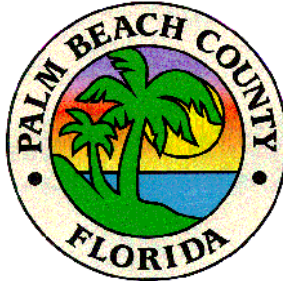


PALM BEACH COUNTY



COMPREHENSIVE COASTAL MONITORING PROGRAM

DRAFT

(Proposed to the DEP 5/99)

Palm Beach County
Department of Environmental Resources

www.co.palm-beach.fl.us/erm/divisions/enhancement/shoreline/index.htm

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Technical Specifications

Introduction

The overall intent of the program is to integrate project-specific monitoring with regional investigations to record shoreline, nearshore and inlet changes. Data gathered through the program will be used to improve the County's sediment budget estimates and to assess the impacts and refine the design parameters of shoreline management projects.

Objectives

The proposed comprehensive monitoring program will provide a basis for the evaluation of the status of native beaches and coastal habitats as well as the performance of coastal projects . Consistent data sufficient for statistical validity and backed by long term funding will be used to provide a county-wide report for simplified analysis and review. To facilitate future design and planning efforts and track program impacts, the monitoring program shall:

- ◆ identify shoreline adjustments,
- ◆ survey beach/nearshore sediment volumetric changes,
- ◆ identify sediment characteristics,
- ◆ monitor inlet sand transfer plant production,
- ◆ map trends of dune extent and exotic vegetation intrusion,
- ◆ measure and track nearshore hardbottom extent,
- ◆ classify relative nearshore and offshore habitat value,
- ◆ evaluate the effectiveness of mitigation,
- ◆ monitor beach escarpment,
- ◆ examine sediment temperature profiles,
- ◆ collect sea turtle hatchling disorientation data,
- ◆ assess sand compaction characteristics
- ◆ survey reproductive success of sea turtle nesting and
- ◆ ensure that state and federal permit conditions are met.

The monitoring shall be performed as follows:

PHYSICAL MONITORING

1.1 BEACH PROFILE SURVEYS

The purpose of beach profiles is to provide the data necessary to evaluate shoreline and volumetric changes which constitute a quantitative appraisal of project performance, indicate short and long term erosional trends, and form the basis of design for future sand transfer and shoreline stabilization projects.

Survey Methods

Beach wading depth profiles will extend from 150 feet landward of the DEP reference monument or from the edge of a building or road (whichever is most seaward) to wading depth, a minimum of -5.0 feet NGVD. Profile alignment will be identical to the azimuth previously established by the DEP for each monument. Elevations will be obtained at 25 foot intervals and at all noticeable breaks in grade. Elevations/soundings will be referenced to the established 1929 NGVD.

Hydrographic profile lines will extend 5,280 feet seaward of the shore or a depth of -30 feet (NGVD), whichever is less. Offshore soundings will be obtained at a maximum of 25 foot intervals along each profile where the subsurface is sand, and 10 feet in hardbottom areas. The hydrographic profiles shall provide for sufficient overlap with the wading depth profiles and be conducted according to USACOE hydrographic standards.

Location, Frequency and Spacing

Beach profiles will be surveyed at DEP reference monuments on an annual basis from June-August. Additionally, as-built surveys are to be performed following each fill event. Project-specific or post-storm profiles will be surveyed as necessary.

Data Format

Survey data will be available in the following electronic formats:

1. ASCII - X, Y, Z format,
2. DEP format,
3. AutoCAD format
4. GIS compatible format, and
- 5 . USACOE ISRP Format

Alternate Methods

Survey data acquired using LADS/LIDAR/SOALS or similar technology may be used bi-annually to provide the data described above.

1.2 BATHYMETRIC SURVEYS- INLETS

The inlet bathymetric surveys will provide data for sediment budget analysis and advanced planning of maintenance dredging and inlet sand transfer.

Bathymetric surveys of the inlet channels, sediment basins and ebb shoals will be performed employing a fully automated hydrographic survey system operated from a stable, shallow draft vessel with a semi-enclosed cabin for protection of the onboard survey equipment. Navigation and positioning for the offshore survey will be accomplished using a real time differential Global Positioning System. The navigation and fathometer systems will be interfaced and the data generated in real time. All data will be recorded on the hard disk drive for post-survey data reduction. Bar check calibration of the fathometer will be taken at the start of each day, periodically throughout the survey, at the end of each survey graph paper roll and at the end of each day. Tide readings will be taken at a minimum of 15 minute intervals during the surveys. Topographic and hydrographic survey work shall be in compliance with the U.S. Army Corps of Engineers Technical Requirements for Surveying, Mapping and Photogrammetric Services March 1989, The U.S. Army Corps of Engineers Engineering Design: Hydrographic Surveying, EM11110-2-1003, Feb. 1991, and the Department of Professional Regulation Laws and Rules including Chapters 177 & 472, Florida Statutes.

Location and Frequency

Surveys of the inlet channels, sediment basins and ebb shoals will be performed concurrent with the beach profiles.

Data Format

Survey data will be available as survey drawings in plan (with a plot of the tide adjusted bathymetric data contours at 1 foot intervals) or cross-section views and in the following formats:

- 1 ASCII - X, Y, Z format,
- 2 AutoCAD format, and
- 3 GIS compatible files.

