ABSTRACT

SHORT-TERM COMMUNITY BASED DUNE MANAGEMENT ACTIVITIES ON A HIGHLY DEVELOPED COAST IN NEW JERSEY

by Stacy McCormack

Recently, local governments have started to realize the effectiveness of dune building as a form of hazard mitigation and have engineered dunes for this purpose. This study evaluates dune management at the local level; specifically, short term management practices, physical constraints, dune management participants, and sources of guidance. A review of municipal regulations, topographic surveys, and interviews with local officials were conducted in four New Jersey communities: Belmar, Spring Lake, Sea Girt and Manasquan. The results of this study indicate that dunes were established as part of local hazard mitigation planning in response to the 1992 storm, and topographic surveys reveal characteristics of a highly developed coast with extensive physical constraints. Local documents address dune vegetation and restricted activities, and the local Departments of Public Works have the most direct influence over the daily management activities. These activities promote recreation and tourism, while hindering dune growth and mobility. Thus, the integrity of the dune and the protection that is serves is compromised. Ideally, communities could be provided with information on local government structures, timelines for better coordination, dune building techniques, and a forum for information sharing through annual primers.

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by Stacy McCormack

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SHORT-TERM COMMUNITY BASED DUNE MANAGEMENT ACTIVITIES ON A HIGHLY DEVELOPED COAST IN NEW JERSEY

Stacy McCormack

Dr. Nancy L. Jackson, Thesis Advisor — Date
Associate Professor, New Jersey Institute of Technology,
Department of Humanities and Social Sciences

Dr. Karl Nordstrom, Committee Member — Date
Professor, Rutgers University, Institute of Marine and Coastal Sciences

---

Dr. Eric Katz, Committee Member — Date
Professor, New Jersey Institute of Technology,
Department of Humanities and Social Sciences

BIOGRAPHICAL SKETCH

Author: Stacy McCormack

Degree: Master of Science

Date: January 2002

Undergraduate and Graduate Education:

- Master of Science in Environmental Policy Studies
  New Jersey Institute of Technology,
  Newark, NJ, 2002

- Bachelor of Arts in Political Science
  Seton Hall University,
  South Orange, NJ, 1998

Major: Environmental Policy Studies

This thesis is dedicated to my mommy.

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CHAPTER 1

INTRODUCTION

1.1 Statement of Objective

Coastal communities are increasingly challenged to manage their beaches and dunes in the face of conflicting values. The importance of coastal dunes as natural defenses from erosion and flooding, support for diverse flora and fauna, and as a source of sediment to the beach system is recognized. Increased residential development on the shoreline and increased demand for recreation and tourism services threaten the integrity of coastal dunes. On developed coasts, local governments have altered dunes to facilitate construction, enhance access or create space for beach recreation (Freestone & Nordstrom, in press). Inhabited coasts have lost many of their natural qualities and have become increasingly artificial and hazardous (Platt, 1994). On eroding shorelines, human attempts to retain a fixed shoreline position by armoring the shoreline can result in truncation or complete loss of beach, dune, and active bluff environments. Landscapes on developed coasts therefore lack the topographical and biological diversity of natural coasts and reliance on natural processes to re-establish natural characteristics in developed communities is an elusive goal (Nordstrom & Mauriello, 2001).

Local officials and governmental bodies need to devise appropriate dune management strategies in the face of competing land-use demands (Nordstrom, Psuty & Carter, 1999). Local governments have started to realize the effectiveness of restoring dynamic coastal systems as a form of hazard mitigation, and have engineered protective dunes for this purpose. These dunes can provide sediment storage and create habitat for wildlife and coastal vegetation, resulting in a balanced coastal ecosystem. Proper dune construction and maintenance along with regular beach nourishment activities are critical to maintain this ecosystem.

The purpose of this study is to evaluate local strategies for dune management. Specific research questions addressed include:

1. What are the short-term dune management practices employed at the local level?
2. What are the physical constraints that local communities face regarding dune management and maintenance?
3. Who participates in dune management on the local level?
4. Where does the guidance for management come from?

Municipal governments are the focus of this study because they are primarily responsible for land use and hazard mitigation planning that affects dune management. This study was conducted on the shoreline reach extending from Shark River Inlet to Manasquan Inlet in New Jersey. Four communities are located in the shoreline reach: Belmar, Spring Lake, Sea Girt, and Manasquan. A review was conducted of federal, state, and local regulations that influence local dune management Topographic survey, of the dunes were conducted at eight sites representative of the types of dunes found in the study area. Data on beach, vegetation and development characteristics were gathered at each site. Interviews were conducted with local officials in each community to determine management programs in force.

CHAPTER 2

LITERATURE SURVEY

2.1 Importance of Dunes

Dunes are an important component of the coastal system because: 1. they prevent flooding of inland areas during raised water levels associated with coastal storms; 2. they represent stored sediment that is available to replenish sediment removed from the beach during storms; and, 3. they can support coastal flora and fauna.

The importance and value of coastal dunes to shore protection is widely recognized. Historically shore protection measures to reduce erosion have been marked by "hard" or "static" structures such as seawalls, revetments, groins and breakwaters. Today, construction of "hard" structures is decreasing because of problems related to beach access, enhanced erosion, and the cost of maintenance. None of these shore protection structures, add sand to the beach. Beach nourishment is the preferred shore protection alternative because it offsets a sediment budget deficit (NRC, 1995). Beach nourishment involves excavation of sediment from one site and placement on a retreating beach to advance the shoreline seaward (NRC, 1990). Dune construction, along with beach nourishment, is popular with coastal communities to mitigate erosion and flood hazards. The wider subaerial beaches provide a source of sediment for dunes to form.

2.2 Dune Formation

Dunes can form as a result of natural processes, human processes, or a combination of the two. Dunes formed by natural processes depend on the transfer of sand from the beach by the local winds. The winds must reach velocities capable of transporting surface sediments and the beach must provide a sufficient source area for dune growth (Livingstone & Warren, 1996). Dunes can be regarded as merely a supply of sand where there is little vegetation. Where vegetation can hold sand for a season or more, sediment will rest after transport and develop ephemeral dunes in the obstruction to airflow. The most recently formed dune near

the beach is known as the *primary* or *foredune*, whereas the older, more vegetated dune is called the *backdune*, or *stable dune* (Klee, 1999).

Dunes can form by human processes. Dunes can be built and maintained by erecting sand fences, planting vegetation, and grading. Sand fencing such as the use of porous fences (i.e. palings, brushwood, straw bales) disrupt the surface airflow and result in sediment desposition. Vegetation planting can be used to accelerate dune formation. The development of vegetated dunes is an interactive process. First, sand is trapped by a bush or clump of grass. Second, vegetation grows in the favorable environment created by accumulating sand. Third, additional species colonize the dune (Livingstone & Warren, 1996).

Grading is often chosen as a means of providing shore protection because other options are too costly. Grading involves moving sediment from low to high portions of the beach, creating a dune that can undergo rapid changes by natural processes. Grading activities are designed to retain the bulk sediment in a dune and fill low elevations in the crest. A graded dune that is stabilized with vegetation may offer better overall protection against storm flooding than the ungraded dune (Nordstrom, 1988). Beach grading is done for protection purposes, to close openings in shore-parallel runnels, to prevent losses and speed their filling with sand, and it can be used to replace sediment along the shore in what is essentially a backpassing operation (Nordstrom, 2000). These activities maintain sediment source areas and maximize the potential for aeolian transport to occur.

There are many problems which affect the advisability of grading. Problems with grading include: erodibility of the newly shaped dune and potential for increased wave attack; increased erodibility of dune sediments emplaced by bulldozing; and increased deflation, in the short term, at newly graded areas due to temporary destruction of vegetation (Nordstrom, 1988). Increased levels of human effort required to maintain a beach and dune system in disequilibrium with natural conditions, and increased requirements, for involvement of government officials to ensure that guidelines for grading are enforced, can pose problems (Nordstrom, 1988).

The concept of maintaining a protective coastal dune on a developed shoreline usually has meant preserving or stabilizing a dune at a fixed location like other engineered structures such as groins and seawalls (Nordstrom, 1986). Dune growth is limited on eroding shorelines stabilized with structures such as groins and seawalls, because of limited source areas of sediment. Dune forms will develop near structures but may not provide the level of protection for private property. Groins can transport sand further offshore in the littoral drift, moving from one groin tip to another, thus causing a net loss of sand on the beach. Seawalls tend to accelerate beach loss because they reflect wave energy, which causes the beach to be scoured away (Clark, 1996). As the shoreline erodes, any protective dune becomes the primary line of defense for protecting upland and human development. Over time, the integrity of the dune is destroyed and the protection that it serves is subsequently diminished.

2.3 Federal Coastal Policy and Dune Management

Responsibility for the management of coastal resources rarely falls exclusively on one level of government. Typically, the landward area of the coastal zone is under the jurisdiction of local and/or state government (Cicin-Sain & Knecht, 1998). There are a number of federal agencies with regulatory or research responsibilities for coasts but there is no overarching federal policy that governs land use and development in coastal areas (May & Deyle, 1998).

Coastal policy is usually a tiered structure of federal, state and local programs (Platt, 1994). Federal programs that influence dune form and function include: 1. Coastal Zone Management Act; 2. National Flood Insurance Act; 3. Federal Flood Control Act; and, 4. Endangered Species Act (Table 1).

Table 1 Federal agencies and their key authorizing legislation that influence dune management

Agencies	Key Authorizing Legislation	Primary Coastal Management Activities
Office of Ocean and Coastal Resources	Coastal Zone Management Act	Implements coastal zone management program; works with states to develop coastal zone programs
Federal Emergency Management Agency	National Flood Insurance Act	Provides disaster assistance to coastal states and local governments
U.S. Army Corps of Engineers	Federal Flood Control Act	Provides technical assistance and funding of shoreline protection, beach nourishment
U.S. Fish and Wildlife Service	Endangered Species Act	Enforces Federal wildlife and endangered species laws

Enacted in 1972, the Coastal Zone Management Act (CZMA) grew out of growing concern for the protection of the environment. The Federal Stratton Commission's 1969 report, *Our Nation and the Sea*, was instrumental in focusing attention of citizens, politicians, and scientists on the importance of coastal regions and the lack of effective management (Beatley, Brower & Schwab, 1994). The Coastal Zone Management Act (CZMA) created a formal framework for collaborative planning of the coast by federal, state, and local jurisdictions. The Act has four main objectives:

1. to protect fragile coasts;
2. to minimize life and property loss from coastal hazards;
3. to create better conditions for coastal resource use, especially in terms of access for recreation; and,
4. to promote inter-governmental cooperation through policy and procedural standardization, leading, hopefully to a reduction in bureaucracy (Carter, 1988).

The Coastal Zone Management Act authorizes and funds the establishment of coastal zone management programs in all coastal states. States wishing to participate in the program are eligible to receive financial assistance to plan and develop a management program for their coastal areas. Each state must define inland coastal zone boundaries, determine permissible land and water uses, and designate areas of particular concern. Areas of significant hazard if developed due to storms, slides, floods, erosion and settlement are specifically mentioned in the legislation as areas of particular concern (Godschalk, Brower, & Beatley, 1989). The Coastal Zone Management Act helps conserve beaches by encouraging and assisting states in implementing programs that provide for the protection of beaches and dunes. Participating states have a comprehensive set of resource and development policies to enhance the likelihood that consistent and predictable decisions on allocation and use of resources will be made in the best interest of society (Nordstrom, 2000).

