1-Introduction

The U.S. Army Corps of Engineers, New York District (USACE) and the State of New Jersey (represented by the New Jersey Department of Environmental Protection, NJDEP) are presently engaged in an erosion control project to protect beaches along the northern coast of the state. The project area encompasses approximately 47 km of exposed, high-energy beaches extending northward from Manasquan Inlet to Highland Beach (Figure 1-1). Wave heights in the vicinity average 0.3-0.7 m with wave periods of 5.6–9.0 seconds (Nordstrom et al., 1982). The area is microtidal with a Mean Spring Low Tide range of 1.62 m (Davies, 1964 and Masselink and Short, 1993). Beach morphology, measured on a scale ranging from dissipative to reflexive, is intermediate with a longshore trough and bar topography (Wright and Short, 1984 and Short, 1991). Beach slopes range from 7.3^0 to 11^0 (Nordstrom et al., 1978). The beachface is punctuated by numerous piers and rock groins and interrupted by an inlet at Shark River. Erosion can be severe with some areas receding as much as 2 m a year (Nordstrom et al., 1978). The volume of sand moved by longshore currents averages between 57,000 m^3/yr at Manasquan Inlet and 377,000 m^3/yr at Sandy Hook (Caldwell, 1966). Longshore current direction is predominately to the north (Ashley, Halsey, and Buteux, 1986).

A total of 19.39 million m^3 of sand was placed on the beaches during the project making this one of the largest such nourishments (in terms of volume) ever constructed. Approximately 6.18 million m^3 of this material was placed along the 15.93 km of beach between Asbury Park and Manasquan Inlet (Figures 1-1 and 1-2), creating a 30 m wide berm 3 m above mean low water (MLW) (Table 1-1). The area between Manasquan Inlet and Shark River was nourished in 1997, while the remainder was nourished in 1999**.** The Manasquan Inlet to Shark River section received an additional 300,000 m^3 of sand in late May 2000, however, this was after conclusion of the monitoring program.

Concern about ecological impacts due to these dredging and filling operations has been focused on potential detrimental effects on infaunal benthos, a major source of forage for commercially important coastal fish and invertebrate species. Previous studies of beach nourishment (e.g., Nelson 1993) concluded that, in most cases, impacts from beach nourishment are minor. Impacts such as short-term reductions in standing stock biomass (an indicator of secondary production) are outweighed by benefits (e.g., medium- to long-term increases in flood protection and recreation), making such projects clearly in the public interest. However, because most previous studies were constructed in beach environments geographically distant from New Jersey (e.g., southeastern U.S. and South Africa), questions have been raised as to the applicability of results reported elsewhere. Findings from this study are intended not only to assess impacts associated with the immediate dredging and filling operations, but also to evaluate the potential for impacts from subsequent renourishment operations and similar projects in the New York-New Jersey area.