Alternate Methods

Survey data acquired using LADS/LIDAR/SOALS or similar technology may be used bi-annually to provide the data described above.

1.3 SEDIMENT CHARACTERIZATION

The purpose of sediment analysis is to provide the data necessary to identify the sand characteristics of native and restored beaches. Trends suggesting the effects of natural sorting will be sought and the collected data will be available for interpretation in conjunction with sea turtle nesting information. Project specific samples will also be used to calculate overfill ratios. Grain size can affect the sand compaction, scarp formation, moisture content, temperature, and other parameters which can affect a sea turtle's ability to build a nest as well as influence the incubation environment.

Sample Collection Methods, Locations and Frequency

Samples of the native beach and nearshore sediments will be collected along pre-set azimuths at every DEP monument within the project limits of beach nourishment projects, at an additional three consecutive DEP monuments immediately north and south of the project limits and at every remaining fifth monument in the county. Sampling of the native beach will serve three purposes: 1) project design use, for calculation of overfill ratios, 2) to chart the project-specific changes in sediment due to natural sorting, which may have impacts to sea turtle nesting, and 3) to determine countywide non-nourished sediment characteristics.

Project Design Purposes. Sampling frequency will be annually for four years post-project construction. A six inch core will be taken at the toe of dune, upper, mid, and lower berm, approximate 0, -3, -6, -9, and -12 feet NGVD sites along the profile using a 3 inch diameter coring tube. For toe of dune and berm samples, the top 6 inches of sand will be removed prior to coring. The core sample will be bagged and labeled. For intertidal and nearshore samples the core cap is removed, and the core is driven into the substrate, retrieved, and capped without losing the fine fraction. Any water is poured off after the sediment settles, and the sample is bagged and labeled with date, DEP monument, sample site, and depth.

Countywide Sediment Characterization. Sampling frequency will be yearly, prior to the turtle nesting season. A six inch core will be taken at ten feet seaward of the toe of dune and at mid-berm sites. Since the dry beach is the zone of marine turtle nesting, samples will be collected at the 12 to 18 inch depth. The cores will be at the approximate mid-clutch depth and consistent with cone penetrometer sampling. Samples will be placed in plastic bags and labeled with date, DEP monument, sample site, and depth.

Sample Analysis

After the samples are collected in the field, each will be split into two sub-samples, one to be archived and one to be used for analysis. Analysis will follow the American Society of Testing Materials (ASTM) Method D422 (or similar) for dry sieving and D1140 (or similar) for wet sieving. Sieve requirements will follow the U.S. Army Corps of Engineers (COE) - Jacksonville District standards. The sieves include the -4.0 phi through the 3.5 phi sieves at half phi interval plus the 3.75 phi sieve, for a total of 17 nested sieves.

Analysis will include calculations for mean, median, standard deviation, skewness, and kurtosis by the Folk and Moment statistical methods. A grain size distribution curve and a frequency curve shall also be required for every subsample analyzed. All sediment classifications shall follow the Unified Soils Classification as required by the COE .

Data Format

The COE recommends the above stated ASTM methods for dry and wet sieving or similar methods. Half phi intervals are also used by the COE for sieving with the addition of the 3.75 phi sieve to determine the silt/clay fraction of the sample (material passing through the 3.75 phi size is silt/clay size material).

The data sheet format has been used in the past by the County and other coastal engineering firms and includes the sieve analysis results in easy-to-read form. Information on the sheet is listed in the ASTM method D422. The grain size distribution curve is described in ASTM D422 and is accepted by the COE.

1.4 SEDIMENT COMPACTION

The purpose of sediment compaction analysis is to provide the data necessary to identify the compaction characteristics of native and restored beaches. Trends suggesting the effects of natural sorting will be sought and the collected data will be available for interpretation in conjunction with sea turtle nesting information. These data would supplement detailed sediment collections and analysis at beach projects to provide control and baseline data necessary for valid comparisons as well as the ability to monitor trends within the county relating to coastal construction projects.

Sediment compaction is believed to affect the adult sea turtle's ability to successfully dig a nest, resulting in an increased number of false crawls. Compacted sands have been shown to affect nest shape and depth and affect the hatchlings ability to emerge from the nests. Beach nourishment has been found to influence sediment compaction. Consistent monitoring will provide the information to evaluate compaction values throughout the county and to assess temporal changes in compaction at project areas.

Survey Methods

Sand compaction measurements will be conducted using a cone penetrometer following the modified Nelson and Dickerson methodology adopted by the FDEP and USFWS. Five replicate measurements will be collected at each of three depths: 0 to 6 inches, 6 to 12 inches and 12 to 18 inches. The values of each depth and each sample point will be averaged.

Location and Frequency

Each May, sediment compaction will be measured, at a minimum, at the same time and locations as sand grain sampling (see section 1.3).

Data Format

Data will be tabulated in a database linked to GIS.

1.5 DIGITAL AERIAL CARTOGRAPHY

The purpose of the georeferenced aerial photography is to provide a qualitative measure of the performance of sand transfer and shore protection projects and quantitative measurements of the extent of exposed hardbottom, beaches and dunes throughout the county.