The National Flood Insurance Act of 1968, as amended by the Flood Disaster Protection Act of 1973, was passed to encourage prudent land-use planning and to minimize

property damage in flood-prone areas. The goal of the act is to encourage state and local governments to make appropriate land-use adjustments, restrict the development of land which is exposed to flood damage, minimize damage caused by flood losses, and to guide the development of proposed future construction, where practical, away from locations which are threatened by flood hazard (Nordstrom, 1986).

The National Flood Program (NFIP) administered by the Federal Emergency Management Agency (FEMA), evaluates structures in coastal high hazard areas on their potential to withstand the impact of wave action. Local communities must adopt ordinances to reduce future flood risks in order to qualify for the National Flood Insurance Program (Nordstrom, 1986). In New Jersey, all but four communities that have designated hazard areas are members of the program (non-emergency). The primary management tool used by FEMA is the high hazard zone or velocity zone (V zone). V zones are the closest flood zones to a shoreline erosion zone to the area flooded by the 100-year storm surge and affected by three-foot wave breaking on top of the surge. In order to qualify for insurance in these areas building construction must conform to specific standards. For example, the first habitable floor of a building must be above the surge plus wave height elevation. Using the Flood Insurance Rate Map, the administrator delineates both the special hazard areas and the risk premium zones of a coastal community. The initial impact of the program was to change the way homes were built by requiring buildings in hazard zones to be elevated rather than slab-on-grade.

FEMA uses dune dimensions to define limits of coastal high hazard areas (codified in a 1988 revision of NFIP) and establishes a prohibition on alteration of primary dunes if that alteration increased flood potential (Nordstrom & Mauriello, 2001). Regulations adopted by FEMA have included frontal sand dunes in the definition of V-zones (44 CFR, Part 59.1). These regulations define the criteria for evaluating whether or not a dune would be able to withstand and act as a barrier to waves and surge during a flood event (NRC, 1990). The present design for protective dunes in the USA is a dune volume, provided by FEMA, for protection against the 100-year flood (Mauriello, 1989). This level of protection is only likely

to be adopted by municipalities if required as a condition of economic support from FEMA. Communities that do not seek funds from FEMA to rebuild damaged dunes are not required to build dunes of the recommended size (Nordstrom, 2000). Under FEMA regulations, communities can not reduce the size of the dunes on their property nor can they be modified for construction since the reduction of sand volume and modifications for construction often reduce the protective capability of the dunes (Gares, 1990).

According to FEMA, the relationship between the quantity of sand that would be removed from a frontal dune due to storms and the recurrence interval of the local storm tide determine the level of effective dune protection (Mauriello, 1989). This relationship established that primary frontal dunes will not be considered as effective barriers to base flood storm surges and associated wave action where the cross-sectional area of the primary frontal dune, as measured perpendicular to the shoreline and above the 100-year stillwater flood evaluation and seaward of the dune crest is equal to or less than 540 square feet (44 CFR.part 65.11).

The US Army Corps of Engineers conducts activities related to: beach erosion control, hurricane protection, navigation improvements, regulation of structures or operations in navigable waters and discharge of dredged or filled material in water and wetlands. The corps designs and implements beach nourishment and berm-building projects as part of erosion control and hurricane protection and dredge and fill projects. Projects are authorized and funding allocated by Congress (Nordstrom, 2000). Beach nourishment can provide wider beaches for recreation and protect coastal development from erosion and flooding. (Beatley, Brower, & Schwab, 1994). Dune building is not a requirement of beach nourishment projects because erosion and flood mitigation is part of the beach volume and berm elevation design, but the agency does encourage communities to build dunes as additional protection. Beach width is a primary control on the type and location of dunes, whether natural or artificially created (Nordstrom & Mauriello, 2001). The primary objective for beach nourishment or replenishment on developed coasts has been storm

protection, but the added sediment volume has provided an adequate source for dune formation and growth.

The Endangered Species Act was enacted in 1973. The Act, administered by the US Fish and Wildlife Service, established a National Wildlife Refuge System – a system of protected zones for wildlife resources. The act also authorizes the enforcement of federal wildlife and endangered species laws and designs and implements habitat restoration activities (Klee, 1999). In New Jersey, the recent initiative for protecting shore birds under the Endangered Species Program administered by the New Jersey Division of Fish, Game and Wildlife has revealed potential for restoring naturally-functioning foredunes (Nordstrom & Mauriello, 2001). The program allows for protection of nesting shore birds affected by adverse human activities by identification of nesting areas and the establishment of protected enclaves. Identification of these enclaves leads to the restriction of activities such as raking, bulldozing, scraping, and backpassing sand during the nesting season. With the elimination of these adverse activities, accumulation of wrack lines, colonization of plants, and growth of incipient dunes may occur. This type of dune formation may be characterized by greater dynamism and topographic diversity than municipally-maintained dunes occurring where the beach is raked and sediment is inhibited by fences and vegetation plantings (Nordstrom & Mauriello, 2001).

2.4 New Jersey Coastal Policy and Dune Management

The primary attraction of New Jersey's shoreline is the sandy beach that fronts a large portion of the 130-mile ocean coastline (Nordstrom, 1986). The shoreline of New Jersey can be classified by three types: coastal barriers, headlands, and bayside shorelines. Since the 1900s New Jersey's shorefront communities have attempted to stabilize their shoreline through the installation of groins, bulkheads, and beach nourishment projects. The New Jersey coast has the longest history of development and stabilization of any barrier coast in the USA, and it has been subject to considerable investigation as a developed coastal geomorphic system (Nordstrom, Lampe & Vandemark, 2000). Efforts by the State of New Jersey to restore dunes

to provide protection in several communities have led to greater acceptance of foredunes as a means of shore protection (Nordstrom, 2000).

Much of the responsibility of coastal management lies with coastal states and localities. State programs and policies oriented toward shore protection play a major role in influencing the likelihood that strategies compatible with beach and dunes are implemented (Nordstrom, 2000). The attractiveness of the Coastal Zone Management Act stems from the freedom that states have to devise their own program. The principal law for the New Jersey Coastal Zone Management Program that influences dune management practices is the Coastal Area Facility Review Act (CAFRA), N.J.S.A 13:19-1 et seq (as amended in July 19, 1993). The Coastal Area Facility Review Act authorizes the New Jersey Department of Environmental Protection to regulate and approve the location, design, and construction of major facilities on New Jersey's barrier islands, all coastal resort areas, and many inland areas (Nordstrom, 1986). Initially, CAFRA applied to residential developments containing more than 24 dwelling units and commercial facilities generating 300 or more parking spaces (Platt, Miller, Beatley, Melville, & Mathenia, 1992). The 1993 legislative amendments to CAFRA (effective 1999) included construction, reconstruction, or expansion of single family or duplex homes.

According to CAFRA, a dune is a wind or wave deposited or man-made formation of sand that lies generally parallel to and landward of the beach, and between the upland limit of the beach and the foot of the most inland slope of the dune. Dune includes the foredune, secondary and tertiary dune ridges, as well as man-made dunes, where they exist. A small accumulation of loose, windblown sand found in a street or on a part of a structure as a result of storm activity is not considered a dune.

Development according to CAFRA is prohibited unless there is no practicable or feasible alternative in the area and as long as it will not cause significant adverse long-term impacts on the natural functioning of the beach and dune system. Activities such as removal of vegetation from any dune, and the excavation, bulldozing or alteration of dunes is also

prohibited, unless these activities are a component of a department approved beach and dune management plan.

CAFRA prohibits direct disturbance to dunes that would reduce their dimensions (Nordstrom, 2000). According to CAFRA sand may be added to dunes through bulldozing, vegetation may be planted, construction of walkways across the dunes, and construction seaward of the dune may be permitted if the structures are used for shore protection. Seasonal recreational uses may be permitted as long as the structures are on pilings. Elevating existing buildings or constructing a second story does not require a permit if the footprint of the building is not increased.

2.5 Local Regulations

Many of the daily management decisions that occur in the coastal zone are made at the local level by hundreds of counties, cities, and towns. In the United States, local governments have primary responsibility for managing land use and development (Beatley, Brower, & Schwab, 1994). Localities have the ability to employ a number of tools to manage land use. Some of the most common are: 1. zoning ordinances which control the type of land uses, 2. subdivision ordinances which regulate the conversion of raw land into building sites, 3. shoreline setback regulations to ensure that sufficient land is available for future public improvements and public structures and buildings are less vulnerable to storm risks, 4. dune protection regulations to prohibit destructive activities, and; 5. land acquisition. Many communities have enacted ordinances to enforce flood insurance regulations, preserve coastal dunes, place the location of development back from the hazard zone, or protect important natural resources (Nordstrom, 1986). In New Jersey many of these ordinances were passed as a result of the devastating 1962 nor'easter that damaged or destroyed much of the foredune development along the coastline (Psuty & Rohr, 2000). Zoning regulations establish the setbacks to prevent people from locating structures too close to eroding shorelines (Nordstrom, 2000). Development Codes establish building height limitations on

beachfront residences and construction rules to reduce building damage from floods, waves, or winds.

Dune ordinances outline the restrictions on use in the dune fields and penalties for their violation. A number of planning documents, to manage dunes, are available to communities and beachfront property owners. These documents include: *Restoration of Sand Dunes Along the Mid-Atlantic Coast* (Natural Resource Conservation Service, 1992); *Guidelines and Recommendations for Coastal Dune Restoration and Creation Projects* (New Jersey Department of Environmental Protection, 1985); and *A Primer for Dune Management with Models of Dune Response to Storm Frequencies* (Psuty & Rhor, 2000). Each of these documents provide dune designs for hazard mitigation and ecological management. Some New Jersey communities have consultants prepare dune management plans. For example, *The Morven Beach Association Dune Management Plan* prepared by The Richard Stockton College of New Jersey Coastal Research Center in 1998 makes recommendations for dune building, stabilization, vegetation strategies, dune maintenance and community education. Other documents, such as *Endangered Beach Nesting Bird Management on New Jersey's Municipal Beaches* (New Jersey Department of Fish and Wildlife), assist communities to manage coastal beaches and dunes for the benefit of wildlife. All of the documents give similar recommendations for fences, vegetation, stabilization, and prohibited activities. Although the Morven Primer for dune building gives the same suggestions as the other public documents, it should be noted that it is not a public document.

According to the above documents, the process of building dunes involves proper fence placement, fence layout, vegetation and fertilization of dunes, monitoring and maintenance of dune activities, and restrictions on trespassing on dunes. Placement of the primary dune must be 100 feet of the horizontal distance from mean high tide. Suggested fence layout to build a barrier dune is two parallel fences (4 foot slatted fence, with posts 6.5 feet and minimum diameter of 3 inches) about 30-40 feet apart, parallel to the shoreline in the dune/backbeach area. To widen a dune, it is suggested to place a fence 15-ft seaward from the old dune.

Ammophila brevigulata is recommended for dune stabilization. It is suggested that *Ammophila breviligulata* is planted from October to April in strips no less than 20 feet wide and 6-9 inches below the surface. Recommended fertilization is for the first five years of vegetation (50 lbs. per acre). In addition to these activities it is suggested that signs restricting access to the dunes be erected to keep human activities from interfering with natural processes. Public education for residents and visitors through distribution of pamphlets, and local resident participation in activities such as dune planting are also encouraged.

2.6 New Jersey Dune Management History

As the development of New Jersey's barrier islands proceeded, little consideration was given to the importance of either the protective or aesthetic values of the beach and dune system (Platt, 1994). The removal of dunes for shorefront construction stemmed from the desire for a view of the sea. Dunes were systematically removed from the shorefront to be replaced with boardwalks, roads, or houses (Nordstrom, 1986). Historically, efforts to provide protection resulted in installation of engineered structures and replenishment activities.

