DATABASE DEVELOPMENT AND EVALUATION OF BEACH NOURISHMENT PROJECTS IN FLORIDA

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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). A total of 37 projects are being actively monitored by FDEP covering about 158.3 miles (254.8 km) 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. Beach nourishment projects in the southwestern Florida region including Longboat Key, Lido Key, Venice and others have been reviewed and evaluated in the initial phase of this effort and are featured in this paper.

INTRODUCTION

There are 37 active beach nourishment projects (Figure 1) with monitoring data and reports in the Bureau of Beaches and Wetland Resources (BBWR) 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 contracted by the BBWR in July 2002 to initiate the task of conducting a comprehensive review and evaluation of this information. Such a review and evaluation will provide valuable feedback information to the BBWR program regarding design optimization and overall effectiveness of beach

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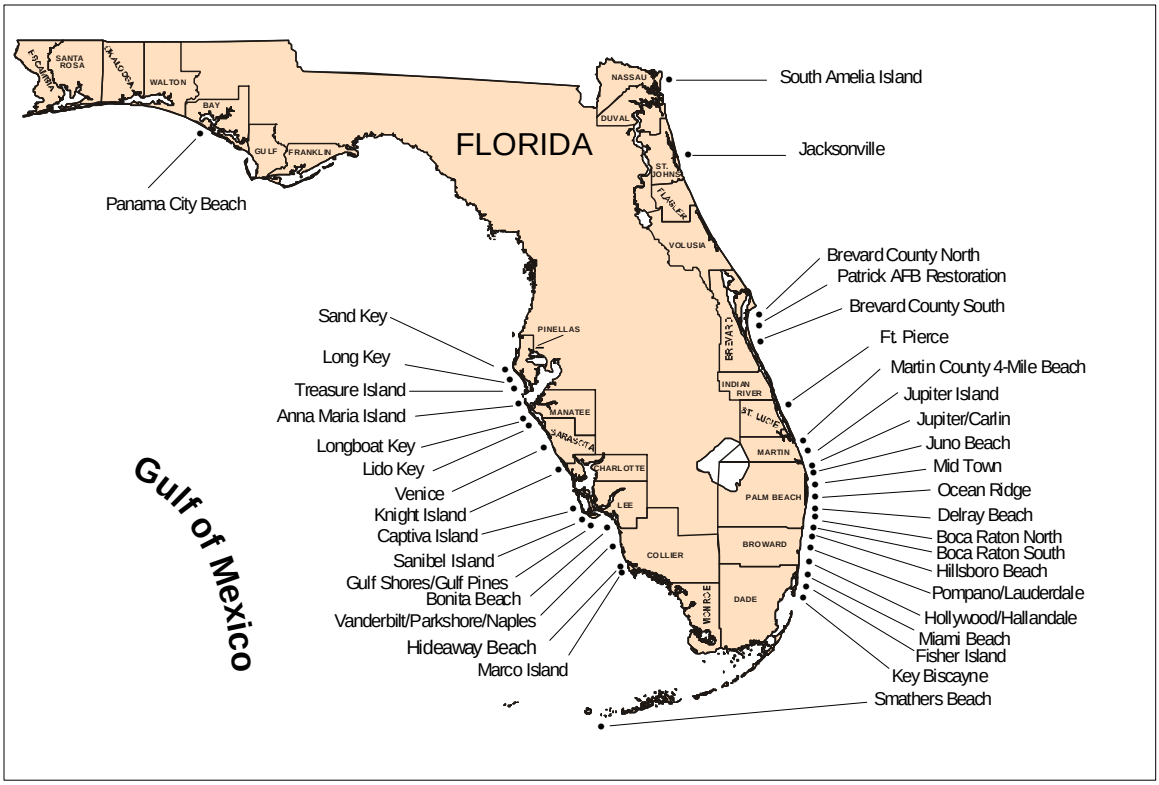