Photographic Specifications

Aerial coverage over the coastline will be approximately 33 percent land and 66 percent water with minimum overlap of 60 percent with adjacent photographs at a scale of 1"=300'. Aerial photos will be vertically controlled. The imagery of the photos will be clear and sharp in detail, of uniform density, average contrast, and free of clouds and cloud shadows, light streaks, smoke, static marks, fog or other blemishes which would render them unsuitable for their intended purpose. Light reflections from water areas will be kept to the minimum possible, consistent with the use of filters and time of image acquisition, and without extensive ground shadow. At the time of the flight, seas shall be calm and clear enough to clearly see the nearshore hardbottom and artificial reefs. The tide shall be at least 2 hours after low tide and prior to high tide. The photo flight will take place during the morning hours with the sun angle between 20 and 45 degrees relative to the horizon, cloud cover less than 10%, and as otherwise required to avoid reflection of sunlight within the target area.

Location and Frequency

Aerials shall provide county wide coverage annually.

Data Format

Aerial photography will be produced in electronic format. Aerial extent of hardbottom will be digitized and quantified yearly. The extent of native dune vegetation and emergent beach area will be calculated every 4 years.

1.6 DUNE ASSESSMENT

The purpose of dune assessment is to provide the data necessary to identify trends of exotic vegetation invasion and extent.

Survey Methods

Digital aerial photography will be used to quantify the extent of the dune. Exotic vegetation type and approximate extent will be mapped from field notes.

Location and Frequency

Countywide every four years

Data Format

Digitized maps with calculated values in GIS format.

1.7 EMERGENCY RESPONSE

The purpose of emergency response is to provide information on the immediate impacts of storms to the beach systems.

Survey Methods

Depending on the intensity of the storm, immediate response will range from:

- ◆ site visits throughout the county to photograph the shoreline at existing monitoring stations, record scarping extent, erosion of dune systems, damage to structures and impacts to turtle nesting,
- ◆ aerial photography,
- ◆ profile surveys at selected locations as quickly as possible following a severe storm event.

Location and Frequency

Countywide as necessary

Data Format

At minimum, a generalized map with photographs and field notes. Other data as described above.

1.8 SAND TRANSFER PLANT PRODUCTION

The purpose of sand transfer production monitoring is to provide information on the efficiencies of the bypass plants, thereby allowing accurate calculations of their contribution to the beach system.

Survey Methods

Production of the stationary plants will be measured using pre- and post-test surveys of the intake pits. The South Boca plant will be tested using surveys of a bermed area at outfall end of the system.

Frequency and Location

Testing will be conducted every four years at the South Boca Inlet, the South Lake Worth Inlet, and the Lake Worth Inlet.

Data Format

The tests will provide flow rates expressed in cubic yards per hour.

1.9 PHYSICAL MONITORING REPORT

The purpose of the monitoring report is to present a summary of the data collected and analyses performed under the Comprehensive Beach and Offshore Physical Monitoring Program. The monitoring report will serve as a basis for planning of future shore protection projects as well as modifying the existing sand transfer programs

A four year monitoring report will be prepared and submitted to the DEP. The report shall include assessment of the performance of the sand transfer projects, coastal processes, and a compilation of all the monitoring data. Based on the evaluation of collected monitoring data, the report will incorporate the following:

Beach Monitoring

- ◆ Beach and hydrographic survey data will be reviewed.
- ◆ Shoreline and volumetric changes will be calculated using the beach profile and hydrographic monitoring surveys.
- ◆ An evaluation of the performance of shore protection and sand transfer projects will be reported.
- ◆ Alternative bypassing locations and historical hot spots will be presented.
- ◆ Sediment characteristics and compaction comparisons and trends will be presented in terms of their relation to other physical changes in the beach.
- ◆ The sediment budget will be updated and compared to previous calculations
- ◆ Data will be reviewed in the context of regional performance.

Inlet Surveys and Ebb Shoal Volumes

The annual bathymetric surveys of the inlet channels, sediment basins, and ebb shoals will be reviewed. Sand volumes within the shoals will be calculated and compared to historical data.

Hardbottom and Dune Extent

Yearly mapping of hardbottom extent and single mapping of dune extent will be compared to historical data.

Emergency Response

A summary of meteorological data and impacts associated with severe storm events will be presented along with descriptions of any remedial action taken.

Sand Transfer Production

Production volumes for all three plants will be calculated.

Supplemental Data Acquisition

Supplemental data from site specific installations such as the Video Metric System, used to identify and quantify spatial and temporal characteristics of littoral sediment transport and shoreline evolution, will be described and analyzed in terms of regional applications

Recommendations

Future projects will be recommended based on the evaluation of the physical and environmental monitoring and project costs. Changes proposed in the comprehensive monitoring program will be presented.

ENVIRONMENTAL MONITORING

2.1 Nearshore Hardbottom

The purpose of monitoring exposed nearshore hardbottom is to provide data necessary to classify relative habitat value, to assess potential environmental impacts which may be related to shore protection projects, and to evaluate the effectiveness of appropriate mitigation.

