Florida Beach Nourishment Projects Monitoring Database

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Abstract: A comprehensive review of extensive beach nourishment project monitoring data is being conducted for the Florida Department of Environmental Protection (FDEP). More than 50 projects are being actively monitored by FDEP covering about 158.3 miles along the Gulf of Mexico and Atlantic Ocean shoreline. A comprehensive database of monitoring data parameters and information is being developed as a web-based format. A review and evaluation of these monitoring data and reports provides valuable information to the FDEP beach management program with regard to design optimization, performance, and cost effectiveness of beach nourishment implementation in Florida. The comparison of predicted vs. measured beach nourishment performance and current methodologies will assist the FDEP and project designers assess effectiveness and adequacy of current predictive methods.

INTRODUCTION

There are more than 50 active beach nourishment projects (Figure 1) with monitoring data and reports in the Bureau of Beaches and Coastal Systems (BBCS) files dating back to 1989 which document performance of the projects. Typical design and monitoring submittals by the project sponsor include: (a) description of the coastal processes in the project area, including shoreline change rates; (b) description of potential impacts to the adjacent shorelines from borrow area dredging; (c) geophysical and geotechnical analysis information of identified potential sand sources and suitability for beach placement; (d) project plans, specifications and estimated costs; (e) immediate pre- and post-nourishment beach and offshore topographic/bathymetric survey data, aerial photography, and, frequently, sediment-related information; and (f) periodic (generally annual) post-construction surveys and aerial photos and performance assessment reports.

The Beaches and Shores Resource Center (BSRC) was tasked by the BBCS to initiate a comprehensive review and evaluation of this information. Such a review and evaluation will provide valuable feedback information to the BBCS program regarding design optimization and overall effectiveness of beach nourishment implementation and will provide a basis for evaluation of cost-effectiveness of beach nourishment in Florida. In addition, the comprehensive database will provide quick and easy access to a concise, consolidated compilation of the monitoring data including project design and construction parameters (e.g., project length, beach width, berm height, filled volume density, sediment characteristics, date of construction) and regional/site-specific conditions (e.g., background shoreline erosion rates, alongshore sediment transport rates, wave conditions).The project database also includes information

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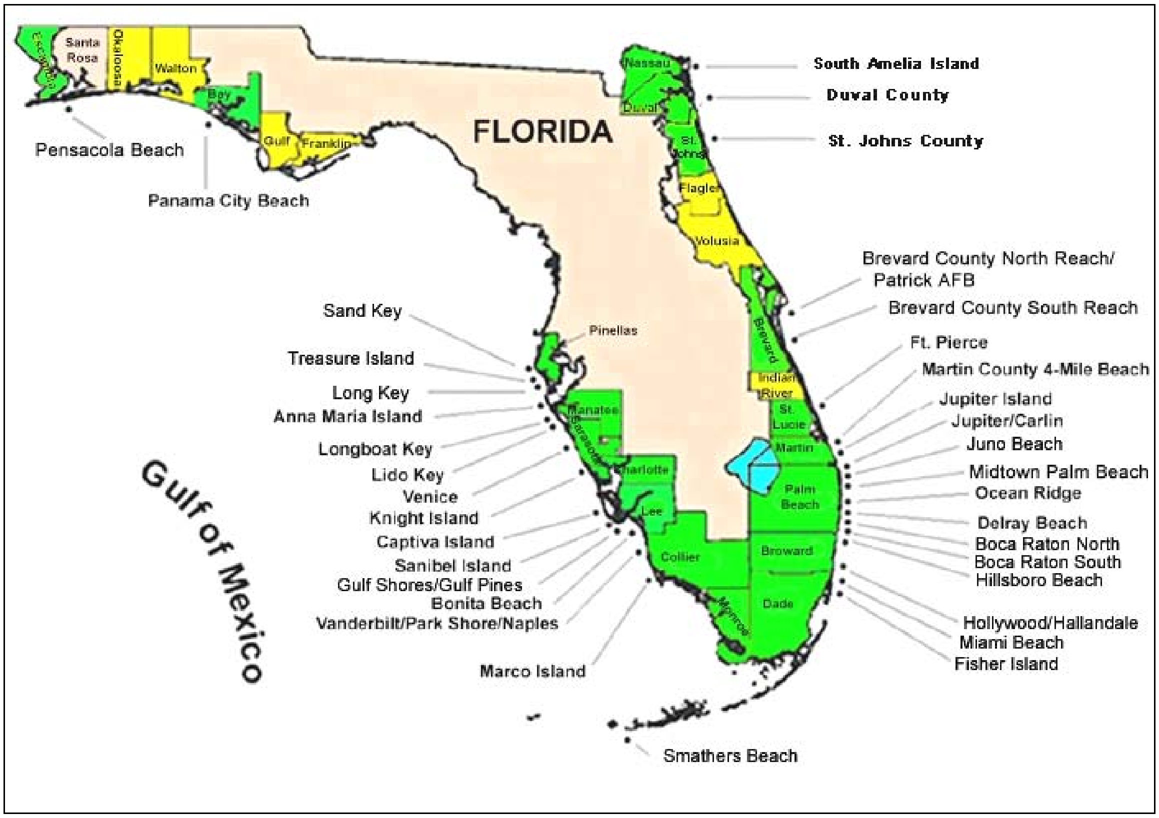


Figure 1. Monitored Beach Restoration/Nourishment Projects in Florida

about project performance such as shoreline and volume change and volume remaining within project limits and study areas per unit time.

The monitoring data and information reviewed and evaluated in this work effort has been acquired as a specific part of beach nourishment project implementation in Florida. In addition to the extensive project monitoring data being acquired, the BBCS conducts larger-scale regional coastal monitoring on a statewide basis. Some of the project monitoring data is integrated into the regional monitoring data collection. A description of the regional monitoring program (Leadon, 2002) as well as other related information can be found at URL: http://www.floridadep.org/beaches/publications/tech-rpt.htm.

A second phase of this work effort is to perform a more in-depth analytical evaluation of the project monitoring data to specifically look at predicted equilibrium toe-of-fill locations as well as longshore spreading of the fill material vs. that observed from the field measurements contained in the monitoring data. There is particular interest in reliability of these fill evolution predictions from an environmental resource protection standpoint in Florida in terms of potential extent of sand coverage of nearshore hardbottom features. In some initial work on this phase, a one-line shoreline change model, DNRBS, (Dean and Grant, 1989) for fill spreading has been utilized and evaluated for shoreline change predictions for the beach nourishment projects.

DATABASE

A Microsoft Access database was created to incorporate all the data collected and calculations performed for the project area. This central repository of the data makes for fast and convenient retrieval of all relevant data pertaining to the projects. In order to publish the results of the study in a universal and compact manner, a publicly accessible web site was developed and is located at URL: http://beach15.beaches.fsu.edu. Users can easily display and download any and all data, parameters, tables and figures related to the projects. The web site can be viewed with any standard HTML web browser. Active Server Pages (ASP) utilizing VBScript ensures dynamic access to the database, so when the database is updated on a regular basis, then the web site will always display the most up-to-date information.

CONTENTS

Monitoring and evaluation data for each project are subdivided into 8 categories (listed below) in the table of contents which are displayed on the web page. Figure 2 shows an example from the Longboat Key project.

1. Location Map
2. Design Parameters
3. Shoreline Change Plots
4. Volume Change Plots
5. Hot Spots
6. Performance Table
7. Performance Summary
8. Planform Change Evaluation

1. Location Map

The Location Map category shows a detailed graphical illustration and description of project and study area limits which are referenced to the FDEP monument ranges for all the nourishment projects.

2. Design Parameters

As shown in Figures 2 and 3, 16 characteristic design-related parameters are listed in the table for each corresponding nourishment project.

3. Shoreline Change Plots

The mean high water (MHW) elevation, referenced to the 1929 National Geodetic Vertical Datum (NGVD), measured at each profile line is used throughout this study to define the representative shoreline location. A summary of shoreline change between pre-construction and post-construction for each FDEP profile line is graphically presented as shown in Figure 4.