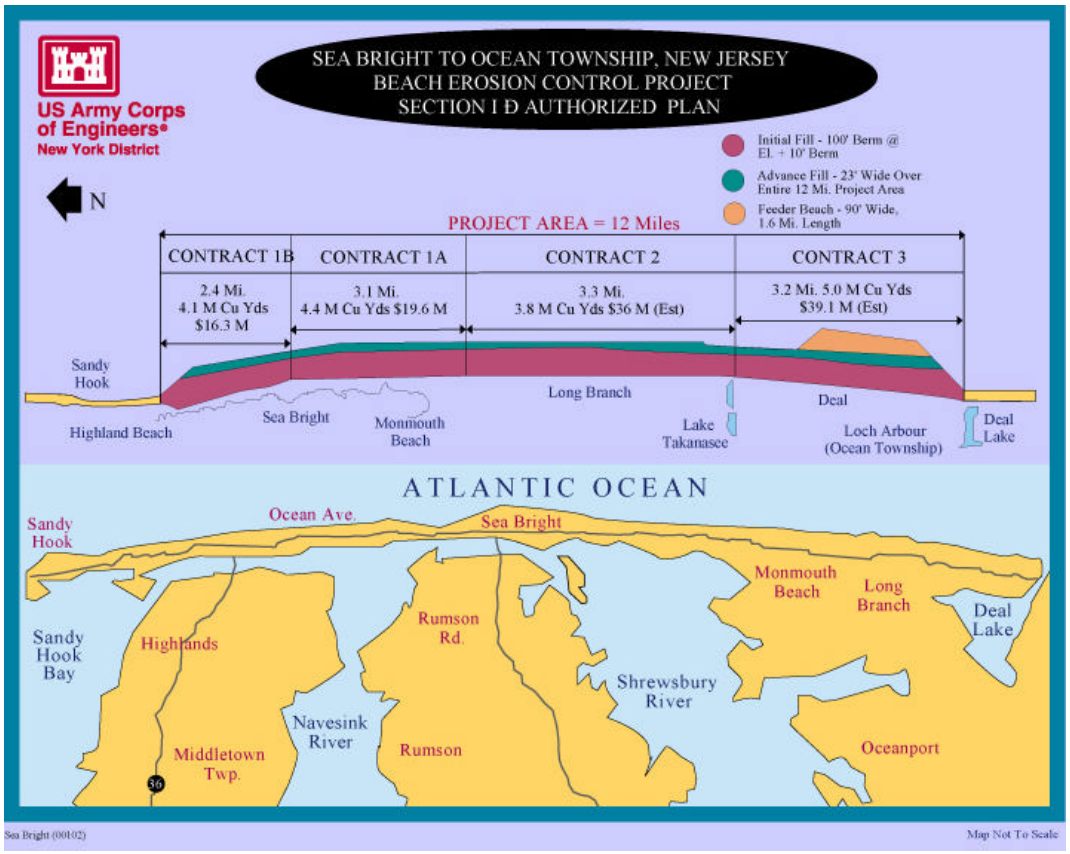

Figure 1-1. Map of Northern New Jersey

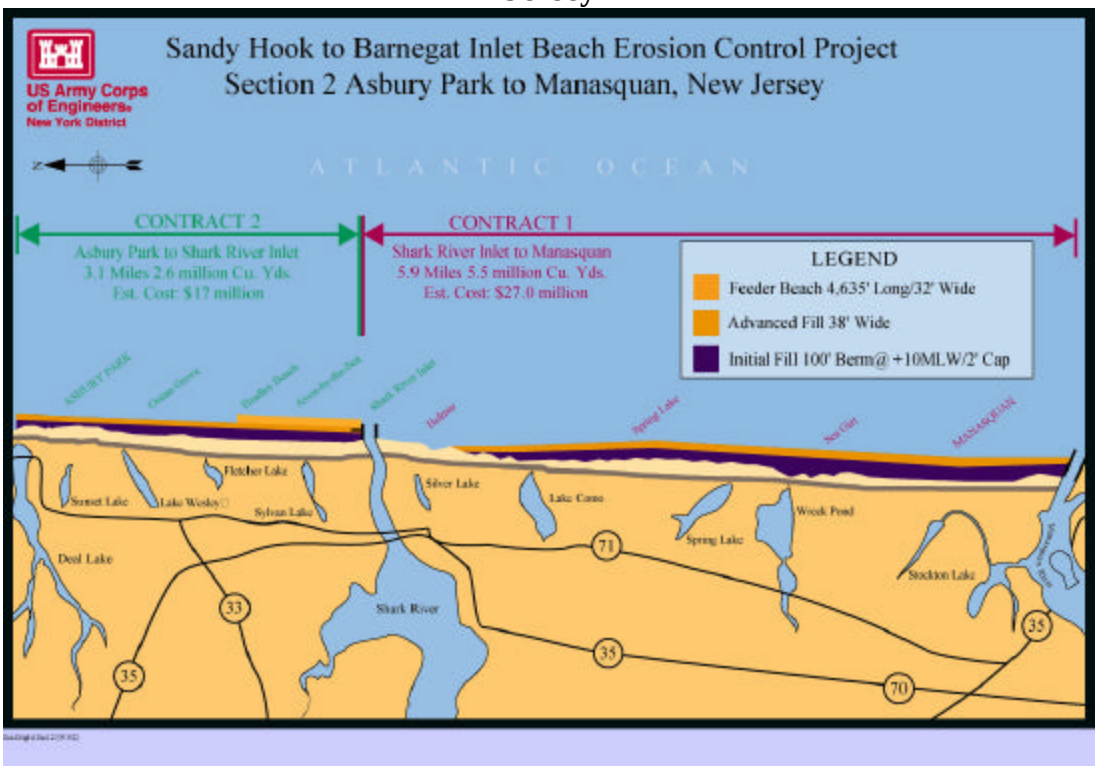

Figure 1-2. Project Area Map.

Table 1-1. Estimated Fill Volumes for the Manasquan Inlet-Asbury Park Beach Erosion Control Project*

Reach	Fill Period	Distance (km)	Fill (million-m^3)
Shark River Inlet to Asbury Park	1999	5.74	1.98
Manasquan Inlet to Shark River Inlet	1997	10.19	4.20
Section 1 Total		15.93	6.18
Project Total**		41.96	19.39

*Data from District Website (www.nan.usace.army.mil)

** Includes all sections from Manasquan Inlet to Highland Beach

Table 1-2. Summary of monitoring efforts for the Biological Monitoring Program.