The extent and permanence of exposed nearshore hardbottom will be determined by aerial cartography as described in Section 1.5. A **Baseline Survey** will be conducted of all significant and persistent nearshore hardbottom. Thereafter, **Annual Monitoring** will be conducted at selected locations prioritized according to the potential for environmental impacts (pending shore protection projects), moderate to high habitat value (as determined during the baseline survey), and proximity to mitigation reef (to provide natural hardbottom/mitigation reef data comparisons).

2.1.1 Baseline Survey

Survey Methods

Each hardbottom area will be visually surveyed by free swimming transects from the shore to the seaward edge of the exposed hardbottom area at intervals sufficient to achieve substantial coverage (approximately 100-foot intervals). Still photographs will be taken to document general features or specific features of interest (e.g. ledges, overhangs, crevasses) within the area. Digitized maps based on the most recent aerial photography will be provided for visual reference. The following observations will be recorded:

Habitat Characterization

Vertical Relief

A visual estimate will be made of the percentage of area along each transect in the following categories:

flat rock	
low relief	(0-2 ft)
moderate relief	(2-4 ft)
high relief	(4+ ft)
ledges, overhangs, crevasses	

Sand

A visual estimate will be made of the percentage of area along each transect comprised of sand.

Biodiversity

Each hardbottom area will be visually surveyed by free swimming transects from the shore to the seaward edge of the exposed hardbottom area at intervals sufficient to achieve substantial coverage (approximately 100-foot intervals). Video documentation will include coverage of typical features and features of special interest (e.g. target species).

The following information will be recorded:

Fish Diversity and Abundance

A species list will be prepared for each reef including notation of relative abundance in the following three categories:

rare	(1 - 5 individuals)
common	(5 - 30)
abundant	(30+)

Juvenile presence/absence will be noted for each species or in broad general categories (e.g. grunts) if species identification is not possible. The 5 dominant species will be noted.

Algal/Invertebrate Coverage

A visual estimate will be made of both algae and invertebrate percent coverage on exposed hardbottom areas. Still photographs including reference of size will be taken in areas of interest, particularly hard corals and gorgonians. Relative abundance will be subjectively estimated for each species (**rare**, **common**, or **abundant**). The 5 dominant species will be noted.

Target Species

Specific note will be made of commercially valuable and 'indicator' species including: sea turtles, snook, snapper, grouper, lobster, worm rock (note percent cover and relief), *Siderastrea* (measure diameter of patches) or other hard corals, gorgonians. A video will be made including target species and a size reference will be included for corals. A visual estimate of relative abundance will be made for each species:

rare	(1 - 5 individuals)
common	(5 - 30)
abundant	(30+)

Location and Frequency

An initial Baseline Survey will be conducted at all exposed nearshore hardbottom locations within Palm Beach County which are over one acre in area and have been observed in aerial photographs over two

years. Subsequent updates of the Baseline Survey will be conducted based on the review of annual photography.

Data Analysis

Habitat Value

Classification categories will be determined for each 'segment' of hardbottom based on persistence, habitat characterization, and biodiversity as follows:

Persistence

Relative persistence will be determined based on the aerial cartography (Section 1.5) and the following relative categories :

- persistent** occurring in same location, similar configuration for multiple years
- variable** occurring in same general location for multiple years but in a variable configuration/exposure
- ephemeral** <2 year exposure duration; periodic reburial of the majority of the area

Habitat Characterization

Vertical relief, as described above, will be considered a factor in determining habitat value.

Biodiversity

Relative abundance of fish as described will also be included in determining habitat value. The following categories will be established:

- high** minimum of 40 species identified, presence of juveniles, abundant algal/invertebrate coverage, >3 target species "abundant"
- moderate** 20 - 40 species identified, presence of juveniles, common algal/invertebrate coverage, >3 target species "common"
- low** less than 20 species identified, few or absence of juveniles, rare algal/invertebrate coverage, >3 target species "rare"

Habitat value will be determined as follows:

Class A	persistent, moderate-high profile with ledges and overhangs or crevasses, high biodiversity,
Class B	persistent - variable, moderate-low profile, high-moderate biodiversity
Class C	ephemeral or low profile, moderate-low biodiversity

Data Format

Field log forms will be developed to ensure consistency of all recorded observations. The forms will be scanned or entered into a database and tables generated as necessary.

Habitat Characterization

A large-scale digitized map based on aerial cartography will be used in the field for mapping observations and then digitization of the observation location. Separate contour map layers will be created to indicate persistence, relief, percent sand, and algal percent cover. All photos will be labeled and catalogued. A selection of representative photos will be scanned.

Biodiversity

A species list will be produced ordered by families and then abundance within families. Dominant species will be denoted. A map layer indicating high, moderate, or low biodiversity will be created.

Habitat Value

Based on the most current set of aerial cartography as a map base, habitat classes will be mapped and each habitat category in Palm Beach County will be digitized and quantified.

2.1.2 Annual Monitoring

Survey Methods

Habitat Review

Habitat characterization information collected during the Baseline Survey will be reviewed in the field and modified as necessary at the time of the Annual Survey. Any significant changes will be noted and habitat classification will be revised as appropriate. Review will focus on the average and maximum relief and width of the exposed area. Still photos will be taken of notable features (e.g. hard corals with size reference, other target species, etc.) as appropriate.