4. Volume Change Plots

The volumetric change information provided represents the change in the quantity

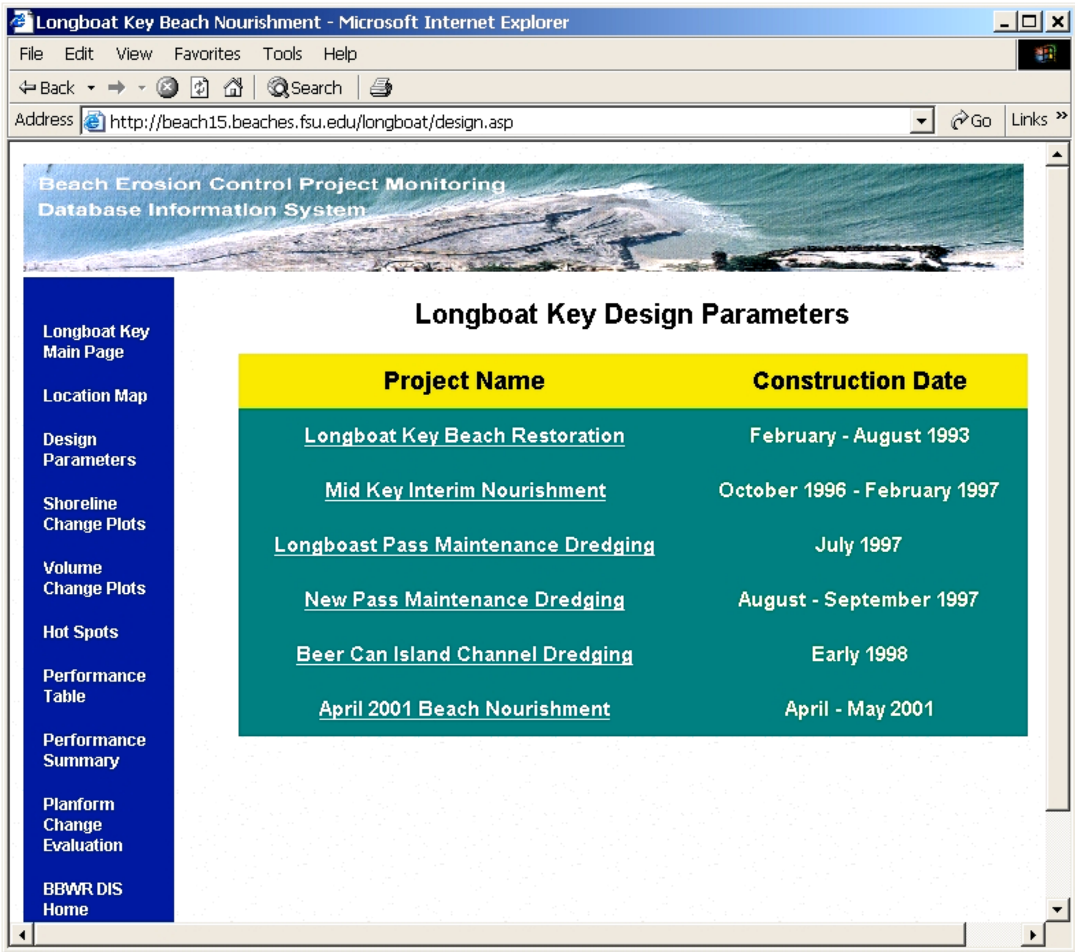
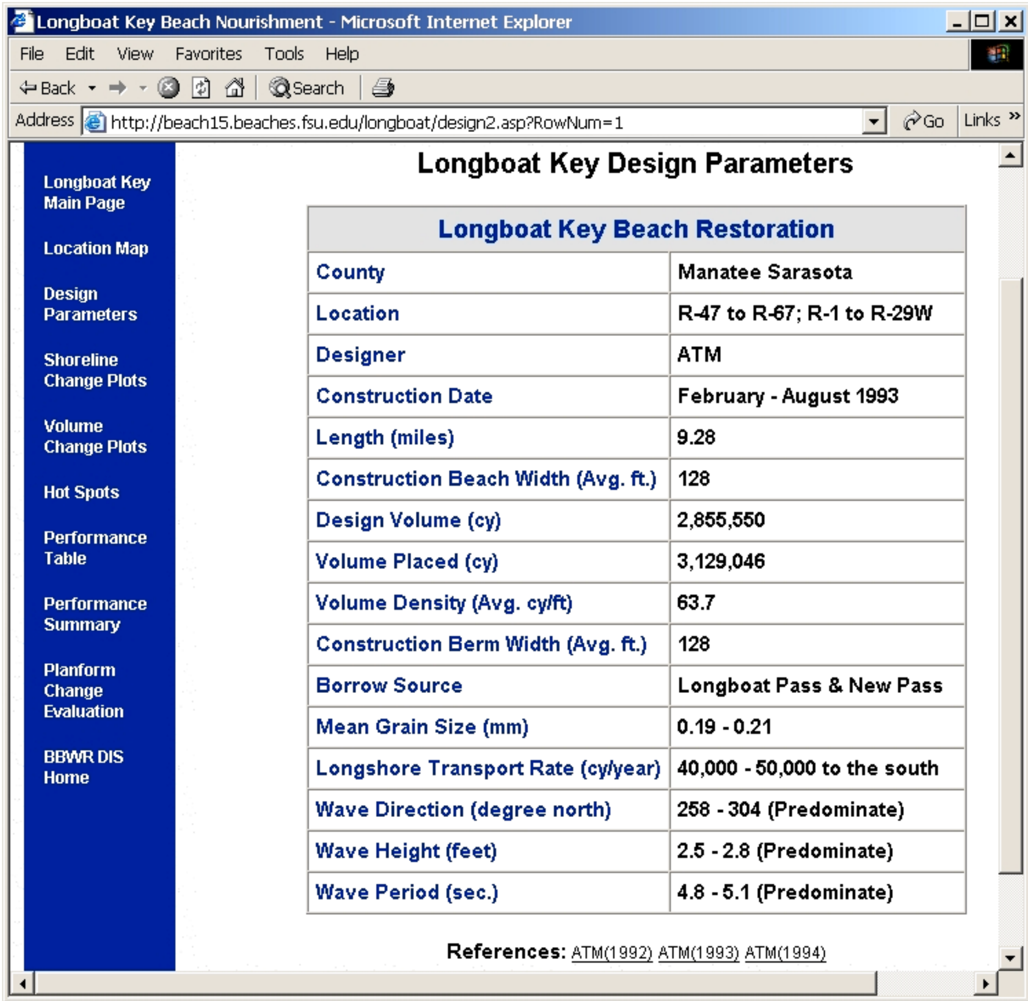


Figure 2: A Web Page Display of Contents and Viewing Area

of sand found within defined project and study area beaches between successive surveys. Volumetric changes, referenced to NGVD, are computed for the entire active profile zone between the upland beach berm crest and an assumed closure depth (Figure 5). Volume changes computed above both the MHW and the closure depth are compared and presented in a bar chart as shown in Figure 6.

5. Hot Spots

All beach fill projects exhibit varying recession/erosion rates along the project lengths; some project segments actually accrete. Beach fill projects often develop hot spot areas that erode much faster than the average erosion rate of the project. The hot spot occurrences may create a need for placement of additional fill in the project area. Specific information documenting hot spots and causes for their formation and possible remediation are generally addressed in the monitoring studies. This information is summarized in a table format in the database. Table 1 presents an example from the Venice Beach project.



