoring data collected along specified regulatory transects and the nearshore hardbottom edge associated with each project area. Typically, areas offshore of a project, if affected by that project, will have a greater abundance of sediment (cover and depth) after construction relative to baseline (pre-construction). The signal of increased sediment abundance tends to fade with increasing distance from the project area (e.g., offshore or downdrift/updrift). Increases in sediment abundance tend to have deleterious effects on the resident benthic community. For instance, reductions in the cover (%) of benthic organisms, changes in the composition of the community, and losses of community functions are observed in project areas with increased in sediment abundance. Such concomitant changes provide further documentation of project related sedimentation effects over time.

The amount of impact may be calculated based on the following measurements of sedimentation and community response:

- *Seaward movement of hardbottom edge*: This is calculated through the hardbottom edge survey. Seaward movement of the hardbottom and sand interface is indicative of direct coverage from the project fill spreading seaward and impacting the hardbottom.
- *Sedimentation*: This is measured using the interval sediment depth recording and line-intercept sediment patch measurements during the annual biological monitoring. Areas of documented sediment coverage are calculated using sediment coverage along a specific length of a transect, and extrapolation between transects.

- *Species Stress*: Indication of stress by a species or functional group (i.e., partial burial or formation of sediment ridge at the base of the coral, bleaching or paling, excessive mucus production, or expanded polyps by corals).
- *Changes in functional group coverage*: documentation of declining coverage of particular species or functional groups documented within quadrats, or elimination of functional groups or species.
- *Changes in functions of hardbottom type*: Documentation showing that a hardbottom classified as one type is shifting to another type of hardbottom, reflecting a change in habitat function (i.e., a community typically documented as having provided a persistent sheltering ground is changing to a more ephemeral community providing grazing habitat).

The acreage of unanticipated impacts arrived at using the measurements above may be adjusted by correlating the findings with trends in the physical monitoring data. This allows impacts to be calculated over an acreage amount incrementally, in percentage of loss. For example, if a 10% reduction in hardbottom function due to increased sedimentation and community degradation is documented within a two acre area, then the resulting impact area would be 10% of 2 acres or 0.2 acres (total loss). Unanticipated impacts will be handled through regulatory compliance and enforcement action.

1.5 Database and Data Analysis

Annual monitoring data shall be analyzed statistically by the BMA Participant (see **Section 1.5.3**). As part of this effort, a single monitoring database will be developed to manage all biological data (**Section 1.5.1**). Required and suggested comparisons for regulatory and nonregulatory datasets are provided in **Section 1.5.2**.

1.5.1 Monitoring Database

A single Access database (or equivalent) will be developed to manage all biological data collected for the cell area. Annual quantitative data on the major benthic biological components, including percent cover, abundance, distribution by size, and species will be stored in the database. The Habitat Classification Tracking Table specified in **Section 1.3.1** (see **Table 1.3.1** above) will also be stored in the database. This database will facilitate efficient QA/QC operations, data management, and will also be filed to a uniform GIS database.

1.5.2 Comparisons

Nonregulatory cell-wide monitoring data aimed at addressing Goal # 2 may be compared between and among multiple time points to evaluate natural changes in the system. Descriptive statistics along with univariate and multivariate analyses should be employed. Care should be exercised when using data collected along transects in different areas as not all spatial or temporal comparisons will yield informative results. For example, transects need to be grouped by distance from shore, as intertidal transects in the southern reaches cannot be used to represent natural variability of nearshore hardbottom. Further, BMA regulatory transects (including updrift/downdrift transects) in the Midtown and Palm Beach Harbor project areas cannot be used to represent natural variability, as they are under the influence of nourishment/placement projects.

For regulatory monitoring data aimed at addressing Goal # 1, temporal comparisons by way of univariate and multivariate tests will be confined to data collected during the most recent monitoring event (current event) and the baseline monitoring event (i.e., statistical tests will not be used to compare results between different post-construction monitoring events). Such a comparison represents repeated measures and, depending on the statistical test, these data are to be analyzed accordingly (e.g., paired T-test, repeated measures ANOVA/ANCOVA, linear mixed-effects models, MANOVA, etc.). Multivariate analysis by way of PRIMER does not require such repeated measures tests, due to the non-parametric permutation-based nature of its routines. Comparison among all monitoring events should solely be through descriptive/summary statistics, presented in graphical or tabular form in the report. The Breaker's artificial reef regulatory transect should be assessed separately from other Midtown regulatory transects due to its proximity to shore.

1.5.3 Statistical Tests

The following includes a list of suggested data treatments and statistical analyses to be performed with each single survey dataset to effectively compare between annual surveys as well as between annual survey and the Habitat Map of Hardbottom: Temporal comparisons by way of univariate and multivariate tests shall be confined to data collected during the most recent monitoring event (current survey) and the baseline survey. Statistical tests will not be used to compare results between different post-construction monitoring events.

1.5.3.1 Descriptive Statistics

Unlike inferential statistics (hypothesis tests [see univariate and multivariate tests below]), descriptive statistics aim to provide simple quantitative summaries of a sample (i.e., they describe the main features of a collection of information)[13]. Such summaries may be either quantitative

[13] Though not typically thought of as descriptive statistics, Diversity Indices provide simple quantitative summaries of sample communities (e.g., richness, diversity, evenness, etc.). For instance, species counts in sample units or groups of sample units may be expressed and analyzed under one of the following two diversity indices: 1) **Shannon Diversity Index (H')** – A measure of the information entropy often used in ecology that accounts for the number of species in sample units (richness) as well as their relative abundance (evenness) as a probability. As such, values range from 0 to 1, with 1 indicating a completely equitable distribution of species among samples. 2) **Pielou's Evenness Index (J')** – A measure of biodiversity which quantifies how equal populations are numerically.

(i.e., summary statistics) or visual (i.e., straightforward graphics). These statistics generally include measurements of central tendency (e.g., mean, median, and mode) and dispersion (e.g., variance and/or standard deviation). Numerical descriptors like mean and standard deviation are good for summarizing continuous data (like the density [n/m^2] of a particular species), while frequency and percentage are more useful in terms of describing categorical data.

One of the most useful and effective statistical calculations is the estimation of percentage change. For example, in the assessment of change in percent cover, size class distribution, and sediment depth over time. The following example provides the formula for calculating percent change over time for sediment depth: %Change = ((Depth F – Depth I)/Depth I))*100; where Depth F is the final sediment depth (depth during the most recent monitoring event), and Depth I is the initial sediment depth (depth during the baseline survey). Changes expressed as percentages provide useful summaries for changes occurring in hardbottom communities as a result of beach nourishment. Percent change may be presented in tabular and/or graphical form, and can be used as the dependent variable in analyses of sediment depth, sand patch size, percent cover, etc.

1.5.3.2 Univariate tests

These consist of both parametric and non-parametric hypothesis tests. While the results of such tests are useful in determining whether impacts from nourishment have occurred, the statistical significance of change in the absolute value of a parameter or in percentage does not necessarily reflect a critical, biologically meaningful threshold. Thus, while tests can indicate significant differences, non-significant differences can still be meaningful. Several useful univariate tests are provided below.

T-test

Simple hypothesis test that operates on the mean. One-sample, Two-sample, and Paired tests are possible; Homoscedastic (equal variance) and Heteroscedastic (unequal variance) tests are also available. Programs should provide a p-value to compare to a pre-determined alpha (usually 0.05). While inappropriate for other, more complex statistical tests, Microsoft Excel may be used to run T-tests.

ANOVA

More advanced hypothesis test that also operates on means. In the event assumptions of general linear models are not met, non-parametric Analysis of Variance (ANOVA), generalized linear, or mixed-effects models may be used to account for the nature of the data.

Based on Shannon Diversity Index, it quantifies the ratio of observed diversity relative to the maximum possible diversity (H'/H'max). Note that other diversity indices are available and acceptable.

Analysis of covariance (ANCOVA) may also be useful. Repeated measures (i.e., violation assumption of independence) must be handled appropriately.

1.5.3.3 Multivariate Tests

These statistics encompass the simultaneous observation and analysis of more than one outcome/dependent variable. Multivariate analysis of variance (MANOVA) models may be used, though analysis via PRIMER routines is more common. Various PRIMER routines are described in 1-6 below. MANOVA and PERMANOVA are suggested for complex multivariate hypothesis tests.

Similarity Matrix

The original data matrix should include data from the current survey as well as from the baseline survey. Bray-Curtis similarity should be used to produce the resemblance matrix. In order to even out the influence of dominant and rare species, data should be square root, fourth root, or log (x+1) transformed prior to producing the resemblance matrix.

Cluster Analysis with Similarity Profile (SIMPROF) Test

Based on simple agglomerative hierarchal clustering, creates a dendrogram from a similarity matrix. Group average linking should be used. Similarity profile analysis (SIMPROF) should be used in conjunction with cluster analysis (tree production). The pi statistic and the results of the associated hypothesis test should be presented in the results section of the monitoring report.

nMDS Ordination

A technique for mapping samples in a low dimensional space (typically 2-D) such that the distance between samples approximately reflects (to one degree or another) similarity in community structure. Model checking should include interpreting the resultant Shepard Diagrams (smooth increasing curves are best) and Stresses (2-D and 3-D), which provide information on the distortion between the ranked dissimilarities and corresponding distances in the plot. Stress scores are to be reported; as a rule of thumb, a score of: < 0.05 suggests excellent representation; < 0.1 suggests a good fit; < 0.2 suggests the pattern is still useful, but should not be completely trusted; and > 0.3 suggests the pattern is little better than random points.

Analysis of Similarity (ANOSIM)

Compares the variation in species abundance and composition among sampling units in terms of grouping factors (or experimental treatment levels). The histogram, R-statistic, and p-values provided as outputs should be reported.

Similarity of Percentage (SIMPER)

Used to determine the role of individual taxa in contributing to the separation (dissimilarity) between two groups of samples (e.g., Artificial vs. Natural, Baseline vs. Year 1 post-construction).

Second Stage Analysis (2STAGE)

Provides a succinct summary in a 2-d picture of the relationship between the multivariate sample patterns under various choices.

1.6 Reporting

1.6.1 Notification of Commencement, Progress, and Completion of Work

Commencement dates of Monitoring events shall be reported via email to the JCP Compliance Officer (JCPCompliance@dep.state.fl) and to staff in the Beaches, Inlets, and Ports program roughly seven (7) days prior to the start of monitoring and the day that monitoring begins. Brief monitoring progress reports shall be submitted (emailed) weekly to the JCP Compliance Officer until completion of the monitoring event. As soon as monitoring activities have ended, the JCP compliance officer shall be notified that the monitoring event has been completed.

1.6.2 Hardbottom Monitoring Data Submissions

Baseline monitoring data will be provided prior to the initial construction event conducted under the BMA. All raw post-construction monitoring data will be provided by the monitoring firm directly and concurrently to the FDEP JCP Compliance Officer, the Permittee, and the Agent (e.g., on portable hard drives or via an FTP site) within 45 days of completing each required post-construction monitoring event. All data submitted shall be provided in standard formats, as specified below. All transect monitoring data submitted shall have been checked against field datasheets and corrected (if necessary) to ensure accuracy. Raw data provided shall consist of the following, each of which are described below: aerial photographs, hardbottom edge survey data, raw transect and quadrat survey data, underwater video and photographs, and field datasheets and survey logs.

1.6.2.1 Aerial Photographs

Aerial photographs will be georeferenced and provided in tiff (tagged image file format). The projected coordinate system and datum used to georeference the images will also be provided.

1.6.2.2 Nearshore Hardbottom Edge Survey Data

Hardbottom edge data shall be supplied as a collection of shapefiles (e.g., as an ESRI file geodatabase). Lines or polygons shall represent the *in situ* mapped landward edge of hardbottom for data obtained from each survey. These data may be depicted as a single line representing the nearshore edge, two lines representing the nearshore and offshore edges, or polygons representing hardbottom patches, depending on the distribution of hardbottom. Hardbottom edge data shall have attributes indicating the portion of each line or polygon representing hardbottom. If sand patches greater than 5 m are crossed during the edge survey, these portions of lines/polygons shall, as attributes, be indicated as sand. In areas where regulatory monitoring is required, a line representing the permitted ETOF will also be provided with the collection of shapefiles.

1.6.2.3 Transect, Quadrat, and Belt Transect Survey Data

Interval sediment depth measurements, line-intercept data, and BEAMR quadrat data collected along transects and invertebrate count data collected within belts will be supplied in Excel format. Each Excel workbook submitted shall include a descriptive name, so data may be easily differentiated by area/type.

1.6.2.4 Underwater Video and Photographs

Qualitative digital video and any digital photographs shall appear in separate folders. Main folders and subfolders shall be identified by descriptive names, so data may be easily differentiated (e.g., by transect).

1.6.2.5 Field Datasheets and Survey Logs

Copies (photographs or scans) of field datasheets shall be submitted in pdf format.

1.6.3 Hardbottom Monitoring Report Submissions

<u>Within 120 days of completing each required post-construction monitoring event</u>, a written monitoring report shall be submitted directly and concurrently by the monitoring firm to the FDEP JCP Compliance Officer, the Permittee, and the Agent. Along with each monitoring report, the data analyzed to produce the report shall also be submitted (e.g., tables used in the analysis of data,

tables used to construct figures, and tables and figures provided in the report will be submitted in Excel format). The table entered into Primer and the Primer analysis file shall also be submitted.

Each monitoring report shall clearly describe methods used in monitoring and data analysis and explain any deviations from the monitoring plan or conditions of permit. Reports shall also provide results in appropriate graphical, tabular and text formats. Monitoring reports are to be cumulative; thus, data (in the form of summary tables and figures) from all previous monitoring efforts shall be included in each report, in an updated fashion. Data and results for regulatory and nonregulatory monitoring will be evaluated and interpreted in each annual report. Additionally, annual reports will include aerial photography analysis, hardbottom edge surveys and acreage estimations and comparisons; sediment analysis including bar graphs depicting sediment patch data, and average sediment depths including monitoring areas, transects, and zones; benthic community analysis and change, and statistical analysis of data.

1.7 Hardbottom Monitoring Background/Revision Information

1.7.1 Hardbottom Classification System Revisions

The system was initially based on four parameters which could be grouped in any combination to describe the hardbottom habitat: proximity to shore - expressed by distance from the shoreline and water depth; relief of the rock; duration of rock exposure; and function. Proximity to shore contained three subcategories: Nearshore (0 – 4 m depth), Intermediate (4 – 8 meters depth of closure]), and Offshore (8 – 12 m [beyond depth of closure]). However, the three cross-shore zones were based on bathymetry contours created from a 2002 LADS survey. The BMA participants conducted an accuracy assessment of map depths versus corrected field depth measurements at the 115 ground truthing sites sampled for the 2014 Baseline Habitat map. This assessment revealed an overall map accuracy of 67%. Most discrepancies in depth zones were encountered in the Intermediate depth zone; 25 Intermediate sites were found to fall in the Nearshore zone (0 to 4 m). Additionally, twelve (12) Offshore sites were found in the Intermediate zone. These errors dropped user accuracies for Intermediate and Offshore Hardbottom designation below 40%. Given these inaccuracies, the cross-shore depth zones have been updated using bathymetry survey data collected by the BMA participants in 2021.

The 2014 ground truthing data show that several benthic community metrics change at a water depth of 3 m. Octocoral abundance was greater at sites deeper than 3 m, particularly mature colonies greater than 10 cm in height. Additionally, five of the eight species of scleractinian corals documented during the 2014 survey were only present in water depths greater than 3 m. These metrics support reclassification of the outer limit of the nearshore zone from a depth of 4 m to 3 m.

The persistence categorization in the 2014 Baseline Habitat Map was accomplished by evaluation of frequency of exposure in aerial imagery between 2000 and 2012. Each polygon was categorized by the number of times that it was mapped in all available aerial imagery. The number of times each area was exposed and mapped in the aerial imagery was assumed to relate to the exposure frequency. All hardbottom polygons were classified by percent exposure: Low exposure (Highly Ephemeral Hardbottom) was defined as 40% exposure in all available maps; Medium exposure (Moderately Ephemeral Hardbottom) was defined as 40% to 60% exposure in all maps; and High exposure (Persistent Hardbottom) was more than 60% exposure. Statistical analyses showed that sand cover was significantly higher between the Low, Medium, and High exposure categories, and stony coral and octocoral abundances had significant relationships with the exposure frequency categories with the highest abundances found on High exposure hardbottom.
Based on the results of the 2014 Benthic Habitat Map, the initial hardbottom classification system was revised to include only two parameters: 1) distance from shore (nearshore, offshore); and, 2) hardbottom exposure (low, medium, high) (see **Section 1.1**). These two parameters can be combined to create the following six hardbottom types: Shallow-High Exposure (less than 3 m depth and greater than 60% exposure), Shallow-Low Exposure (less than 3 m depth and less than 60% exposure), Deep-High Exposure (greater than 3 m depth and greater than 60% exposure), and Deep-Low Exposure (greater than 3 m depth and less than 60% exposure).

Table 1.7.1. Original transect information including name, type, project area (nearest R-monument), length, and date installed. Note that revisions to transects are provided in **Table 1.2.1**.

Name	Type		Location	Length	Installed
	(Reg / Nonreg)	(Sed Only/ Bio)	(R#)	(m)	(mm/yy)
R-80.5	Nonreg	Bio	R-80+500'	150	6/22/2015
R-83	Nonreg	Bio	R-83	156.8	6/22/2015
R-88	Nonreg	Bio	R-88	172	10/30/2014
R-90	Reg	Bio	R-90	282	10/20/2014
T-14	Reg	Sed Only	R-90+400'	200	10/3/2014
T-13	Reg	Sed Only	R-91+340'	200	10/2/2014
R-91	Reg	Bio	R-91+850'	308	10/3/2014
R-92	Reg	Bio	R-92+280'	325.6	10/17/2014
R-92 Offshore Station	Nonreg	Bio	R-92	22	6/22/2015
R-93	Reg	Bio	R-93	203	10/17/2014
R-94	Nonreg	Bio	R-94	281	10/29/2014
R-94 Offshore Station	Nonreg	Bio	R-94	22	6/22/2015
R-95 (Breakers)	Nonreg	Bio	R-94+685'	245	10/22/2014
T-9	Reg	Sed Only	R-94+1,140'	194	10/2/2014
T-8	Reg	Sed Only	R-95	56	10/1/2014
T-7	Reg	Sed Only	R-96+740'	62	10/1/2014
R-97	Reg	Bio	R-97	62	10/22/2014
T-6	Reg	Sed Only	R-98	75.2	10/1/2014

R-98	Reg	Bio	R-98+600'	94	10/20/2014
T-5	Reg	Sed Only	R-98+700'	78	9/30/2014
R-99	Reg	Bio	R-99	95	10/20/2014
T-4	Reg	Sed Only	R-99+300'	90	9/30/2014
R-100	Reg	Bio	R-100+230'	117	10/22/2014
R-101	Reg	Bio	R-101	107.3	10/22/2014
R-103	Reg	Bio	R-103	151	10/29/2014
R-113	Nonreg	Bio	R-113+380'	2.2	10/30/2014
R-115	Nonreg	Bio	R-115+340'	15.5	10/30/2014
R-116	Nonreg	Bio	R-116+560'	29.5	10/30/2014
R-132	Nonreg	Bio	R-132+260'	117	10/30/2014
R-133	Nonreg	Bio	R-133+180'	143	10/30/2014
R-136	Nonreg	Bio	R-136	137	6/19/2015
R-139	Nonreg	Bio	R-139+110'	67	6/19/2015
R-142	Nonreg	Bio	R-142	125.5	6/19/2015
R-145	Nonreg	Bio	R-145	157.4	6/19/2015

Table 1.7.2. Original Habitat Classification Tracking Table. Acreage of hardbottom by distance from shore and persistence of exposure.

Depth Zone	**Exposure Category (Acreages)**			
	Low (<30%)	**Medium (30-70%)**	**High (>70%)**	***Total***
Above MHW	28.36	3.17	0.15	*31.68*
Nearshore (MHW to 3 m)	167.27	58.27	19.60	*245.14*
Offshore (3 to 8 m)	177.99	70.04	81.75	*329.78*
Far Offshore (8 to 12 m)	37.34	4.25	3.11	*44.70*
Total	*410.95*	*135.73*	*104.61*	***651.30***

APPENDIX B-2

Hardbottom Mitigation Plan

2.0 Introduction

The current projects proposed in the BMA do not include any anticipated direct or secondary impacts, therefore no mitigation is required. In the event future projects having resource impacts are proposed to be included in the BMA (which would require an amendment), the Hardbottom Mitigation Plan provides a strategy to offset these impacts. The following plan summarizes the strategy for assessing mitigation requirements to anticipated project impacts.

2.1 Impact Avoidance and Minimization

Projects included within the BMA must be designed to avoid and minimize resource impacts to the maximum extent practicable. Additionally, criteria outlined in s. 373.414, F.S. must be considered to determine that proposed projects are not contrary to the public interest. Any areas of anticipated project impact involving endangered species or designated critical habitat will warrant consultation with state and federal agencies including NMFS, FWC, FWS, and the Corps.

2.2 Mitigation Strategies for Anticipated Impacts

Anticipated impacts to habitat from BMA projects will be offset by upfront mitigation or mitigation constructed concurrent with project construction. Mitigation ratios were evaluated using information from previously permitted projects since 2000. The majority of the projects evaluated used the Uniform Mitigation Assessment Method (UMAM) to calculate the mitigation required to offset the functional loss at the impact site. The mitigation amounts were averaged to determine a standard and adequate ratio of 1:1 when mitigation is completed prior construction of the beach nourishment or restoration project, or a 1:1.5 ratio when the mitigation is constructed concurrently or after construction of the project, to account for a time lag of up to 2 years.

Typically, anticipated impacts involve direct burial of resources occurring within the equilibrium toe of fill of sand placement, and any predicted secondary impacts due to increased sediment loading in the system. Direct impact estimations are usually associated with the equilibrium toe of fill prediction, and the secondary impacts are impacts predicted beyond the ETOF. All anticipated direct impacts are typically considered a permanent loss, as they are predicted within the ETOF and are traditionally mitigated by creation of a new habitat to replace the lost habitat and associated functions. In the case of hardbottom resources, this is best achieved by the creation of an artificial reef using comparable materials to imitate the natural substrate. Secondary loss, which is typically expressed by a loss of functionality, and can be either permanent or temporary, is best mitigated through the re-establishment or restoration of the degraded functions. For example, in hardbottom habitats, coral nurseries can serve as transplant donors to impacted receiver sites needing re-establishment; enhancement of certain corals' spawning sites can increase the larval support for a secondary area surrounding a spawning site; and propagation of corals or octocorals can serve to restore fauna that have been impaired (Abelson, Avigdor, 2006, Artificial Reefs vs Coral Transplantation as Restoration tools for Mitigating Coral Reef Deterioration: Benefits, Concerns, and Proposed Guidelines; *Bulletin of Marine Science*,78(1) 151-159). The below table shows mitigation options for offsetting any anticipated impacts for future projects (Table 2). At the implementation phase of the BMA, there are no anticipated impacts from the currently proposed projects that require mitigation.

Table 2: Mitigation of Anticipated Impacts

Impact type	Mitigation option 1	Mitigation option 2	Mitigation option 3
Anticipated impact – direct burial (burial in ETOF)	Upfront mitigation reef (ratio of 1: 1) Placement dependent on type of HB community, and features of impacted reef (depth, relief)	Post project mitigation reef (ratio of 1: 1.5) Placement dependent on type of HB community, and features of impacted reef (depth, relief)	Alternative mitigation (if possible)
Anticipated Impact– secondary impact resulting in community degradation, loss of recruitment	Coral nursery –typical of impacted habitat	Creation of spawning sites – typical for impacted habitat	Propagation of octocorals or scleractinian corals typical for impacted habitat

2.3 Unanticipated Project Impacts

Any unanticipated impacts assessed through project specific monitoring transects will be subject to compliance and enforcement action by the Department.

APPENDIX B-3

Marine Turtle Habitat Monitoring Plan (FWC)

3.0 Introduction

Cell-Wide monitoring of nesting beaches on Palm Beach Island will be implemented as part of the BMA impact analysis required under state and federal laws. Cell-Wide monitoring will enable assessment of changes in marine turtle nesting on project beaches relative to fluctuations in nesting that occur naturally across the island. Placement of sand on the shoreline, either through dune restoration or nourishment, during beach management activities changes the nesting substrate in the project area and can impact the availability of important nearshore habitat. Implementing a cell-wide approach through the BMA will allow any changes observed in monitored nesting parameters to be evaluated across the broader landscape that includes the project site and adjacent island beaches. Monitoring marine turtle behavior and reproductive success on an island-wide basis in addition to project-specific monitoring offers an opportunity to determine the influence of beach management activities across a broader spatial and temporal scale within a framework including fluctuations in marine turtle nesting independent of beach management activities.