During the March 1984 storm sections of the New Jersey coast had some of the worst erosion and washover in history. The president declared the New Jersey coastal communities a disaster area the following month (Nordstrom, 2000). Approximately 20 municipalities received funds passed through to the state from the federal government to repair and restore dunes damaged (Nordstrom, 2000). A report, *An Assessment of Dune and Shore Protection Ordinances* issued by the Department of Environmental Protection Division of Coastal Resources in December 1984, concluded that State expenditures for shore protection would be most cost effective if they coincided with programs that protect and create dunes. The study examined 31 dune ordinances and recommended future shore protection expenditures by the State be conditioned upon municipal adoption and enforcement of an effective dune management program (Psuty & Rohr 2000). The state responded by adopting the Hazard Mitigation Plan in 1985 which recommended dune creation and enhancement as one of the

primary hazard mitigation efforts. Communities participating in the Hazard Mitigation Plan received money for vegetation and fencing. As a condition of this funding, municipalities signed a state aid agreement requiring them to adopt or amend municipal ordinances to conform with state coastal zone management rules (Nordstrom & Mauriello, 2001).

A dune district management concept was developed in New Jersey in the late 1970s. This approach was unique because development of the dune management plan was initiated and promoted by academic geographers who had no governmental ties (Gares, 1989). Ideally, dunes could migrate along the shoreline and boundaries could be readjusted after a predetermined time. The migration aspect is the fundamental difference between the conception of a dune as a static protection structure and as a shifting component. The Dune Management District differs from traditional setbacks in that it acknowledges that erosion is a continuing process and it includes a dune as a principle component of regulation (Nordstrom, 2000). Dune preservation districts are established as zones where dunes are protected so as to allow them to perform their function of buffering storm damage and reducing flood hazard (Nordstrom & Psuty, 1980). Dune district zoning is designed to increase the value of the dune for protection by favoring an increase in the dimensions of the dune through limiting shorefront construction (Nordstrom & Psuty, 1980).

The dune management district was incorporated into the "Dune and Shorefront Protection Act" for adoption as law. The law was withdrawn from consideration after negative public reaction (Gares, 1989). Four factors played important roles in the rejection of the act. First, critics contended there were too many unanswered questions regarding the delineation methodology. Second, one of the major criticisms was that the width of the boundary was not consistent from community to community. Third, local residents viewed this new management plan as threatening and criticized the State's involvement in local land use policies. Fourth, criticism came from property owners whose perception was that they would have to sacrifice their investments without compensation (Gares, 1989).

The December 1992 storm was the harshest storm since 1962, in terms of both damage and weather conditions (USACE, 1993). It caused severe dune erosion and the New Jersey shoreline was declared a disaster area 6 days after the storm. The storm resulted in destruction of public property including debris-ridden roadways, beach erosion, collapsed public facilities, boardwalk, and sewer damage. Communities along the coast received funding from FEMA to build dunes.

The 1992 storm solidified support for a stable source of shore protection funding and the State Beach Erosion Commission was reactivated with the goal of studying and evaluating current shore protection strategies. Recommendations were made by the Interagency Hazard Mitigation Survey Team calling for "a definitive and coordinated governmental program of dune creation, restoration, maintenance and expansion with established procedures and funding of emergency recovery and long-term protection" (FEMA interagency report 1993).

Previous research on local coastal management focuses on hazard mitigation planning (Platt, 1994; Fisher, Rivas & Cendrero, 1995; Burby, 1998; Fisher & Arredondo, 1999; Neuman, 1999; Francoise, Pau, & Eulalia, 2000), state and local programs to manage dunes (Gares, 1989; Beatley, Brower, & Schwab, 1994; Cin-Sain & Knecht, 1998; Nordstrom, in press; Nordstrom, Jackson, Bruno, & de Butts, in press), and vegetation studies of dunes (Nordstrom, 1988; Gares, 1990; Nordstrom & Gares, 1994; Nordstrom, Lampe, & Vandemark, 2000; Freestone, Nordstrom, in press).

The focus of this study is to assess local dune management activities by examining physical attributes of local dune systems and specific management objectives as identified by local-officials. The study was conducted in the communities of Belmar, Spring Lake, Sea Girt, and Manasquan. Since the 1992 storm dune building has become increasingly popular. Yet, since the original dune building projects in 1992, there has been little follow up to the hazard mitigation plans implemented. In order for communities to recognize the successes and failures of their hazard mitigation plan, it is critical for them to readdress factors that influence the mitigation process.

CHAPTER 3

METHODOLOGY

3.1 Study Area

The study area is bounded by Shark River Inlet to the north and Manasquan Inlet to the south in New Jersey (Figure 1). The four communities located along the 8.5 km reach are: Belmar, Spring Lake, Sea Girt, and Manasquan. The section of beach from Belmar to Manasquan was last nourished in 1997.

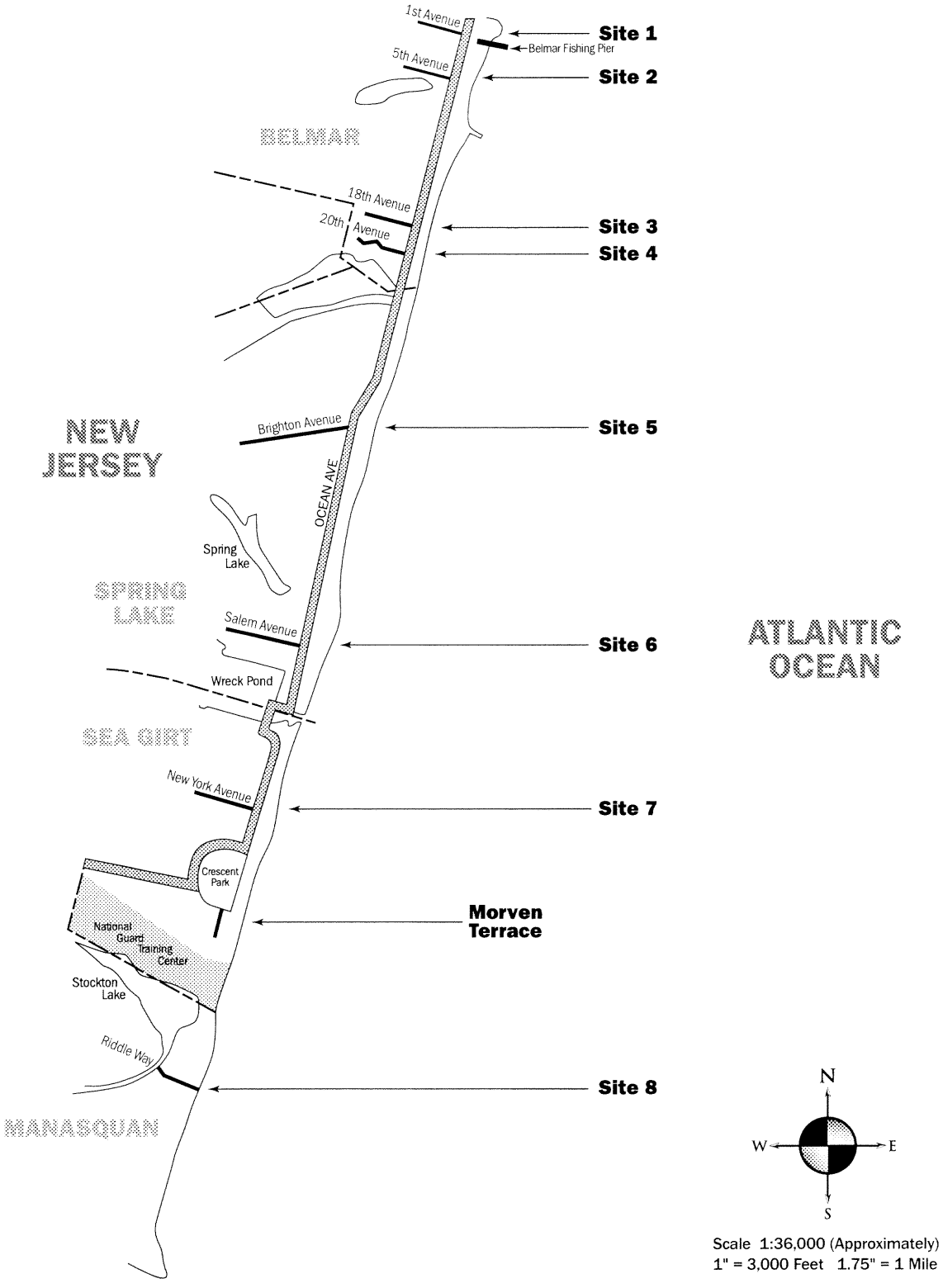

Figure 1 Study area from Shark River Inlet to Manasquan Inlet including Belmar, Spring Lake, Sea Girt, and Manasquan. Each segment represents similar long shore dune segments.

A field reconnaissance of the study area identified longshore segments with similar beach and dune attributes. A total of eight segments were identified. At least one profile site was chosen to represent the beach and dune characteristics in each segment.

The Recreation Area and Bird Nesting Beach, Site 1 (Figure 2) is located in Belmar. The profile site represents 0.25 km of the coast from Shark River inlet to First Avenue. The site was chosen because it is located in a town-owned recreation and bird nesting space and is the only section of the shoreline in Belmar that has not been replenished. The site hosts a variety of recreational activities such as fishing, bird watching, and exercise stations but swimming is prohibited. Bird nesting is encouraged by two Osprey nests on either side of a sand path. The path runs through the vegetated dune field and provides access to the beach. The primary frontal dune has a collapsed sand/snow fence on its seaward side.

Figure 2 Photograph, looking west, of the First Avenue Recreation Area and Bird Nesting Beach at Site 1 in Belmar, NJ.

Site 2 (Figure 3) is located at the Fifth Avenue beach in Belmar. The dune consists of a linear human-created artificial ridge that is located immediately landward of the boardwalk. There is a linear sand fence on the seaward side of the dune, which runs parallel to the shoreline. The linear dune continues for 1.25 km along the seaward side of the boardwalk from First Avenue, on the southern side of the Belmar Fishing Club Pier, to Thirteenth Avenue. This site (Figure 1) was selected because it is representative of the majority of the beach/dune system in Belmar.

Figure 3 Photograph, looking north, of the dune at Site 2 in Belmar, NJ.

Site 3 (Figure 4) is located at the Eighteenth Avenue Beach in Belmar (Figure 1). This profile site was selected because of the removable boardwalk and presence of two dune ridges. Beginning at Thirteenth Avenue and continuing to Twentieth Avenue, one dune ridge is on the seaward side of the boardwalk and one dune ridge is on the landward side of the boardwalk. The landward dune ridge is bound on all four sides by the old boardwalk beams. The profile represents the dune conditions from Eighteenth Avenue to Twentieth Avenue or approximately 0.5 km of shoreline.