Biodiversity

Fish Diversity and Abundance

Fish counts will be conducted at the three fixed DGPS-documented stations at each survey location. A minimum of three replicate counts will be conducted at each station. The species list generated during the Baseline Survey will be used as a log form for fish counts during the Annual Monitoring survey. Fish counts will be conducted using the Bohnsack method, modified to include a 10'-radius cylinder and count duration of 5 minutes. Life stage (juvenile, adult) will be noted to the lowest taxon possible.

Algal and Invertebrate Species Lists

A species list and notations of relative abundance will be made at each survey location by free-swimming a random transect between the fixed stations. Relative abundance will be subjectively estimated for each species (**rare**, **common**, or **abundant**). The five most abundant species will be noted as such.

Target Species

Specific note will be made of commercially valuable and 'indicator' species including: sea turtles, snook, snapper, grouper, lobster, worm rock (note percent cover and relief), *Siderastrea* (measure diameter of patches) or other hard corals, and gorgonians. A video will be made including target species and a size reference will be included for corals. A subjective determination of relative abundance will be made for each species:

rare	(1 - 5)
common	(5 - 30)
abundant	(30+)

Location and Frequency

An annual survey will be conducted at fixed monitoring locations. Locations will be selected based on habitat value, proximity to mitigation reef areas (for comparative purposes), and potential risk of

environmental impacts from shore protection projects. Locations under consideration include Coral Cove, Lost Tree/JDMSP, Ocean Reef, Palm Beach (north end of Midtown), Palm Beach north of Sloan's curve, SPB/Manalapan, South Ocean Ridge, and South Boca. Other locations may be added as appropriate. Each location will include three fixed DGPS-documented monitoring stations. Video documentation will be provided between stations. Each location will be sampled annually as close as possible to the same month each year.

Data Analysis

Habitat Review

Baseline Survey maps of habitat features will be reviewed and revised as necessary based on Annual Monitoring.

Biodiversity

Data will be statistically compared to previous Annual Monitoring and Baseline Surveys to identify possible trends as well as to Mitigation Reef Surveys to compare habitat value and structure success.

Data Format

Habitat Review

Map layers will be generated showing the current extent, relief and ephemeral nature of the nearshore hardbottom. All photos will be labeled and catalogued. A selection of representative photos will be scanned.

Biodiversity

A species list ordered by families and then abundance within families generated by the surveys will be entered into a sortable database. Map layers will be generated for fish, algae, invertebrates and target species showing diversity, abundance and the five most dominate species and their distribution. Presence/absence of juveniles will be noted. All tapes and photos will be labeled and catalogued. A selection of representative photos will be scanned.

2.2 Mitigation Reef Monitoring

The purpose of monitoring mitigation reefs of various designs is to provide the data necessary to assess their relative persistence, physical stability and habitat value as well as to compare the structures to natural hardbottom.

Survey Methods

Purpose & Goals

The purpose of this monitoring is to collect quantitative and/or qualitative physical and biological data on artificial reefs and comparative natural reefs and nearshore hardbottom to determine the relative effectiveness of various artificial reef materials and designs. The goal of this analysis is to answer the following questions:

- 1) Do shallow water (< -12 ft NGVD), ephemeral nearshore hardbottom habitats contain disproportionate numbers of juvenile fish, as compared to deeper habitats (> 12 ft NGVD)?
- 2) Do fish and invertebrate species inhabiting shallow water (-8 to -12 ft NGVD) nearshore hardbottom habitats represent distinct assemblages compared to those from deeper (> -12 ft NGVD) reefs?
- 3) Are species assemblages on artificial reefs influenced by specific characteristics of construction materials?
- 4) Are species assemblages on artificial reefs influenced by the orientation and/or configuration of the structures?
- 5) To what extent do these artificial reefs simulate physical and biological characteristics of adjacent natural nearshore hardbottom and reefs?

These questions are to be addressed in the final report and provide the basis for summarizing the relative effectiveness of the reef types:

Objectives

- 1) Conduct four field surveys (August, September, January, February or March) in the identified reef locations.
- 2) Collect quantitative data on fish communities, primarily fish counts categorized by life history stages.
- 3) Collect qualitative data including the predominant invertebrate and algal assemblages, occurrence of 'target species',

estimated percent coverage of available hard surface area, and assessment of relief/habitat complexity.

- 4) Conduct a fathometer survey of the artificial reef and provide a detailed 3-dimensional map of the relief on each of the reef areas in DTM GIS format.
- 5) Prepare a statistical analysis of fish data comparing individual artificial reef designs to natural habitat of similar relief and at similar water depths.

Survey Locations

Artificial reef monitoring locations include the six types of reefs listed in the following table and constructed as mitigation or enhancement in conjunction with the Jupiter Carlin, Juno Beach and Ocean Ridge beach nourishment projects. Artificial reef study types include several configurations and orientations of limestone boulders, concrete bridge rubble, and two designs using limestone boulders surrounded by a scour- protection “mattress” synthetic material (Armorflex or Geogrid mattresses). Some of the reefs were constructed in areas with no naturally-occurring underlying rock support and some were built with underlayments of synthetic grid material or filter cloth. Water depth varies between -9 feet NGVD on some of the most shallow bridge rubble to approximately -25 feet NGVD.