Cell-wide monitoring must be sufficient to adequately assess the spatial and temporal extent of marine turtle nesting independent of beach management activities; to assess reproductive success within and outside the project areas; and to enable statistically valid comparisons of nesting among each site (treatment, reference, and cell-wide). Such monitoring enables state and federal resource managers to evaluate the impact of spatially and temporally isolated beach management activities on overall utilization of Island habitats by nesting marine turtles. It is important to note that the goal of cell-wide monitoring is not to implement the intensive, project-specific monitoring required under existing permits across the entire Island. Rather, cell-wide monitoring standardizes surveys within and outside project sites over time to enable assessment of beach management activities on marine turtle nesting across Palm Beach Island.

Cell-wide monitoring shall be implemented for all marine turtle nesting beaches across Palm Beach Island. For beaches within the Town of Palm Beach, the preference is for one Marine Turtle Permit Holder (MTPH) to conduct all BMA-required monitoring throughout the duration of the BMA to ensure data consistency. Nesting surveys and marking for marine turtle nests in cell-wide areas outside the Town's boundaries shall be conducted by the FWC-authorized MTPH for that beach. If there is no FWC-authorized MTPH on a particular beach, the required cell-wide monitoring may be completed by the Town of Palm Beach MTPH. Each MTPH must determine the resources necessary to conduct any additional work required as part of the cell-wide monitoring plan. In all cases, maintaining the existing network of volunteers on Palm Beach Island is a priority during implementation of the Palm Beach Island BMA.

3.1 Nesting Information (Historical), Zones, and Assessment Methods

The purpose of the cell-wide nesting beach monitoring program is to separate natural spatial and temporal variability from variation caused by a specific beach management activity (i.e., impact). Monitoring of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtle nesting behavior will be implemented to assess changes in nesting decision, nest site selection, and reproductive success due to specific beach management activities. Loggerhead and green turtle hatch success on Reference Zones will be compared to hatch success for the Treatment Zones with an expectation of at least 60% hatch success for both locations. Leatherback (*Dermochelys coriacea*) nesting will also be monitored but may not be included in subsequent analysis depending on number of nests.

To develop the cell-wide monitoring protocol, DEP staff provided a map of Palm Beach Island divided into 70, 1,000-foot long zones (shore parallel) roughly based on R-monuments. Historical nesting data from 2006 to 2011 were used to calculate an average number of nests per zone (~36 loggerhead nests + 5 std. dev) for ~66 zones surveyed across the island. More detailed information on nesting success, nest density, hatch success and nest location along the profile will be compared from 16 Reference Zones not scheduled for beach management activities within the Town of Palm Beach – nourishment, dune restoration, or groin construction or repair - and from 16 Treatment Zones subject to beach management. While the goal is to use the same Reference Zones throughout the monitoring period, subsequent beach management activities within an identified Reference Zone may require selecting an alternative location.

3.2 Cell-Wide Monitoring Methods

Prior to initiation of monitoring under the BMA, and prior to beach management activities, each of the 66 island-wide zones shall be reviewed in the field to identify distinct physical features such as armoring, groins or natural dunes; this survey will be repeated periodically as needed.

A. All monitoring and reporting shall utilize existing zones set as part of original BMA monitoring plan or as delineated for beaches added in subsequent IPA approvals. Zone characterization (e.g., Treatement, Reference or Cell-wide) may change over time if additional beach management activities occur in that area.
B. Each zone across the island will be characterized as follows:
    1. History of beach management activities (dune restoration, nourished, non-nourished, dredge material placement);
    2. Source of fill (upland, offshore: DEP staff).

3. Back berm characteristics (sea wall, revetment, dune: noted by DEP or FWC staff during field work).
4. Shoreline structures (groin, breakwater, outfall: noted by DEP or FWC staff during field work).

C. The FWC volunteer MTPH(s) shall begin daily surveys Island-wide (across all zones) on March 1 and shall continue until October 15 or twelve days after the last emergence on the island except where daily monitoring must continue for beach cleaning or ongoing construction. Nests remaining in the beach shall continue to be checked at least three-times a week for post-construction monitoring.
   1. All nesting emergences shall be counted and classified as to nesting decision (e.g., nest or non-nesting emergence or false crawl) per species by date.
   2. The number of nests and false crawls per species shall be counted and reported for all zones.
   3. GPS locations shall be collected for all nests as follows.
      a. By MTPH or Contractor as agreed upon between MTPH and Contractor.
      b. GPS locations shall be obtained using either a handheld or Department-approved unit (Volunteer MTPH will not be expected to purchase new GPS units for cell-wide monitoring).

3.3 Project Specific Marine Turtle Monitoring

To identify nesting response specific to each beach management event, sixteen (16) of the sixty-six (66) zones with ongoing or recent beach management within the Town of Palm Beach will be randomly selected to monitor more intensely for reproductive success by collecting nesting decision (nest or false crawl), location of nesting decision across the profile, nest fate, and nest inventory data (hatch and emergence success) for each species (Treatment Zones). An additional sixteen (16) Reference Zones in proximity to the Treatment Zones will be randomly chosen within the Town in areas not designated for beach management.

If future beach management occurs in an identified Reference Zone, a new reference area will be selected on a one-for-one basis to maintain a total of thirty-two (32) zones (16 Treatment and 16 Reference zones) for Project-specific Monitoring. Data collection will occur within these zones as follows.

A. The FWC MTPH shall mark all nests within the Treatment and Reference Zones according to the pre-determined sampling schedule with a goal of evaluating loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) nesting patterns, hatch and emergence success as follows. Leatherback (*Dermochelys coriacea*) nesting may be too sporadic to provide meaningful results.

1. The FWC-authorized Marine Turtle Permit Holder (MTPH) shall install a back dune marking system for all nests marked for inventory . The fate of all marked nests shall be documented during daily surveys (overwashed, washed out, disoriented, predated) and recorded using standardized codes approved by FWC;
2. In the event that nest markers are removed or washed out, all efforts shall be made by the MTPH to replace the markers timely but no later than five days after initial loss.

B. The following variables shall be measured within each Treatment and Reference Zone (n=32 total, 16 in each Zone) in accordance with the FWC Marine Turtle Management Conservation Guidelines.
   1. All nesting emergences shall be counted and classified as to nesting decision (e.g., nest or non-nesting emergence or false crawl) per species;
   2. The location of each emergence apex (nest and false crawl) across the profile shall be measured relative to the landward and seaward edges of the berm (seawall or dune toe and wrack line) and to any scarps;
      a. Approximate clutch location or the landward-most apex of the false crawl shall be measured with a sub-meter accuracy GPS unit.
      b. Nest fate shall be documented using standardized codes agreed upon between the FWC and the MTPH (e.g. disorientation, inundation, wash over, wash out or erosion, predation).

   3. Nest inventories shall be conducted for all marked nests within the 32 zones (16 Treatment and 16 Reference) to document hatch and emergence success. Nest inventories shall be conducted no sooner than three days after signs of first emergence or 70 days after date laid (80 days for leatherbacks);
      a. Nest inventory data shall include number of eggs hatched, pipped live eggs, pipped dead eggs, dead in the nest, live in the nest, damaged eggs, and whole eggs in accordance with the FWC Marine Turtle Conservation Handbook.
      b. In the event that nest markers are removed or washed out, all efforts shall be made by the MTPH to replace the markers timely but no later than five days after initial loss.

C. Data shall be provided to FWC electronically in the monitoring spreadsheet by January 15 each year (MTPH).

   1. Data shall be analyzed using standard statistical methods to identify and quantify any impacts to marine turtle reproductive success and nesting behavior on project areas relative to other nesting beaches on the Island;

2. The resource agencies will review monitoring results and determine if additional consultation is needed to address any differences indicated by the statistical testing – was the null hypothesis of no impact due to cell-wide beach management activities rejected? If not, can specific aspects of the managed projects be identified as significantly correlated with significant results?

3.4 Reporting Protocols

The Excel spreadsheet summarizing the results of all surveys shall be submitted electronically to FWC by January 15 of the following year. Daily survey sheets shall be provided upon request.

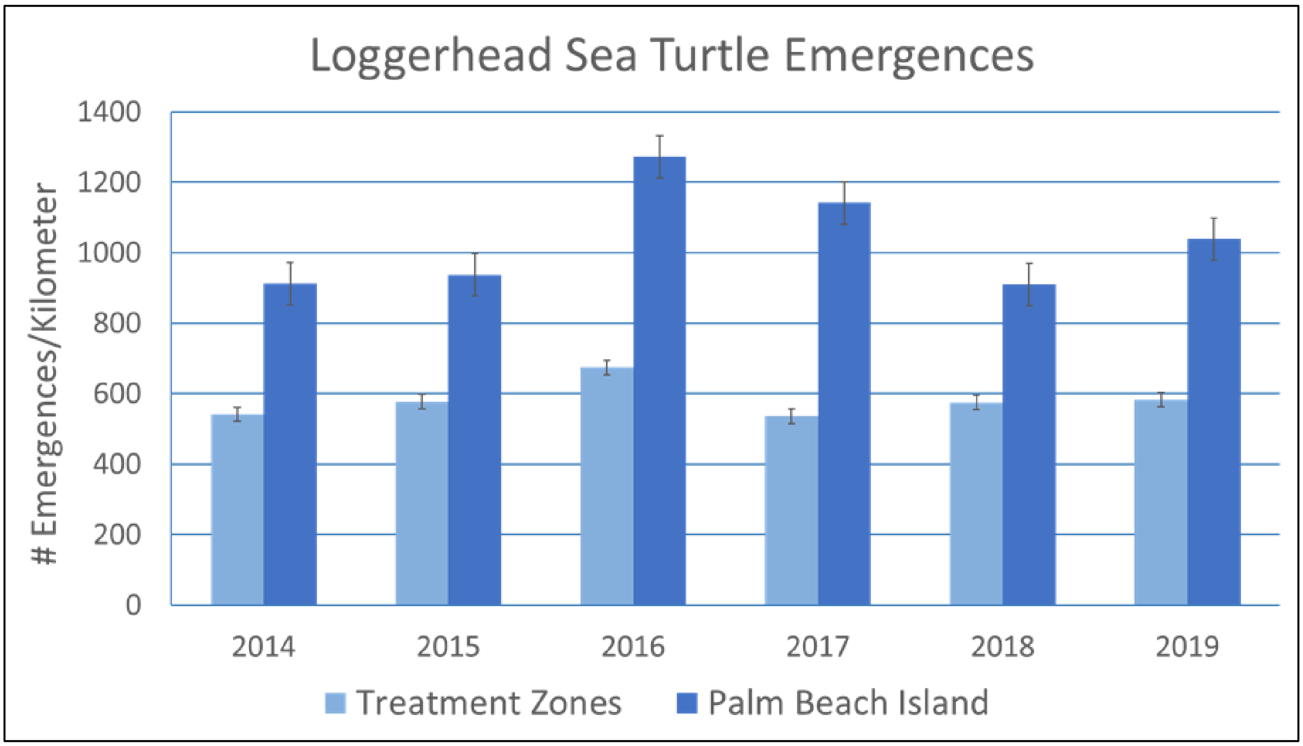

Figure 3.1. Annual number of Loggerhead marine turtle emergences per kilometer in the Treatment Zones and on Palm Beach Island (excluding Treatment Zones) from 2014 to 2019. Beach management events (nourishment) occurred in the Treatment Zones March through April, 2015 and 2016.

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APPENDIX B-4

Physical Monitoring and Reporting Plan

4.0 Monitoring Protocols

Topographic and bathymetric profile surveys of the beach and offshore shall be conducted annually. Surveys will be conducted during a spring or summer month and repeated as close as practicable during that same month of the year. The monitoring area will include profile surveys at each of the Department of Environmental Protection's DNR reference monuments within the bounds of the agreement area. For those project areas that contain erosion control structures, such as groins or breakwaters, additional profile lines will be surveyed at a sufficient number of intermediate locations to accurately identify patterns of erosion and accretion within this subarea. All work activities and deliverables shall be conducted in accordance with the latest update of the Department's *Monitoring Standards for Beach Erosion Control Projects, Sections 01000 and 01100*.

4.1 Reporting Protocols

An engineering report and the monitoring data shall be submitted to the Department and all parties to this beach management agreement within 90 days following completion of a post-construction borrow area survey and each annual monitoring survey. The report shall summarize and discuss the data, the performance of the beach fill projects, and identify erosion and accretion patterns within the coastal cell. The report shall update the shoreline and volumetric changes at each reference monument and by reach. The annual report shall include the volume of sand discharged by the Sand Transfer Plant through each discharge pipeline during the previous twelve months. In addition, the report shall include a comparative review of project performance to performance expectations and identification of adverse impacts attributable to the projects. Appendices shall include plots of survey profiles and graphical representations of volumetric and shoreline position changes for the monitoring area. Results shall be analyzed for patterns, trends, or changes between annual surveys and cumulatively since project construction.

APPENDIX B-5

Historical Hardbottom Data and Analysis

<u>Town of Palm Beach Historic Aerial Photographic Interpretation</u>

Interpreted Hardbottom By Date Collected & Beach Management Agreement Study Area Reach

THESE DATA SHOULD BE CONSIDERED AS DRAFT UNTIL A FINAL QA-QC HAS BEEN CONDUCTED FOLLOWING COMPLETION OF ALL DELINEATION ACTIVITIES.

Reach Designation	August 2000 Acreage (PBC)	July 8, 2001 Acreage (PBC)	July 29, 2003 Acreage (PBC)	July 16 & 17, 2004 Acreage (PBC)	July 25 & August 6, 2005 Acreage (PBC)	July 26, 2006 Acreage (PBC)	July 15 & 20, 2007 Acreage (PBC)	July 31, 2008 Acreage (PBC)
Reach 1: R76 to R78	0.05	0.44	0.01	0.00	0.00	0.00	0.00	0.00
Reach 2: R78 to R90+400'	46.69	43.96	36.34	42.86	87.81	67.36	68.47	56.05
Reach 3: R90+400' to R95	39.40	45.03	44.95	42.28	48.29	47.49	44.43	44.43
Reach 4: R95 to R102+300'	34.54	43.48	48.00	47.27	17.11	39.09	26.73	26.80
Reach 5: R102+300' to R110+100'	18.35	18.07	19.80	17.46	16.59	19.69	17.32	10.42
Reach 6: R110+100' to R116+500'	19.01	20.58	4.87	1.77	13.74	17.23	11.67	4.84
Reach 7: R116+500' to R128+530'	1.72	2.67	6.58	9.18	18.70	0.09	1.28	3.04
Reach 8: R128+530' to T133+500'	7.44	8.60	2.61	5.34	12.91	14.90	11.37	2.23
Reach 9: T133+500' to R137+400'	8.52	2.17	0.61	8.62	10.90	18.77	12.85	8.81
Reach 10: R137+400' to R145+740'	19.72	24.67	7.73	33.24	26.44	38.48	36.87	33.36
Reach 11: R145+740' to R151+300' (Boynton Inlet)	6.18	2.06	0.06	3.68	1.86	3.84	1.04	0.61
Total Acreage	**201.60**	**211.74**	**171.56**	**211.71**	**254.34**	**266.94**	**232.03**	**190.61**

Reach Designation	October 2-3, 2009 Acreage (PBC)	October 10, 2010 Acreage (ACA)	October 10, 2011 Acreage (ACA)	March 30, 2012 Acreage (ACA)	Average	SD	Trend
Reach 1: R76 to R78	0.20	0.00	0.26	0.06	0.085	0.143	decreasing
Reach 2: R78 to R90+400'	77.24	68.98	62.59	59.61	59.831	15.336	increasing
Reach 3: R90+400' to R95	53.92	63.59	51.86	55.45	48.427	6.721	increasing
Reach 4: R95 to R102+300'	50.69	50.69	31.81	41.93	38.178	10.844	increasing
Reach 5: R102+300' to R110+100'	19.58	21.08	12.57	19.68	17.551	3.138	decreasing
Reach 6: R110+100' to R116+500'	1.10	1.23	4.17	2.15	8.530	7.439	decreasing
Reach 7: R116+500' to R128+530'	1.72	1.45	1.02	2.24	4.141	5.254	decreasing
Reach 8: R128+530' to T133+500'	0.45	2.72	4.35	2.53	6.288	4.730	decreasing
Reach 9: T133+500' to R137+400'	1.03	3.42	5.07	2.52	6.941	5.498	decreasing
Reach 10: R137+400' to R145+740'	6.87	3.27	7.36	12.33	20.862	12.989	decreasing
Reach 11: R145+740' to R151+300' (Boynton Inlet)	1.28	N/A	N/A	N/A	2.290	1.939	decreasing
Total Acreage	**214.06**	***216.42**	***181.06**	***198.5**	**212.547**	**27.918**	**decreasing**

* Total Acreage does not include entire BMA study area

Town of Palm Beach Historic Aerial Photographic Interpretation

Interpreted Hardbottom by Date Collected, Beach Management Agreement Study Area Reach, and Offshore Zone

Delineation of the Nearshore (seaward to the -13.1’ depth contour NAVD 88), Intermediate (between the -13.1’ and -26.2’ depth contour NAVD 88), and Offshore (between the -26.2’ and -40.0’ depth contour NAVD 88) zones as determined by the FDEP is based on the Town of Palm Beach, Florida August 9, 2010 beach profile data collected by Sea Diversified, Inc. and referenced to NAVD 88, NAD 83/90.R73 - R135. The FDEP has also compared the August 9, 2010 depth contours to the 2002 Laser Airborne Depth Sounder data and determined that the data sets are in satisfactory agreement.

THESE DATA SHOULD BE CONSIDERED AS DRAFT UNTIL A FINAL QA-QC HAS BEEN CONDUCTED FOLLOWING COMPLETION OF ALL DELINEATION ACTIVITIES.

Reach Designation	Zone	August 2000 Acreage (PBC)	July 8, 2001 Acreage (PBC)	July 29, 2003 Acreage (PBC)	July 16 & 17, 2004 Acreage (PBC)	July 25 & August 6, 2005 Acreage (PBC)	July 26, 2006 Acreage (PBC)	July 15 & 20, 2007 Acreage (PBC)	July 31, 2008 Acreage (PBC)
Reach 1: R76 to R78	Nearshore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 1: R76 to R78	Intermediate	0.05	0.44	0.01	0.00	0.00	0.00	0.00	0.00
Reach 1: R76 to R78	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 1: R76 to R78	**Total**	**0.05**	**0.44**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Reach 2: R78 to R90+400'	Nearshore	42.58	36.46	29.38	37.22	75.33	57.07	55.77	44.55
Reach 2: R78 to R90+400'	Intermediate	4.11	7.49	5.94	5.63	12.46	10.29	12.68	9.47
Reach 2: R78 to R90+400'	Offshore*	0.00	0.01	1.02	0.01	0.02	0.00	0.02	2.03
Reach 2: R78 to R90+400'	**Total**	**46.69**	**43.96**	**36.34**	**42.86**	**87.81**	**67.36**	**68.47**	**56.05**
Reach 3: R90+400' to R95	Nearshore	12.68	11.72	13.78	9.57	8.97	11.68	8.27	11.32
Reach 3: R90+400' to R95	Intermediate	22.91	29.38	27.19	29.60	33.54	28.71	26.56	26.12
Reach 3: R90+400' to R95	Offshore*	3.81	3.93	3.98	3.11	5.78	7.10	9.60	6.99
Reach 3: R90+400' to R95	**Total**	**39.40**	**45.03**	**44.95**	**42.28**	**48.29**	**47.49**	**44.43**	**44.43**
Reach 4: R95 to R102+300'	Nearshore	2.60	0.02	0.02	0.00	0.11	0.44	0.04	0.36
Reach 4: R95 to R102+300'	Intermediate	30.74	41.18	46.98	45.91	17.00	35.82	25.50	24.13
Reach 4: R95 to R102+300'	Offshore*	1.20	2.28	1.00	1.36	0.00	2.83	1.19	2.31
Reach 4: R95 to R102+300'	**Total**	**34.54**	**43.48**	**48.00**	**47.27**	**17.11**	**39.09**	**26.73**	**26.80**
Reach 5: R102+300' to R110+100'	Nearshore	5.42	4.51	5.42	2.41	3.50	4.07	3.74	1.36

Reach Designation	Zone	August 2000 Acreage (PBC)	July 8, 2001 Acreage (PBC)	July 29, 2003 Acreage (PBC)	July 16 & 17, 2004 Acreage (PBC)	July 25 & August 6, 2005 Acreage (PBC)	July 26, 2006 Acreage (PBC)	July 15 & 20, 2007 Acreage (PBC)	July 31, 2008 Acreage (PBC)
Reach 5: R102+300' to R110+100'	Intermediate	12.84	13.39	14.22	14.94	13.00	15.54	13.54	9.00
Reach 5: R102+300' to R110+100'	Offshore*	0.09	0.17	0.16	0.11	0.09	0.08	0.04	0.06
Reach 5: R102+300' to R110+100'	**Total**	**18.35**	**18.07**	**19.80**	**17.46**	**16.59**	**19.69**	**17.32**	**10.42**
Reach 6: R110+100' to R116+500'	Nearshore	19.01	20.58	4.87	1.77	13.74	17.23	11.67	4.84
Reach 6: R110+100' to R116+500'	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 6: R110+100' to R116+500'	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 6: R110+100' to R116+500'	**Total**	**19.01**	**20.58**	**4.87**	**1.77**	**13.74**	**17.23**	**11.67**	**4.84**
Reach 7: R116+500' to R128+530'	Nearshore	1.72	2.67	6.58	9.18	18.70	0.09	1.28	3.04
Reach 7: R116+500' to R128+530'	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 7: R116+500' to R128+530'	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 7: R116+500' to R128+530'	**Total**	**1.72**	**2.67**	**6.58**	**9.18**	**18.70**	**0.09**	**1.28**	**3.04**
Reach 8: R128+530' to T133+500'	Nearshore	7.44	8.60	2.61	5.34	12.91	14.90	11.37	2.23
Reach 8: R128+530' to T133+500'	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 8: R128+530' to T133+500'	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 8: R128+530' to T133+500'	**Total**	**7.44**	**8.60**	**2.61**	**5.34**	**12.91**	**14.90**	**11.37**	**2.23**
Reach 9: T133+500' to R137+400'	Nearshore	8.52	2.17	0.61	8.62	10.90	18.77	12.85	8.81
Reach 9: T133+500' to R137+400'	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 9: T133+500' to R137+400'	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 9: T133+500' to R137+400'	**Total**	**8.52**	**2.17**	**0.61**	**8.62**	**10.90**	**18.77**	**12.85**	**8.81**
Reach 10: R137+400' to R145+740'	Nearshore	19.72	24.67	7.73	33.24	26.44	38.48	36.87	33.36
Reach 10: R137+400' to R145+740'	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 10: R137+400' to R145+740'	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Reach Designation	Zone	August 2000 Acreage (PBC)	July 8, 2001 Acreage (PBC)	July 29, 2003 Acreage (PBC)	July 16 & 17, 2004 Acreage (PBC)	July 25 & August 6, 2005 Acreage (PBC)	July 26, 2006 Acreage (PBC)	July 15 & 20, 2007 Acreage (PBC)	July 31, 2008 Acreage (PBC)
Reach 10: R137+400' to R145+740'	**Total**	**19.72**	**24.67**	**7.73**	**33.24**	**26.44**	**38.48**	**36.87**	**33.36**
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Nearshore	6.18	2.06	0.06	3.68	1.86	3.84	1.04	0.61
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Intermediate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Offshore*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reach 11: R145+740' to R151+300' (Boynton Inlet)	**Total**	**6.18**	**2.06**	**0.06**	**3.68**	**1.86**	**3.84**	**1.04**	**0.61**
Total Acreage	Nearshore	125.87	113.46	71.06	111.03	172.46	166.57	142.90	110.48
Total Acreage	Intermediate	70.65	91.88	94.34	96.08	76.00	90.36	78.28	68.72
Total Acreage	Offshore*	5.10	6.39	6.16	4.59	5.89	10.01	10.85	11.39
Total Acreage	**Total**	**201.60**	**211.74**	**171.56**	**211.71**	**254.34**	**266.94**	**232.03**	**190.61**