Year	1994-1996				1997				1998				1999				2000	
Season	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp
Project Activity																		
Dredging/Filling	Pre	Pre	Pre	Pre	Pre	Pre	Pre	C^1	$Post^1$	$Post^1$	$Post^1$	$Post^1$	$Post^1$	$Post^1$	$Post^1$	C^2	C^2	$Post^2$
Monitoring Component																		
Intertidal Benthos		X		X		X	X^M	X		X		X		X	X^M	X	X^M	X
Nearshore Benthos		X^{95}		X^{95}		X		X		X		X		X		X		X
Intertidal Ichythoplankton		X	X			X	X			X	X			X	X			
Nearshore Ichythoplankton		X	X			X	X			X	X			X	X			
Surfzone Fishes			X				X				X				X			
Surfzone Fish Food Habits			X				X				X				X			
Borrow Area Benthos		X		X		X		X		X		X		X		X		X
Borrow Area Fishes		X		X		X		X		X		X		X		X		X
Borrow Area Fish Food Habits		X		X		X		X		X		X		X		X		X
Recreational Fishing		X		X		X								X		X		
Turbidity/Suspended Sediments							X				X							

Pre = Pre-construction period for all reaches

$Post^1$ = Post-construction period for South Reach (Manasquan River to Shark River Inlet)

$Post^2$ = Post-construction period for Middle reach (Shark River Inlet to Asbury Park)

C1 = Construction of South Reach - completed in November 1997.

C2 = Construction of Middle reach - completed in December 1999.

X^M = Monthly Intertidal Benthos

X^{95} = Began 1995

Figure 1-3. Oblique aerial photograph of pre-construction beaches at the Manasquan River Inlet looking north.

Figure 1-4. Oblique aerial photograph of pre-construction beaches at the Shark River Inlet looking north.

Figure 1-5. Oblique aerial photograph of pre-construction beaches at Asbury Park looking north.

Environmental impacts from beach nourishment are typically confined to the immediate borrow (dredge) and beach (fill) areas and include reduced abundance of infauna, altered infaunal community structure, altered feeding habits among fish, crabs, and other commercially important species (due to changes in the availability of prey items), and increased turbidity. The overall objective of monitoring the Asbury/Manasquan project has been to determine if these impacts are severe and long-term. There are no standard sampling programs for collecting this type of information; however, Cochran (1963), Morrisey et al. (1992), and Nelson (1993) provide useful guidelines, Saila et al. (1976), Cohen (1988), and Underwood (1992) provide specific advice for applying these principles to environmental impact studies.

During the summer and fall of 1993, the New York District and U.S. Army Engineer Research and Development Center, Waterways Experiment Station (WES) conducted a pilot study of the borrow and beach areas to obtain the information needed to design the environmental monitoring for Reach 1 of the Asbury/Manasquan project (Coastal Ecology Branch 1994). The pilot study characterized longshore variation in the abundance of intertidal infauna, characterized km-scale variation in the abundance of infauna within the borrow areas, and examined the effectiveness of various methods for sampling nearshore ichthyoplankton and juvenile fishes. Based on this information, the report recommended a monitoring plan for this reach of the Asbury/Manasquan project. The District and WES discussed these recommendations with resource agency representatives in March 1994, and the Biological Monitoring Plan (BMP) was developed (Table 1-2)

Detection of changes in benthos at both the borrow areas and the beach placement sites is the major focus of the monitoring program. Although the BMP addresses general concerns associated with beach nourishment, certain aspects were tailored to fill specific gaps in knowledge relevant to the specific project area. Northern New Jersey high-energy beaches represent a complex, highly developed, highly altered ecosystem. Much of the shoreline has previously been "hardened" via construction of groins and jetties (Figures 1-3 to 1-5). Many of the numerous salt ponds scattered behind the former dune lines are now connected to the beach by water control structures. To evaluate the ecological meaning of project-induced changes against this background of pre-existing conditions, several less traditional monitoring components were incorporated into the BMP. Food habits of fishes, particularly bottom-feeders, collected in the surf zone and at offshore borrow areas were being examined to detect potential higher trophic level consequences of the nourishment process. Likewise, ichthyoplankton and juvenile fish assemblages were being characterized to evaluate the importance of northern New Jersey high-energy beaches as nursery areas. In addition, creel surveys of fishermen using jetties, groins, and sandy beaches were being conducted to evaluate effects on recreational fishing. Threatened and endangered species data were also considered (particularly avian and sea turtle occurrences), but are reported separately by the New York District.