Longboat Key Design Parameters

Longboat Key Beach Restoration	
County	Manatee Sarasota
Location	R-47 to R-67; R-1 to R-29W
Designer	ATM
Construction Date	February - August 1993
Length (miles)	9.28
Construction Beach Width (Avg. ft.)	128
Design Volume (cy)	2,855,550
Volume Placed (cy)	3,129,046
Volume Density (Avg. cy/ft)	63.7
Construction Berm Width (Avg. ft.)	128
Borrow Source	Longboat Pass & New Pass
Mean Grain Size (mm)	0.19 - 0.21
Longshore Transport Rate (cy/year)	40,000 - 50,000 to the south
Wave Direction (degree north)	258 - 304 (Predominate)
Wave Height (feet)	2.5 - 2.8 (Predominate)
Wave Period (sec.)	4.8 - 5.1 (Predominate)

References: ATM(1992) ATM(1993) ATM(1994)

Figure 3: Design Parameters for the 1993 Longboat Key Beach Restoration Project

Table 1: Hot Spots for Venice Beach

	Ranges	Description	Comments
1995 Report CT (1995)	116-117	South of the inlet and rock revetment.	Erosion is due to a deficit of material transport into the fill area as a result of the inlet.
	121		23.1 cy/ft of shoreline was eroded due to the protrusion 50-75 feet seaward of a line connecting the shoreline north & south of R-121. Due to wave refraction, the wave energy is concentrated toward the protruded shoreline.
1997 Report CT (1997)	121, 125, 128		Protrusion of the fill as a result of the configuration of the pre-fill shoreline.
	131-133		Erosion may be due to "end-effects" and is expected to occur.