Reach Designation	Zone	October 2-3, 2009 Acreage (PBC)	October 10, 2010 Acreage (ACA)	October 10, 2011 Acreage (ACA)	March 30, 2012 Acreage (ACA)	Average	SD	Trend
Reach 1: R76 to R78	Nearshore	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 1: R76 to R78	Intermediate	0.00	0.00	0.26	0.06	0.069	0.140	decreasing
Reach 1: R76 to R78	Offshore*	0.20	0.00	0.00	0.00	0.017	0.058	increasing
Reach 1: R76 to R78	**Total**	**0.20**	**0.00**	**0.26**	**0.06**	**0.085**	**0.143**	decreasing
Reach 2: R78 to R90+400'	Nearshore	58.36	46.23	43.71	41.98	47.387	12.385	increasing
Reach 2: R78 to R90+400'	Intermediate	17.53	22.72	18.88	17.62	12.068	5.987	increasing
Reach 2: R78 to R90+400'	Offshore*	1.35	0.03	0.00	0.01	0.375	0.694	increasing
Reach 2: R78 to R90+400'	**Total**	**77.24**	**68.98**	**62.59**	**59.61**	**59.831**	**15.336**	increasing
Reach 3: R90+400' to R95	Nearshore	13.19	14.47	11.99	14.65	11.858	2.080	increasing
Reach 3: R90+400' to R95	Intermediate	35.20	40.26	34.70	34.74	30.743	4.955	increasing
Reach 3: R90+400' to R95	Offshore*	5.53	8.86	5.17	6.06	5.827	2.033	increasing
Reach 3: R90+400' to R95	**Total**	**53.92**	**63.59**	**51.86**	**55.45**	**48.427**	**6.721**	increasing
Reach 4: R95 to R102+300'	Nearshore	0.00	0.00	0.09	0.32	0.333	0.731	decreasing
Reach 4: R95 to R102+300'	Intermediate	49.93	50.09	31.33	40.96	36.631	10.953	increasing
Reach 4: R95 to R102+300'	Offshore*	0.76	0.60	0.39	0.65	1.214	0.857	decreasing
Reach 4: R95 to R102+300'	**Total**	**50.69**	**50.69**	**31.81**	**41.93**	**38.178**	**10.844**	increasing
Reach 5: R102+300' to R110+100'	Nearshore	5.13	4.61	2.34	4.74	3.938	1.315	decreasing
Reach 5: R102+300' to R110+100'	Intermediate	14.39	16.43	10.23	14.89	13.534	2.125	decreasing
Reach 5: R102+300' to R110+100'	Offshore*	0.06	0.04	0.00	0.05	0.079	0.049	decreasing
Reach 5: R102+300' to R110+100'	**Total**	**19.58**	**21.08**	**12.57**	**19.68**	**17.551**	**3.138**	decreasing
Reach 6: R110+100' to R116+500'	Nearshore	1.10	1.23	4.17	2.15	8.530	7.439	decreasing
Reach 6: R110+100' to R116+500'	Intermediate	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 6: R110+100' to R116+500'	Offshore*	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 6: R110+100' to R116+500'	**Total**	**1.10**	**1.23**	**4.17**	**2.15**	**8.530**	**7.439**	decreasing
Reach 7: R116+500' to R128+530'	Nearshore	1.72	1.45	1.02	2.24	4.141	5.254	decreasing

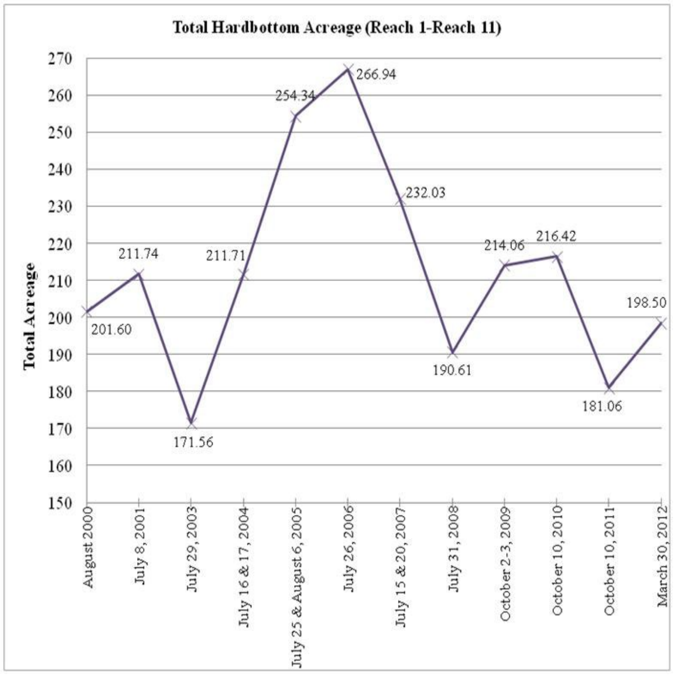
Reach Designation	Zone	October 2-3, 2009 Acreage (PBC)	October 10, 2010 Acreage (ACA)	October 10, 2011 Acreage (ACA)	March 30, 2012 Acreage (ACA)	Average	SD	Trend
Reach 7: R116+500' to R128+530'	Intermediate	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 7: R116+500' to R128+530'	Offshore*	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 7: R116+500' to R128+530'	**Total**	**1.72**	**1.45**	**1.02**	**2.24**	**4.141**	**5.254**	decreasing
Reach 8: R128+530' to T133+500'	Nearshore	0.45	2.72	4.35	2.53	6.288	4.730	decreasing
Reach 8: R128+530' to T133+500'	Intermediate	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 8: R128+530' to T133+500'	Offshore*	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 8: R128+530' to T133+500'	**Total**	**0.45**	**2.72**	**4.35**	**2.53**	**6.288**	**4.730**	decreasing
Reach 9: T133+500' to R137+400'	Nearshore	1.03	3.42	5.07	2.52	6.941	5.498	decreasing
Reach 9: T133+500' to R137+400'	Intermediate	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 9: T133+500' to R137+400'	Offshore *	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 9: T133+500' to R137+400'	**Total**	**1.03**	**3.42**	**5.07**	**2.52**	**6.941**	**5.498**	decreasing
Reach 10: R137+400' to R145+740'	Nearshore	6.87	3.27	7.36	12.33	20.862	12.989	decreasing
Reach 10: R137+400' to R145+740'	Intermediate	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 10: R137+400' to R145+740'	Offshore*	0.00	0.00	0.00	0.00	0.000	0.000	No change
Reach 10: R137+400' to R145+740'	**Total**	**6.87**	**3.27**	**7.36**	**12.33**	**20.862**	**12.989**	decreasing
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Nearshore	1.28	N/A	N/A	N/A	2.290	1.939	decreasing
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Intermediate	0.00	N/A	N/A	N/A	0.000	0.000	No change
Reach 11: R145+740' to R151+300' (Boynton Inlet)	Offshore*	0.00	N/A	N/A	N/A	0.000	0.000	No change
Reach 11: R145+740' to R151+300' (Boynton Inlet)	**Total**	**1.28**	N/A	N/A	N/A	**2.290**	**1.939**	decreasing
Total Acreage	Nearshore	89.13	77.40	80.10	83.46	111.994	34.396	decreasing
Total Acreage	Intermediate	117.05	129.50	95.40	108.27	93.044	18.497	increasing
Total Acreage	Offshore*	7.90	9.53	5.56	6.77	7.512	2.356	increasing
Total Acreage	**Total**	**214.06**	****216.42**	****181.06**	****198.50**	**212.547**	**27.918**	decreasing

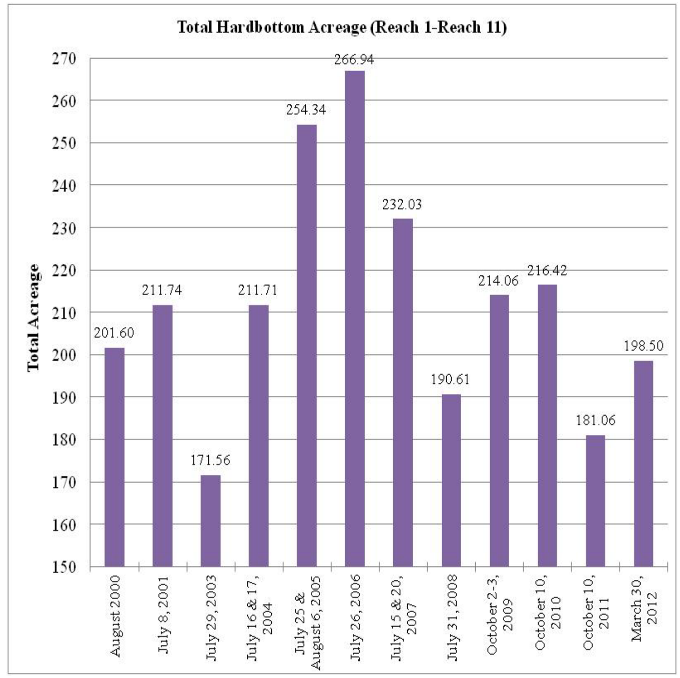
* The aerial imagery for all reviewed datasets does not extend to the eastern boundary (-40.0' depth contour NAVD 88) of the Offshore Zone. Therefore, the values presented for the Offshore

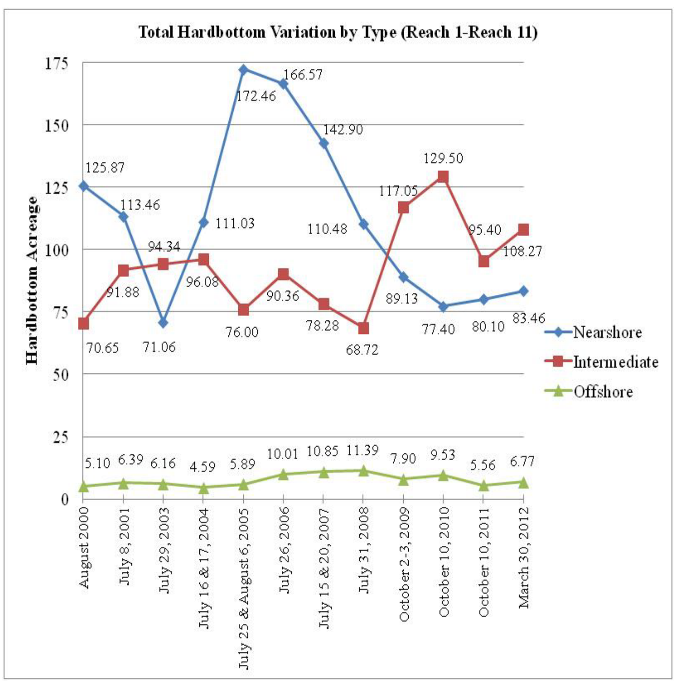
Zone as defined by the FDEP may not represent all hardbottom resources within this area. Based on review of the evaluated datasets, hardbottom resource delineation has been conducted for all features within the aerial image.

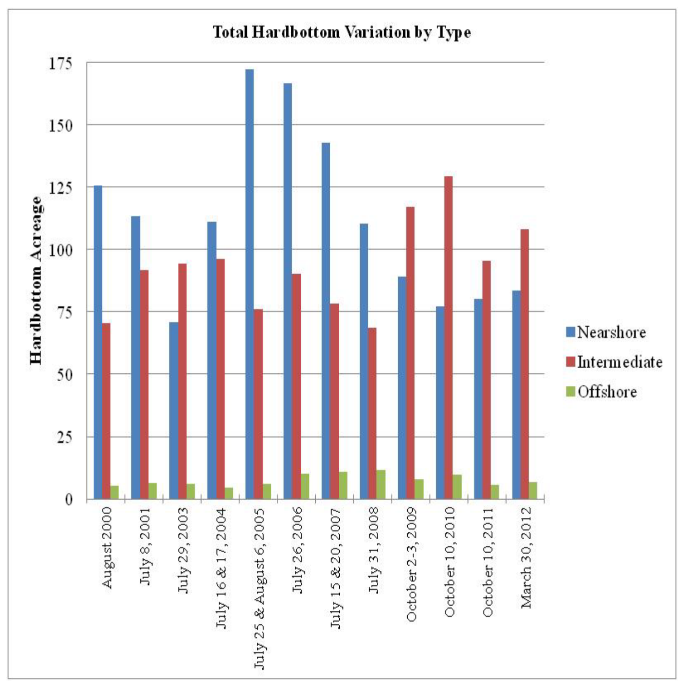
** Total Acreage does not include entire BMA study area

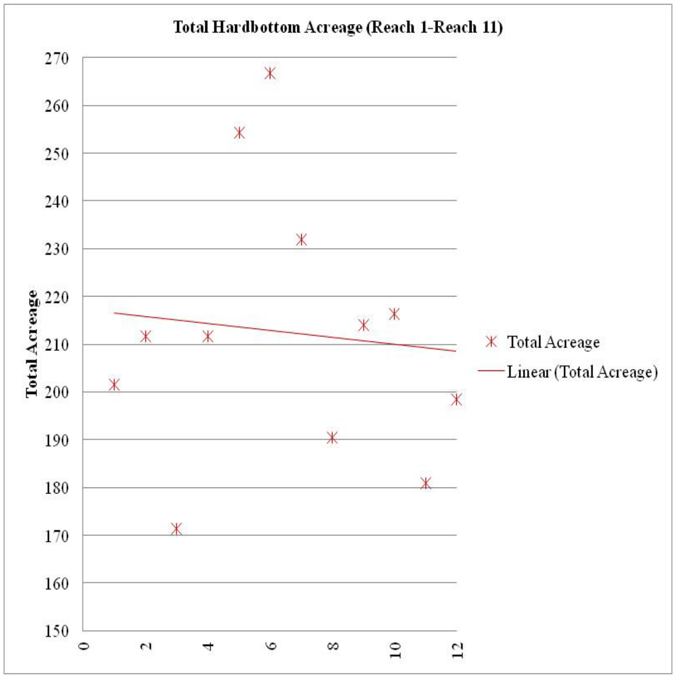
Hardbottom Data for Entire Cell



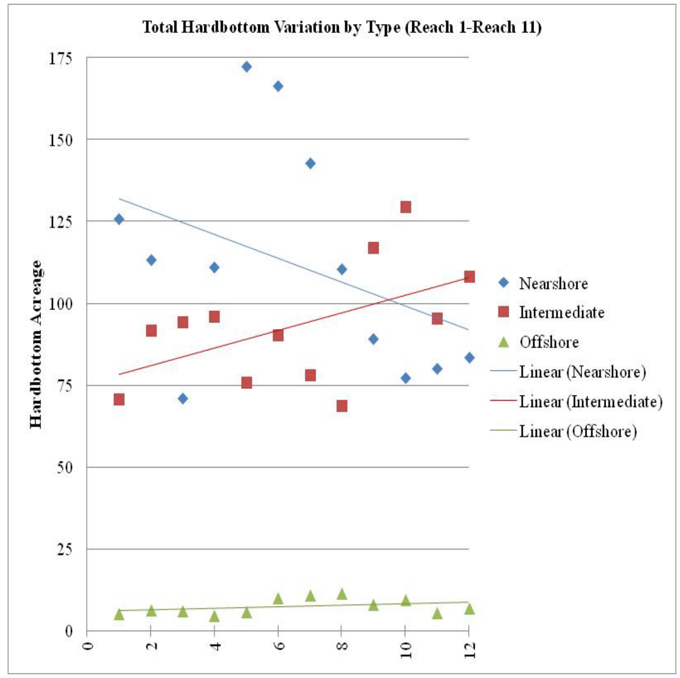




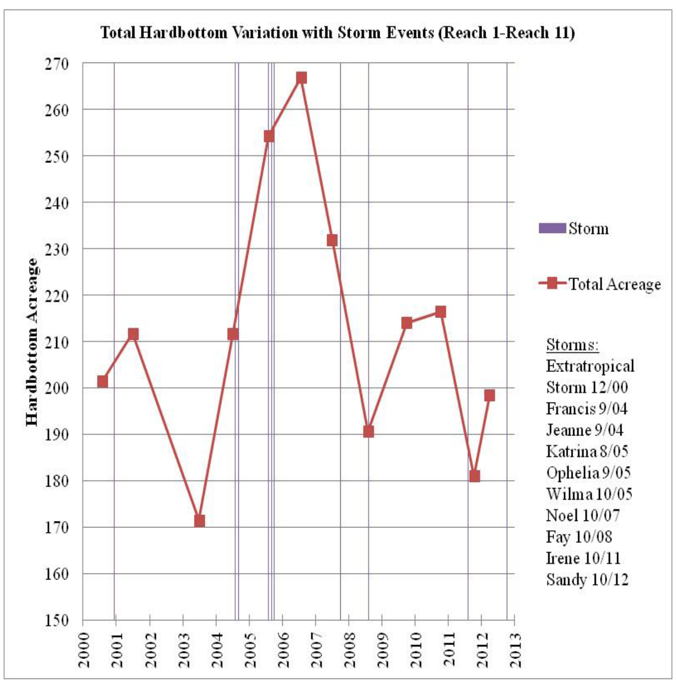




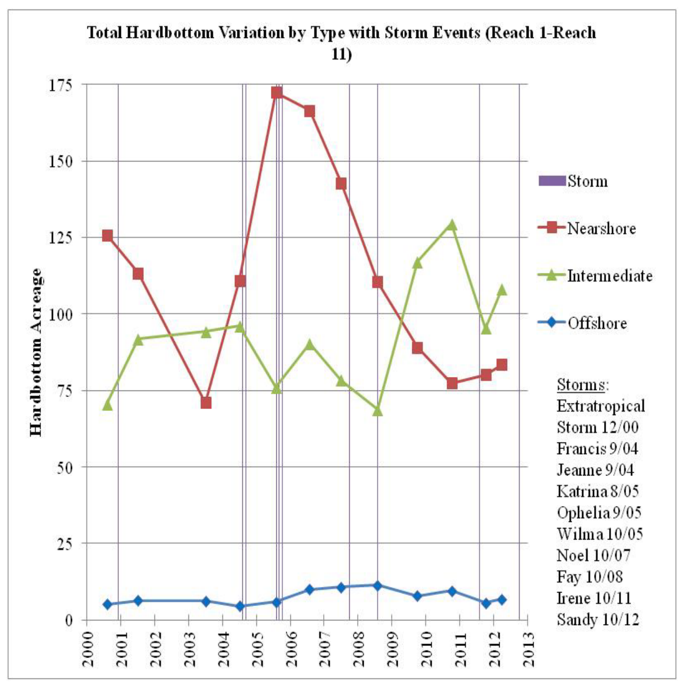
Total Hardbottom Acreage (Reach 1-Reach 11)
Total Acreage
Total Acreage
Linear (Total Acreage)



Total Hardbottom Variation by Type (Reach 1-Reach 11)
Hardbottom Acreage
Nearshore
Intermediate
Offshore
Linear (Nearshore)
Linear (Intermediate)
Linear (Offshore)

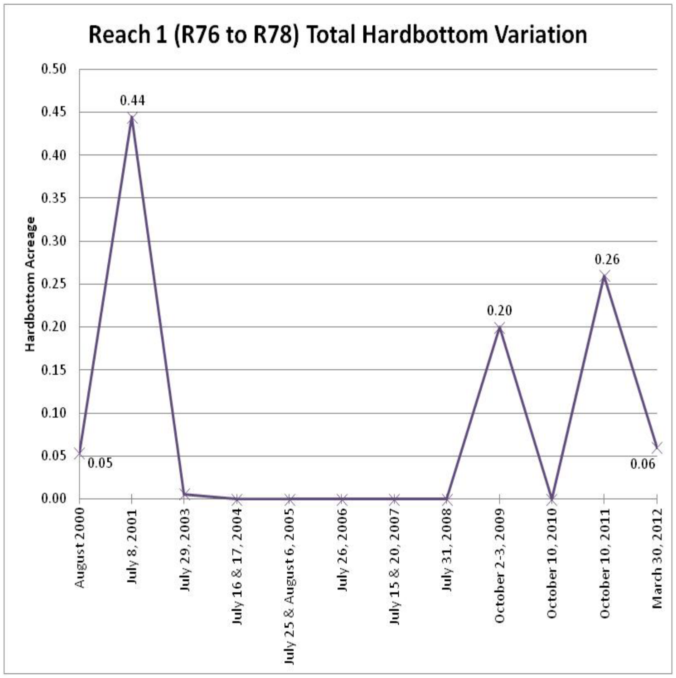


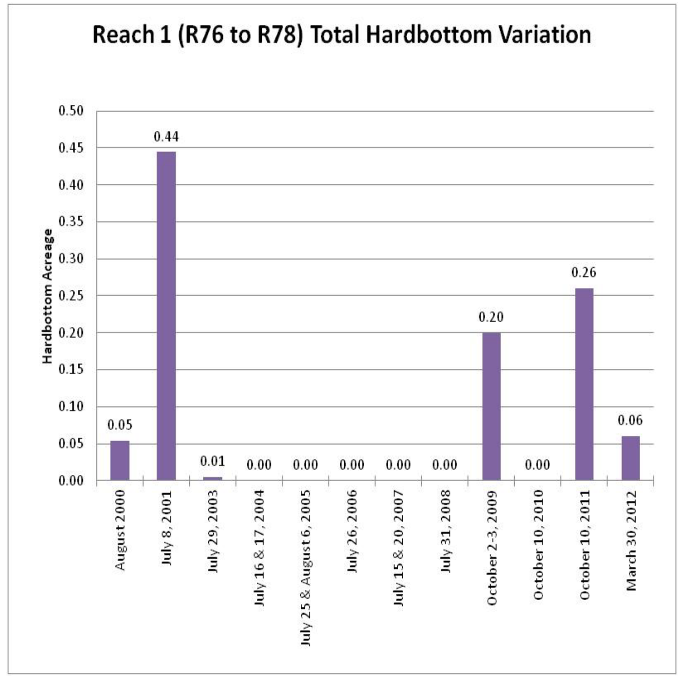
Total Hardbottom Variation with Storm Events (Reach 1-Reach 11)
Hardbottom Acreage
Storm
Total Acreage
Storms:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

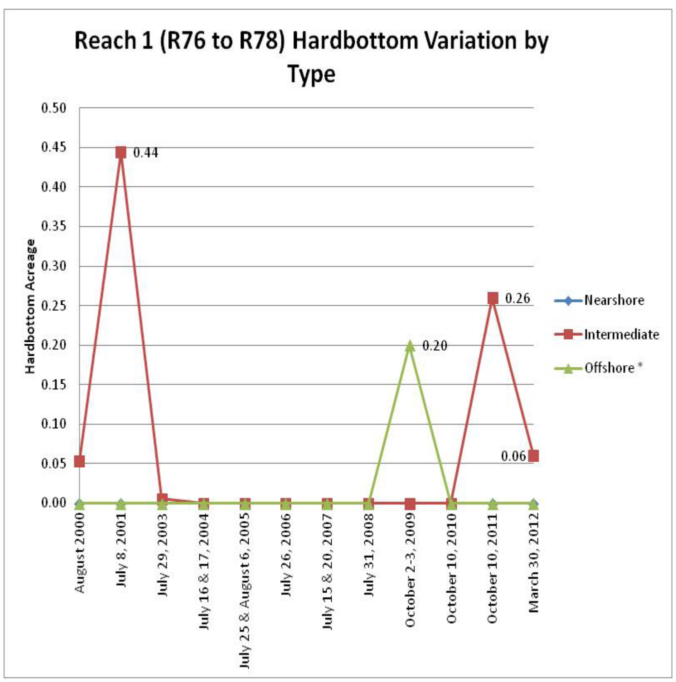


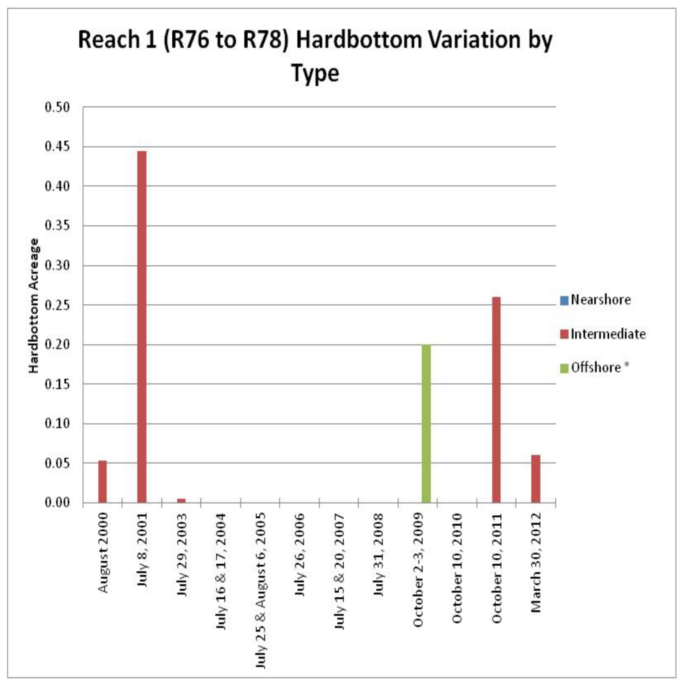
Total Hardbottom Variation by Type with Storm Events (Reach 1-Reach 11)
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore
Storms:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