Figure 1. Monitored Beach Nourishment Projects in Florida

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 about project performance such as shoreline and volume change and volume remaining within project limits and study area 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 BBWR 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 calculation 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 Chang 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

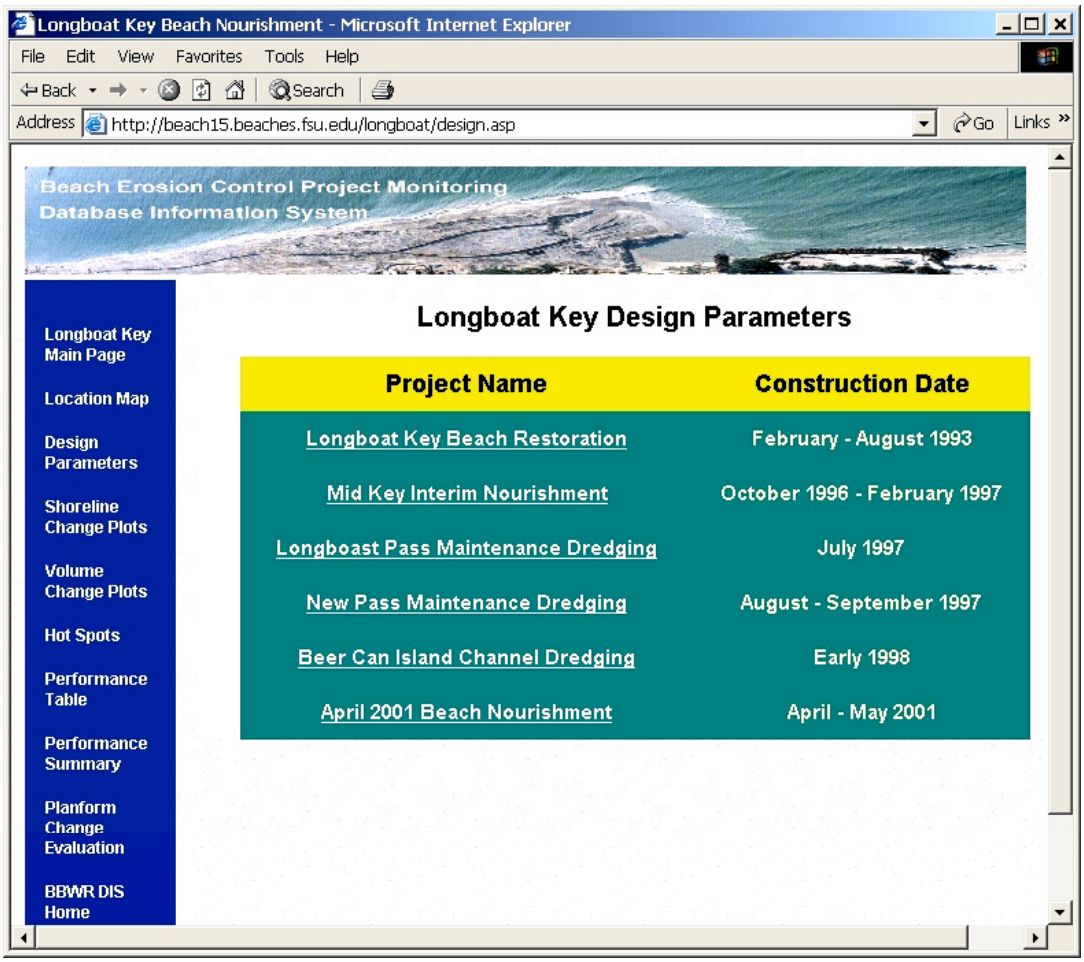

Figure 2: A Web Page Display of Contents and Viewing Area

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 observed closure depth (Figure 5). Volume changes computed above both the MHW and –15 ft. contours 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 are usually addressed in the monitoring studies. This information is summarized in a table format in this category in the database. Table 1 presents an example from the Venice Beach project.