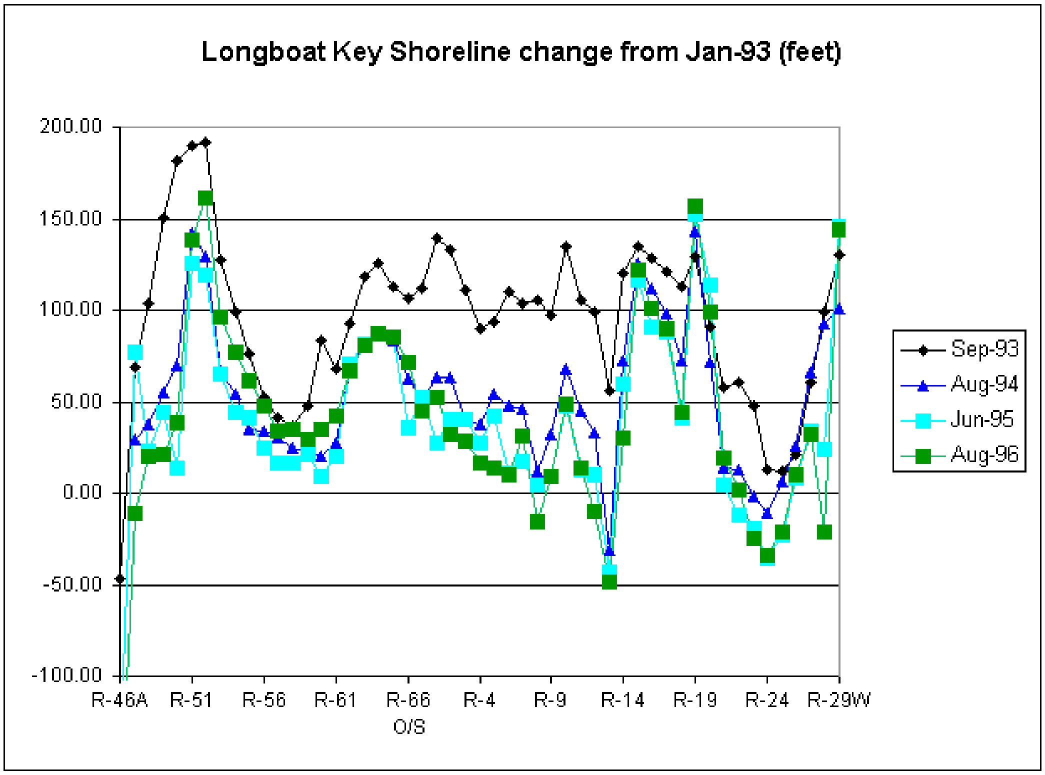


Figure 4: Longboat Key Shoreline Change From Pre-Construction

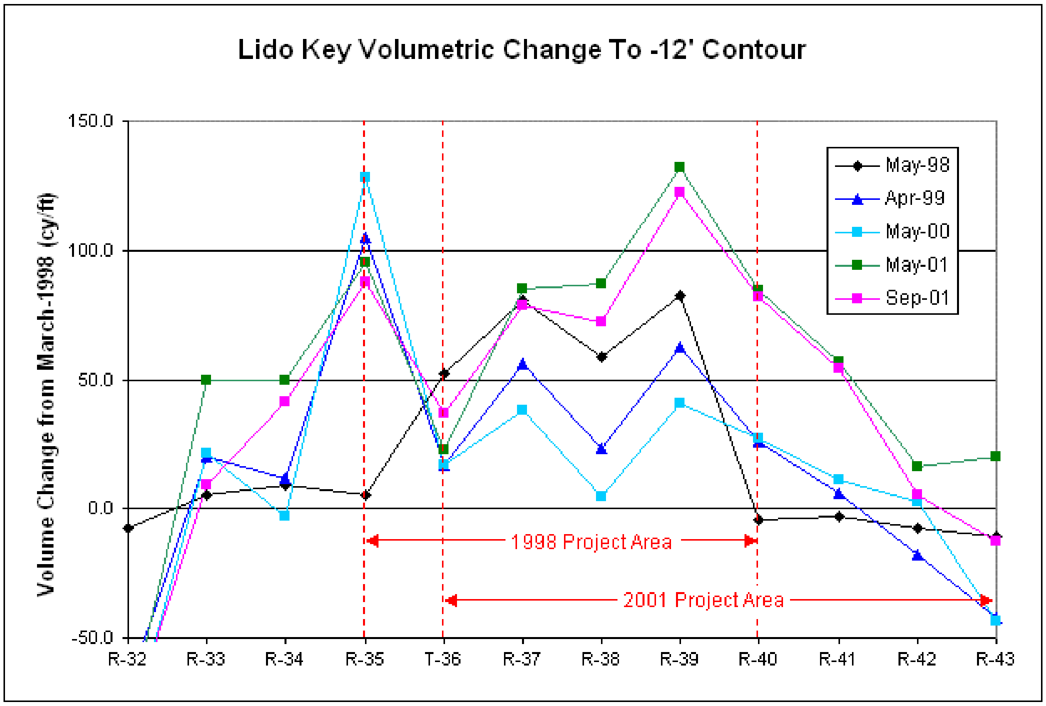


Figure 5: Lido Key Volumetric Change to –12 ft. Contour

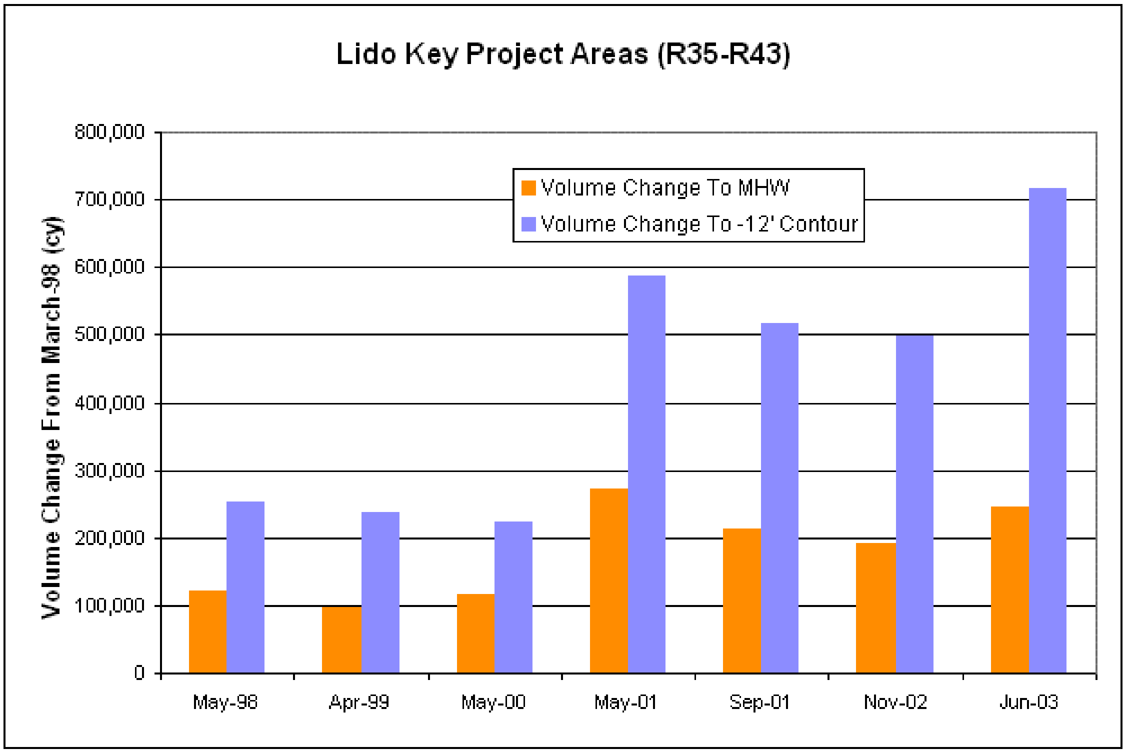


Figure 6: Lido Key Volumetric Change to -12 ft. and MHW

6. Performance Table

The performance of a project in terms of annual volume change, and percentage of volume remaining after completion of beach nourishment is calculated from monitoring survey data. An example is shown in Table 2. A similar table for shoreline changes is also included in this category. The Table gives a brief view of historical evolution of the beach fill for each nourishment project.

Table 2: Performance Table for Miami Beach Restoration Project

Miami Beach Surfside Performance									
Years of Post Construction	Date of Survey	Volume Above -15'				Volume Above MHW			
		Remaining (%)	Changes* (cy/ft)			Remaining (%)	Changes* (cy/ft)		
			Avg.	Max	Min		Avg.	Max	Min
0	8-1999	100	119	141	101	100	51	62	42
1	11-2000	76	91	110	83	66	33	42	25
1.5	3-2001	79	95	124	77	64	33	40	27
3	10-2002	49	59	84	45	52	27	38	21

*Changes from May-1998 Pre-Construction

7. Performance Summary

This category presents summaries of performance evaluations of the projects as provided by and based on monitoring reports by the project sponsors' (local government) engineering consultants. It provides the in-depth observations of the project performance based on the consultant's interpretation of the monitoring data. Portions of the projects not performing to expectations are usually identified with analytical explanations and recommendations for remedial work in future renourishment projects.

8. Planform Change Evaluation

A companion task appended to the project monitoring review and database development work as a second phase of this work effort is to assess measured changes to fill planform characteristics compared to predicted changes. The comparison of the predicted shoreline and volumetric response with monitoring results will provide valuable information and insight for improving beach nourishment design and performance prediction for erosion control, as well as, environmental management. For illustrations of modeled vs. measured response for the Venice, Florida project, see Figures 7 and 8.

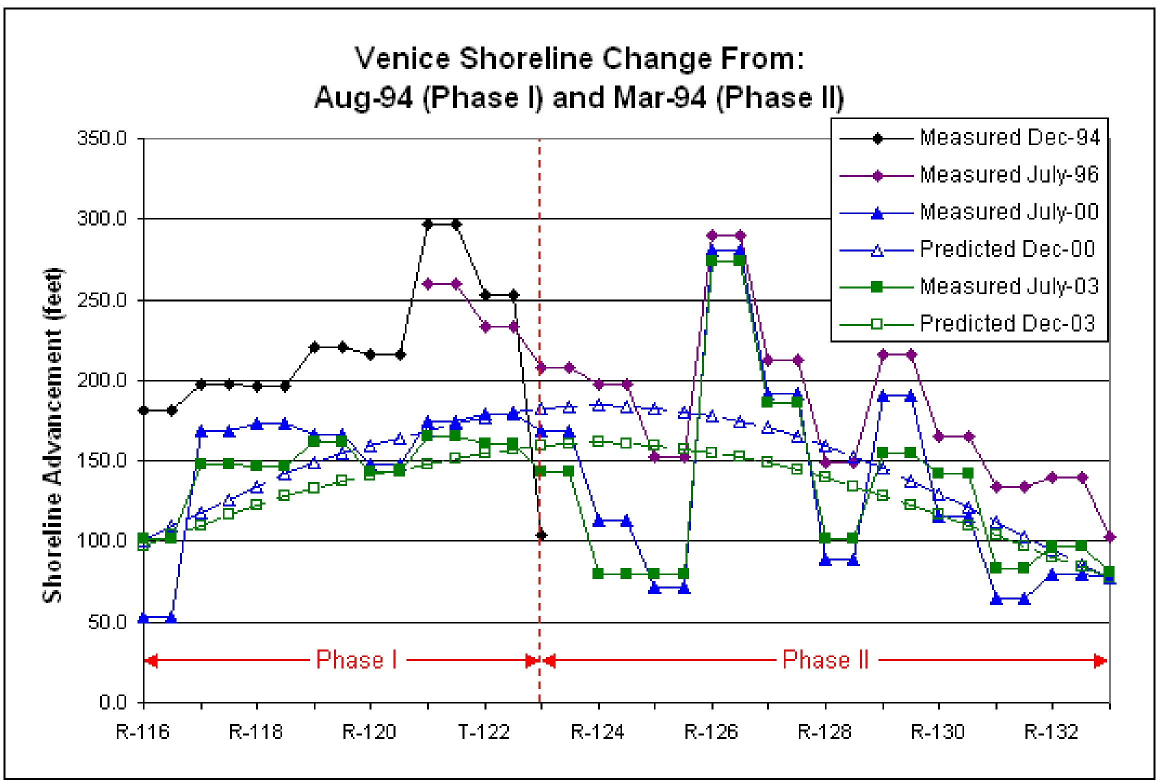


Figure 7: Comparison Between Predicted and Measured Shoreline Changes for Venice Beach Nourishment Project

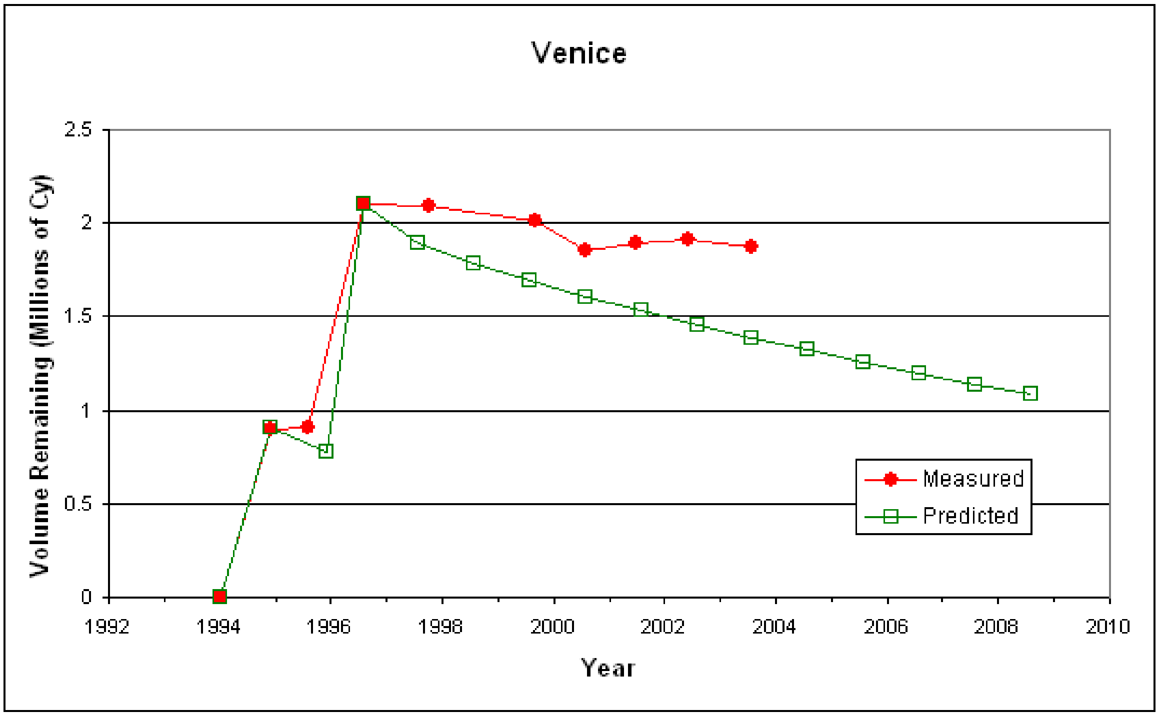


Figure 8: Comparison of Measured and Predicted Performances for Venice Beach Nourishment Project