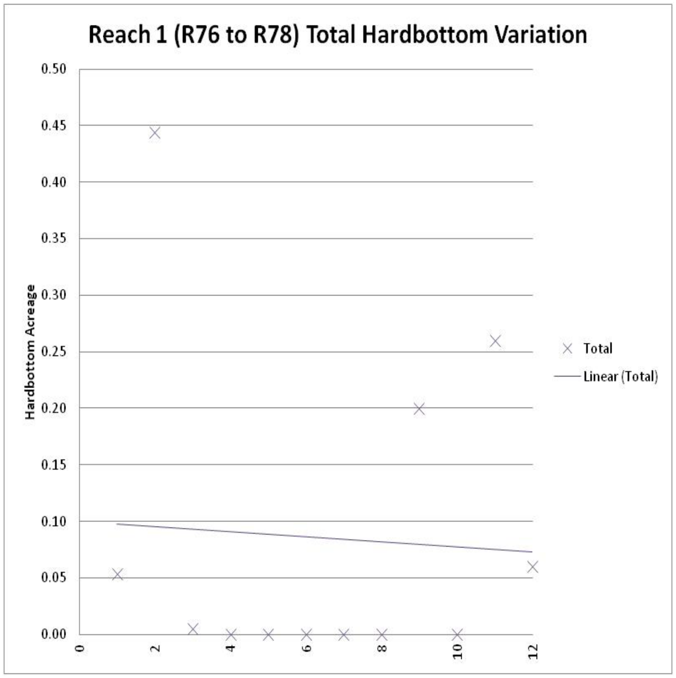
Hardbottom Data for Reach 1

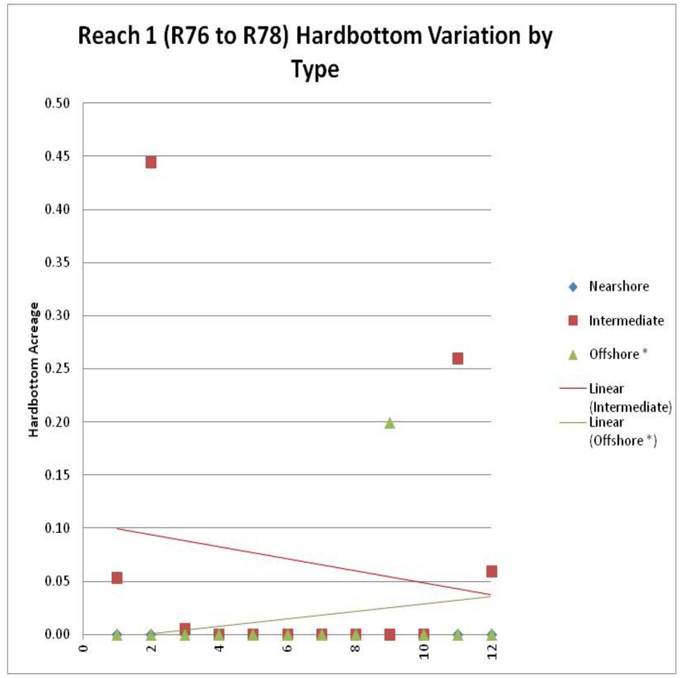


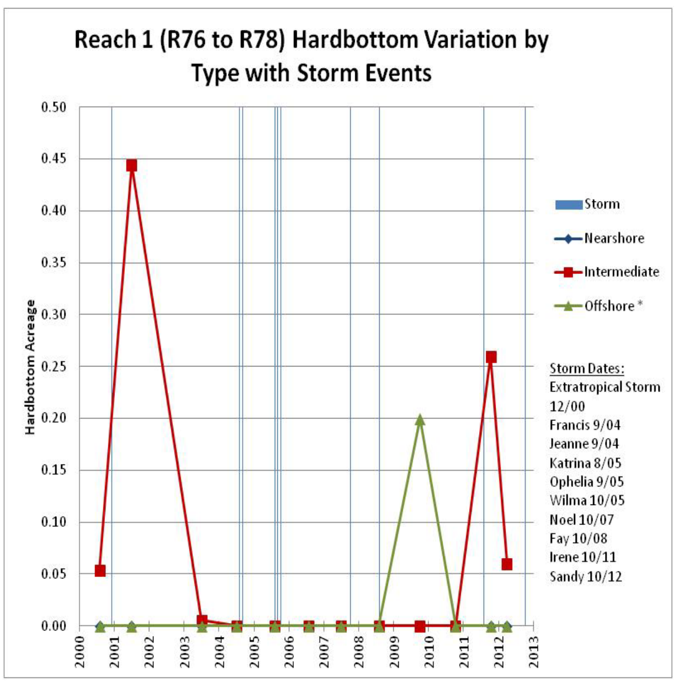




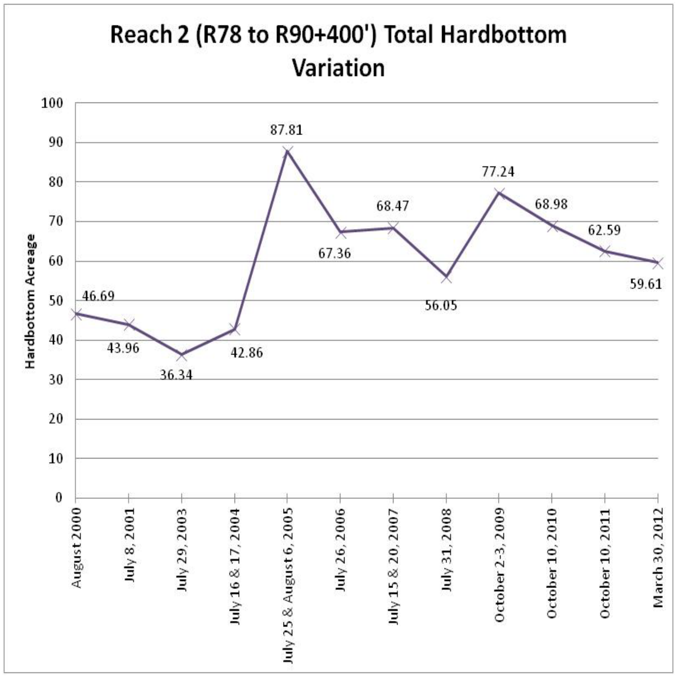


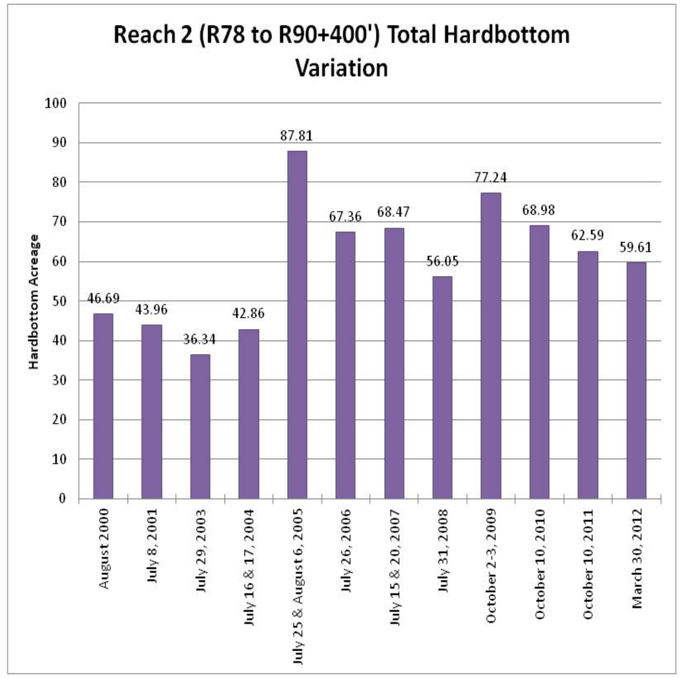

Reach 1 (R76 to R78) Total Hardbottom Variation
Hardbottom Acreage
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
Total
Linear (Total)

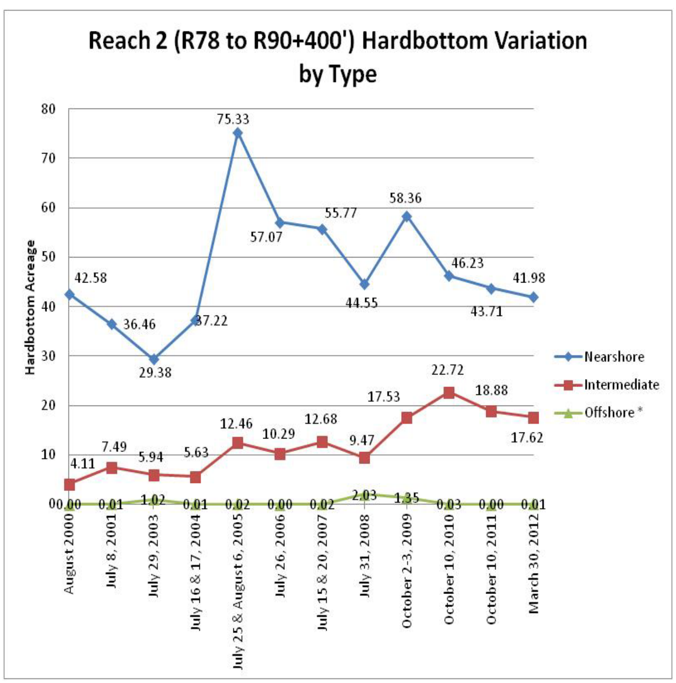

Reach 1 (R76 to R78) Hardbottom Variation by Type
Hardbottom Acreage
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
Nearshore
Intermediate
Offshore *
Linear (Intermediate)
Linear (Offshore *)

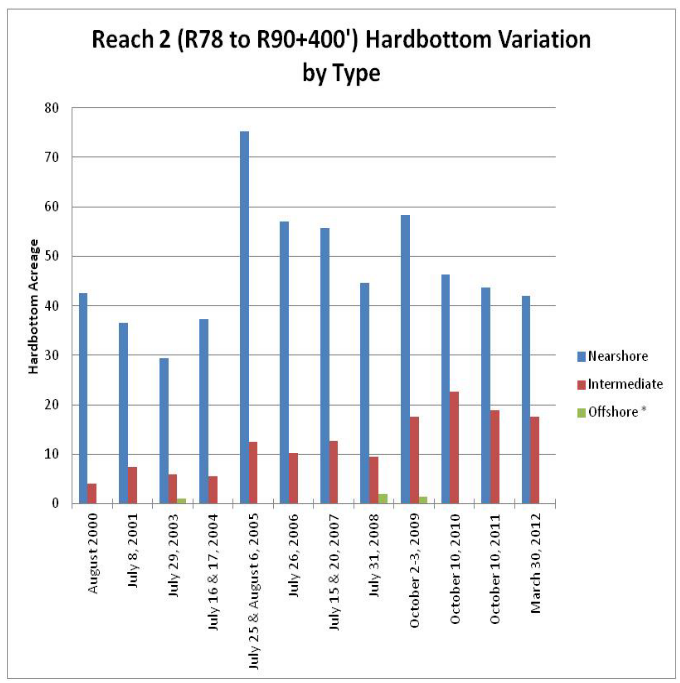

Reach 1 (R76 to R78) Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

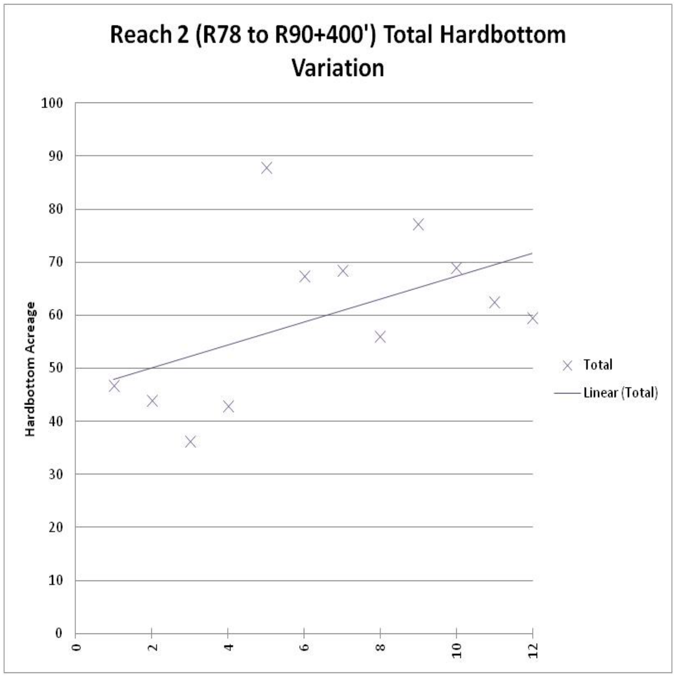
Hardbottom Data for Reach 2

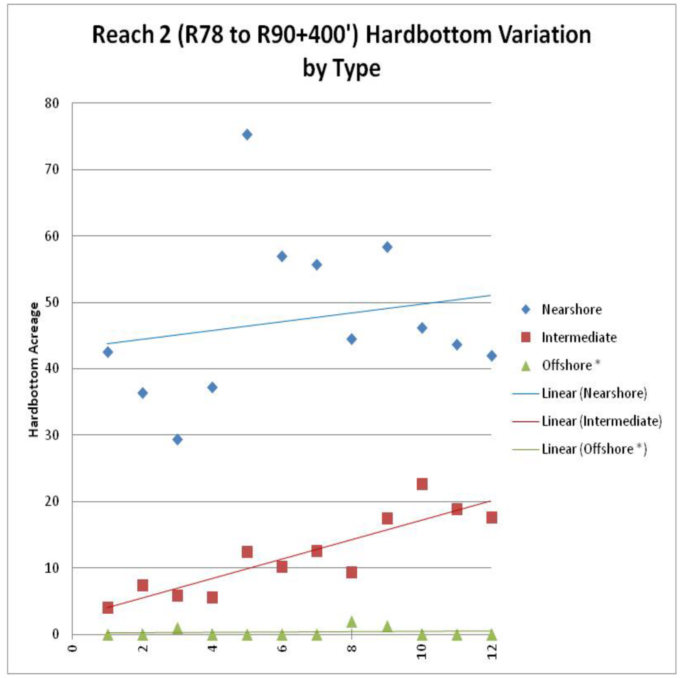


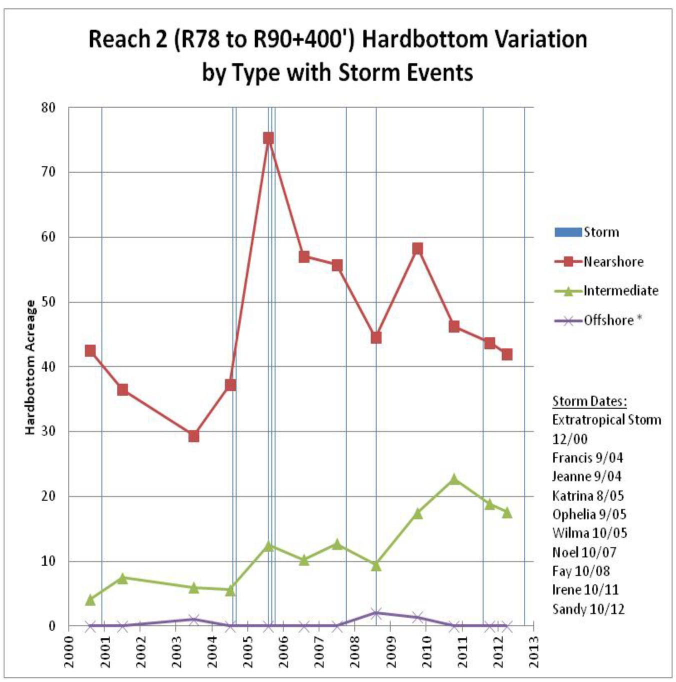




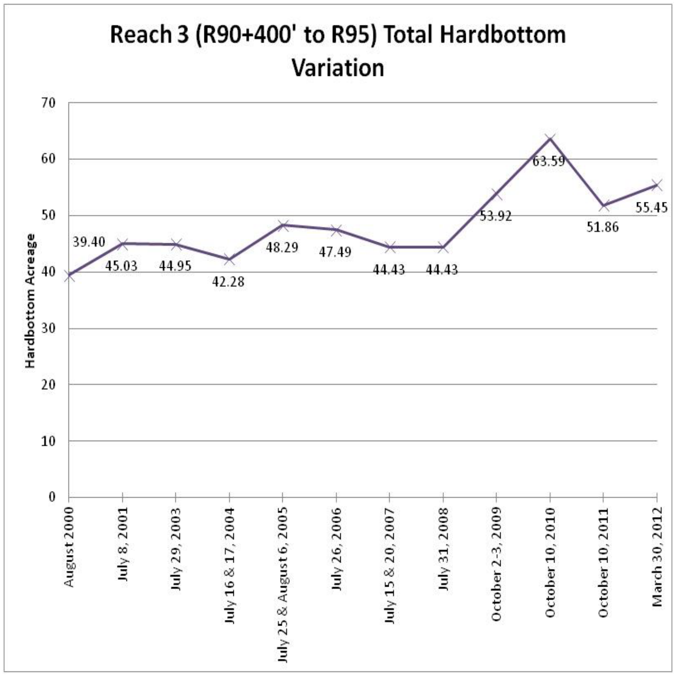


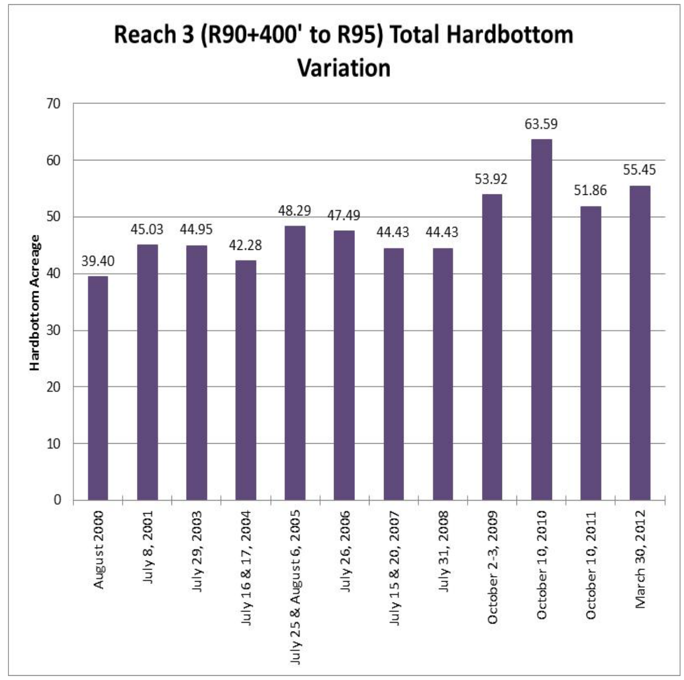

Reach 2 (R78 to R90+400') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

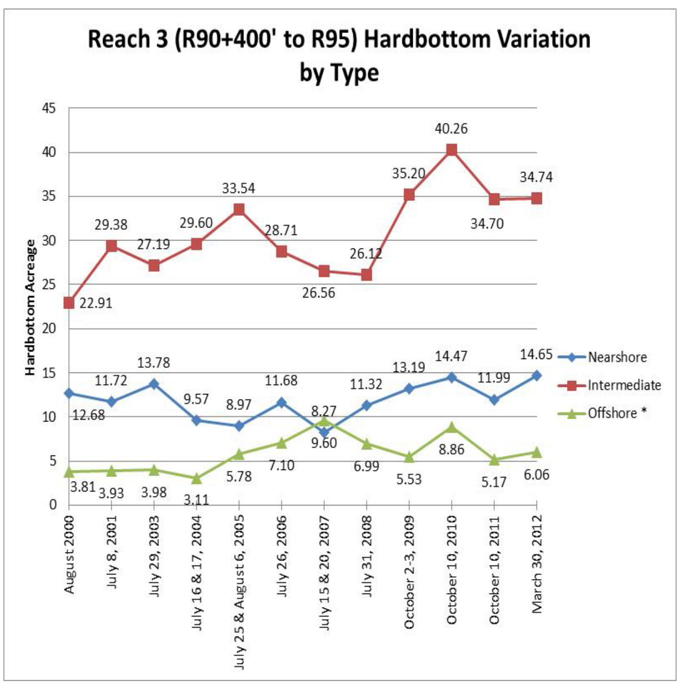

Reach 2 (R78 to R90+400') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)
Linear (Intermediate)
Linear (Offshore *)