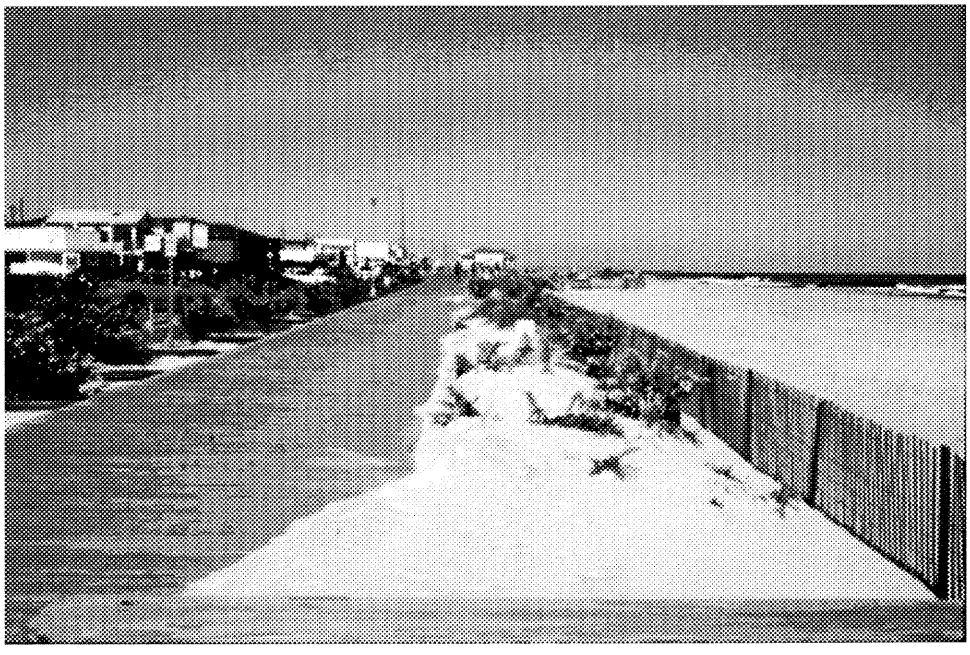

Figure 4 Photograph, looking north, showing dunes on the landward and seaward side of boardwalk at Site 3 in Belmar, NJ.

Site 4 (Figure 5 & 6) is located at the Twentieth Avenue beach in Belmar (Figure 1). This profile site was chosen because the removable boardwalk ends and the dunes back up to Ocean Avenue, the first parallel road. Site 4 was chosen as the southern most profile site in Belmar because it has no boardwalk and an exposed seawall under the dune. South of Twentieth Avenue the dunes end and a cement wall separates the Borough of Belmar from the entrance to the Borough of Spring Lake. There is no dune in front of the wall.

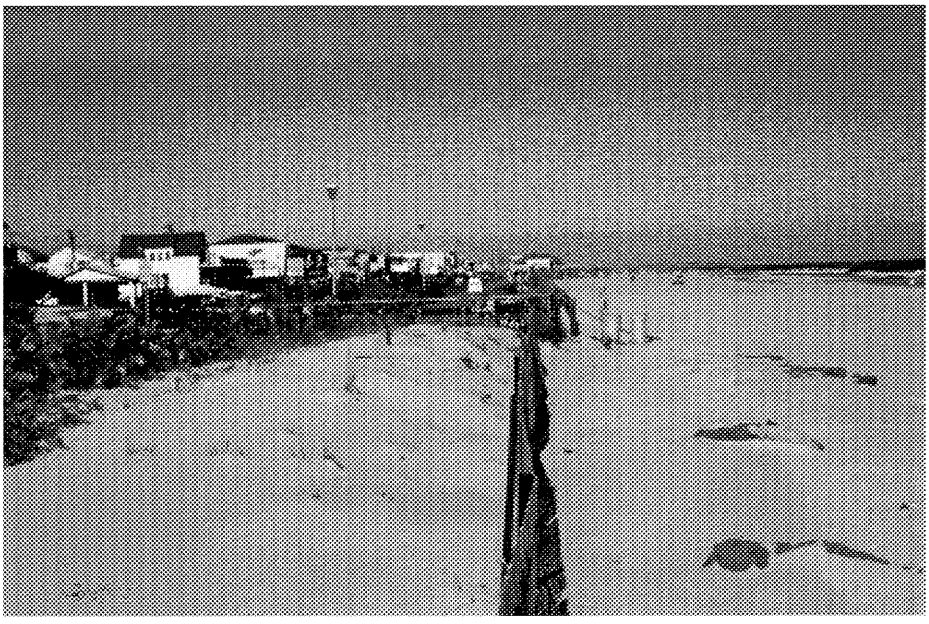

Figure 5 Photograph, looking north, showing seaward side of dune at Site 4 in Belmar, NJ.

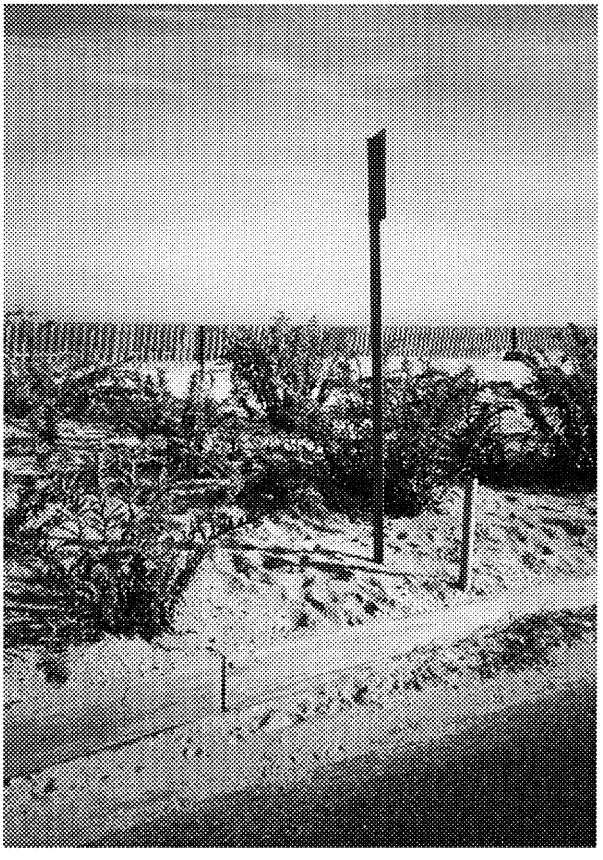

Figure 6 Photograph, showing landward side of dune at Site 4 in Belmar, NJ.

In Spring Lake two profile sites were chosen; Brighton Avenue (Site 5) (Figure 7) and Salem Avenue (Site 6) (Figure 8). Site 5 is located on the north end of Spring Lake (Figure 1), 1 km south of Site 4. Site 6 is located 1.5 km south of Site 5. These two sites were chosen because of their variation in slope. Site 5 is located next to the north end pavilion where pedestrian traffic is higher. The dune abuts Ocean Avenue where the slope to the curb is steeper than at Site 6. Spring Lake's dune is generally consistent throughout the length of their 3-km coast.

Figure 7 Photograph, looking south, of dune at Site 5 in Spring Lake, NJ.

Figure 8 Photograph, looking south, of dune at Site 6 in Spring Lake, NJ.

The profile site chosen at New York Avenue (Site 7) is to the south of the road offset (Figures 1 and 9). Sea Girt has no dunes along its public beach from Beacon Boulevard south to New York Avenue (0.5 km). In the vicinity of Ocean Avenue, there is an oceanward offset to the road (Nordstrom, 1986). This site was chosen because the private beachfront residential lots abut the dune. This section of privately owned beach begins at New York Avenue and continues south about 1 km to the National Guard Training Center.

Figure 9 Photograph looking south, showing private property abutting dune in Sea Girt at Site 7 in Sea Girt, NJ.

Site 8 (Figure 10) is located at Riddle Way in Manasquan, 2 km from Site 7 and south of the Nation Guard Training Center (Figure 1). Site 8 was chosen to represent the dune characteristics along the 2.5 km shoreline of Manasquan. The linear dune in Manasquan begins at the southern end of The National Guard Training Center and ends at Riverside Drive at the Manasquan River. There is a paved boardwalk/walkway separating the private beachfront properties and the fence at the dune (Figure 10).

Figure 10 Photograph, looking south, showing landward side of dune and boardwalk at Site 8 in Manasquan, NJ.

3.2 Topographic and Vegetation Data

Fourteen variables were gathered at each of the eight profile sites between September and November 2001 (Table 2) to characterize the beach and dune. Beach and dune elevation measurements were recorded, using a transit and stadia rod, at different horizontal intervals based on dune dimensions at each profile site. Elevations ranged from 0.5 to 6.0 m intervals. Elevations reported are relative to curb elevation.

Beach width was determined by walking the distance from the dune toe (usually marked by a sand fence) to the berm crest with a tape measure. Dune width was measured

from the dune toe (or sand fence at the dune toe) to the back of the dune or the limiting structure after plotting the elevations. A limiting structure can be defined as any structure that could limit dune mobility such as the boardwalk, paved streets or building. Location of the wrack line was determined by measuring the distance between the wrack line and the dune toe or sand fence at the dune toe with a tape measure. The other characteristics of the profile sites such as development line, presence of wind blown sand across the development line, number of dune ridges, characteristics of the fence, presence of a structure under the dune, and dune location were taken by visual observation of the site.

Vegetation was identified using the reference book, "*Common Plants of the Mid-Atlantic Coast*" (Silberhorn, 1982). Vegetation identification was conducted by matching the plants at each profile site to the guidebook. Vegetation density was measured by using a 0.5 by 0.5-square meter frame at three locations landward, seaward and at the crest of the dune. At each location vegetation was measured by counting plants inside the frame. The height of the dune vegetation was determined by visually selecting the tallest plant on the profile line and measuring it from the sand surface to the highest point on the plant.

3.3 Local Management Assessment

Local governments work in collaboration with state and national agencies in order to formulate their hazard mitigation plan. Each community participates in FEMA's National Flood Insurance Program. Belmar and Manasquan entered in 1972, Spring Lake entered in 1982 and Sea Girt entered in 1976. Through FEMA and the Army Corps of Engineers these four communities participate in beach nourishment activities which are critical to dune formation and growth.

Several departments, officers, and commissioners at the local level influence the decision making process on dune management. Interviews, conducted with municipal officials, focused on dune management goals of each community. Local officials are familiar with local interests and are directly accountable to the landowners most affected by planning

decisions (Nordstrom, 2000). Interviews were conducted with the Zoning Officer, head of the Department of Public Works in each community and the head of the Local Environmental Commission (or local official responsible for dune vegetation). All interviews were face to face and on-site. Interviews were structured by a list of questions tailored specifically to the managerial roles and responsibilities of each interviewee. Questions were used as a guide for informal discussion. A strict question and answer format was not used. Most of the interviews lasted about 30 minutes.

Zoning officers were asked about the management of privately held beaches or dunes and dune management on this type of property, master plan goals, dune building history and policy development, and the influence of CAFRA and FEMA on dune management. Interviews with the Department of Public Works focused primarily on day-to-day beach maintenance. The questions covered boardwalk construction and repair, post-storm dune restoration, hazard mitigation effectiveness, fence design and regulations regarding dune maintenance. Interviews with the Environmental Commissioners focused on vegetation selection and planting techniques. In Manasquan and Belmar, the Environmental Commissions had not engaged in any vegetative planting activities and these activities had been taken over by another department. In Manasquan, vegetation was the responsibility of the Beach Manager. In Belmar vegetation was the responsibility of the Department of Public Works.