PROJECT PERFORMANCE EVALUATION

The Web based display of the Database provides an easy and valuable source to review each project from different aspects, such as shoreline and volume change plots, performance tables of shoreline and volume changes, performance summaries, and model predictions of project performance. The data collected by the end of June 2004 for all the projects was collated together in order to facilitate comparisons and summaries of neighboring projects. The projects were separated into two regions, the 24 projects on the Gulf and the 17 projects on the Atlantic Coast. Figures 9 to 14 provide a series of plots of project performance in terms of shoreline and volume percentage change.

1. Shoreline Percentage Change

a. The Gulf Coast Projects (Figure 9) **-** Average beach width for all 24 projects receded 22% one year post-construction and stabilized at approximately 68% of constructed beach width for the two to six years post-construction time period. The beach width remained above at least 40% of the initial placement for 22 of the projects. The exceptions were Treasure Island (1996) and Long Key (1996) which recessed back to pre-fill levels in just 3 years. It should be noted that the evaluated Treasure Island project is a re-nourishment project of a short segment of the total project area. The total project area has a lack of specific project monitoring surveys to document total project performance, but historic FDEP survey data and aerial photography document extensive beach width throughout the central portion of Treasure Island as a result of the beach nourishment project.

b. The Atlantic Coast Projects (Figure 12) **-** Average beach width of 17 projects receded 35% one year post-construction and continued to retreat at an average rate of 8% per year from the second year to the sixth year post-construction. Beach width for one third of the projects fell below 40% of the initial filled width 6 years post-construction.

2. Volume Percentage Change above MHW

a. The Gulf Coast Projects (Figure 10**) -** A total of 6 (out of 24) Gulf Coast projects, Indian Rocks Beach, Sand Key, Treasure Island (1996 & 2000), Long Key (1996 & 2000) were not included in Figure 11 due to a lack of surveyed or reported profile data. Average volume above MHW for the rest of 18 projects receded about 17% from the initial fill volume for the first year post-construction and stayed at around 70% of volume filled above MHW for the two to six years post-construction time period.

b. The Atlantic Coast Projects (Figure 13) - Average volume above MHW of 16 projects receded 29% one year post-construction and continued to retreat at an average rate of 8% per year from the second year to the sixth year post-construction. Three projects, Ft. Pierce, Hollywood/Hallandale, and Hillsboro Beach, lost more than 60% of the filled volume in three years post-construction. The other 12 projects held more than 40% of the initial placement at six years post-construction.

3. Volume Percentage Change above Depth of Closure

a. The Gulf Coast Projects (Figure 11**) –** Average volume above depth of closure of 24 projects lost about 12% of the filled material for the first year post-construction and stayed above at least 80% of the total construction volume from two to six years post-construction. Treasure Island (1996) lost all the filled material in 3 years post-construction. More than two third of the projects (17 projects) retained at least 75% of the filled volume to six years post-construction.

b. **The Atlantic Coast Projects** (Figure 14) - Average volume above depth of closure of 17 projects lost about 21% of the filled material for the first year post-construction and stayed above at least 66% of the total construction volume from two to five years post-construction. Two projects, Boca Raton South and Ft. Pierce, lost more than 70% of the filled material in 3 years post-construction due to the effects of inlet and inlet jetties. The other 15 projects kept at least 45% of the filled volume since completion of the construction.

PROJECT PERFORMANCE VS DESIGN PARAMETERS

The relationship between project performance versus project length or volume density (volume placed / beach width) were investigated by using the information found in the Performance Table. The project lengths ranged from 0.4 to 17.5 miles for the Gulf Coast and 0.8 to 12.5 miles for the Atlantic Coast. The volume density varied from 24 to 150 (cy/ft.) for the Gulf Coast and 32 to 163 (cy/ft.) for the Atlantic Coast.

A total of 12 correlations between percentage remaining of shoreline, volume above MHW or volume above depth of closure and volume density or project length for both the Gulf and Atlantic Coast projects were plotted and analyzed. However, there was no clear trend or correlation found for 11 of the 12 analytical results. An example was shown in Figure 15.

In the Gulf Coast projects, percentage volume remaining above depth of closure was plotted versus project length. Two projects, Knight Island and Marco Island Central Beach, showed unusual accretion and were, therefore, removed from the plots. Figures 16 and 17 show this correlation for the 1 to 3 years and 4 to 6 years post-construction, respectively.

CONCLUSIONS

1. Gulf Coast projects, in general, retained higher percentage of the nourishment material and approached stability earlier than the Atlantic Coast projects. This may be related to the offshore slope and wave climate, of which the Gulf Coast is milder than the Atlantic Coast.

2. For the Gulf Coast projects, designed project length may play an important role in the project performance, in terms of percentage remaining of filled volume. Projects with more than 1 mile in length held above 80% of the filled volume for all 6 years post-construction. For those projects with less than 1 mile in length, total volume remaining varied from below 0% to about 90% for the first 3 years post-construction and became stabilized at a range of 40 to 80% from 4 to 6 years after fill. For the Atlantic Coast projects, a correlation between project length the performance was not as apparent, although the overall general trend still confirms that greater project length results in better project performance.

3. At present , most Atlantic Coast projects have less than 5 years of monitoring data available. At least 8 years of monitoring data for this region is needed to make a more thorough, conclusive evaluation, since most project areas do not appear to have stabilized within 6 years of post-construction monitoring based on review of the available monitoring survey data. These results do not necessarily mean that Atlantic Coast projects have not performed well. For example, although the monitoring survey data for the Duval County project has covered limited time periods (i.e., 4 years), available vertical aerial photography clearly shows successful restoration of the shoreline and beach/dune profile within that project area.

REFERENCES

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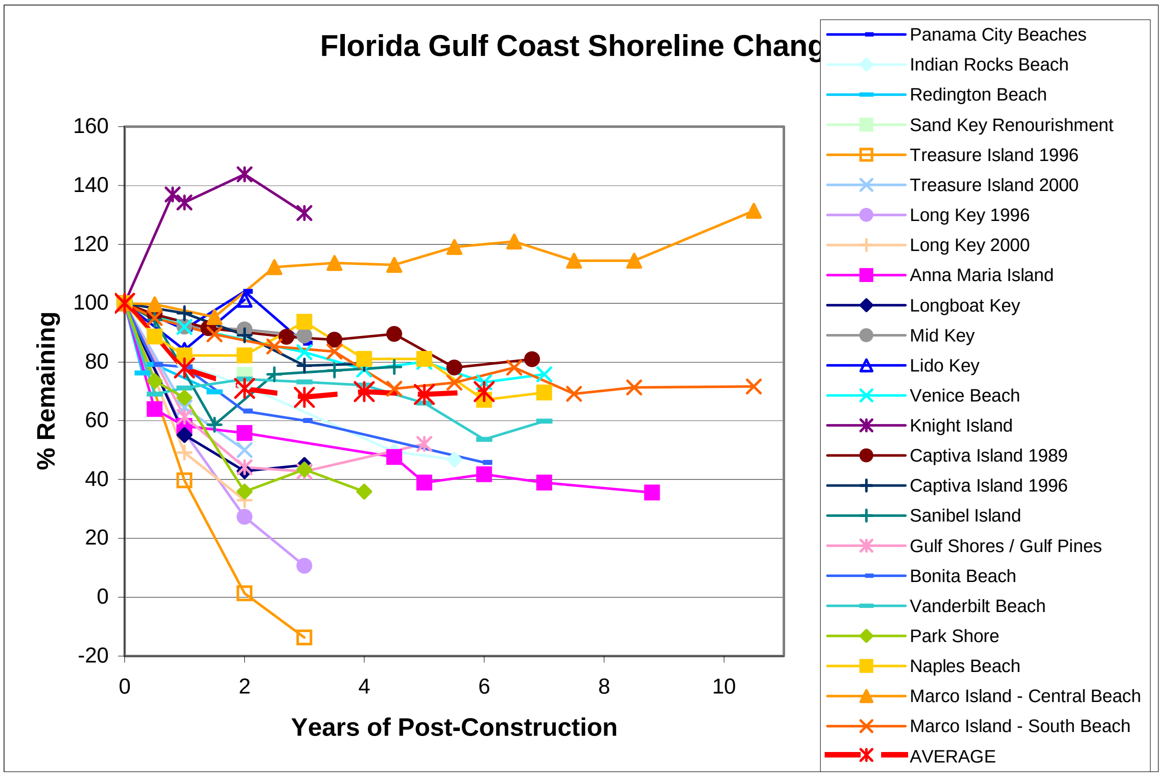