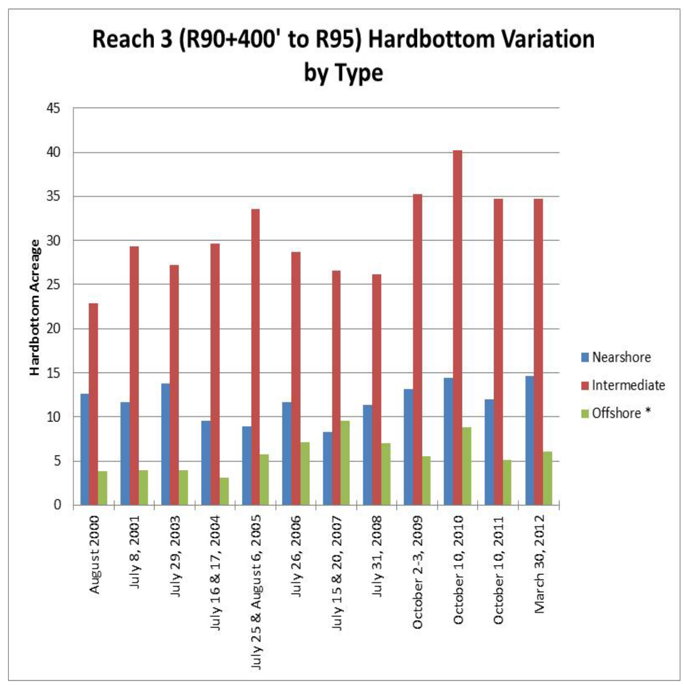

Reach 2 (R78 to R90+400') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

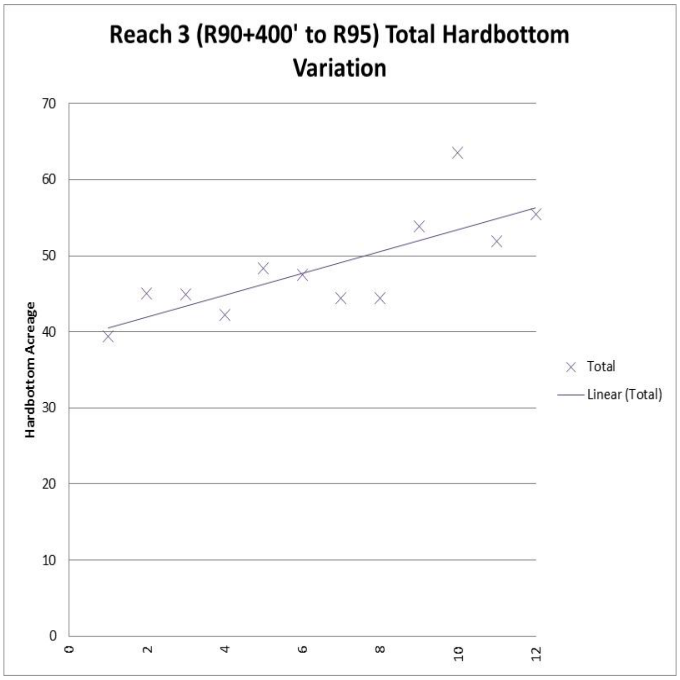
Hardbottom Data for Reach 3

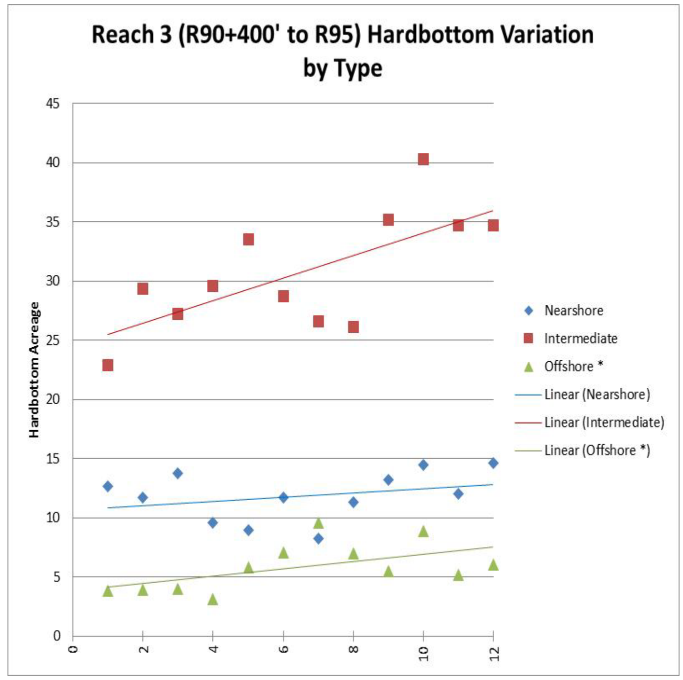


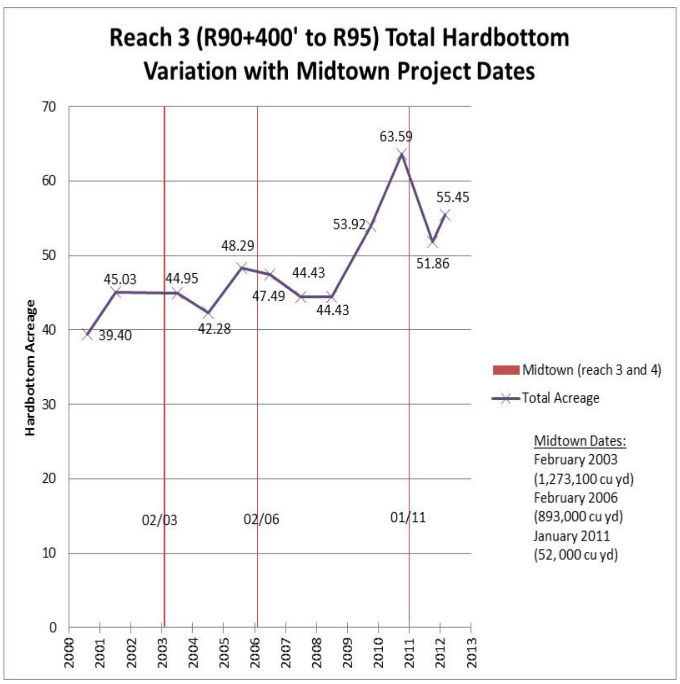


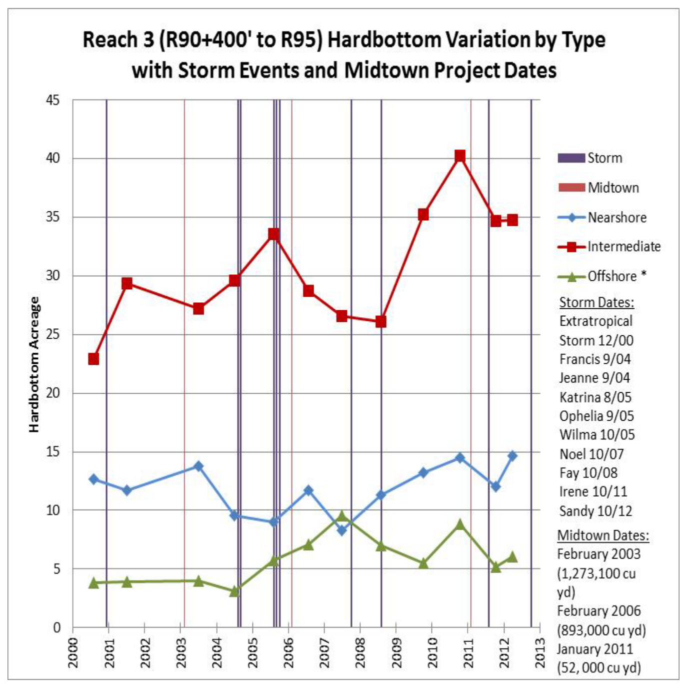




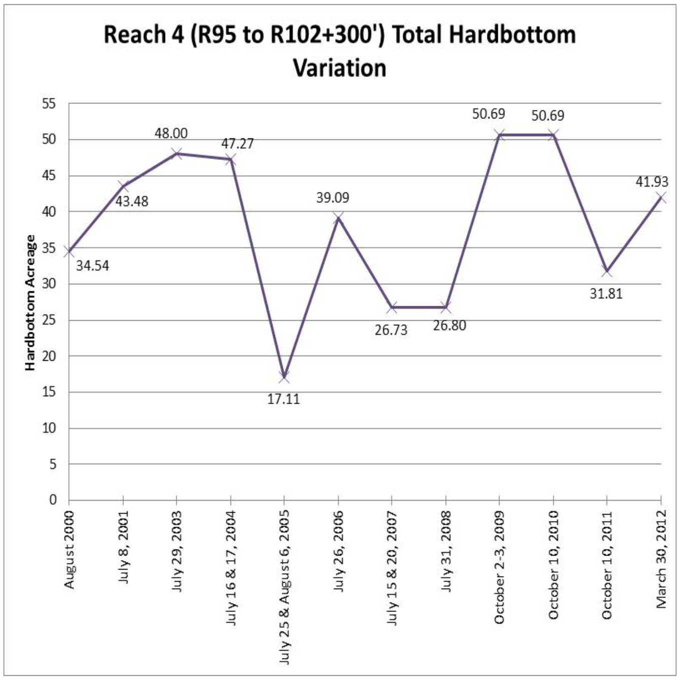

Reach 3 (R90+400' to R95) Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

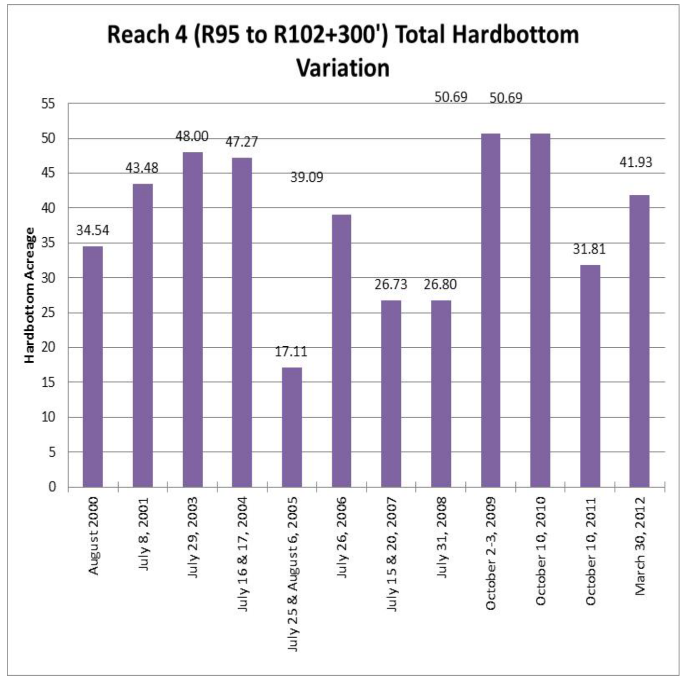

Reach 3 (R90+400' to R95) Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)
Linear (Intermediate)
Linear (Offshore *)

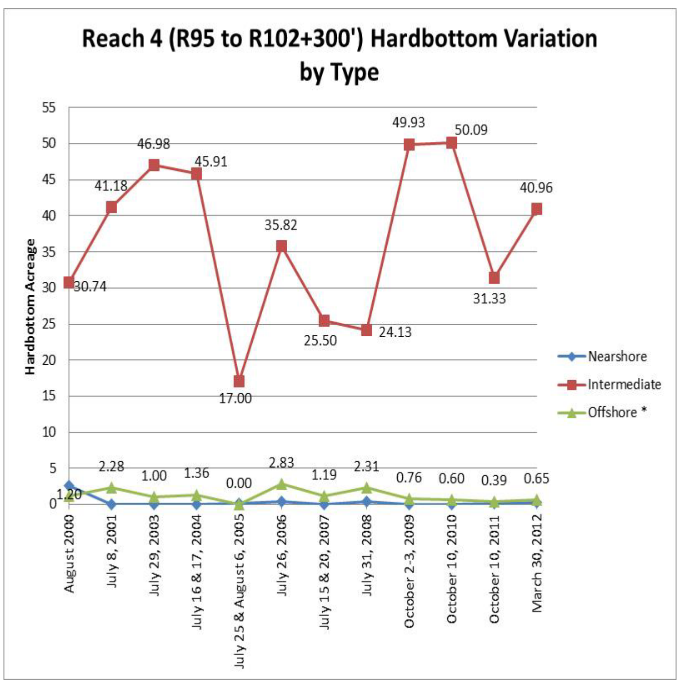

Reach 3 (R90+400' to R95) Total Hardbottom Variation with Midtown Project Dates
Hardbottom Acreage
39.40
45.03
44.95
42.28
48.29
47.49
44.43
44.43
53.92
63.59
51.86
55.45
02/03
02/06
01/11
Midtown (reach 3 and 4)
Total Acreage
Midtown Dates:
February 2003
(1,273,100 cu yd)
February 2006
(893,000 cu yd)
January 2011
(52,000 cu yd)

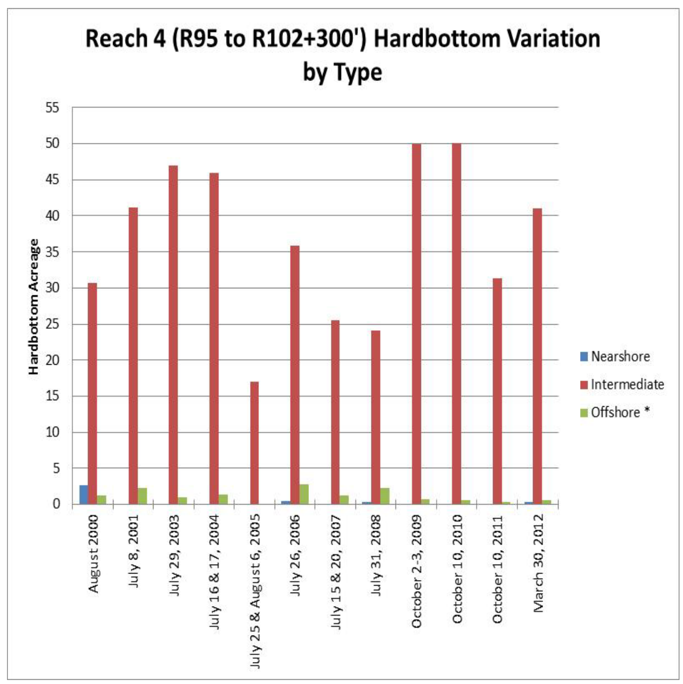

Reach 3 (R90+400' to R95) Hardbottom Variation by Type with Storm Events and Midtown Project Dates
Hardbottom Acreage
Storm
Midtown
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12
Midtown Dates:
February 2003
(1,273,100 cu yd)
February 2006
(893,000 cu yd)
January 2011
(52,000 cu yd)

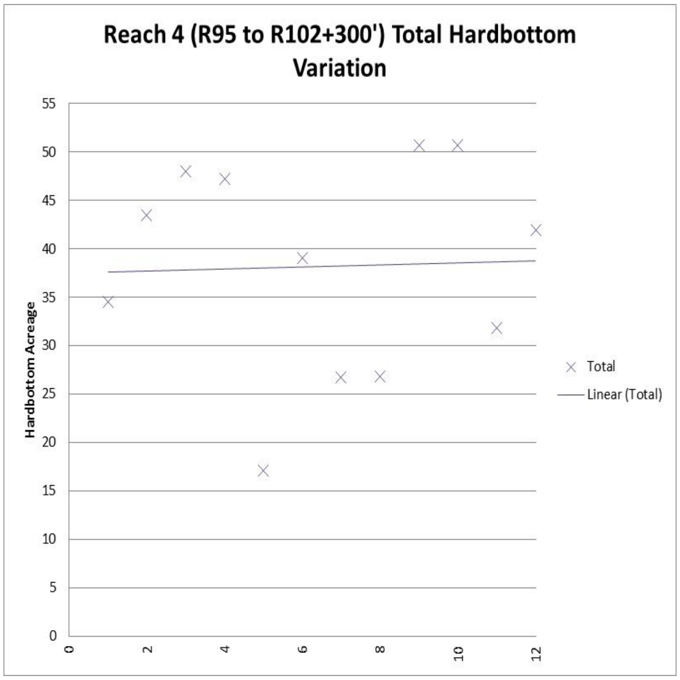
Hardbottom Data for Reach 4

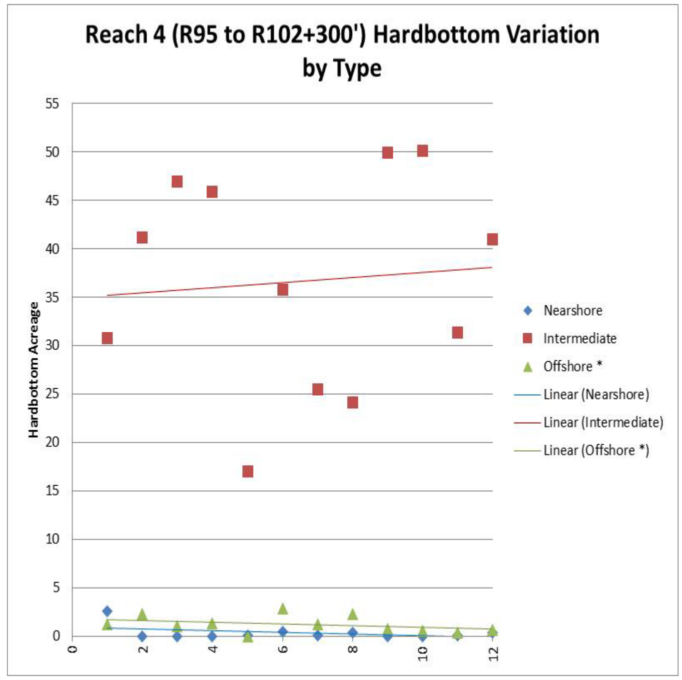


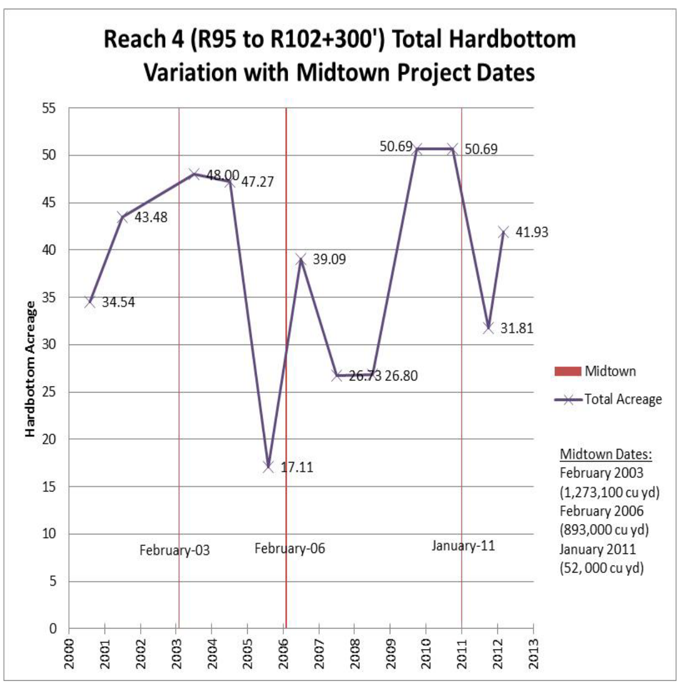


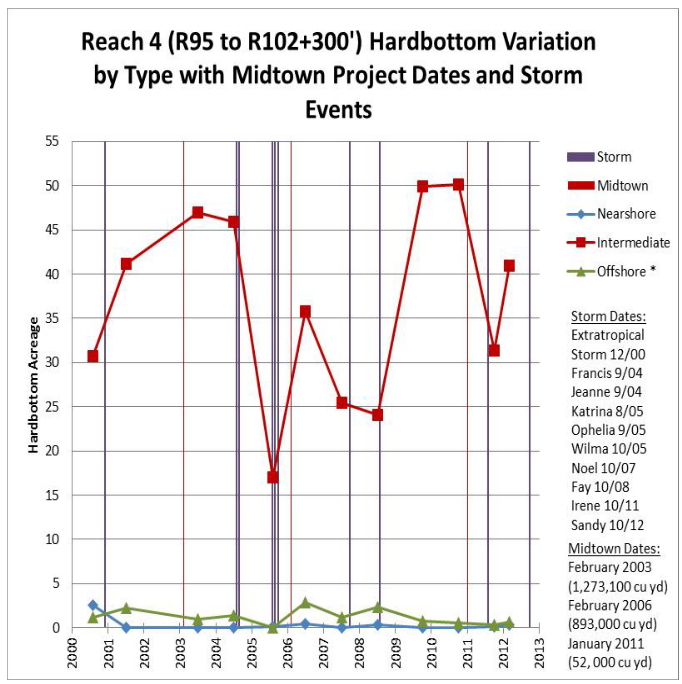




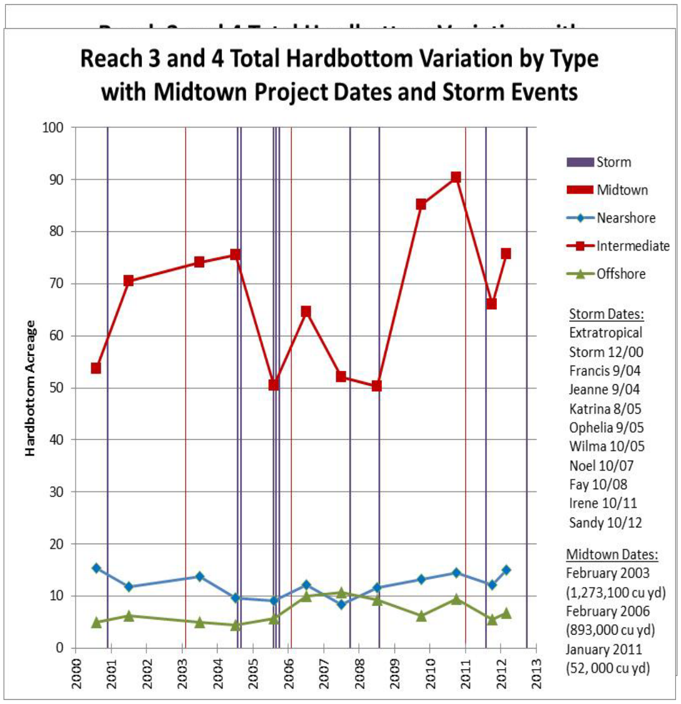

Reach 4 (R95 to R102+300') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

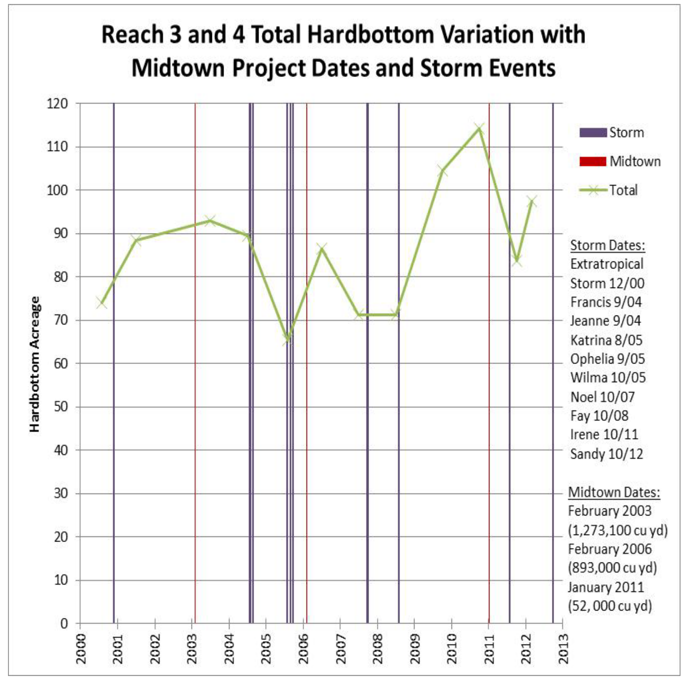

Reach 4 (R95 to R102+300') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)
Linear (Intermediate)
Linear (Offshore *)


Reach 4 (R95 to R102+300') Total Hardbottom Variation with Midtown Project Dates
Hardbottom Acreage
34.54
43.48
48.00
47.27
17.11
39.09
26.73
26.80
50.69
50.69
31.81
41.93
February-03
February-06
January-11
Midtown
Total Acreage
Midtown Dates:
February 2003
(1,273,100 cu yd)
February 2006
(893,000 cu yd)
January 2011
(52,000 cu yd)

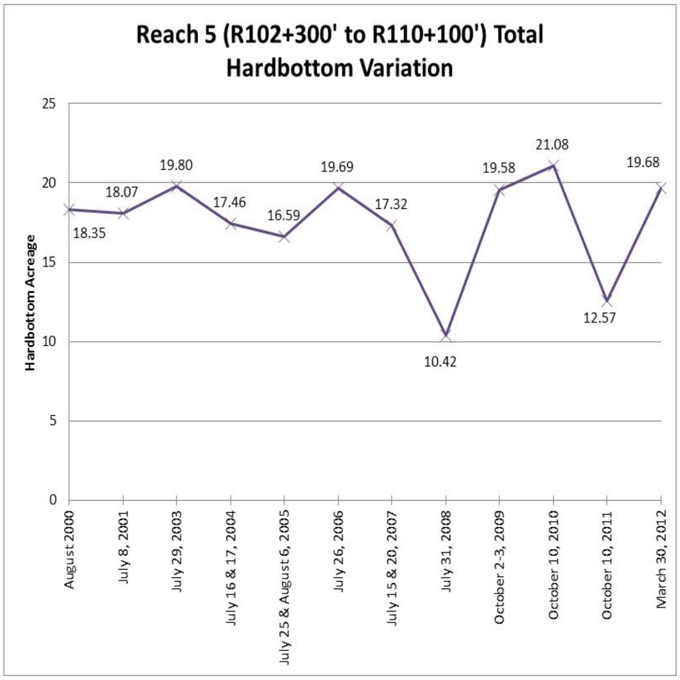

Reach 4 (R95 to R102+300') Hardbottom Variation by Type with Midtown Project Dates and Storm Events
Hardbottom Acreage
Storm
Midtown
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12
Midtown Dates:
February 2003
(1,273,100 cu yd)
February 2006
(893,000 cu yd)
January 2011
(52,000 cu yd)

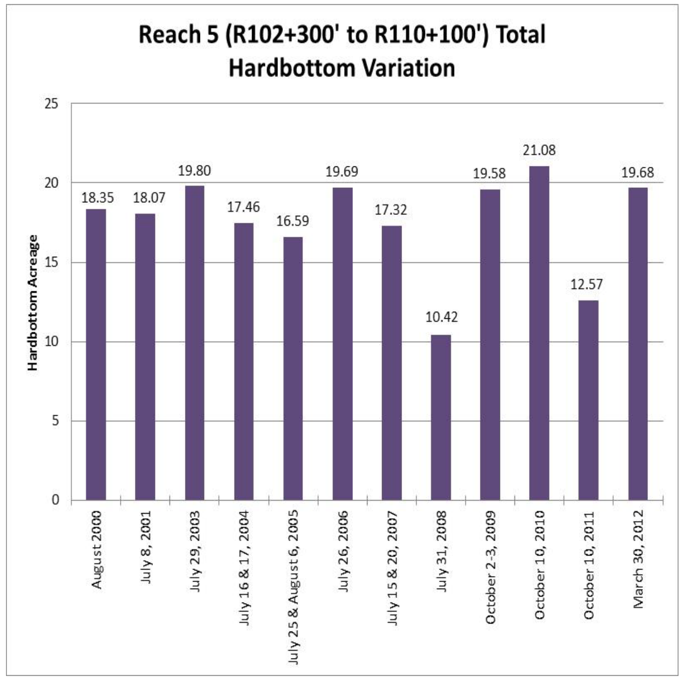
Hardbottom Data for Reaches 3 and 4 Combined