Comparative natural reef/nearshore hardbottom areas or “control groups” have been selected in shallow water at Coral Cove and in deeper water in an area known as The Breakers reef. Primary emphasis is to compare individual artificial reef designs to natural habitat at similar water depth and of similar habitat complexity as follows:

Artificial Reef Types	Water Depth (ft NGVD)
1) Royal Park Bridge Concrete	-9 to -12
2) J/C Filter cloth & Limestone Boulder	-15 to -20
3) Juno Armor-Flex/Geogrid & Limestone Boulder	-17 to -20
4) Juno Rock Mattress & Limestone Boulder	-17 to -25
5) Donald Ross Bridge Concrete	-18 to -25
6) Gulfstream Limestone Boulder	-9 to -14

Comparative Natural Reef Types	Water Depth (ft NGVD)
1) Coral Cove	-9 to -12
2) The Breakers Reef	-15 to -25

Fish Diversity, Abundance and Life History Stage.

Each of the reef types will be surveyed once per month during the summer months (i.e. June, July, August, and September) and on two occasions later in the monitoring year (January and March).

Free-Swimming Fish Observations. Qualitative fish species data will be collected by free-swimming throughout the reef area and recording all fish species observed. Fish will be identified to the lowest possible taxonomic category enumerated and categorized as to life history stage (e. g. newly settled, juvenile, sub-adult, and adult).

Stationary Fish Counts. Quantitative data will be collected by conducting stationary fish counts. All surveys will be conducted when visibility exceeds 10 feet. Stationary counts will be conducted at three randomly selected locations (replicates) on each reef type. Each stationary count will be conducted for ten minutes and according to a modified version of the methodology described in Bohnsack and Bannerot (1986)¹ and Bortone, et al, (1989)². All fish occurring within a cylinder measuring 3 meters in radius will be identified to the lowest possible taxonomic category, enumerated, and categorized as to life history stage (e. g. newly settled, juvenile, sub-adult, and adult).

Invertebrate and Algal Diversity.

Qualitative invertebrate and algae data will be collected at each reef type.

Species Lists. Species lists will be made by swimming throughout the reef area and recording all algal and invertebrates to a minimum taxonomic classification of phylum. Species (phyla) will be subjectively categorized as predominant, common, or rare.

¹ Bohnsack, J. A. and S. P. Bannerot. 1986. A Stationary Visual Census Technique for Quantitatively Assessing Community Structure of Coral Reef Fishes. NOAA Technical Report NMFS 41. 15pp.

² Bortone, S. A., J. J. Kimmel, and C. M. Bundrick. 1989. A Comparison of Three Methods for Visually Assessing Reef Fish Communities: Time and Area Compensated. Northeast Gulf Science 10(2): 85-96.

Colonization. At each reef type, three replicate one third-meter square photographs will be taken for documentation of colonization. Notations will be made relative to each photograph listing species present to a minimum classification of phylum, noting the most predominant phyla, and estimating the percent area within the quadrat that has been colonized.

Physical Stability and Quantification of Area.

An annual fathometer survey of artificial reef constructed in the Juno Beach/Jupiter area will provide a detailed 3-dimensional map of the relief on each of the reef areas in DTM GIS format. The goals of this mapping are to create an accurate detailed map of the reef areas, to document any scouring at the reef edges, and to document and differentiate between subsidence and burial.

Habitat Diversity. Habitat diversity in each reef area will be visually assessed by free-swimming throughout the area. Estimates will be made of the percentage of the study area characterized according to the following categories:

- sand veneer
- uncolonized rock
- low relief (0-2 ft)
- moderate relief (2-4 ft)
- high relief (4+ ft)
- ledges, overhangs, crevasses

Photodocumentation. Still photos will be taken to document features of interest including ledges, overhangs and scouring, snook, snapper, grouper and juvenile assemblages of fish, worm rock, *Siderasteria*, lobster and sea turtles.

Reports. An Annual Report will discuss the overall conclusions regarding the effectiveness of various materials, construction techniques, and depth regimes in mitigating for loss of hardbottom habitat. Databases will be compiled in MS Access format, and graphs and tables will be compiled with MS Excel.

Fish Data. Fish data will be presented as summary statistics (e. g. percent frequency occurrence, catch per unit effort, relative abundance). Life stage information and abundance data will be used to address differences in recruitment and assemblage structure between treatment groups using parametric analysis of variance (ANOVA) techniques.

Invertebrate Data. Invertebrate data will be presented as species lists in tabular format separated into phylogenetic categories. Comparisons among treatment groups will be made using Chi-Square analysis.

Habitat Data. Habitat data will be presented as percent coverage, and comparisons among treatment groups will be made using Chi-Square analysis.

2.3 OFFSHORE REEFS

The purpose of the monitoring is to provide the data necessary to establish habitat value and provide baseline information on offshore reefs, determine long-term trends and to assess potential environmental impacts resulting from dredging or fill placement projects.

Survey methods

Relative Abundance of Associated Fish

Quantitative data on reef fish communities will be collected using a modified Bohnsack methodology, consisting of ten minute stationary counts within a 7.5 m radii cylinder. Fish will be identified, enumerated, and placed into one of six size categories. The 7.5 m radii cylinders will be centered at the distal end of each of the two 30 m transects used in the fish surveys (see below).