An interim report summarizing 1994 sampling and the initial implementation of that plan was submitted to the New York District in June 1995. Preliminary analyses of data derived from the

various components of the monitoring program indicated that no major changes in the study plan were necessary. A second year of pre-construction data was collected in 1995 and was the subject of a second interim report submitted in March 1996. Delays in contracting the dredging project afforded an opportunity to collect another full year of baseline data in 1996, which enhanced the overall strength of the baseline portion of the monitoring plan through provision of data to assess interannual variation. Results of the entire pre-construction baseline portion (1994-1996) of the monitoring studies were summarized in 1998 (USACE, 1998). Results of the during-construction (1997) and the first year of post-construction (1998) sampling for nourishment of the southernmost reach (Manasquan Inlet to Shark River) were reported in 1999 (Burlas, Ray, and Clarke, 1999). The present report summarizes the results of the entire project including both during construction (1999) and post-construction (2000) for nourishment of the northernmost reach of the project area (Shark River to Asbury Park).

Literature Cited

Ashley, G. M., S. D. Halsey, and C. B. Buteux 1986. New Jersey's longshore current pattern. Journal of Coastal Research 2: 453-463.

Burlas, M., G. L. Ray and D. G Clarke 1999. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project Phases II-III. During Construction and 1st Year Post-Construction Studies U.S. Army Corps of Engineers, New York District. New York, NY.

Caldwell, J. M.1966. Coastal processes and beach erosion. Journal of the Boston Society of Civil Engineers 53, 142-157. (Coastal Engineering Research Center Reprint 67-1).

Coastal Ecology Branch. 1994. Environmental Monitoring for Reach 1 of the Asbury/ Manasquan Section of the Atlantic Coast of New Jersey Sandy Hook to Barnegat Inlet Beach Erosion Control Project. Final Report submitted to the U.S. Army Engineer District, New York, May 1994.

Cochran, W. 1963. *Sampling Techniques*, Second Edition. J. Wiley and Sons, Inc., New York, NY, 413 pp.

Cohen, J. 1988. Statistical Power Analysis for the Behavioral Sciences, Second Edition. Lawrence Erlbaum Associates, Publishers, Hillsdale, NJ, 575pp.

Davies, J. L. 1964. A morphogenic approach to world shorelines. Zeitschrift fur Geomorphology 8: 127-142.

Masselink, G. and A. D. Short 1993. The effect of tide range on beach morphodynamics and morphology: a conceptual model. Journal of Coastal Research 9: 785-800.

Morrisey, D., L. Howitt, A. Underwood, and J. Stark. 1992. Spatial variation in soft-bottom benthos. Marine Ecology Progress Series 81:197-204.

Nelson, W. 1993. Beach restoration in the southeastern U. S.: Environmental effects and biological monitoring. Ocean and Coastal Management 19:157-182.

Nordstrom, K. F., S. F. Fisher, M. A. Burr, E. L. Frankel, T. C. Bucalew, and G. A. Kucma 1978. Coastal Geomorphology of New Jersey. Volume II. Rutgers, the State University of New Jersey, Center for Coastal and Environmental Studies, New Brunswick, NJ. 137pp.

Nordstrom, K. F., J. R. Allen, . J Sherman, N. P. Psuty, L. D. Nakashima, and P. A. Gares 1982. Applied Coastal Geomorphology at Sandy Hook, New Jersey. National Park Service Cooperative Research Unit Report Number CX 1600-6-0017. Rutgers, the State University of New Jersey, Center for Coastal and Environmental Studies, New Brunswick, NJ. 88pp.

Saila, S., R. Pikanowski, and D. Vaughan. 1976. Optimum allocation strategies for sampling benthos in the New York Bight. Estuarine, Coastal, and Marine Science 4:119-128.

Short, A. D. 1991. Macro-meso tidal beach morphodynamics- an overview. Journal of Coastal Research 7: 417-436.

Underwood, A. 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. Journal of Experimental Marine Biology and Ecology 161:145-178.

U.S. Army Corps of Engineers New York District 1998. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury to Manasquan Section Beach Erosion Control Project. Phase I. Pre-Construction Baseline Studies. U.S. Army Engineer District, New York and U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Wright, L. D. and A. D. Short 1984. Morphodynamic variability of surf zones and beaches: a synthesis. Marine Geology 59: 93-118.