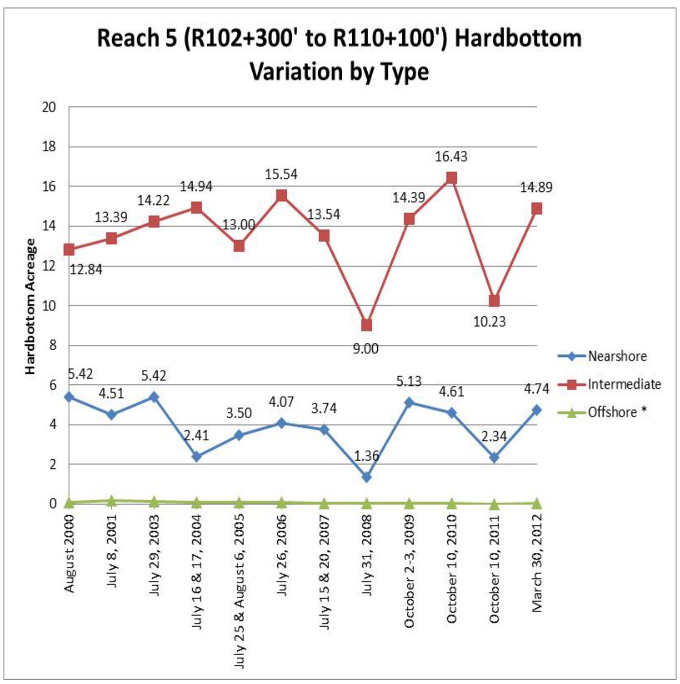


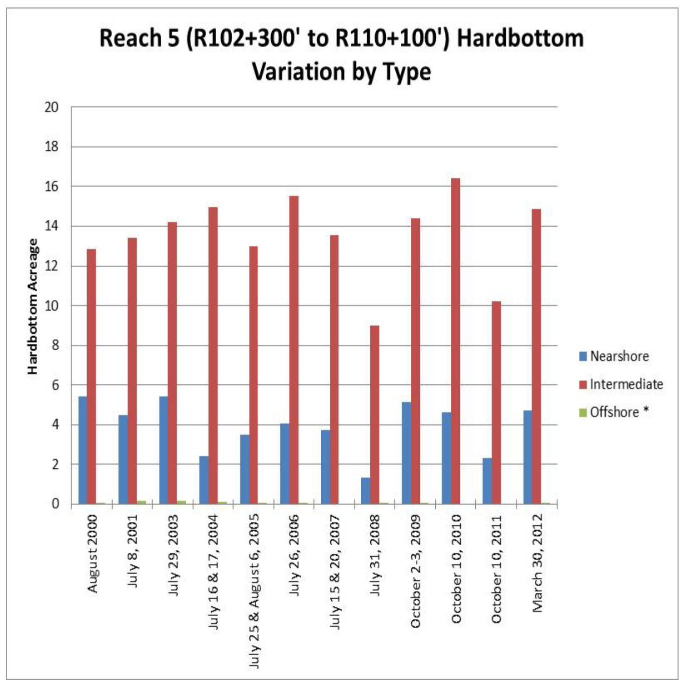


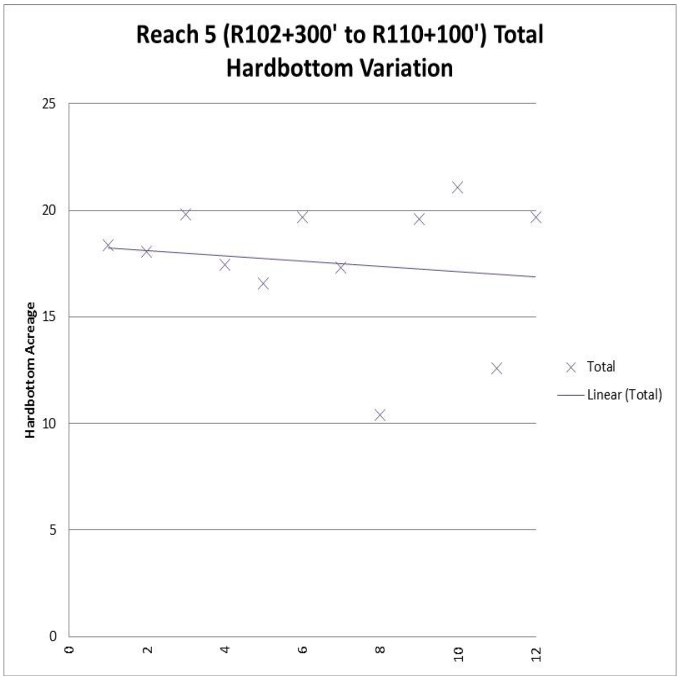
Hardbottom Data for Reach 5

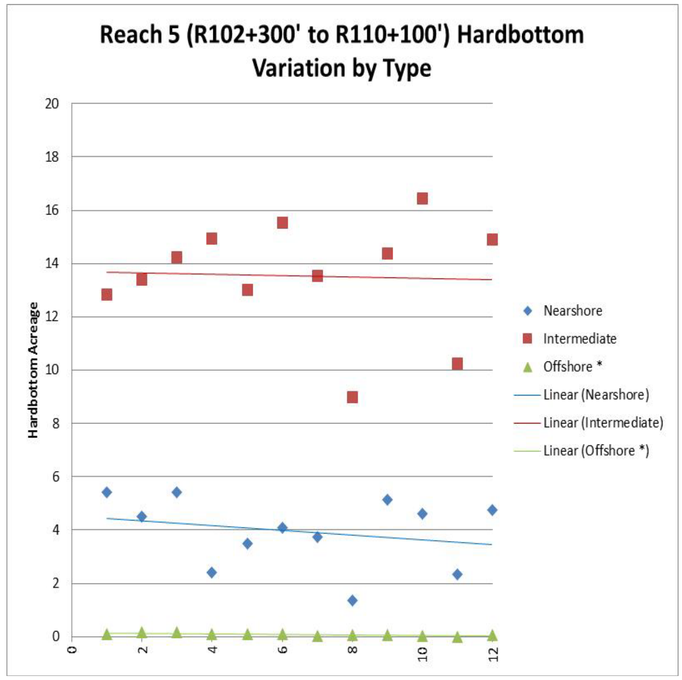


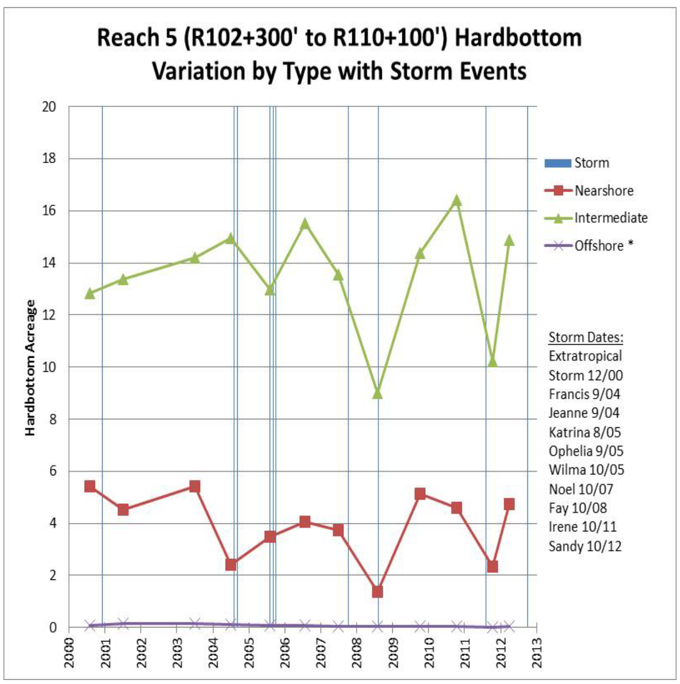




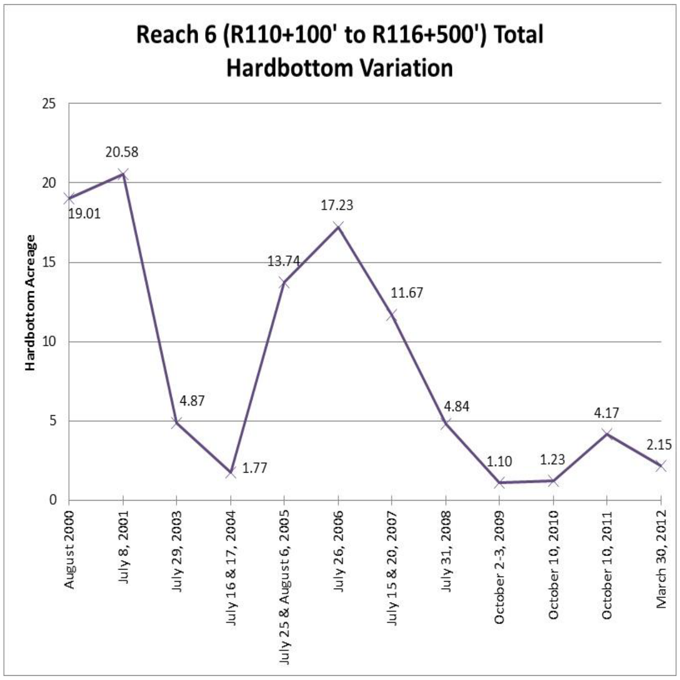


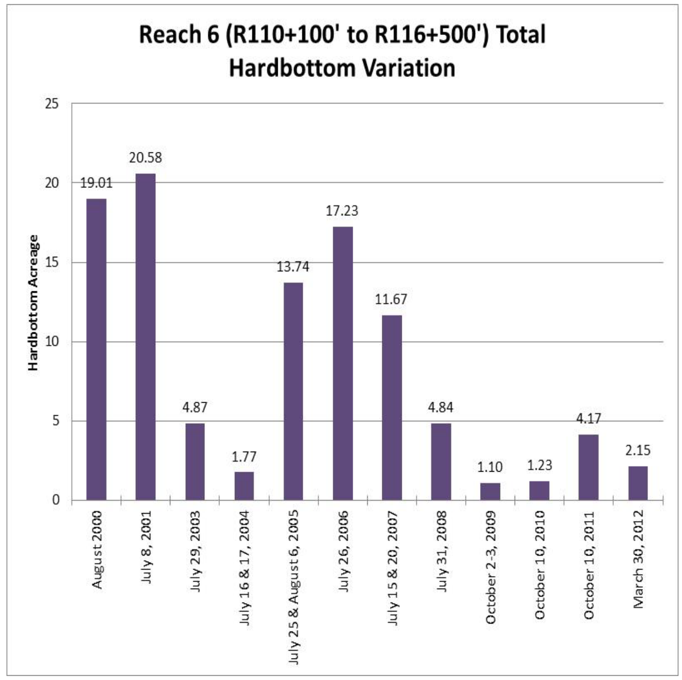

Reach 5 (R102+300' to R110+100') Total Hardbottom Variation
Hardbottom Acreage
25
20
15
10
5
0
0
2
4
6
8
10
12
Total
Linear (Total)

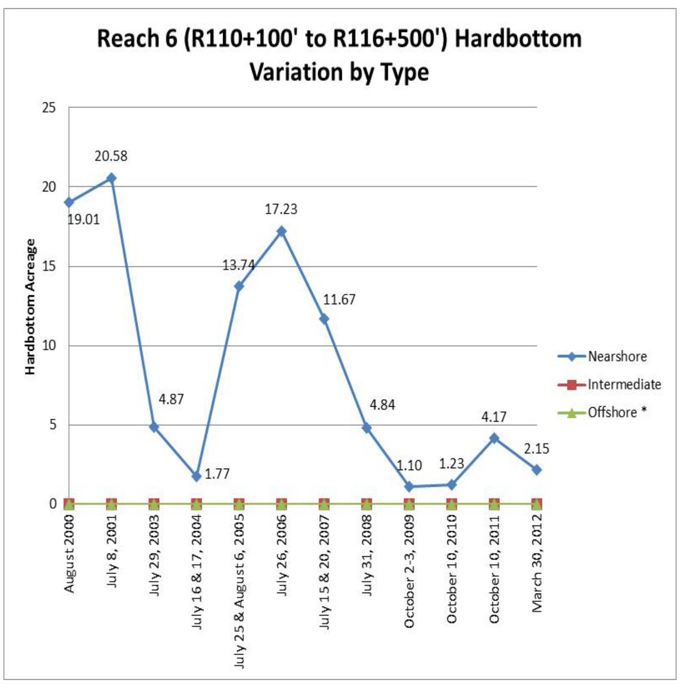

Reach 5 (R102+300' to R110+100') Hardbottom Variation by Type
Hardbottom Acreage
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
Nearshore
Intermediate
Offshore *
Linear (Nearshore)
Linear (Intermediate)
Linear (Offshore *)

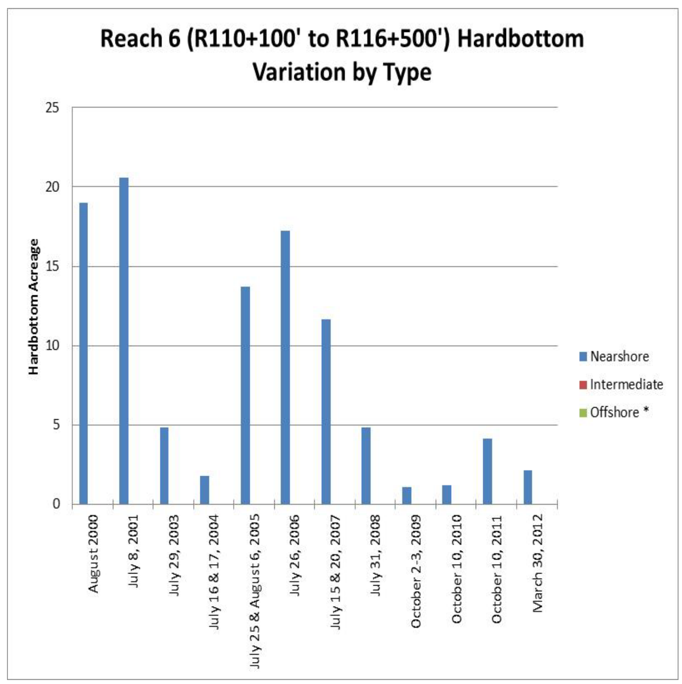

Reach 5 (R102+300' to R110+100') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
20
18
16
14
12
10
8
6
4
2
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

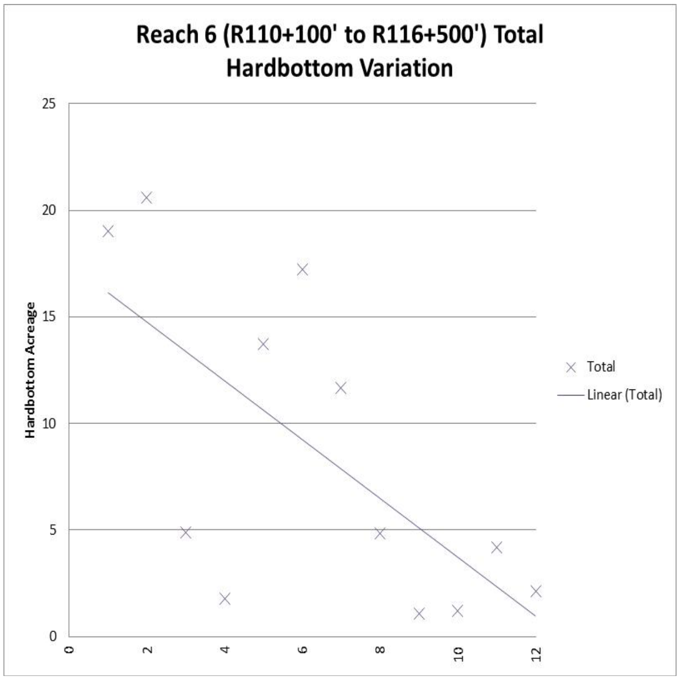
Hardbottom Data for Reach 6

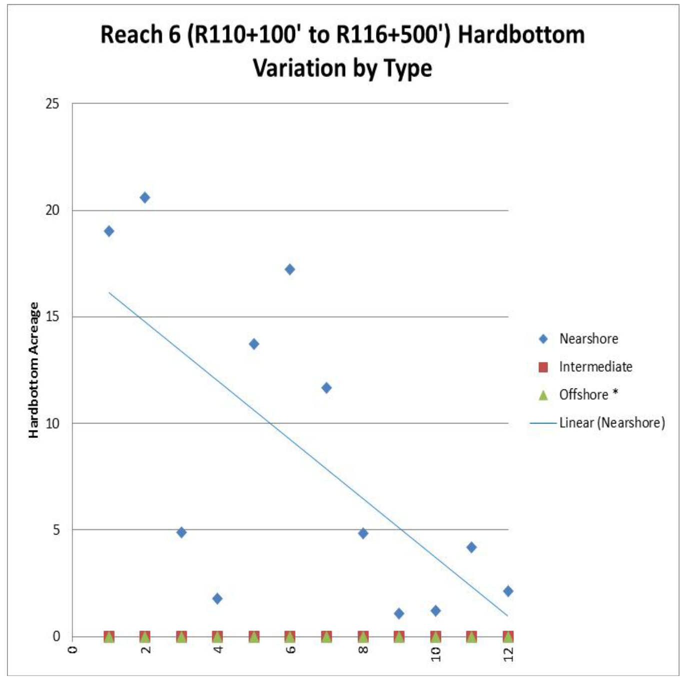


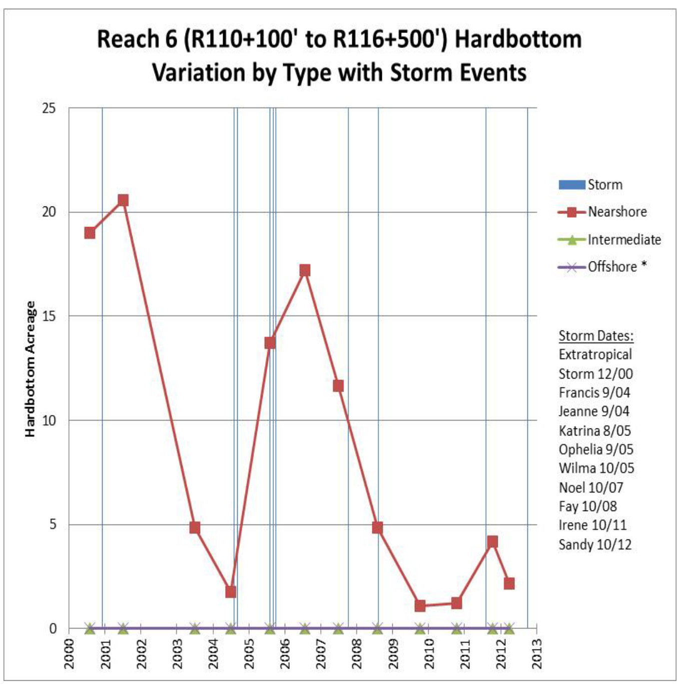




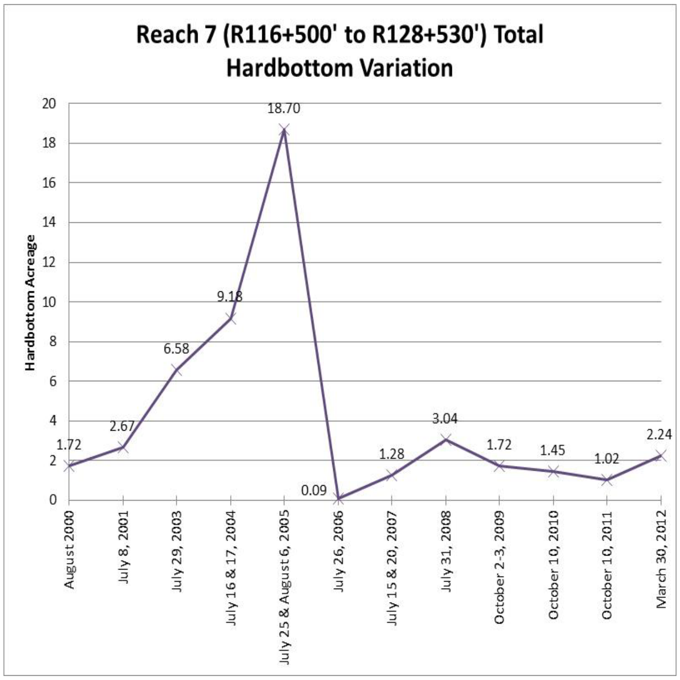


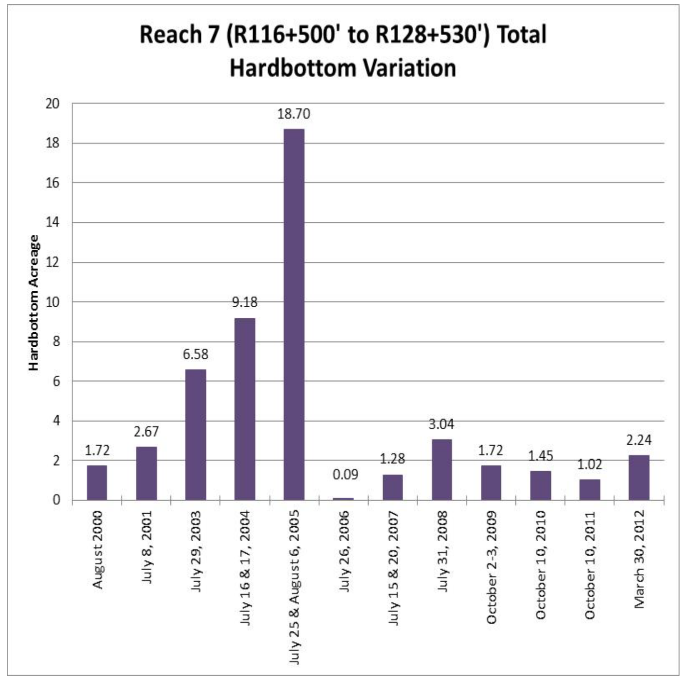

Reach 6 (R110+100' to R116+500') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

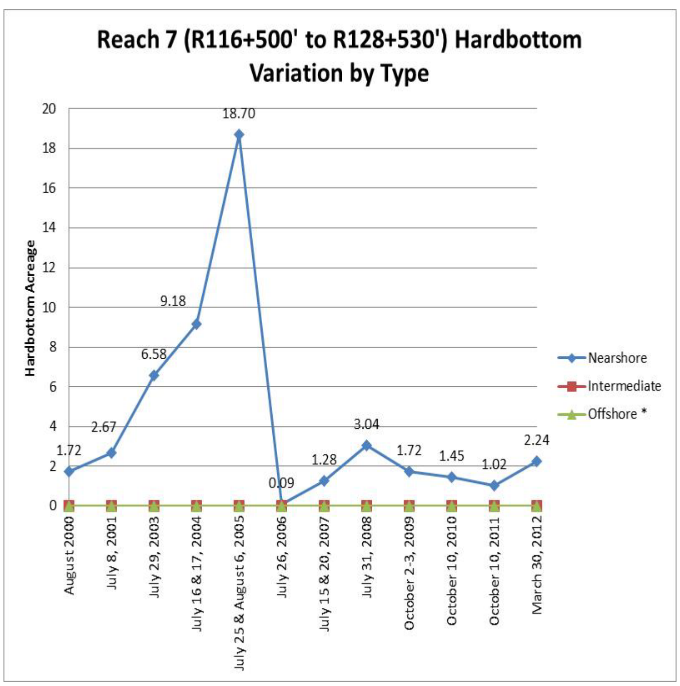

Reach 6 (R110+100' to R116+500') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)

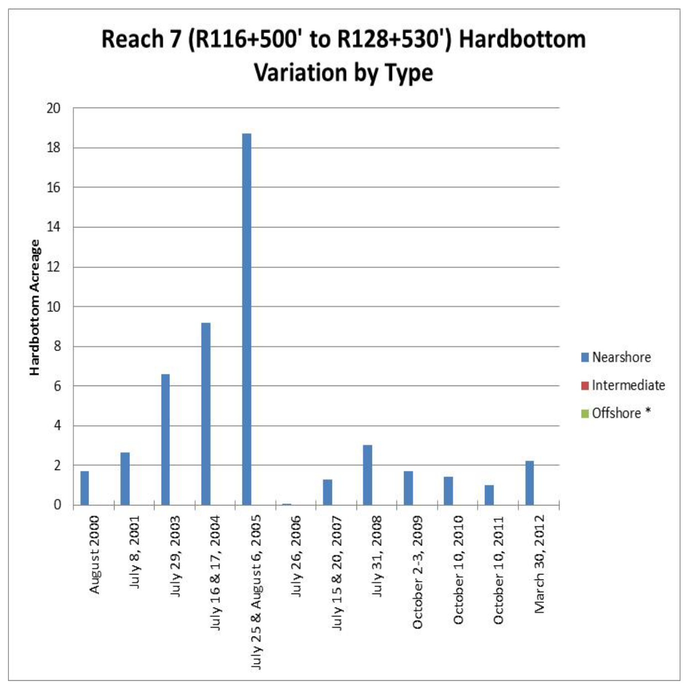

Reach 6 (R110+100' to R116+500') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