Habitat Characterization and Species List

At the conclusion of the ten minute stationary count, each diver will attach the end of a 50 m fiberglass tape measure to the substrate at the center of the sampling cylinder and swim in a pre-determined direction until the tape is deployed, counting and assigning fish to size classes as they are encountered within 1 meter on either side of the tape. When the end is reached, the diver swims back along the tape and assigns the substrate at each one meter interval to one of several pre-determined habitat categories. Any stony coral encountered within 1 meter on either side of the tape will be measured (length and diameter, or radius).

Sedimentation

Triple-ring steel stands holding three 64 ounce plastic jars the tops of which are fitted with a 2" diameter, 8" long piece of baffled PVC pipe

will be used as sediment traps. Sediment falls out of suspension and is retained inside the jars. Three times during the winter dredging season (November to March) the jars are replaced with clean jars with a single sampling event not to exceed 2 months. The collected material is processed and analyzed for total dry weight and sedimentation is then calculated (mg total dry weight/cm³/day).

Survey Location and Frequency

Surveys will be conducted on offshore reefs at Coral Cove, Singer Island, Palm Beach (approximately DEP 86) Gulfstream, and Spanish River. The locations were selected because of their proximity to borrow areas and their general character. Three locations within each reef will be selected: inner, middle, and outer. Within each of these locations, two replicate surveys will be conducted at pre-selected points, which will be marked for future reference. (A replicate survey is defined as all data collected from one stationary sample, one habitat transect, and one fish transect.)

Fish stationary counts, fish transects, and habitat transects will be conducted once per year. These annual surveys will be conducted at approximately the same time each year, to reduce inter-seasonal variation. One sediment sample will be collected from each location within each reef every two months (3 locations x 5 reefs x 6 times/year = 90 samples).

Data Format

Sediment data and field log forms, used for consistency of observation, will be scanned or entered into a sortable database, which will be linked to location maps and GIS

Analysis

Fish data will be presented as summary statistics (e. g. percent frequency occurrence, catch per unit effort, relative abundance). Length frequency information will also be used to address differences in fish size between reefs and between years. Statistical analysis of differences between and among locations and reefs will be done with parametric analysis of variance (ANOVA) techniques.

Habitat data will be presented as percent coverage (e. g. number of points representing each habitat type / total number of data points x 100).

Sedimentation data will be compared to historical data and discussed relative to location and depth of station, as well as to any severe weather conditions

Reporting

A report analyzing nearshore hardbottom, offshore reef, and mitigation structures will be generated once every four years. The report will provide detailed maps and databases combined in GIS format, which will include an assessment of the relative habitat value and classification of the natural systems. The report will discuss trends in recruitment, life stages, growth rates, distribution and diversity of fish, algae and invertebrates on the reefs and compare mitigation reefs and nearshore hardbottom over time. Project impacts will be addressed, as will any impacts associated with severe weather events. The report will also propose modifications to methodologies as necessary based on findings and experience of the survey teams.

2.4 MARINE TURTLE MONITORING

Palm Beach County beaches provide critical nesting habitat for two species of endangered marine turtles, the green and leatherback sea turtles, and is one of the largest nesting habitats for the loggerhead sea turtle in the western hemisphere. During 1998, in Palm Beach County, a total of 14,057 loggerhead nests (or 16% of Florida nests), 1,278 green nests (or 23% of Florida nests), and 138 leatherback nests (or 39% of Florida nests) were documented along our surveyed beaches. The exact number of nests in the county is unknown because only 85% (38 of 45 miles) of beaches are monitored. Therefore, these figures underestimate the significance of Palm Beach County beaches to sea turtles.

Given the magnitude of sea turtle nesting within Palm Beach County and the long term shore protection options proposed, it is essential to have complete and accurate sea turtle related data for the entire county. At minimum, several key biological and physical parameters need to be monitored in order adequately assess nesting and reproductive success trends and potential influences.

Biological parameters include:

- the enumeration of nests and false crawls
- hatching and emerging success
- disorientation events
- predation events

Related physical parameters include:

- sand temperature
- sediment compaction or shear resistance
- scarp formation
- sediment grain size and sorting coefficient

Due to the temporal and spatial variations commonly associated with this data, it is necessary to have consistent, accurate information in sufficient sample sizes. The information is needed to establish baseline data to understand long term trends, make sound management decisions and to serve as control data to assess potential impacts from long-term erosion and shoreline construction projects.

Several deficiencies presently exist in the current status of sea turtle data collection in Palm Beach County:

- ◆ 9.4 miles (21%) of nesting habitat in Palm Beach County are NOT consistently surveyed throughout the nesting season;
- ◆ The areas surveyed are conducted by a conglomeration of over 15 organizations and citizen groups. Standardized methods, consistent monitoring and quality assurance/control measures and data management programs must be implemented and monitored in order to have comparable data;

- ◆ Reproductive success, including hatching and emerging success, is not consistently surveyed throughout the county. Sample sizes are rarely adequate for trend analysis or statistical comparisons when they are needed; and,
- ◆ Sediment temperatures on the beaches within the county are not monitored and not well understood. The sex of hatchlings is determined by the incubation temperature. In addition, recent research has indicated that temperatures on nourished beaches (with darker sediments) in Florida may reach lethal levels. With beach nourishment being an integral part of coastal management, it is imperative that we have an understanding of the sand temperature regimes within the county.