Table 2 Variables of Beach, Dune and Development characteristics

Variable Name	Definition	Method of Measurement
Shoreline Orientation	Azimuth of the high water line	Compass
Beach Width (m)	Distance from the dune toe or storm fence at the dune toe to the berm crest	Tape Measure
Dune Width (m)	Distance from obstructing structure (ie.curb at the street, boardwalk) to the dune toe/ storm fence	Transit and Stadia Rod
Development Line	Presence or absence of a structure obstructing dune migration	Visual Observation
Presence of Wind Blown Sand	Evidence of aeolian activity across the development line	Visual Observation
Number of Dune Ridges	Number of dune crests in a site	Visual Observation
Vegetation Type	Identification of biota on the dune	Visual Observation
Vegetation Density	Number within 0.5 square meter frame	Visual Observation
Location of Wrack Line	Distance of the wrack line from the dune toe or storm fence	Tape Measure
Height of Vegetation	Height of the tallest vegetation	Stadia Rod
Characteristics of Fence	Description of the storm fence at the dune toe (ie. linear fence, zig-zag fence)	Visual Observation
Structure Under Dune	Presence of a structure supporting the dune	Visual Observation
Dune Location	Location of the dune on the backbeach relative to the boardwalk or property line	Visual Observation
Dune Elevation (m)	height of the dune above the backbeach	Transit and Stadia Rod

CHAPTER 4

RESULTS

4.1 Belmar

4.1.1 Physical Characteristics

Site 1 (Figure 11) is one of the segments of the study area that has not been replenished. The shoreline orientation at Site 1 is northeast/southwest. The distance from the berm crest to the foredune toe is 76.5 m and the width of the primary frontal dune is 5 m. The distance of the wrack line from the dune toe is 66.5 m. The dune elevation above the back beach is 0.50 m. The primary frontal dune has a collapsed storm fence at the seaward side with windblown debris in the storm fence. The dune is bounded on the landward side by Ocean Avenue and by a fence separating the Recreation and Bird Nesting beach and Ocean Avenue which runs parallel to the shoreline. There is no room for dune mobility beyond the fence at the sidewalk abutting Ocean Avenue. The area is heavily vegetated with *Ammophila breviligulata, Rosa Rigota,* Austrian Pine, *Juniperus Virginiana, Myrica pensylvanica*, and Milkweed. Vegetation density varies between the crest and the landward and seaward side of the dune. The landward side of the dune abuts the boardwalk with no vegetation. The crest of the dune has the most coverage with 7 plants per 0.5 m^2 and the seaward side of the dune has 3 plants per 0.5m^2.

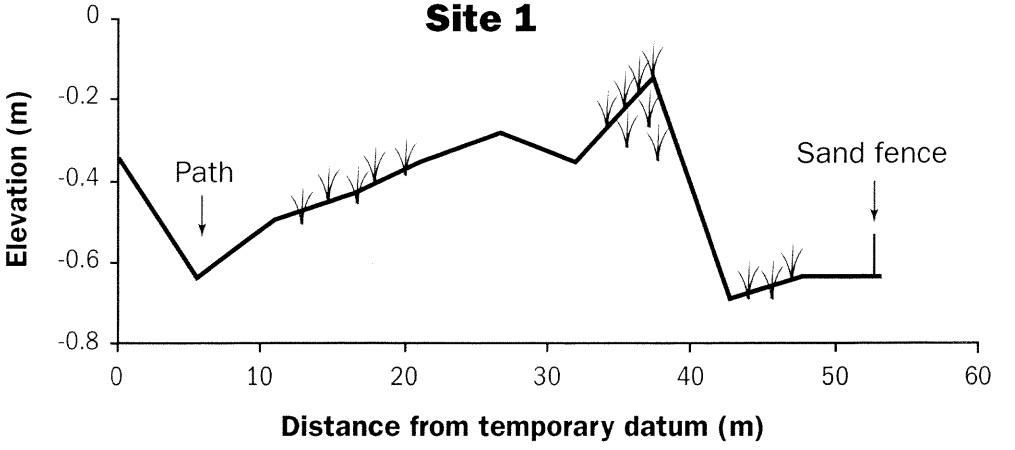

Figure 11 Profile at Site 1.

Site 2 (Figure 12) is oriented northwest/southeast. The distance from the berm crest to the dune toe is 64.8 m. The width of the single-linear dune is 3.8 m and the dune height above the back beach is 0.8 m. The dune is seaward of the boardwalk and the crest of the dune is level with the boardwalk allowing for sand to blow onto the boardwalk. There is no landward migration of the dune form. The dune is vegetated with *Ammophila breviligulata* and *Solidago sempervirens* which reach a maximum height of 0.75 m. Vegetation on the seaward side of the dune is considerably less than at the crest. The landward side abuts the boardwalk and does not allow for vegetation growth. Vegetation coverage was most dense on the crest with 3 plants per 0.5 m^2. The wrack line is 43.5 m seaward from the linear fence at the dune toe.

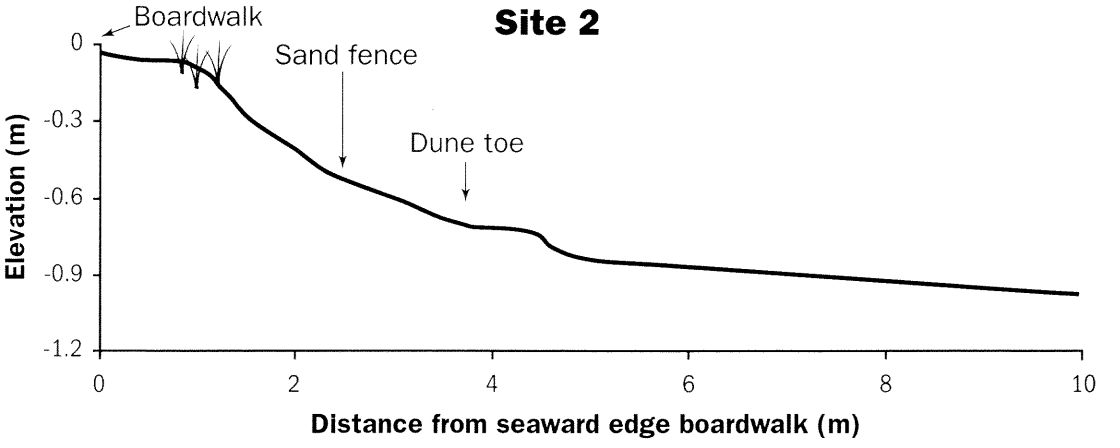

Figure 12 Profile at Site 2. The 0 m elevation represents the boardwalk elevation.

The shoreline at Site 3 (Figure 13) is oriented northeast/southwest. The distance from the berm crest to the fence at the dune toe is 64.8 m. The width of the dune is 3 m and the height of the dune above the backbeach is 0.5 m. The wrack line is 37.8 m from the dune toe. A second dune is located landward of the beach and separated by the boardwalk. Sand is blown onto the boardwalk from both dune, and there is wind blown sand on the street from the landward dune. Neither dune has room for migration. The landward dune is bounded on all sides by the old boardwalk beams with one *Ammophila breviligulata* plant within the section. The dune seaward of the boardwalk has vegetation on the landward side of the dune (5 plants per 0.5 m^2), the crest (3 plants per 0.5 m^2), and the seaward side (3 plants per 0.5 m^2). The vegetation on the seaward dune reaches a maximum of 0.56 m, and the landward dune, maximum height of the vegetation is 1.2 m.

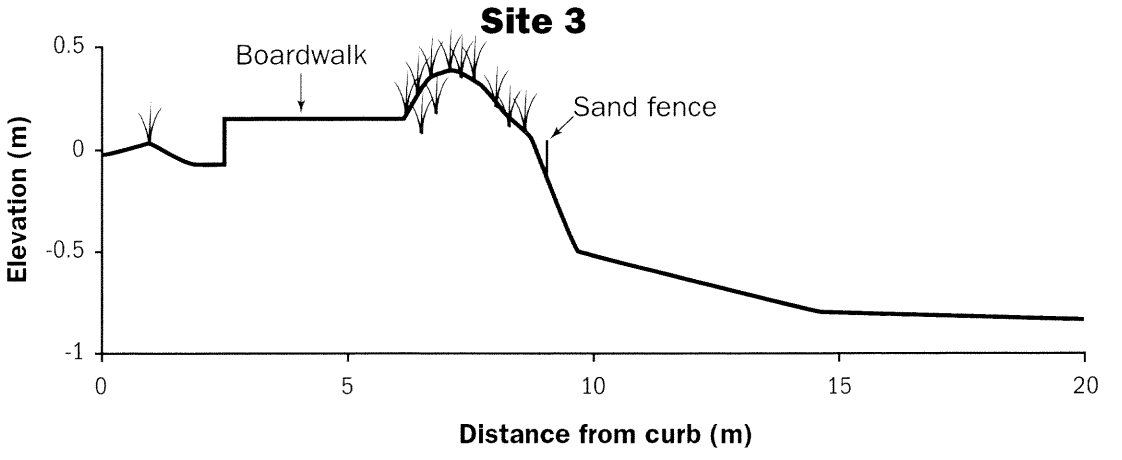

Figure 13 Dune profile at Site 3. The 0 m elevation represents the top of the curb.

The dune at Site 4 is located on top of a seawall (Figure 14). The seawall is exposed on the seaward side. The shoreline orientation is northeast/southwest. The distance from the berm crest to the dune toe is 29.2 m. The dune is 8.0 m in width and the height above the backbeach is 0.85 m. The dune backs up to Ocean Avenue. The dune is vegetated with *Solidago sempervirens* which reaches a maximum height of 1.0 m. The dune is heavily vegetated on the landward side with 10 plants per 0.5 m^2 but has little to no vegetation on the seaward side and the crest. The wrack line is 39.0 m from the dune cannot migrate because it is bound by a permanent boardwalk on the landward side. The seawall on the seaward side also hinders dune mobility.

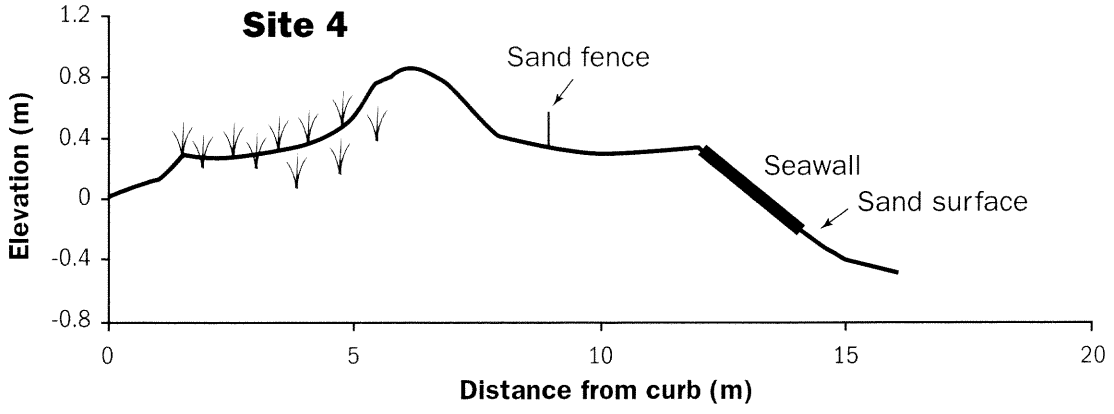

Figure 14 Dune profile at Site 4. The 0 m elevation represents the top of the curb.

4.1.2 Local Controls

The town of Belmar has a comprehensive plan and zoning ordinance, activities in the beach and dune zone are governed by the municipal dune ordinance. The ordinance addresses the area between the east side of Ocean Avenue. and the beach. "Dune areas" are defined as all tracks of land beginning at a point south of the Belmar Fishing Club and extending east of the boardwalk (Borough of Belmar, 1999). Dune areas may include locations along the beachfront that are constructed or planted for the purpose of preserving and protecting the shoreline (Borough of Belmar, 1999). The ordinance specifies that boundaries of the dune areas are not rigid and may shift and migrate as a result of natural

processes. Natural vegetation or indigenous vegetation is defined as dune or beach grass, dusty miller, hudsonia, sea rocket, seaside goldenrod, bayberry, or beach plum and other plants which normally grow or may be planted in the dune area (Borough of Belmar, 1999).