Figure 9: Project performance in terms of shoreline percentage change for the Florida Gulf Coast

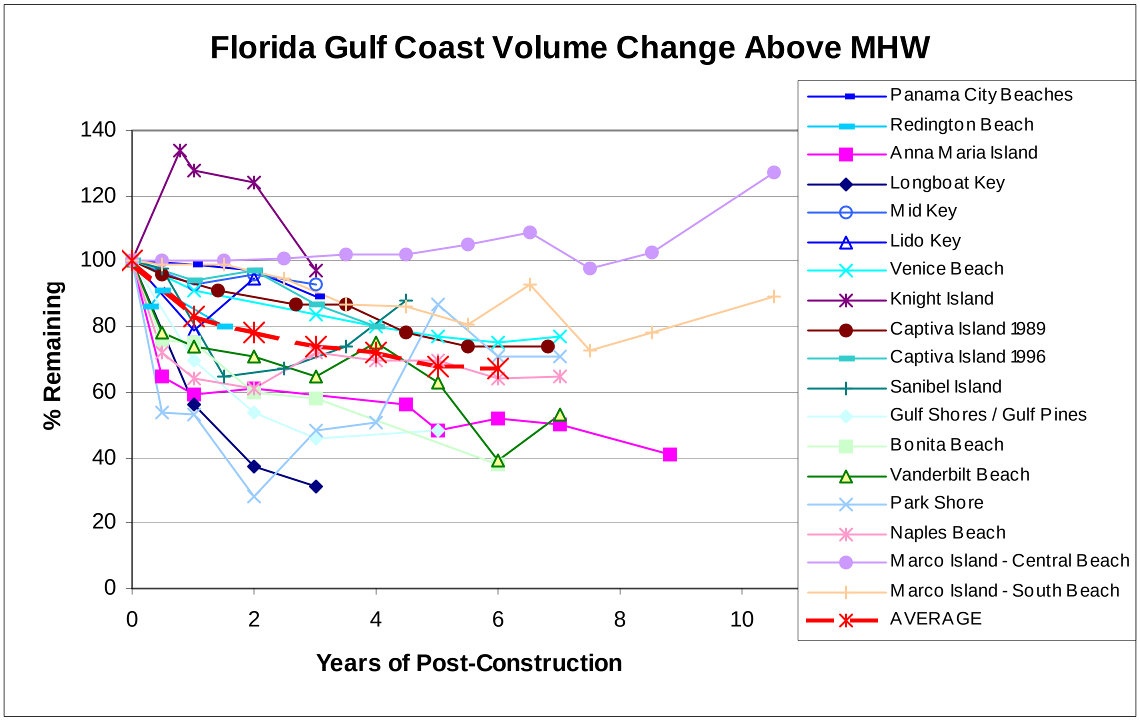

Figure 10: Project performance in terms of volume percentage change above MHW for the Florida Gulf Coast

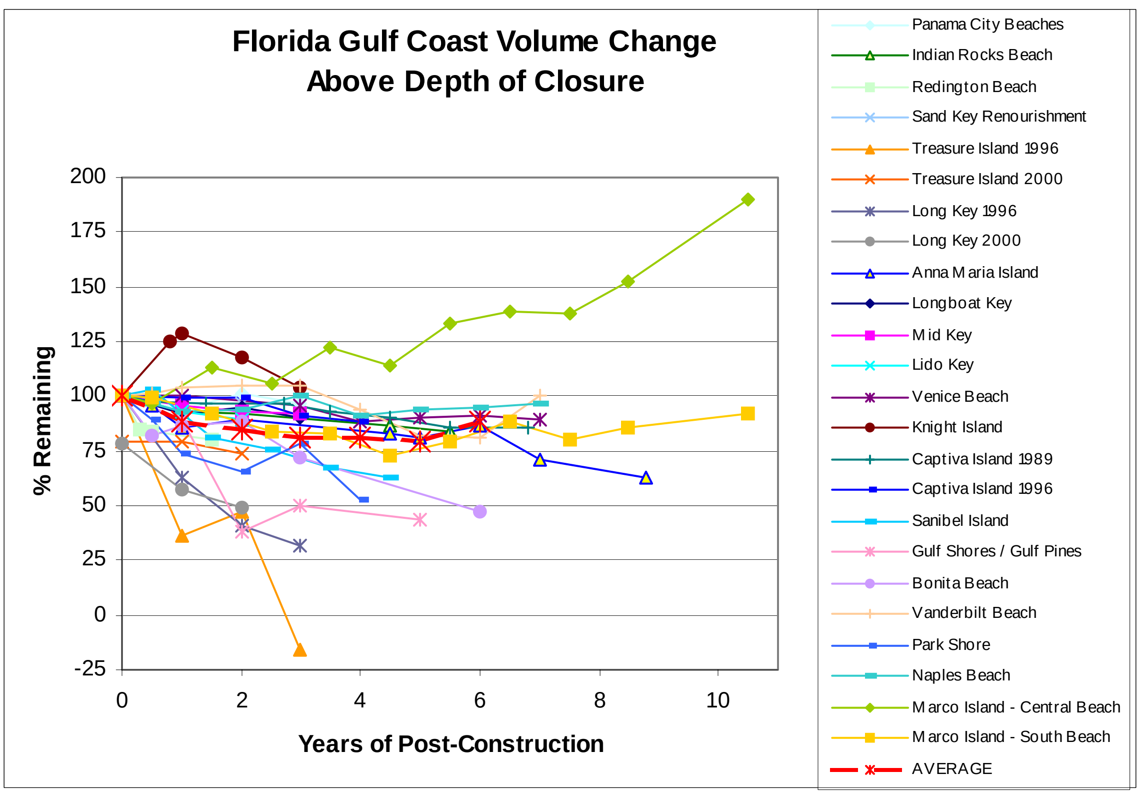

Figure 11: Project performance in terms of volume percentage change for the Florida Gulf Coast