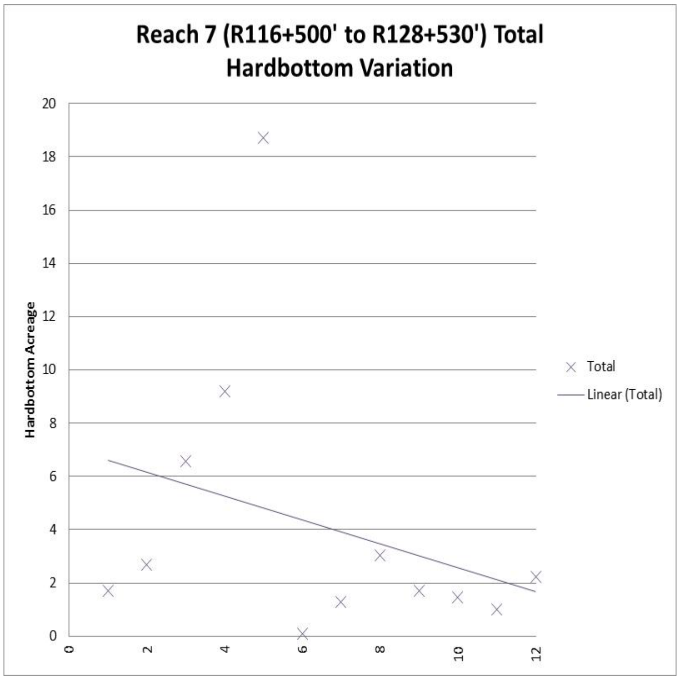
Hardbottom Data for Reach 7

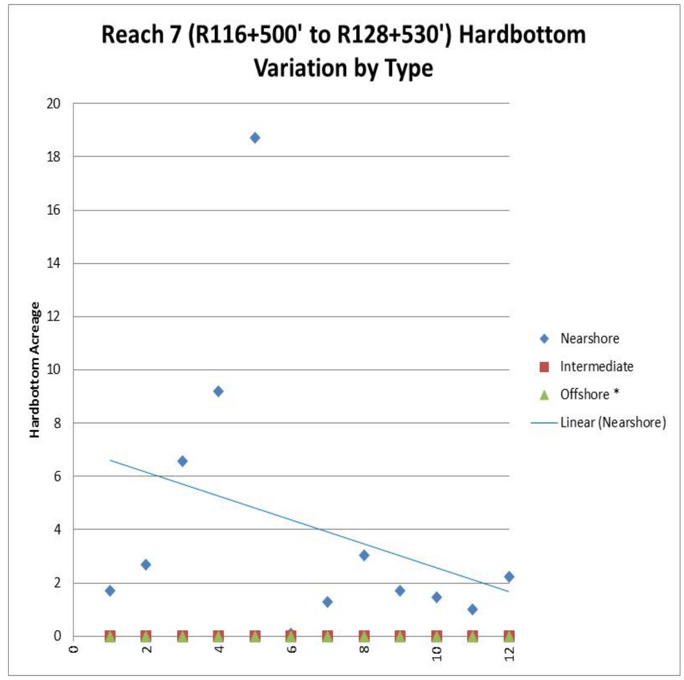


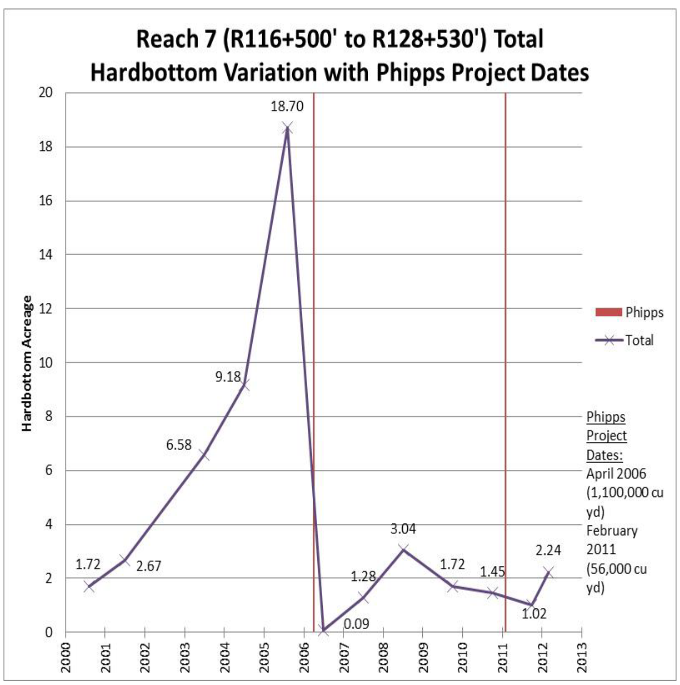


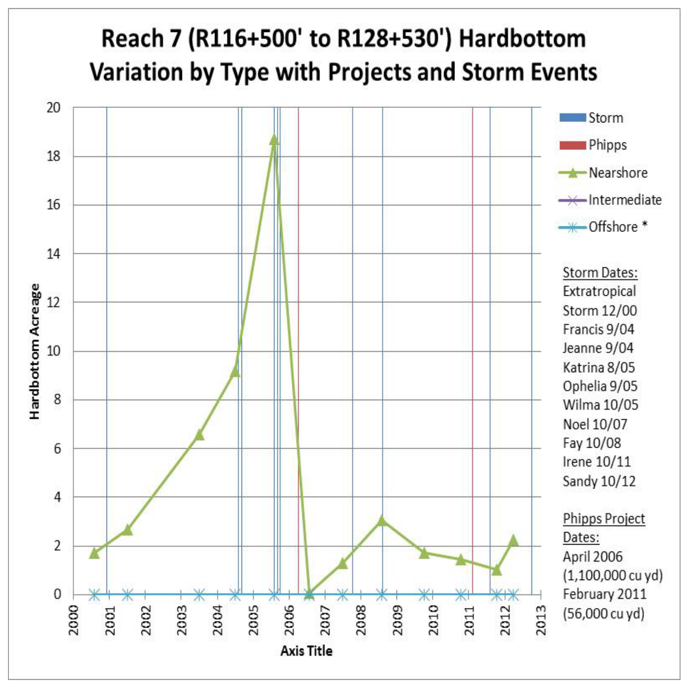




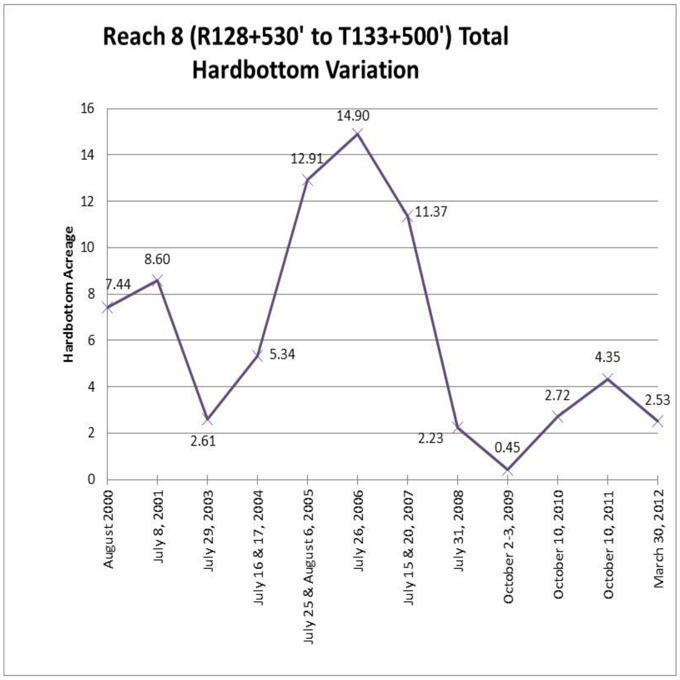

Reach 7 (R116+500' to R128+530') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

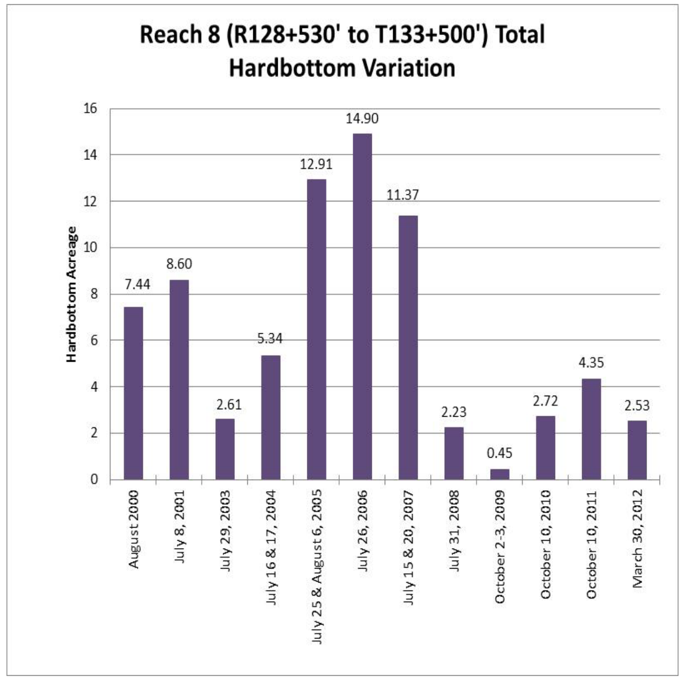

Reach 7 (R116+500' to R128+530') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)

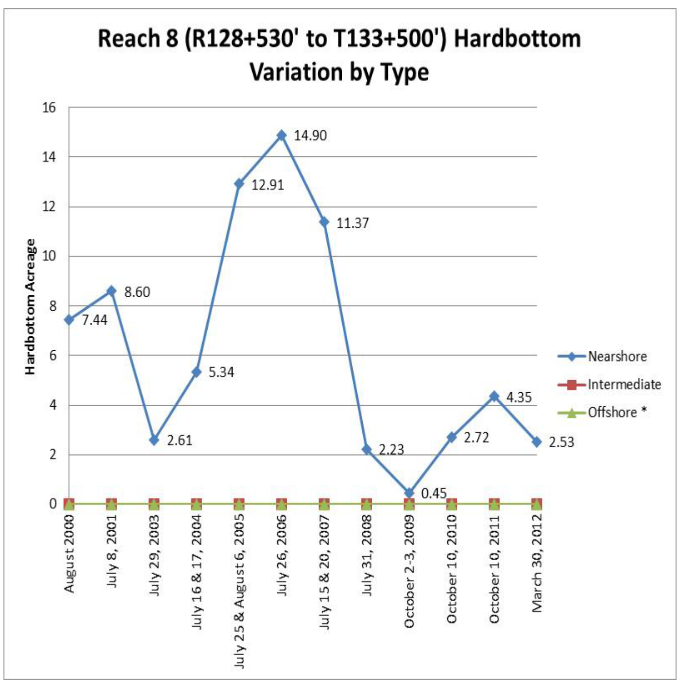

Reach 7 (R116+500' to R128+530') Total Hardbottom Variation with Phipps Project Dates
Hardbottom Acreage
Phipps
Total
1.72
2.67
6.58
9.18
18.70
0.09
1.28
3.04
1.72
1.45
1.02
2.24
Phipps Project Dates:
April 2006 (1,100,000 cu yd)
February 2011 (56,000 cu yd)

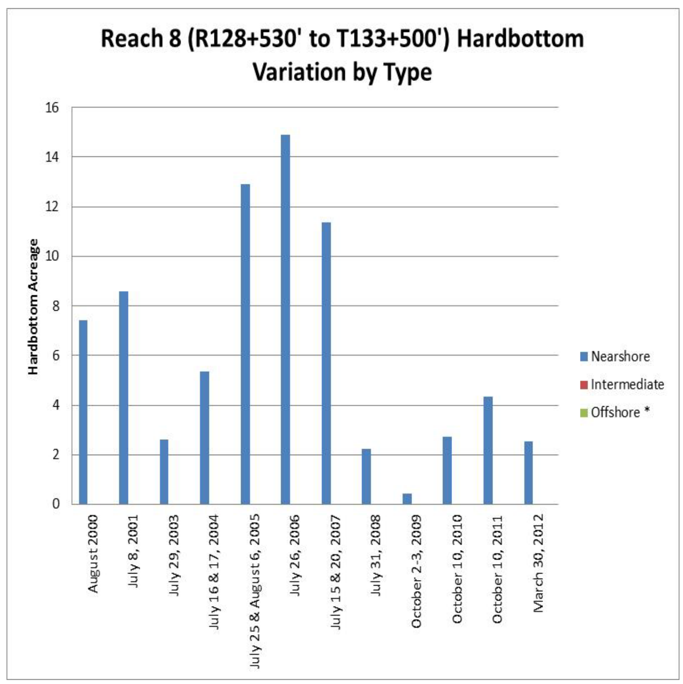

Reach 7 (R116+500' to R128+530') Hardbottom Variation by Type with Projects and Storm Events
Hardbottom Acreage
Axis Title
Storm
Phipps
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12
Phipps Project Dates:
April 2006 (1,100,000 cu yd)
February 2011 (56,000 cu yd)

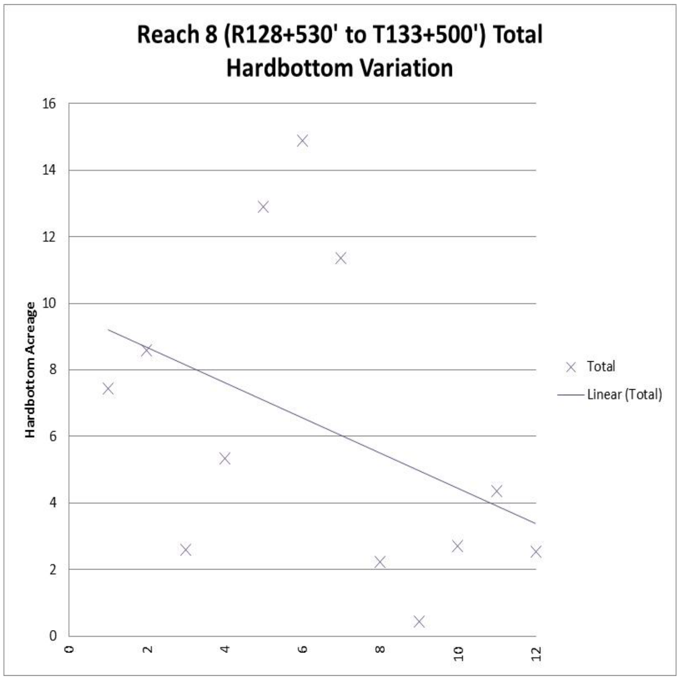
Hardbottom Data for Reach 8

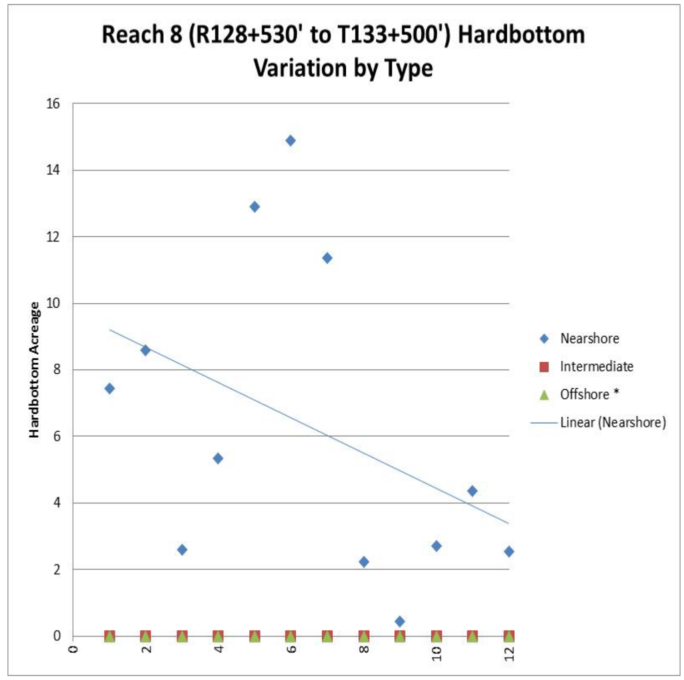


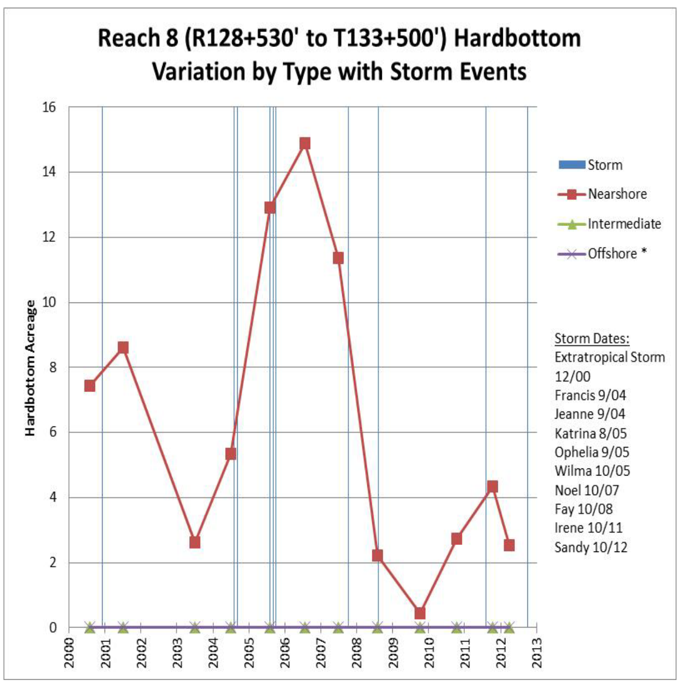




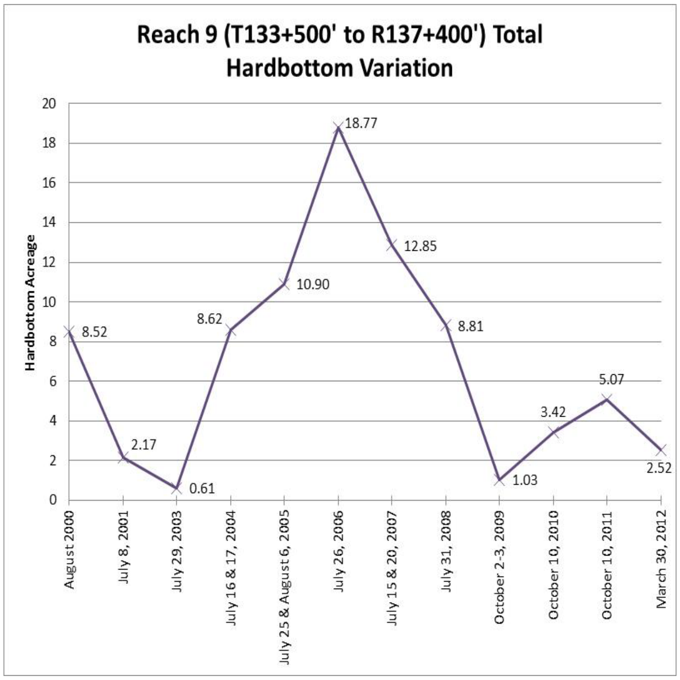


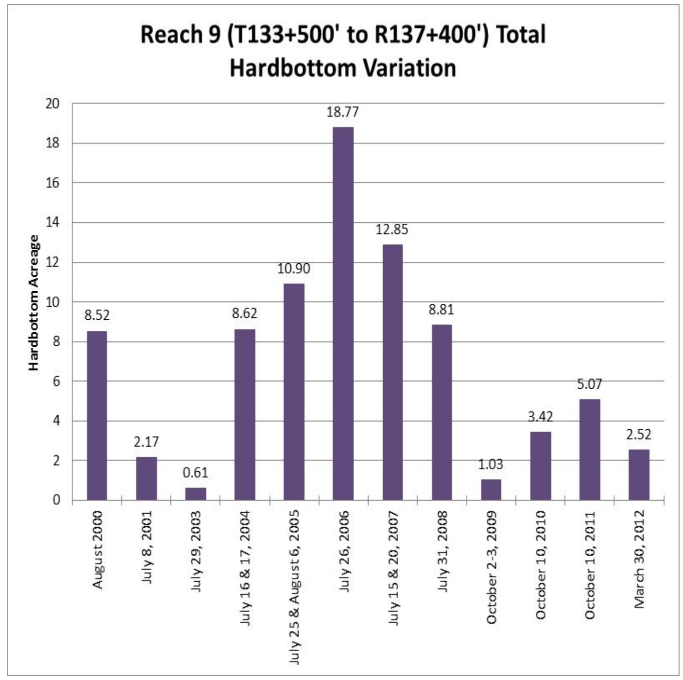

Reach 8 (R128+530' to T133+500') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

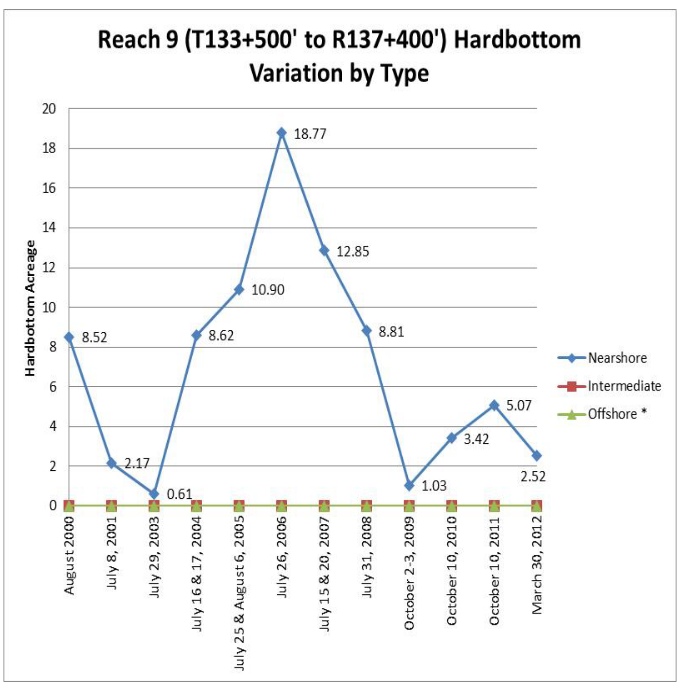

Reach 8 (R128+530' to T133+500') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)

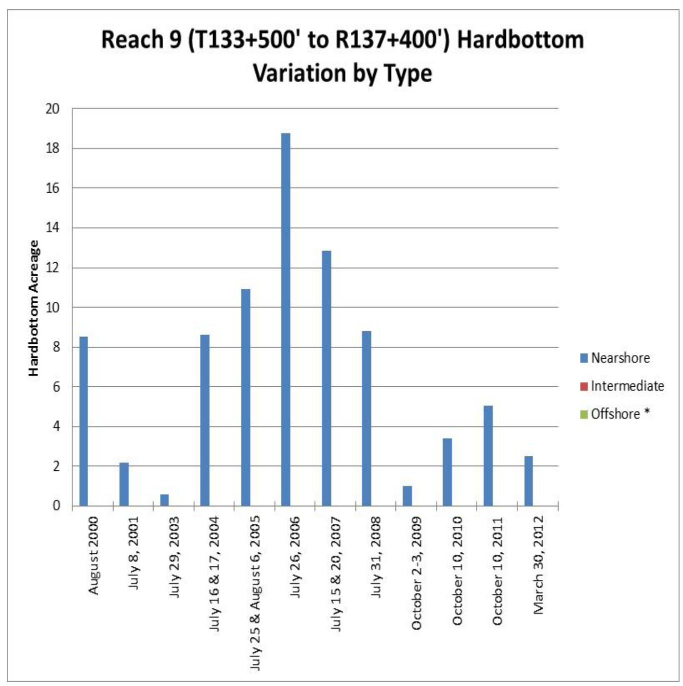

Reach 8 (R128+530' to T133+500') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