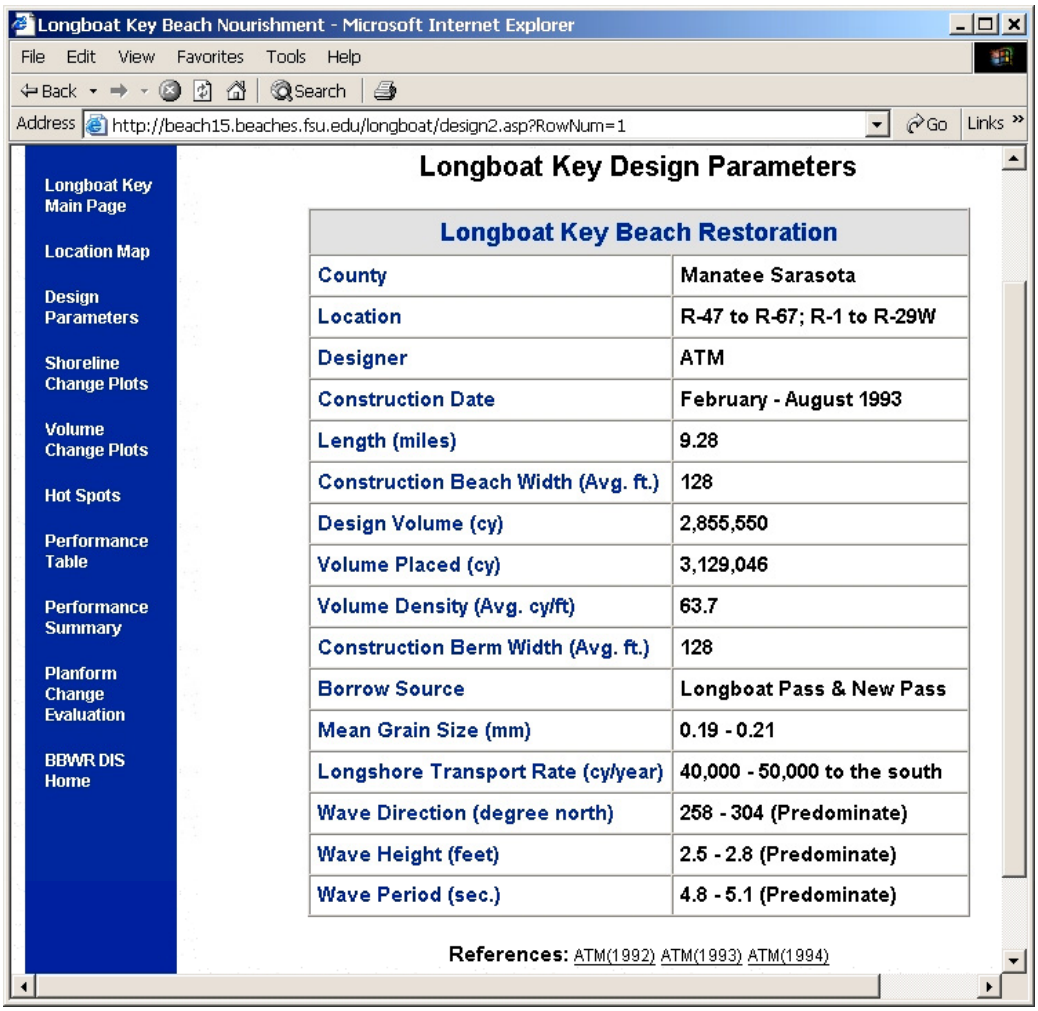

Figure 3: Design Parameters for the 1993 Longboat Key Beach Restoration Project

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	121, 125, 128		Protrusion of the fill as a result of the configuration of the pre-fill shoreline.
CT (1997)	131-133		Erosion may be due to "end-effects" and is expected to occur.