The second section of the dune ordinance lists prohibitions. The Borough of Belmar prohibits any construction, trespassing, bicycles, vehicles or destruction in the dune area, except for the purpose of cleaning, maintaining, restoring or planting by authorized officials.

The last section of the ordinance is "Violations" outlining fines or punishment for violating any sections of the dune ordinance. Any person, firm or corporation who shall violate any provisions of this section, upon conviction thereof, be subject to a fine of not more than the sum of five hundred dollars, from one hour to fifty hours of community service or a jail sentence of not more than ninety days or both at the discretion of the Judge (Borough of Belmar, 1999).

4.1.3 Interviews

According to the Head of the Department of Public Works the dunes were originally built for hazard mitigation and protection of the boardwalk from storms through a FEMA grant after the 1992 storm (Merle, 2001). Maintenance, recommended by FEMA, is done as post-storm protocol. Sections of the boardwalk were rebuilt after the 1992 storm but the structure was never relocated landward. Sections of removable boardwalk were installed between Seventeenth and Twentieth Streets as a way to retreat during the winter but the sections are not longer removed. Placement of sand fences, is done with an "in house" design in order to trap sand and buffer the boardwalk from storms. Most of the fences are from the 1992 storm and are replaced as needed by the Department of Public Works. The railing along the seaward side of the boardwalk was removed for aesthetic purposes, allowing the dune crest to be exposed at the boardwalk edge.

Trash pickups and beach raking is done as needed in the winter and daily from May through October. The Department of Public Works, along with other paid employees, do a

small percent of the trash pick up by hand. The majority of the beach cleaning is done by mechanical raking.

Replacement planting is done by the Department of Public Works in order to stabilize the dunes. The Environmental Commission is no longer involved with regular dune maintenance therefore the questions designed for the Environmental Commission were answered by the Department of Public Works. No organized vegetation plantings are conducted. Most of the plantings are done in the spring on a replacement basis only. The only type of vegetation planted in Belmar is *Ammophila brevigulata,* suggested to the Department of Public Works by Church's Nursery. The nursery sells vegetation to the community and recommends densities and patterns for planting. The *Solidago sempervirens* that grows in the dunes occurs naturally occurring.

According to the Zoning Officer, the First Avenue Bird Nesting Area was created through a federal grant 25 years ago. Birdsall Engineers (who are also responsible for the Masterplan) assisted the community in the design of the area (McMann, 2001). The Department of Public Works does little maintenance to this section of the shoreline except to replace fencing. This section of the shoreline is not raked or cleaned regularly.

4.2 Spring Lake

4.2.1 Physical Characteristics

The shoreline at Site 5 (Figure 15) is oriented northeast/southwest. The distance from the berm crest to the dune toe is 64.5 m. The dune width is 30.0 m and the height above the back beach is 1.25 m. The dune backs up to Ocean Avenue. There is no storm fence at the toe. The dune is heavily vegetated with *Rosa Rigota* and *Ammophila breviligulata* that reaches a maximum height of 1.0 m. The vegetation varies between the three sampling points. The vegetation coverage on the dune is greatest on the crest with 5 plants per 0.5 m^2 and least on the landward side with 3 plants per 0.5 m^2. The seaward side has 4 plants per 0.5 m^2. The wrack line is 36.5 m from the dune toe. The dune toe lies under the elevated boardwalk which allows for aeolian transport under the boardwalk.

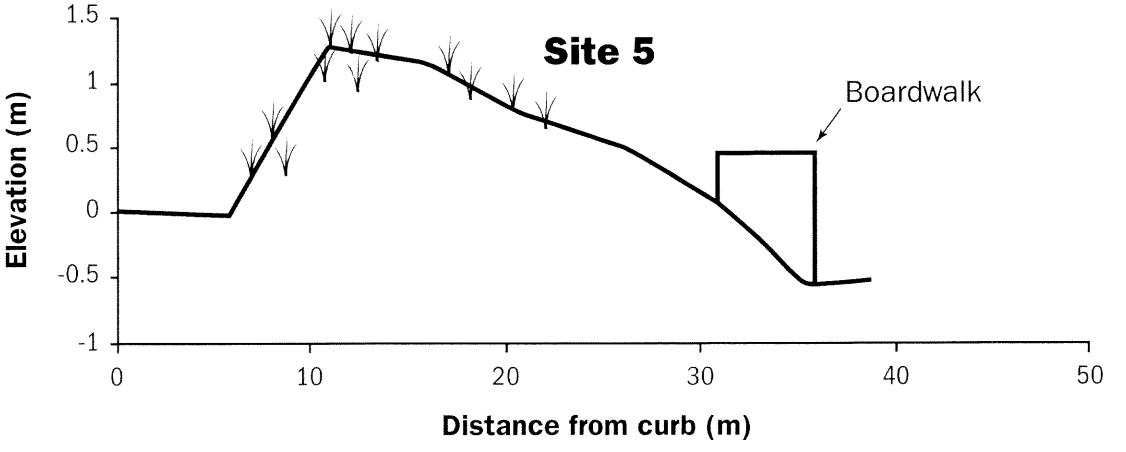

Figure 15 Dune profile at Site 5. The 0 m elevation represents the top of the curb.

The shoreline at Site 6 (Figure 16) is oriented northeast/southwest. The distance from the berm crest to the dune toe is 64.5 m. The width of the dune is 42.0 m and the height above the back beach is 2.1 m. The wrack line is 63.0m from the dune toe. There is an elevated boardwalk which allows for sediment transport under the boardwalk. The dune is heavily vegetated with *Ammophila breviligulata, Rosa Rigota* and *Solidago sempervirens.* The vegetation density varies between the seaward and landward sides of the dune. The landward side is densely vegetated. The seaward side has no vegetation while the crest has 4 plants per 0.5 m^2. The maximum vegetation height is 1.5 m. The dune has no fencing.

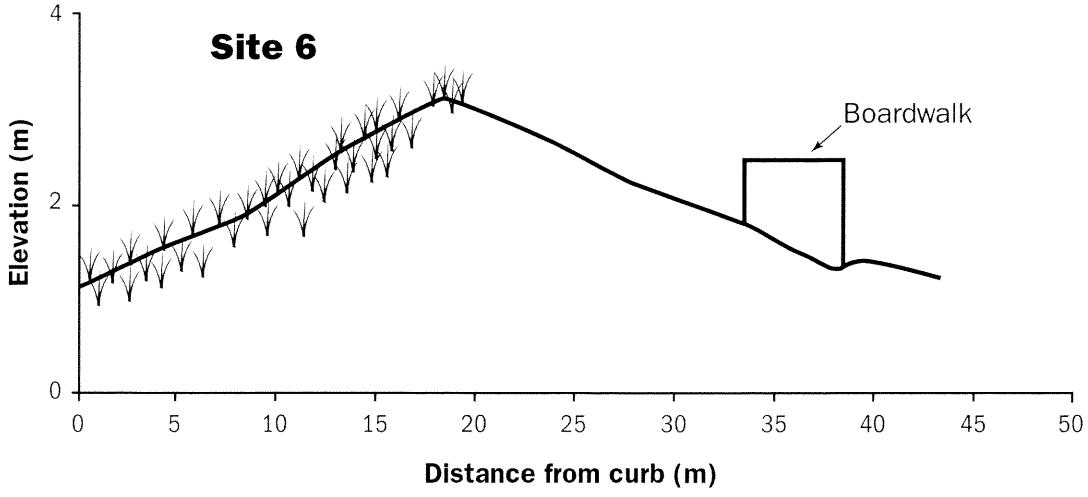

Figure 16 Dune profile at Site 6. The 0 m elevation represents the top of the curb.

4.2.2 Local Controls

The town of Spring Lake has a comprehensive dune ordinance and is similar to the dune ordinance in Belmar. Spring Lake's dune ordinance defines 'dune areas' and recognizes that the boundaries of the 'dune areas' are not rigid. The 'dune area' may shift and migrate to new locations and these new locations are contained within the definition. (Borough of Spring Lake, 1998)

The second section of the ordinance includes provisions for natural vegetation. Natural Vegetation includes plants such as dune or beach grass, dusty miller, hudsonia, sea

rocket, seaside goldenrod, bayberry or beach plum and other plants which normally grow or may be planted in the "dune areas" (Borough of Spring Lake, 1998).

The third section, entitled Prohibitions, states that no person, firm or corporation shall place any structure or object of any kind within the "dune areas," trespass by foot, operate bicycle or motor vehicles remove or destroy the natural vegetation, sand fences, or other types of dune protective devices in the "dune areas" (Borough of Spring Lake, 1998). Exceptions are for officers and employees of the Borough and other authorized personnel to enter into and upon the "dune areas" for the purpose of maintenance, repair, restoration and planting in order to preserve and protect the "dune areas."

4.2.3 Interviews

There are no privately held beaches in the community. All dunes are on public beach. The dunes were built for hazard mitigation and to prevent beach erosion after the 1992 storm. Since the building of these dunes, there has been no attempt to revise the community's dune policies. There are plans to add dune management to the new community master plan (Kirk, 2001).

Plantings are done, by Eagle Scouts and other volunteers, as needed in order to stabilize the dunes. Information on types of species to plant and density of plantings is provided by the Environmental Commissioner's son who studies landscape architecture at Rutgers. The vegetation is purchased near Trenton. The Environmental Commissioner is not provided with guidelines or recommendations by any government agency (Burke, 2001). The Environmental Commissioner indicated that although the Commission does not oversee the vegetative plantings, they try to enforce no trespassing on the dunes which could destroy the vegetation.

The Spring Lake Department of Public Works are responsible for dune building and maintenance (Weinmiller, 2001). There are guidelines for dune management but the department does not necessarily follow them. The boardwalk, managed by the Department of Public Works, was originally built in the 1930s. The structure was destroyed numerous times but never relocated. Trash pick-ups are done once a week. Fencing is laid out but

with no recommendations from any outside agency. The winter storm fences are placed 50-60 feet from the boardwalk with enough room for the Department of Public Works machines to get through. There is no protocol for post-storm dune restoration. Each year the Department of Public Works excavates sediment from under the boardwalk and replenishes the beach by placing it in a mound on the backbeach. This practice is continued because it has been done in previous years.

4.3 Sea Girt

4.3.1 Physical Characteristics

Site 7 (Figure 17) extends onto private property. The shoreline is oriented northeast/southwest. The distance of the berm crest to the dune toe is 77 m. The dune width is 17 m and the height of the dune above the backbeach is 1.9 m. The wrack line is 125.4 m from the dune toe. Since the dune backs up to the private property line, the development line is the row of beachfront homes. There are two dunes in this dune field that are vegetated with *Ammophila breviligulata* and *Solidago sempervirens* which stand at a maximum height of 0.4 m. The vegetation coverage is greatest at the crest which has 8 plants per 0.5 m^2. There is no vegetation on the seaward side. The landward side of the dune has little vegetation. Vegetation density is 2 plants per 0.5 m^2. The boardwalk is elevated allowing for sediment transport underneath.