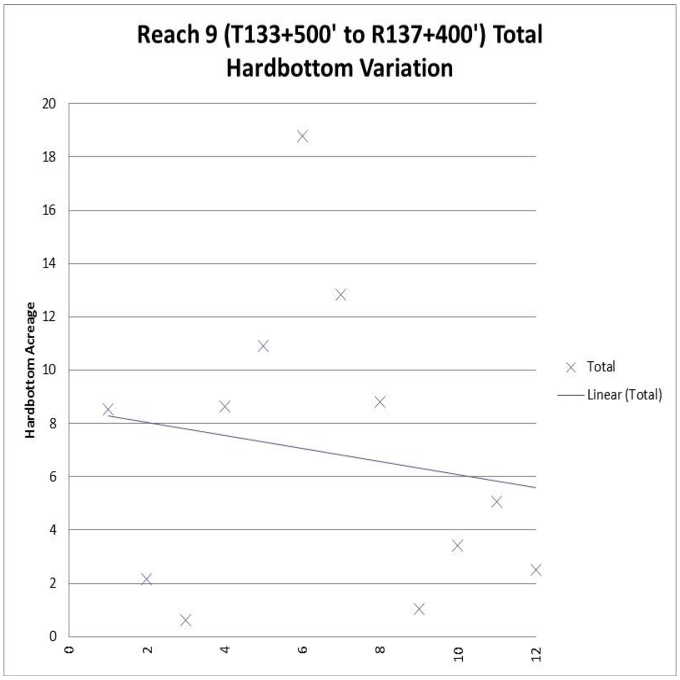
Hardbottom Data for Reach 9

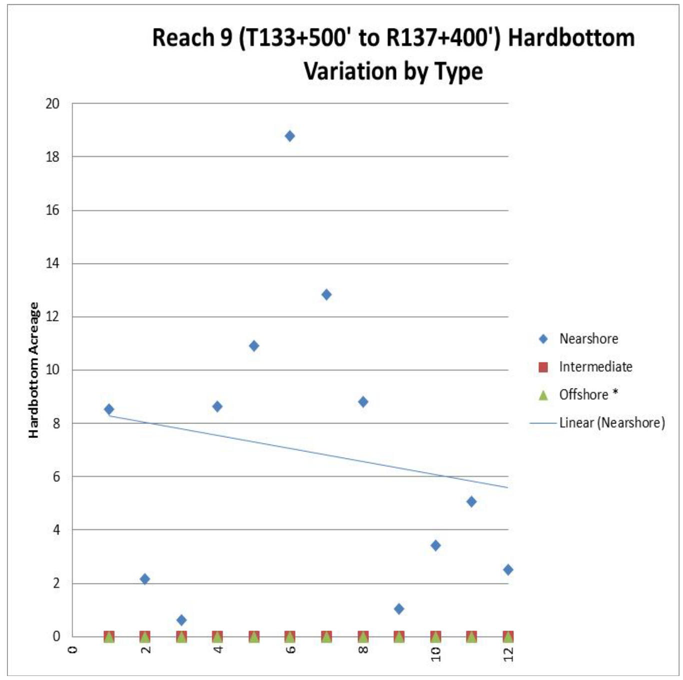


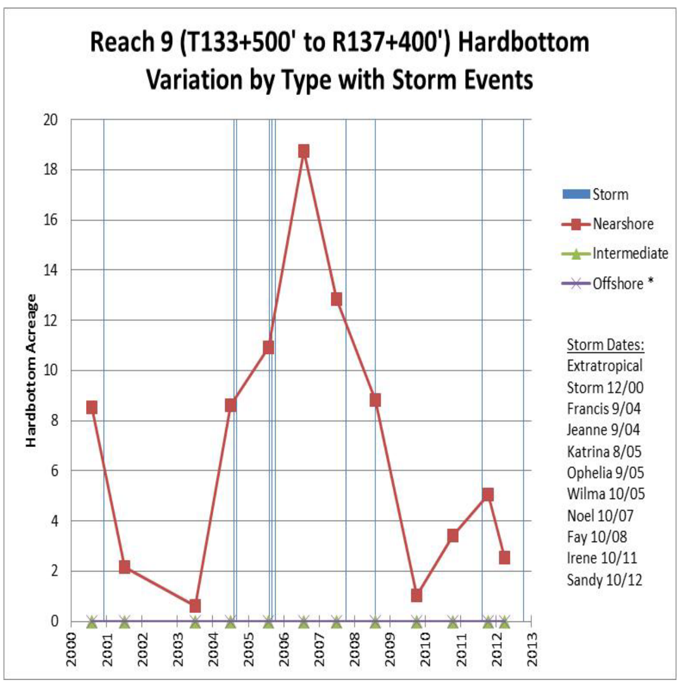




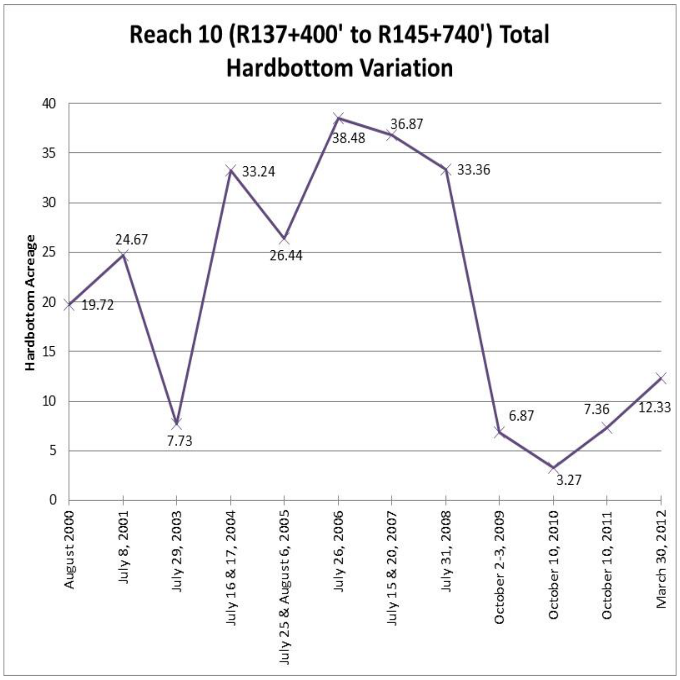


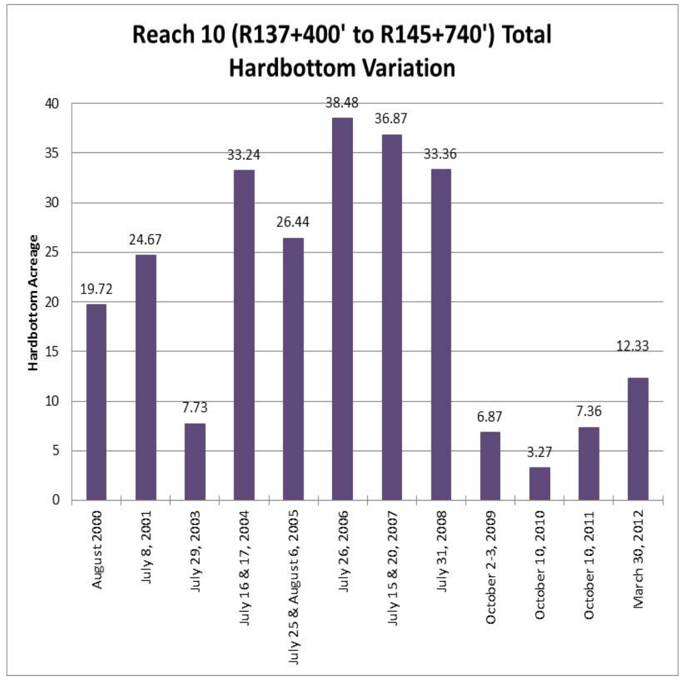

Reach 9 (T133+500' to R137+400') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

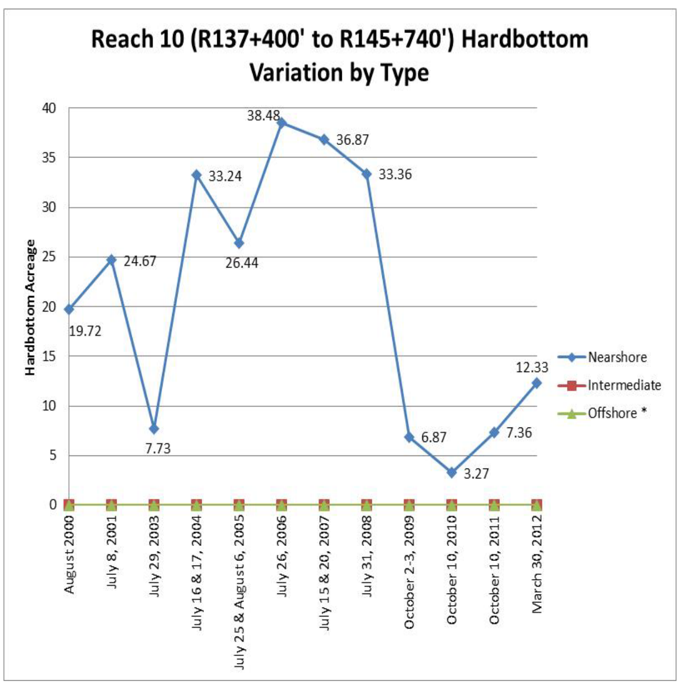

Reach 9 (T133+500' to R137+400') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)

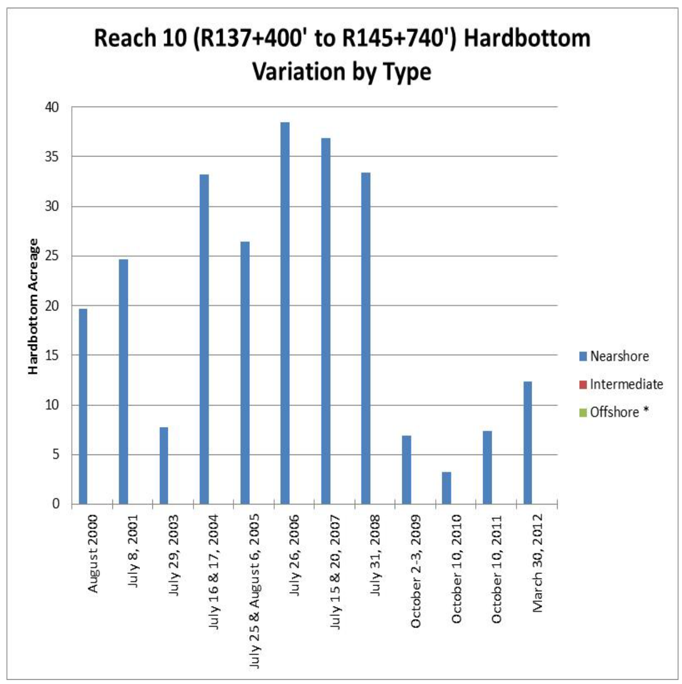

Reach 9 (T133+500' to R137+400') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

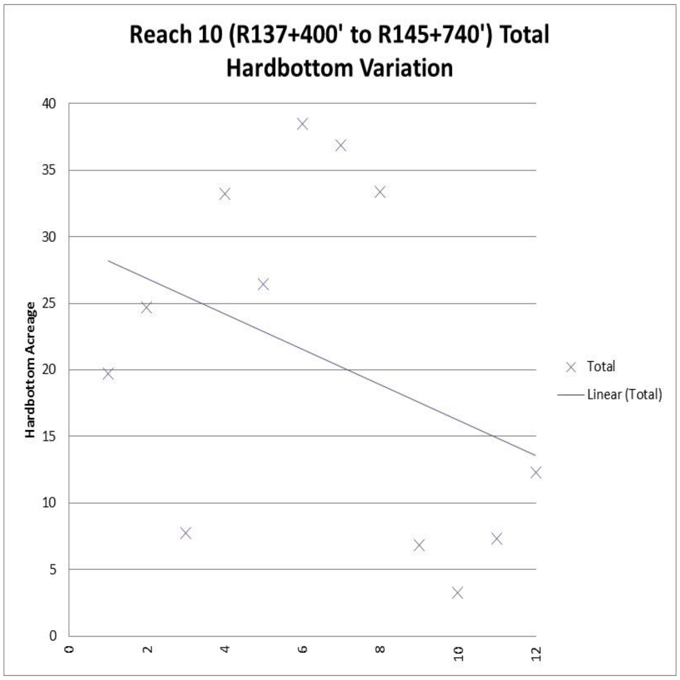
Hardbottom Data for Reach 10

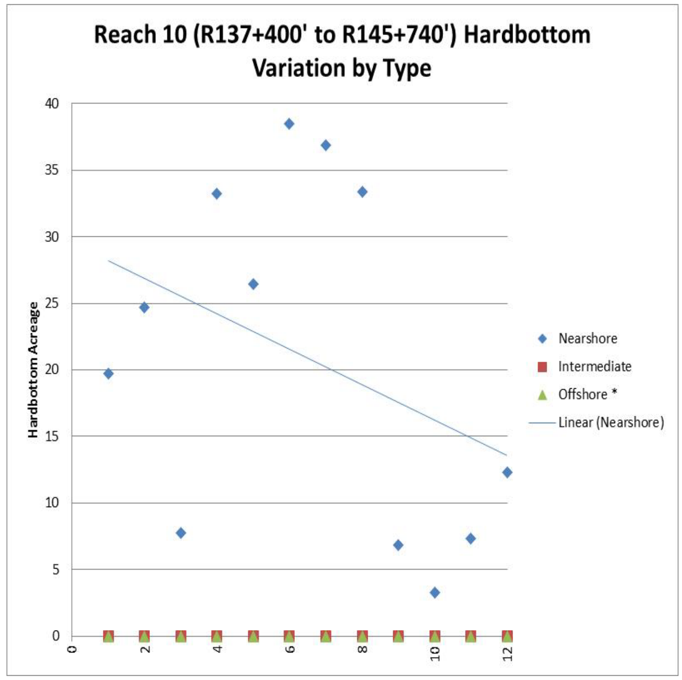


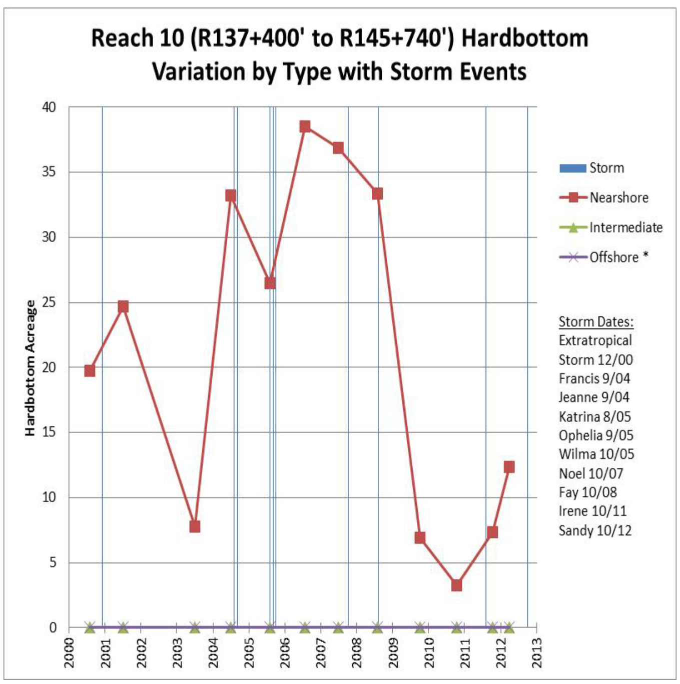




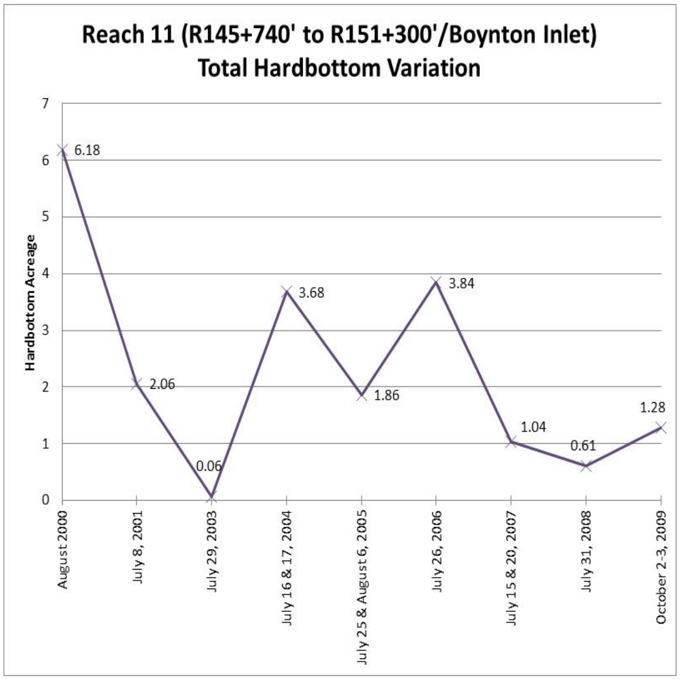


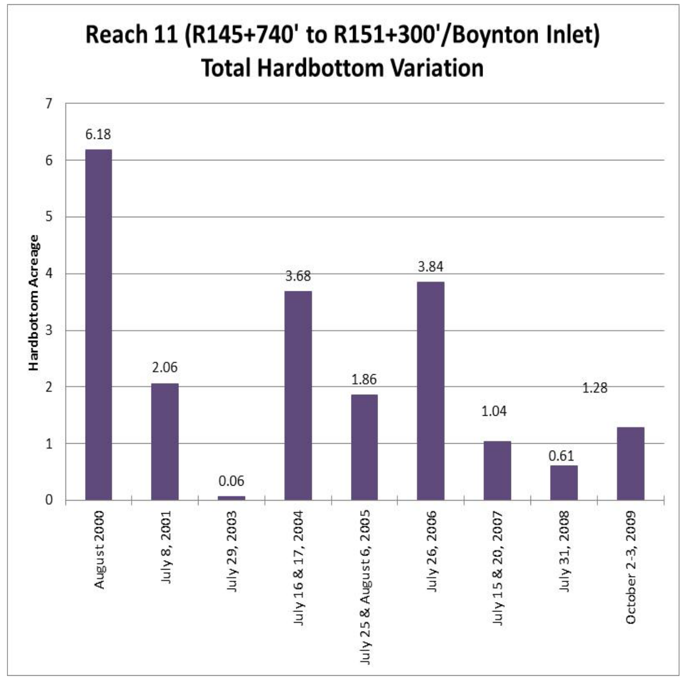

Reach 10 (R137+400' to R145+740') Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)

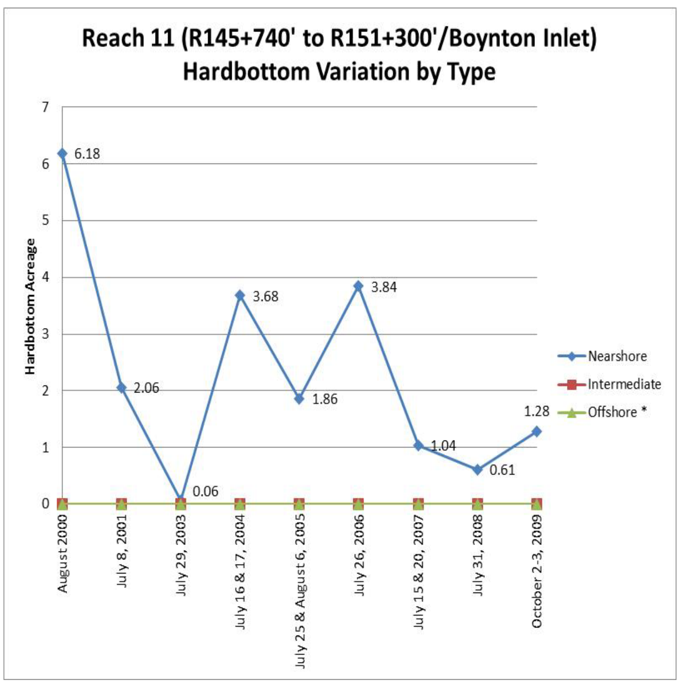

Reach 10 (R137+400' to R145+740') Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)

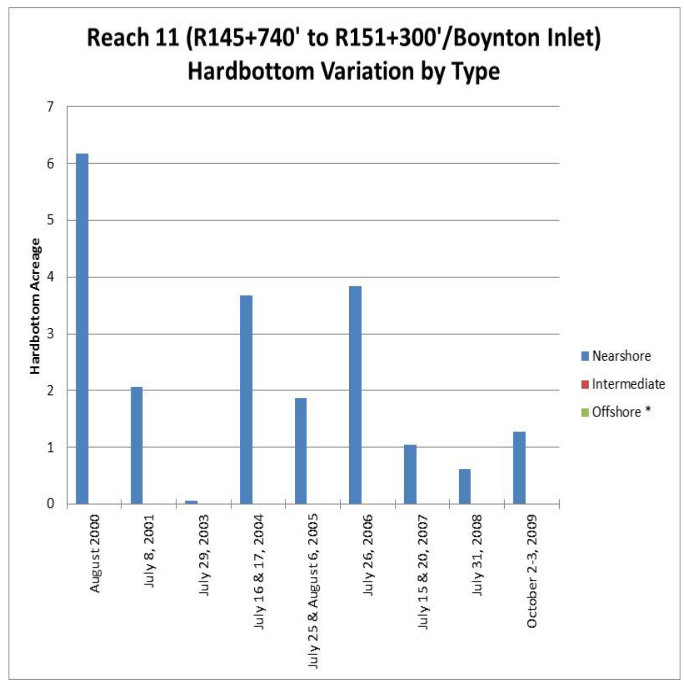

Reach 10 (R137+400' to R145+740') Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical
Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08
Irene 10/11
Sandy 10/12

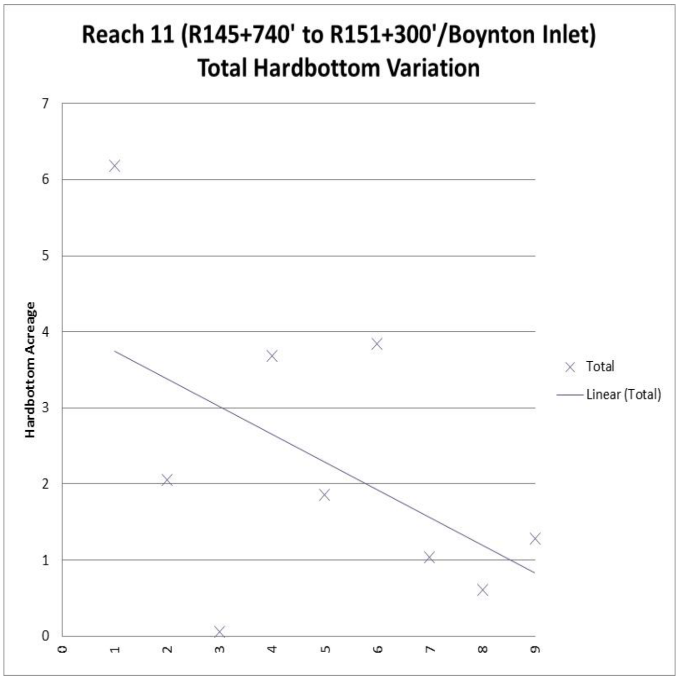
Hardbottom Data for Reach 11

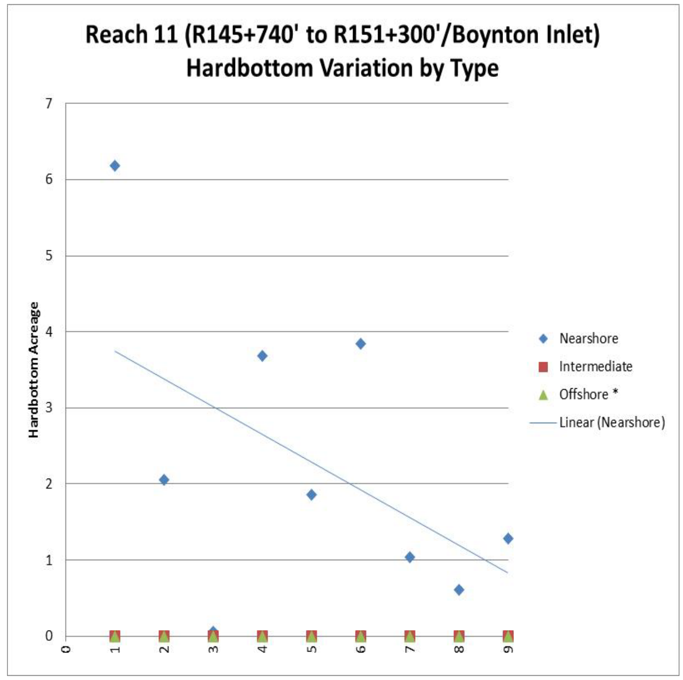


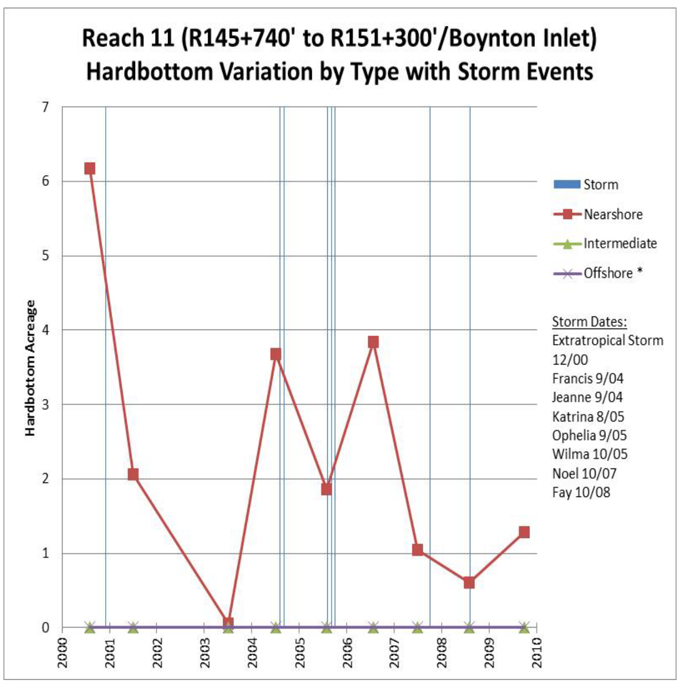







Reach 11 (R145+740' to R151+300'/Boynton Inlet)
Total Hardbottom Variation
Hardbottom Acreage
Total
Linear (Total)


Reach 11 (R145+740' to R151+300'/Boynton Inlet)
Hardbottom Variation by Type
Hardbottom Acreage
Nearshore
Intermediate
Offshore *
Linear (Nearshore)


Reach 11 (R145+740' to R151+300'/Boynton Inlet)
Hardbottom Variation by Type with Storm Events
Hardbottom Acreage
Storm
Nearshore
Intermediate
Offshore *
Storm Dates:
Extratropical Storm 12/00
Francis 9/04
Jeanne 9/04
Katrina 8/05
Ophelia 9/05
Wilma 10/05
Noel 10/07
Fay 10/08

APPENDIX B-6

Monitoring Summary

Monitoring	Surveys	Survey Period	Deliverables	Plan Section
Hardbottom Monitoring	Historical Aerial Review	Prior to the development of cell-wide hardbottom monitoring plan	Map (GIS) of potential hardbottom habitat distribution based on analysis of twelve years (2000-2012) of historical aerials.	1.2.3.1 and Appendix B-5
	Habitat Mapping	Summer immediately following the execution of the BMA	Habitat Map of Hardbottom (GIS mapping package)	1.2.3.2
	Aerial Photograph Survey	Summer (annual); Data required within 45 days and Report within 120 days following each monitoring event	Aerial photographs (in tiff)	1.2.5.1, 1.3, 1.4, 1.6.2.1
	Hardbottom edge survey		Shapefiles	1.2.5.2, 1.3, 1.4, 1.6.2.2
	Transect monitoring		Excel spreadsheets, PDF of field sheets, digital video and photographs	1.2.4, 1.2.5.3, 1.2.5.4, 1.3, 1.4, 1.6.2.3
Marine Turtle Monitoring	Daily nesting / false crawl surveys	Daily during nesting season (annual); Data due January 15th of each year	Excel spreadsheet with number of nests/false crawls and nest GPS location. GIS nest site location; hatch and emergence success	3.0 - 3.3
Physical Monitoring	Topographic and bathymetric profile surveys of the beach and offshore	Spring or summer months (annual); Data and report within 90 days following each monitoring event.	Excel spreadsheets with data and report	4.0 and 4.1