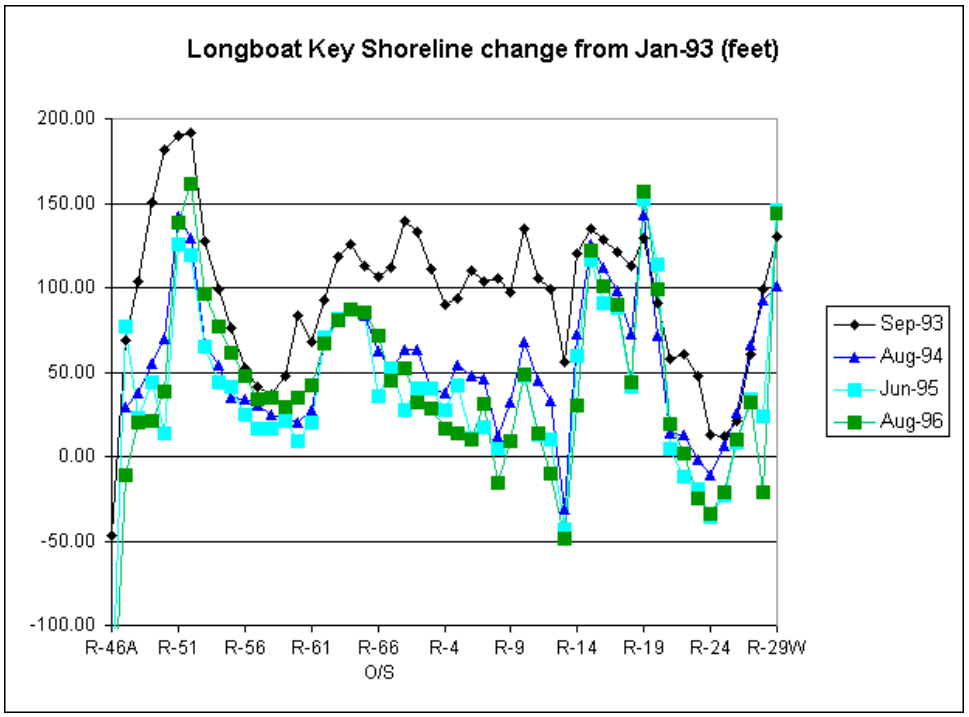

Figure 4: Longboat Key Shoreline Change From Pre-Construction

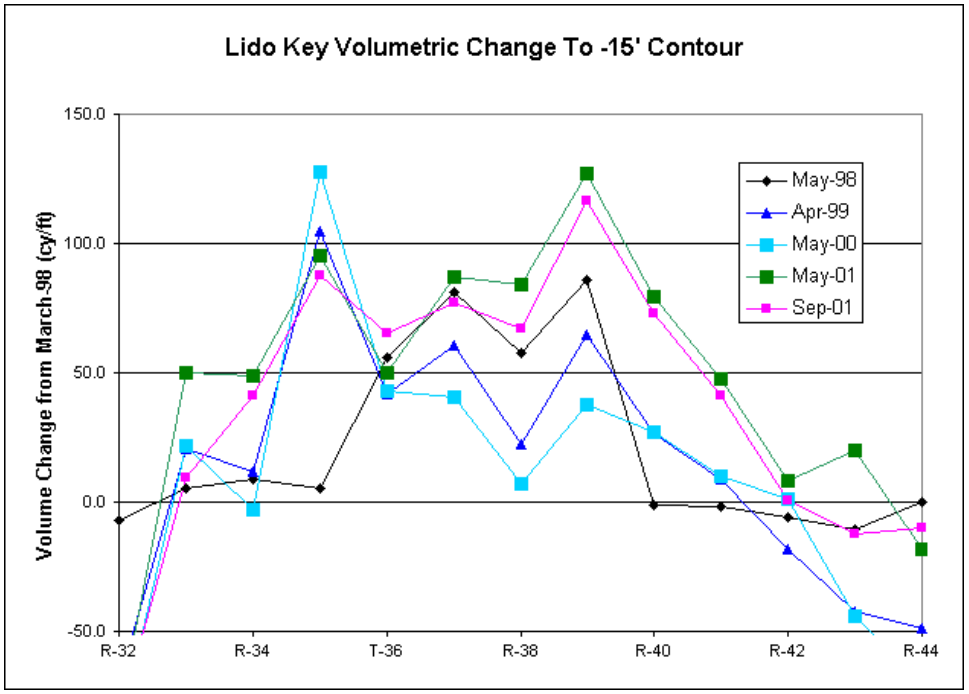

Figure 5: Lido Key Volumetric Change to –15 ft. Contour

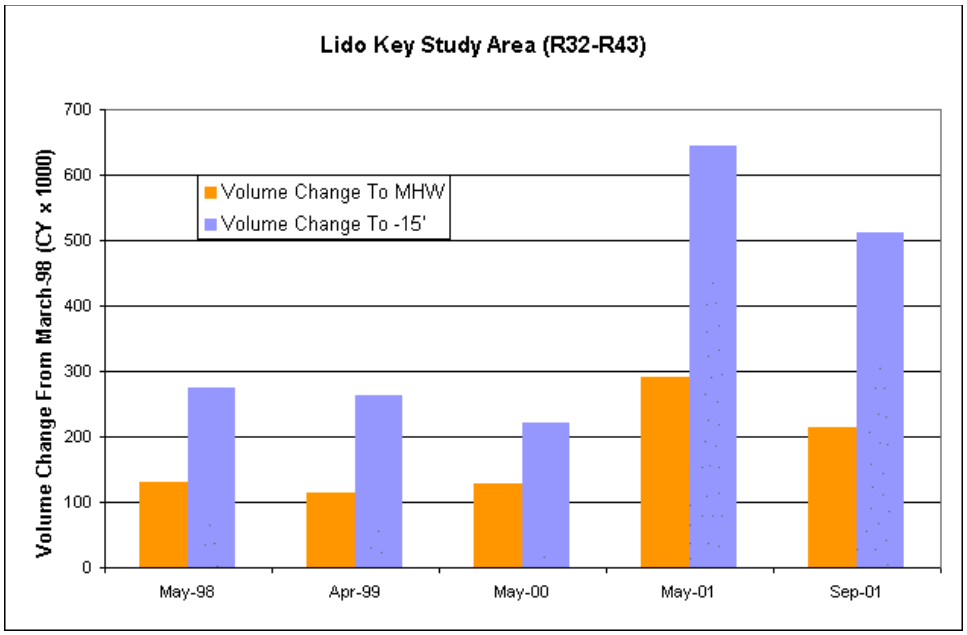

Figure 6: Lido Key Volumetric Change to -15 ft. and MHW

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. It gives a brief view of historical evolution of the beach fill for each nourishment project.

Table 2: Performance Table for Venice Beach Restoration Project

Venice Beach Restoration 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	12-1994	100	115	193	40	100	56	99	12
0.7	7-1995	102	117	168	59	88	49	83	14
1	10-1995	100	116	160	52	79	44	75	17
2	7-1996	105	121	184	52	93	52	91	25
3	9-1997	105	121	177	63	84	47	81	21
5	8-1999	100	116	195	40	77	43	76	20
6	7-2000	93	107	186	21	73	41	73	16

*Changes from March-94 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. Specifically, planform characteristics analyzed include evolution of the toe-of-fill (TOF), which reflects the seaward limit of fill migration, and fill spreading, or diffusion, in the longshore direction. This work will include review and evaluation of current predictive methodologies. Project design consultants are routinely asked to provide projections of expected equilibrium toe-of-fill positions in order to assess potential fill coverage of nearshore environmental resources; e.g., "hardbottom" substrate.