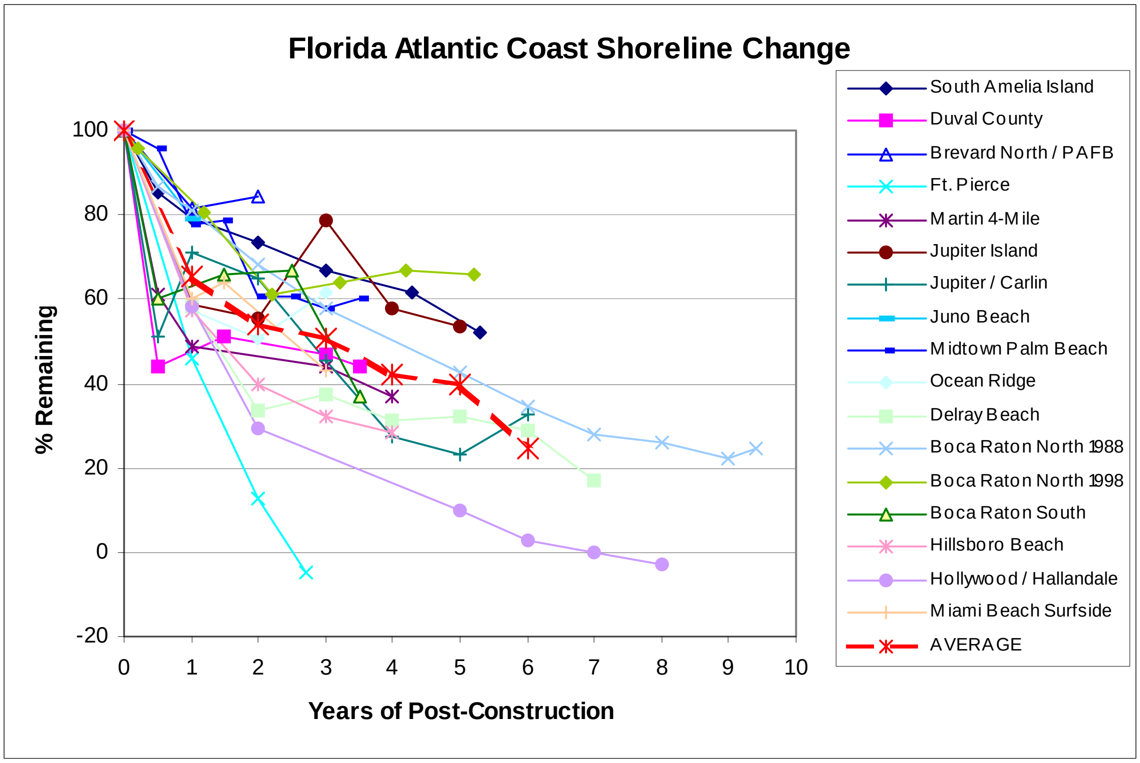

Figure 12: Project performance in terms of shoreline percentage change for the Florida Atlantic Coast

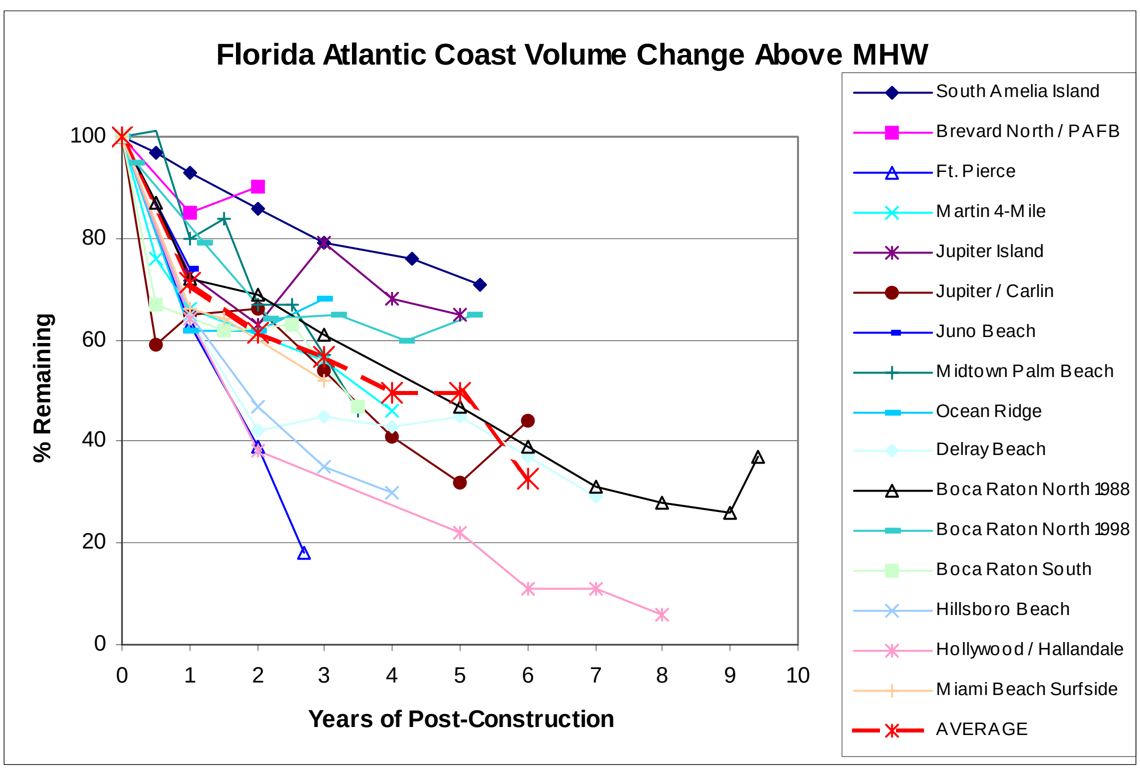

Figure 13: Project performance in terms of volume percentage change above MHW for the Florida Atlantic Coast

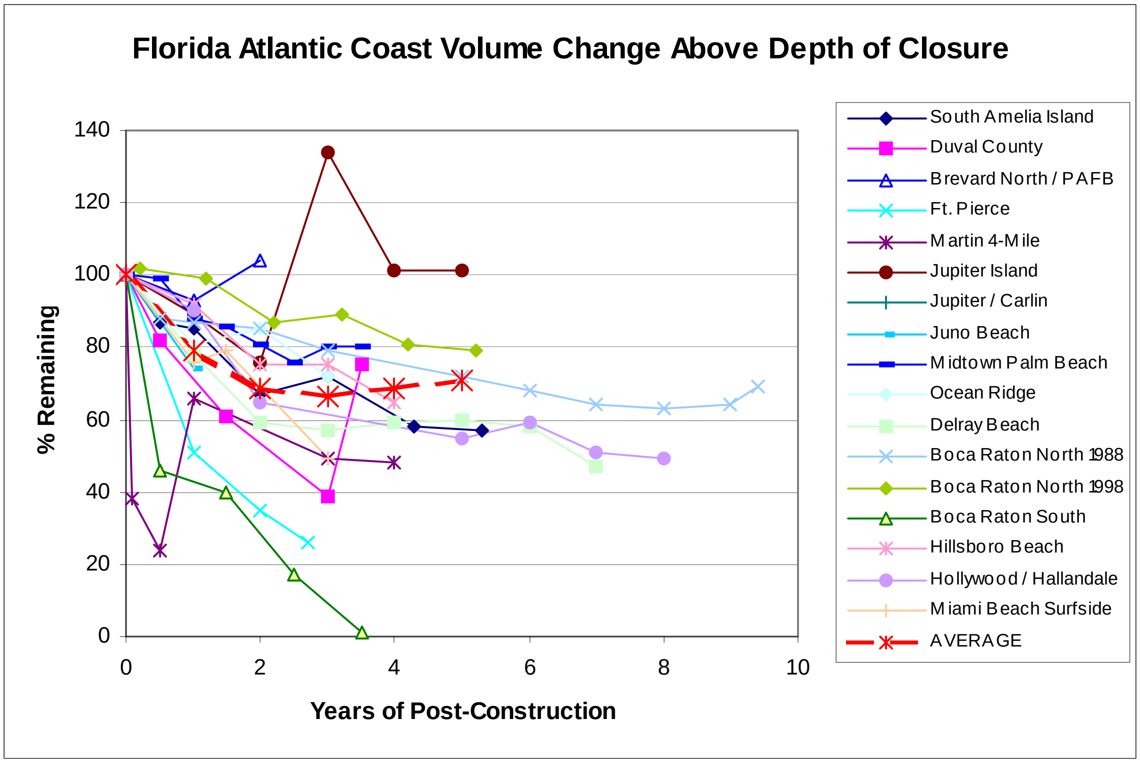

Figure 14: Project performance in terms of shoreline percentage change for the Florida Atlantic Coast