Monitoring programs implemented for each of these parameters would provide the baseline data necessary for evaluating trends as well as provide the data necessary to serve as controls for specific projects. Furthermore, with adequate data, a better understanding of the relationships among the biological and physical variables could be obtained.

Proposed Comprehensive Monitoring Programs

This proposal will address these deficiencies by implementing the following five strategies:

- ◆ Create and coordinate of additional volunteer programs to fill the gaps in nesting surveys.
- ◆ Develop standardized data collection and reporting methods for all fifteen survey programs with a goal that 95% of the nests, false crawls, predation events and disorientation events are reported.
- ◆ Collect statistically meaningful hatch and emergence success data by redirecting sampling effort to nourished and control beaches so that each nourished beach will have multiple controls to allow project-specific as well as countywide, long-term trends to be detected.
- ◆ Evaluate sediment characteristics, compaction and beach temperature.

This approach will take advantage of existing programs and the recruitment of volunteers to minimize costs, reduce duplication and focus effort on more meaningful aspects of monitoring.

2.4a Volunteer program

A comprehensive volunteer-based program will be implemented under the direction of Palm Beach County, incorporating active recruiting, thorough training and coordination, data management and analysis.

Survey Methods

Nesting surveys, including the enumeration of nesting and non-nesting (false) crawls, reproductive success, escarpment monitoring, predation and

disorientation data will be collected at all beaches that do not presently have regular surveys.

Frequency and Location

Annual nesting surveys will be conducted at each of the four beaches (9.4 miles) not presently regularly surveyed by existing programs daily from May 1 through August 31. From March 1 to April 30, surveys would be conducted every two to three days for leatherback and early loggerhead nests. After September 1, surveys would be conducted every two to three days for late green nests. Hatch and emergence success for loggerhead turtles will be collected from a statistically valid number of nests throughout the nesting season. Escarpment surveys will be conducted weekly.

Implementation of this program will be carried out through several phases due to the extensive training and coordination of volunteers and trainers that is required. A pilot program has been developed and implemented in the north part of the County where the highest nesting occurs. This program will serve as the foundation for expansion and implementation to other un-surveyed beaches. Up to three nesting seasons may be needed to fully implement the program.

2.4b Coordination of Sea Turtle Groups and Organizations

The development of standardized methods and training programs, implementation, consistent monitoring and quality assurance/control measures and data management programs for each of the groups conducting surveys throughout the county to provide a countywide estimate of reproductive success.

Survey Methods

Comprehensive monitoring of variables includes hatch and emergence success, hatchling disorientation, predation, and escarpments. A program of consistent, long term and representative sampling of reproductive success throughout the county will be implemented with the cooperation of existing monitoring groups. Monitoring groups would be compensated for their participation and increased responsibilities. Contractual agreements will govern additional requirements. Contracts for projects which monitor beach nourishment projects (Lake Worth Inlet, Midtown, Delray, Boca Raton & Juno) will be reviewed and modified as necessary to meet regional monitoring goals. Technical training, support and guidance will be provided.

Frequency and Location

Survey frequency will be the same as section 2.4a. Survey locations will include the existing programs which include Juno Beach, MacArthur State Park, Singer Island, Palm Beach Shores, Breakers, Midtown Palm Beach, southern Palm Beach, Lantana, Manalapan, Ocean Ridge, Gulfstream,

Delray Beach, Highland Beach and Boca Raton.

Due to the variety of work presently being carried out by the different groups, a phased approach introducing each new variable will be implemented for each organization. Consistent monitoring of all variables should be in place within two seasons provided adequate staffing is provided for development and coordination.

2.1c Project site monitoring

The existing ERM program which monitors three project areas will be continued.

Survey Methods

Same as section 2.4b.

Frequency and Location

Survey frequency will be the same as section 2.4a. Survey locations will include the existing ERM projects at Jupiter/Carlin, south Manalapan/South Lake Worth Inlet and Ocean Ridge. Portions of this work are likely to be contracted out.

2.1d Sediment temperature monitoring

Sediment temperature monitoring will provide insight into short and long term trends on beaches throughout the county. In addition, at the shore protection projects, sediment temperature profiles will be examined and compared to natural beaches.

Survey Methods, Frequency and Location

A series of 50 data-logging temperature sensors will be established at specified locations throughout the county. Their placement will vary to facilitate comparisons of project related monitoring and to provide the ability to characterize temperatures throughout the county. Data loggers will be deployed May 1 through September 30 to capture data through the majority of the nesting and incubation season and placed at a depth of 18" (45 cm). The loggers will record data every 15 minutes and will be downloaded and checked at least once per month. This recording frequency allows for investigation of short term changes and can be averaged to be used for comparisons. Sediment characteristics and compaction will be evaluated at all sensor locations (as described in sections 1.3. and 1.4).

Marine Turtle Annual Report

An annual report will be prepared evaluating and summarizing sea turtle nesting, nesting success, disorientation, predation, hatching and emergence success, hatchling productivity, sediment temperatures, compaction, grain

size and escarpment formation for all beaches throughout the County. Project related effects as well as long term trends will be analyzed and assessed with program continuation. The Annual report will be submitted to DEP by December 31.

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October 30, 2001