Initial work has included TOF evaluation of several projects along the southeast coast of Florida and use of the DNRBS shoreline change model in predicting performance of a number of the monitored beach nourishment projects. Other one-line shoreline response models, such as GENESIS (Hanson & Kraus, 1989), are also applicable to these comparative analyses. 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, 8, and 9.

CONCLUSIONS

A comprehensive review and evaluation work effort is being conducted to compile beach nourishment monitoring data for the State of Florida and to provide an easily accessible database of some of the fundamental monitoring information on the web. Information provided includes project characteristic, shoreline and volumetric change performance results, as well as, other project assessment information. A total of 37 projects with physical monitoring data are included in the database.

Analysis work includes evaluation of planform evolution of the nourishment projects with specific comparison of equilibrium toe-of-fill adjustments and longshore spreading observed from measured data with analytical predictions. Predictive methods are reviewed including application of one-line shoreline response modeling. Results will assist the State of Florida's beach management project implementation and environmental resource protection programs.

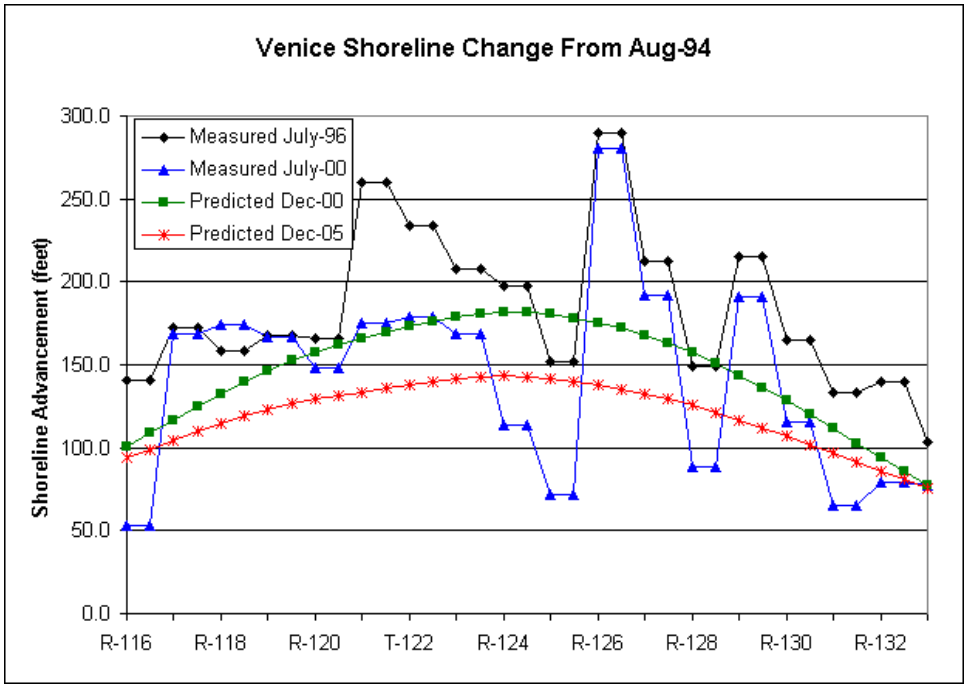

Figure 7: Comparison Between Predicted and Measured Shoreline Changes for Venice Beach Nourishment Project