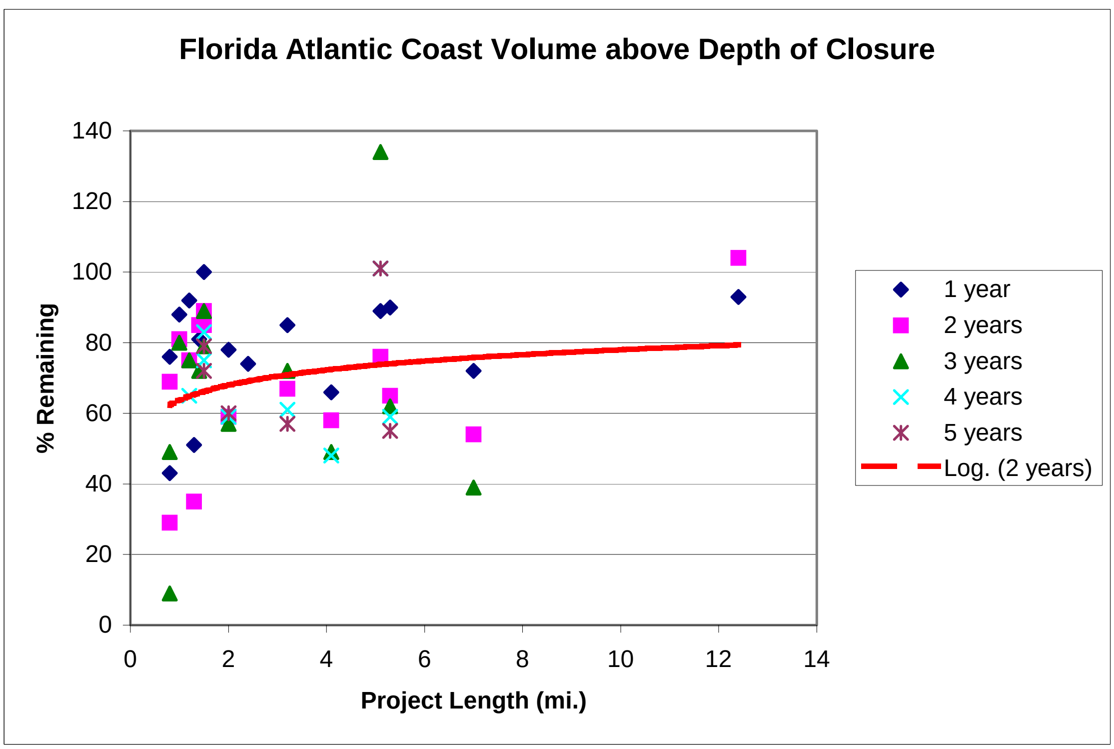

Figure 15: Percentage Remaining of Volume above Depth of Closure related to Project Length for the Atlantic Coast projects

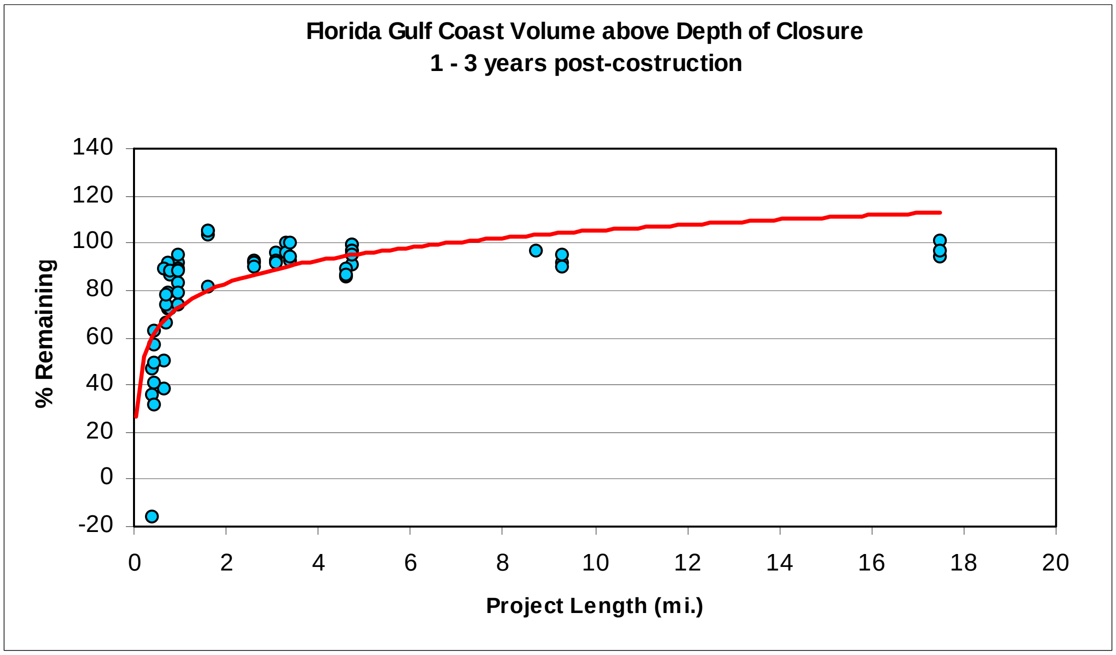

Figure 16: Percentage Remaining of Volume above Depth of Closure 1-3 years post-construction related to Project Length for the Gulf Coast projects

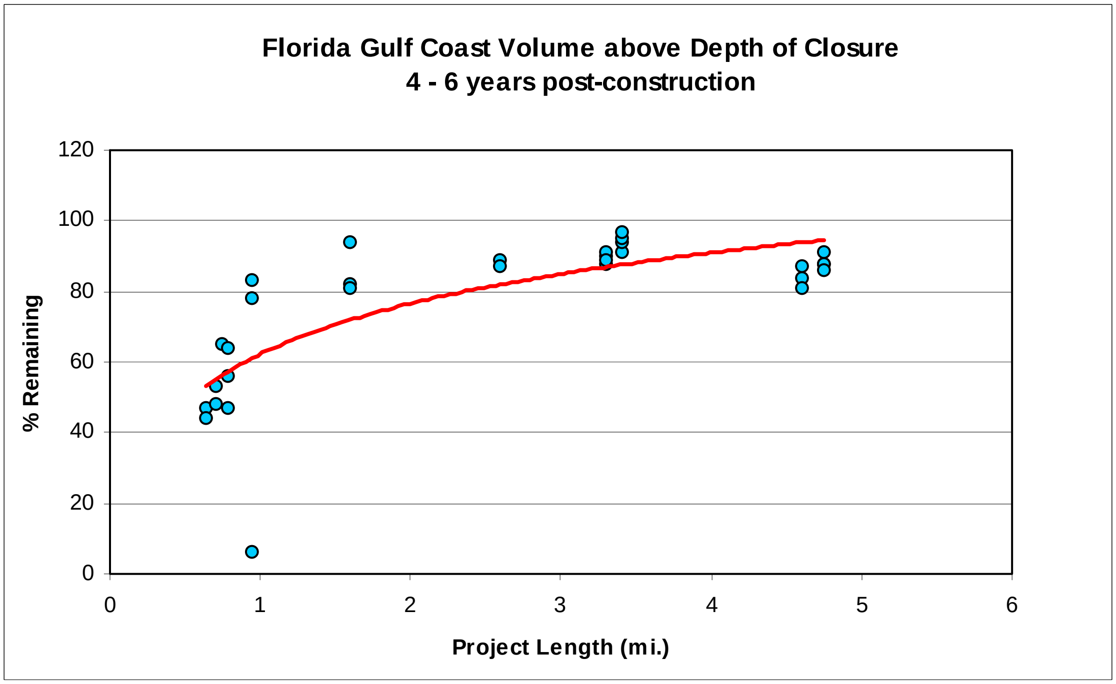

Figure 17: Percentage Remaining of Volume above Depth of Closure 4-6 years post-construction related to Project Length for the Gulf Coast projects