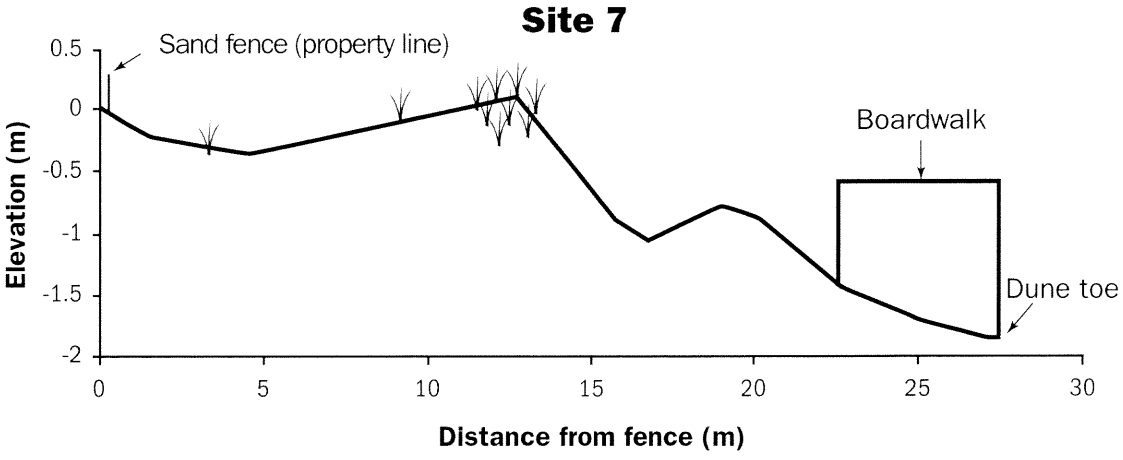

Figure 17 Dune profile at Site 7.

4.3.2 Local Controls

In Sea Girt, the dune ordinance defines the 'dune area' as that area between the seaward edge of the dune and the landward edge of the dune in order to protect the shoreline against erosion (Borough of Sea Girt, 1985). Dune areas will be delineated by appropriate signs prohibiting traffic and warning of prosecution of violations. The beach/dune area are considered to be dynamic and not capable of rigid definition or delineation, or of completely firm stabilization. Dunes can and do migrate, so that particular sites, at one time free of dunes, may, as a result of natural forces, become a part of the dune area declared to be in the interest of the Borough to protect (Borough of Sea Girt, 1985).

Natural Vegetation is defined as such plants as beach grass, dusty miller, hudsonia, sea rocket, seaside goldenrod, bayberry or beach plum which normally grow or may be planted on the slopes of dunes or behind them; no distinction is to be made as to how such plants are introduced into their location (Borough of Sea Girt, 1985).

Additionally, no one shall place permanent structures or objects of any kind on the beach or in the dune area, remove or destroy the natural vegetation, sand fences or other protective devices or redistribute sand on the beach and dune. Any residential structure or accessory building damaged, destroyed or in need of repair may be repaired or replaced on the original foundations with no increase in building coverage, height or gross floor area and subject further to the provision of the Borough (Borough of Sea Girt, 1985). Exceptions to the prohibitions include the construction of pathways or walkways providing beach access. Violations of these provisions shall be met with fines and possible imprisonment

The Ordinance states that property owners abutting the Sea Girt Beach, between Trenton Boulevard and New York Boulevard must apply for an application, to construct an erosion control structure such as a seawall, bulkhead, or similar permanent structure, in the dune area. Only one access point is permitted across the dune area for each residence and all applications for construction in the dune areas shall be reviewed by the Borough Engineer. One of the purposes of this Ordinance is to ensure that adequate restoration, enhancement

and maintenance of sand dunes located seaward of any oceanfront erosion control structures is achieved and the highest practical height of such sand dunes is maintained. Therefore, no dune shall be directly or indirectly lowered or reduced in height by the action or inaction of any owner (Borough of Sea Girt, 1994). Moreover, if the height of the dune shall become lower than the elevation deemed materially significant by the Dune Inspector, and the bulkhead or seawall becomes routinely exposed, the owner thereof, shall be obligated to install such sand fence and plantings as may be prescribed by the Borough Engineer. It becomes the owner's responsibility to replace and maintain fencing and vegetation. If the dune is lowered or caused to be lowered by the direct or indirect action of any owner, then the dune shall, upon due notice to the owner, be restored to its immediately pre-existing elevation by the owner or at his expense (Borough of Sea Girt, 1994).

According to the Borough of Sea Girt Zoning Ordinance, single family residences have strict regulations for lot coverage, building height (maximum 35 feet) and accessory buildings. It is not clearly indicated whether the beachfront homes along Morven Terrace have stricter regulations for land use than the inland residences. Construction and Zoning ordinances in the Borough of Sea Girt address construction without regard to the location of these residences (beach front properties or more inland residences). Landscaping and vegetation is not regulated for any private property.

The residents of Morven Terrace are a private group of homeowners in Sea Girt who came together to create the Morven Beach Association. The Richard Stockton College of New Jersey Coastal Research Center was contracted by the Morven Beach Association to develop a dune management plan, and provide the necessary guidance during dune construction. The Research Center developed a basic management plan consisting of erecting and maintaining fences and vegetation to establish a primary dune (Farrell, Stewart &, Lepp, 1998). The plan recommended fencing along the seaward, landward, and side yard borders of the project area and planting and maintaining an indigenous beach grass stand once a primary

dune area had been established (Farrell, Stewart, & Lepp, 1998). The suggestions for fence layout and vegetation are the same as other primer for dune building.

4.3.3 Interviews

In Sea Girt, only replacement plantings have been conducted since the dunes were built in 1992. Sea Girt has no dunes seaward of the boardwalk. The only beach with dunes designed by the Department of Public Works are located at the Sea Girt Lighthouse (Brisbon, 2001). No recommendations or guidelines for vegetation plantings have been made by any government agency.

Sea Girt Department of Public Works does not mange dunes in Sea Girt since there are no permanent dunes along the boardwalk. The Department of Public Works manages the boardwalk which has been destroyed two or three times since the 1970s when it was relocated about 20 ft. to the west. When the boardwalk is taken apart, the sand is swept out and relocated onto the back beach once a year. This procedure keeps sand from building up under the boardwalk. Trash pick-ups are regularly done in the summer by the Beach Department.

Sea Girt is the only community in which the zoning regulations were reviewed since it is the only municipality with private property abutting the beach. There is no local management or incentive for dune building through the zoning officer (Ratz, 2001). The primer available to the Morven Beach Association assists residents with ideas and planning for hazard mitigation. The master plan currently does not recognize dunes but the plan is in the process of being revisited.

4.4 Manasquan

4.4.1 Physical Characteristics

The shoreline orientation of Site 8 (Figure 18) is northeast/southwest. The distance from the berm crest to the dune toe is 41.7 m. The dune backs up to a paved boardwalk and sand is blown across the paved walk onto private property. The width of the dune is 13 m and the height of the dune above the back beach is 1.5 m. The linear dune is vegetated with *Ammophila breviligulata* and *Solidago sempervirens*. Vegetation coverage on the crest is 10 plants per 0.5 m^2. The landward side of the dune has less coverage (2 plants per 0.5 m^2). The seaward side of the dune has no vegetation. The maximum height of the vegetation is 0.8 m and the wrack line is 10.7 m from the dune toe.

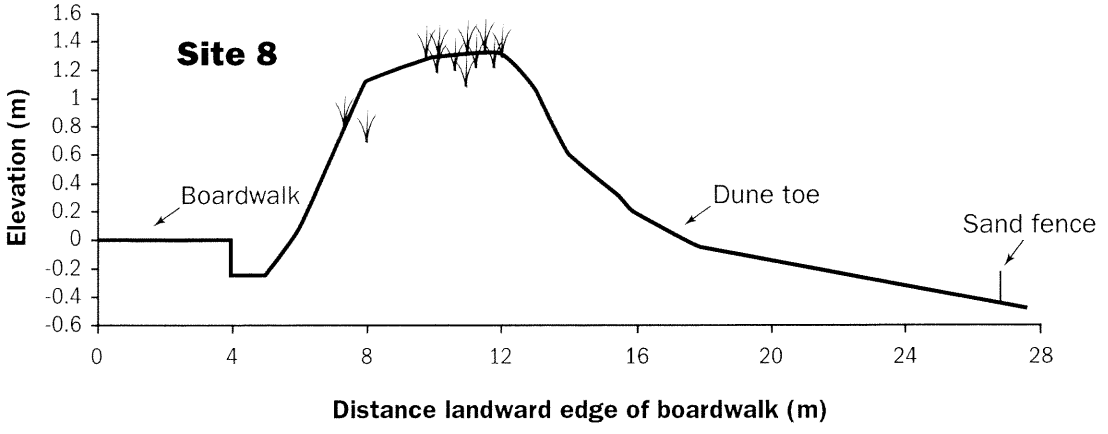

Figure 18 Dune profile at Site 8. The 0 m elevation represents the landward edge of the boardwalk.

4.4.2 Local Controls

The masterplan currently recognizes dunes with the goal of hazard mitigation. The Dune Ordinance defines the dune as a wind or wave deposited formation of vegetated or drifting wind-blown sand, generally parallel and landward between the inland limit of the beach and the foot of the most inland dune slope, including primary, secondary, and tertiary dunes where they exist. Formations of sand immediately adjacent to beaches that are stabilized by retaining structures, such as sand fences, planted vegetation, and other measures are

considered to be natural dunes, regardless of the degree of modification of the dune by wind or wave action or disturbance by development (Borough of Manasquan, 1989). The ordinance identifies the area where dunes could migrate as the Dune Development District (DDD) and defines the district as an area located seaward of the boardwalk delineating a beach zone presently without dunes. The width of the Dune Development District (DDD) will extend an average of 50 feet from the boardwalk line toward the ocean. Placement of fencing and planting of vegetation will be completed in an effort to trap wind blown sand and develop a dune. The DDD is considered to have dynamic boundaries which moves in response to seasonal winds and storms. The boundaries of the DDD will be reviewed every twelve months and following any storm that damages large portions of the district.

Activities which are prohibited in the dune area or Dune Development District are operation of motor vehicles, removal of sediment and native vegetation, placement of non-living trees, brush, shrubs or other debris, pedestrian traffic on or over dunes or sand fencing, and removal, mutilation or destruction of sand or sand fencing unless removal is part of an authorized dunes maintenance activity (Borough of Manasquan, 1989). Landward of dune areas, property owners may remove clean wind blown sand, which must be deposited eastwardly of the property line and beach walkway (Borough of Manasquan, 1989).

According to the Manasquan Zoning Ordinance, single-family residences have strict permitted activities. Construction of building accessories such as garages, fences, walls, satellites, and any amenities serving the resident must be approved. It is clearly indicated that building height is restricted to 35 feet for beachfront property as well as inland residences. The zoning provisions do not regulate landscaping or vegetation for beachfront properties or inland properties. The area landward of the Dune Development District beyond the boardwalk is zoned for single-family residences.

4.4.3 Interviews

Manasquan dunes were established after the 1992 storm along with paved a boardwalk, which is managed by the Beach Department. Dune plantings are done annually, with supervision of the Department of Public Works and Beach Department, to stabilize the dunes (Coder, 2001). Local inmates are supervised by the Department of Public Works to do the planting. The vegetation is purchased at Church's Nursery. *Ammophila breviligulata* is the only vegetation planted and other vegetation is discouraged. The Beach Department is currently seeking guidelines and recommendations from governmental agencies for further assistance on vegetation and management (Hemphill & Bloomenstock, 2001). The dunes were designed using FEMA guidelines.

Since 1992 the dunes have grown and become a problem for beachfront residents. The unanticipated height and migration of the dunes have forced the Department of Public Works to skim down the landward side of the dune in order to keep it from taking over the boardwalk and destroying two gazeboes. Recommendations have been made to the Department of Public Works by Stew Farrell from the Richard Stockton College of New Jersey Coastal Research Center for Dune Management.