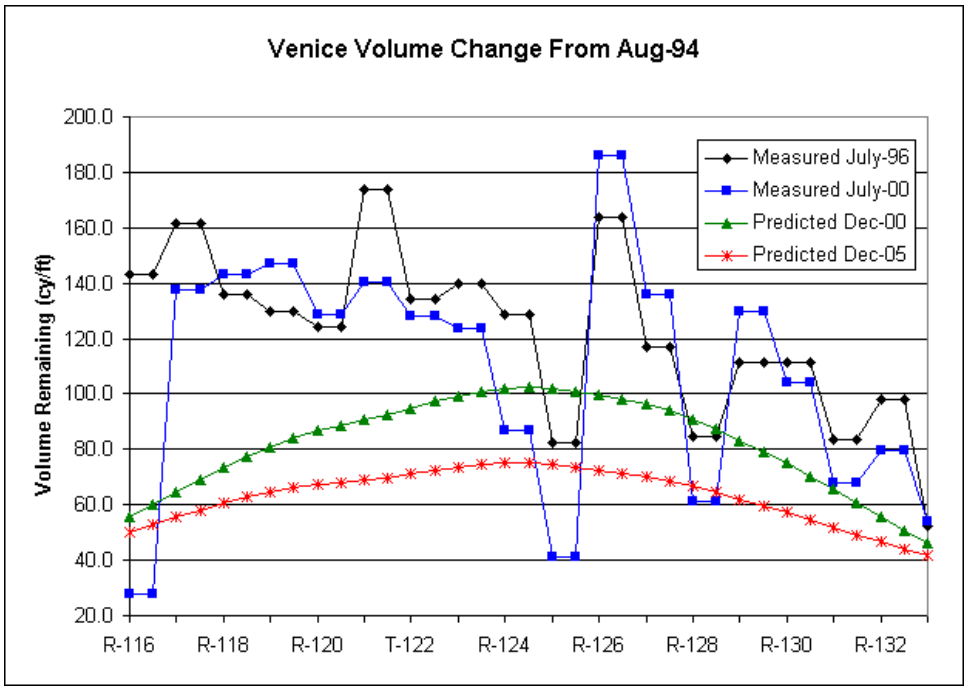

Figure 8: Comparison Between Predicted and Measured Volume Changes for Venice Beach Nourishment Project

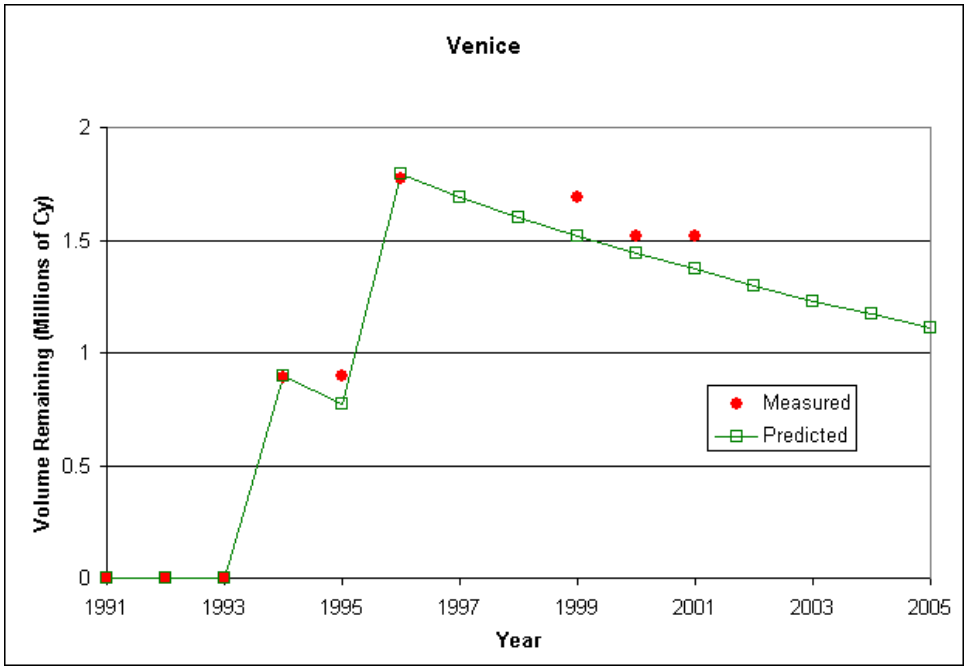

Figure 9: Comparison of Measured and Predicted Performances for Venice Beach Nourishment Project

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KEY WORDS

Beach, Nourishment, Erosion, Monitoring, Planform, Shoreline, Fill, Spreading, Florida.