Results Summary:

1. All communities built dunes as part of local hazard mitigation planning in response to the 1992 storm.
2. All communities have characteristics of a highly developed coast and face extensive physical constraints for dune growth and mobility.
3. All communities have local documents addressing dunes. All communities have specific dune ordinances which address vegetation and restricted activities.
4. In each of the communities the Department of Public Works has the most direct influence over the daily management activities of the beach and dune system.
5. All communities purchase their vegetation from Church's Nursery. Each of the interviewees alluded to a place near Trenton or specifically named Church's Nursery, except for Sea Girt that has not purchased vegetation.

CHAPTER 5

DISCUSSION

5.1 Discussion of Results

The results of this study indicate that local land use planning in these communities evolved from a focus on post-disaster recovery. Dunes were established for storm protection in response to the 1992 storm, with the help of a nourishment project in 1997. Unfortunately, daily management and maintenance activities do not promote the goal of hazard mitigation. Management activities in these communities are based on seasonal recreation and tourism. For example, beach raking and other cleaning operations which hinder dune growth are continually utilized.

Federal and state governments play a role in setting ground rules for mitigation and enabling communities to deal with the complex land use problems involved. Local governments are the driving force. There are various ways communities can reach their determined goals but regardless of the plan developed it must be a strategy employed by the community (Godschalk, Kaiser, & Berke, 1998). Policy development depends on many actors, including agency personnel, professional associations, and civic organizations. Sustained interaction and communication among participants is important in helping to define issues, develop solutions, and bring them to the attention of others (Burby, 1998).

The interviewees from each community do not communicate with each other or exchange information through activities in their respective community or their counterpart in the neighboring borough for best management practices. These municipalities have not coordinated strategies with each other or within a larger regional context. Municipalities who share a natural resource can work together to coordinate comprehensive mitigation strategies. It is clear that although suggestive management practices are available from government and academic sources, they are not being utilized to their fullest extent. Municipalities do not actively seek out better management ideas or recommendations from either state, county

or academic resources. Guidelines and recommendations from government and nongovernmental agencies are available and consistent but localities are not readily adopting them. Documents from outside the community with general guidelines that lack specification for individual communities often fail because they do not recognize the constraints that communities face.

Interviews conducted reveal that the construction/zoning officials view their dunes as a means of protection of public infrastructure, specifically the boardwalk. It is also clear that the zoning and construction guidelines do not necessarily meet the needs of the community in terms of prohibiting development, regulating certain land use activities or promoting dune development. Although these documents make an attempt to preserve dunes in their existing size and location they do not address the growth of dunes or surrounding land use. The language of the local documents speak to the management of a dynamic dune, yet daily activities are not consistent with this goal. For example, the Department of Public Works continually sweeps sediment from the boardwalk which has blown off of the crest of the dune. This management activity is inconsistent with the dynamic definition adopted by the communities in their ordinances. These dunes are clearly managed as static structures although their local documents speak to the management of a dynamic dune system. Designing management strategies to incorporate geomorphic features may seem axiomatic to geomorphologists, but this concept is often lost on municipal managers who have historically used static structures to stabilize the shoreline (Nordstrom, Jackson, Bruno, & de Butts, in press).

It is clear that the daily maintenance practices of the Department of Public Works who have the greatest influence over the beach dune systems are working toward the goal of recreation and tourism with little focus on the integrity of the dunes for hazard mitigation or ecological conservation. It is clear that the Department of Public Works' primary objective is managing the beach for summer recreation. Clean, wide, spacious beaches and aesthetically pleasing dunes for the summer tourists are the goals of current beach and dune management activities.

Effective dune management depends on an integrative approach including the Zoning/Construction Office, Environmental Commission, Department of Public Works, and local citizens. Results from this study suggest the role of the Environmental Managers or Commissioners is restricted. The Environmental Commission has little to no interaction with the management of the beach or beach/dune system. The role of beach maintenance is almost completely determined by the Department of Public Works. Moreover, none of the communities expressed a significant interest in managing their beach or dunes for environmental purposes (i.e. habitat). If the Environmental Commissioner were the lead official in the management of the beach and dune system, the goal of hazard mitigation could be compromised by the goal of environmental preservation and habitat renewal. Clearly, meeting the goals of hazard mitigation as well as promoting environmental purposes is a comprehensive and integrative agenda. Neither the Department of Public Works nor the Environmental Commission should be a leader but instead a process of decision making whereby the goals of all stakeholders can be met is ideal.

At the First Avenue Recreation and Bird Nesting Beach in Belmar, the beach was designed to promote nesting of osprey and other recreation activities (i.e. fishing and exercise). Although the Department of Public Works does not rake the wrack line, there is no monitoring of birds or upkeep of previously installed fencing. Additionally, there is no local management for this section of beach or encouragement from the state to preserve this space for environmental purposes such as promoting habitat for endangered species, or beach recreation.

Beach and dune survey results indicate that these municipalities are faced with extensive physical constraints. The section of coast considered in this study is highly developed and leaves little space for dune migration. It is clear that these dunes are being managed not as migratory features but as static structures. In all four communities, the landward side of the dune is significantly restricted by a boardwalk or street curb. Topographic surveys indicate, although each community claims to manage their dunes for hazard mitigation purposes, all four communities have distinctly different dune forms. For example, the dunes are small and stabilized in Belmar.

Dune growth is inhibited because of the extensive reliance on summer recreation and tourism. Therefore activities which promote these values take precedence over dune building activities. In Spring Lake, the dunes are much larger and vegetated because the community appreciates the aesthetics and depends less on seasonal tourism. In Manasquan, the dunes are high in elevation in order to protect beach front homes but their size spurred controversy and adversity because the dunes obstruct views of the ocean.

As indicated in the primers and other dune building guidelines, successful dune management includes space on the landward side for dune migration, vegetation as a means of stabilization, proper fence layout and specific prohibited activities (i.e. trespassing, motor vehicles). The above suggestions are not being followed to the degree needed for protective dunes in the four communities. Additionally, topographic results suggest that these dunes have little to no diverse vegetation and fence layout seems to strive for prohibition of trespassing, not further dune development or growth in terms of volume of sediment for significant storm protection.

Primers and dune building documents are available to the municipalities but are not highly publicized. In Belmar, a primer for storm response was identified but wide distribution does not seem apparent and there is no indication that the use of these primers are encouraged by all stakeholders or officials. The primers are identical in substance which forces the communities to reject all of them if one does not apply to their specific needs. The primers are a genuine guideline to building dunes but do not address the structure of implementation. They focus only on the construction end of the process and not on the local infrastructure needed to execute and maintain the dunes once the dunes are built.

Local documents in most of the municipalities are substantially vague. Although all of the communities have ordinances which address beach and dune protection in terms of prohibiting immediate destruction, other documents which have greater long term influence on the dunes lack specific land use regulations.

Zoning and construction guidelines often do not significantly discuss the impact of landscaping, construction or impervious coverage. Furthermore, these documents do not differentiate between beachfront single-family residences and inland single-family residences. This lack of designation leads to the allowance of construction and other land use activities which can hinder protective dune development.

5.2 Suggestions for Further Action

The bulk of literature addressing local coastal management focuses on the theory of integrated coastal management, scientific studies of aeolian activity and analysis of state and national coastal policies. The study of coastal management as a whole lacks studies on the management obstacles, physical constraints and community issues which surround local management decision making. Understanding these variables and their influence is critical to understanding the success and failure of management activities on the local level.

In addition to the sparse information regarding local management activities and their obstacles, there is also little suggestive information as to how localities can begin to respond to hazards and then implement these plans over the long-term. Currently, primers discuss how to construct dunes but do not address the process of incorporating these strategies into the long-term mitigation plans of the community and how to integrate them into all aspects of local land use planning. Additionally, they don't address dune building for the diverse landscapes of a highly developed coast.

Ideally, primers would be an annual publication from a qualified source that include suggestions for outlines of local governmental structures, timelines for better coordination, dune building techniques for a diverse coast, and a source of information sharing between communities. Using these outlines, local governments can structure dune management by delegating specific responsibilities to the departments with the expertise to handle these tasks. For example, the Environmental Commissioner would lead the effort to manage dunes for ecological values, while the Zoning Officer would maintain construction codes and landscape

requirements to facilitate dune protection. Such an approach would help communities to have a more holistic approach in managing the coastal zone. Lastly, an interdepartmental commission should be established consisting of representatives from all departments involved in coastal zone management to ensure that all stakeholders involved are working together towards a common goal.

Timelines would be essential in coordinating efforts by all actors, including federal and state agencies. Timelines would also ensure that maintenance activities such as planting vegetation and fence replacement would work in concert with federal activities, namely beach nourishment. Timelines should also be part of a larger strategy for neighboring communities, who share this natural resource, to function in a more integrative and holistic manner.

Guidelines need to take into consideration the specific physical constraints of the community to whom it is provided. For example, if a community's only viable option is to construct dunes on the seaward side of it's boardwalk, the primer should describe how to build the dune incorporating a boardwalk, as well as the necessary management for that specific situation. Each community would receive a primer designed to handle it's specific landscape.

Finally, each primer should facilitate communication between similar communities and involved government agencies with a section dedicated to information sharing. Communities with similar beach and dune characteristics who subscribe to a particular version of the primer could share information and strategies about their management activities. This forum for communication could be shared throughout all levels of governmental coastal zone management.

APPENDIX A

DEPARTMENT OF PUBLIC WORKS INTERVIEW QUESTIONS

These are the interview questions asked of the Department of Public Works heads.

Department of Public Works

Belmar: Andy Merle

Spring Lake: Bob Weinmiller

Sea Girt: Phil Brisbon

Manasquan: James Coder

1. Where and when was the boardwalk originally built?
2. How many times was the boardwalk destroyed?
3. Was the boardwalk ever relocated?
4. Who manages the boardwalk maintenance?
5. What is the protocol for dune restoration after a storm?
6. Have the present dunes been effective hazard mitigation?
7. Are you required by the state to restore dunes? Are their any specific guidelines for rebuilding dunes?
8. Who is responsible for the rebuilding?
9. How often do you do trash pick-ups?
10. How old is the fencing around these dunes?
11. Who does the fence layout?
12. What guidelines do you follow for fence layout?
13. How is the placement determined if you have no specific guidelines?
14. Does anyone else influence these layout decisions?
15. What types of goals are you trying reach with these fences?

APPENDIX B

ENVIRONMENTAL COMMISSION INTERVIEW QUESTIONS

These are the interview questions asked of the Environmental Commissioners.

Environmental Commission

Belmar: Bud Doyle

Spring Lake: Mike Burke

Sea Girt: Peter Halace

Manasquan: Alice Hemphill & Jim Bloomenstock (Beach Department)

1. How often is the vegetative planting done?
2. Who facilitates the planting?
3. Does the Environmental Commission supervise planting? How long have you supervised these activities?
4. Are there any guidelines or regulations that you follow for planting?
5. How are the plant species chosen?
6. Where are the plants purchased?
7. Is there a specific density at which you are planting the vegetation?
8. What are your specific goals in vegetating the dunes?
9. At any other times is the Environmental Commission consulted regarding vegetation?
10. Do you have any other involvement regarding the management of the beach/dune system?

APPENDIX C

ZONING OR PLANNING BOARD INTERVIEW QUESTIONS

These are the interview questions asked of the Zoning or Construction Officers.

Zoning or Planning Board

Belmar: Pat McMann

Spring Lake: Ron Kirk

Sea Girt: Sandy Ratz

Manasquan: Dick Fury

1. Are there any privately held beach or dune areas?
   - Do you have local regulations to manage those areas?
   - Do you have any influence over the types of landscape?
   - Can you encourage property owners to create/maintain dunes?
   - What are the incentives?
2. Does your master plan recognize dunes?
3. What goals do the master plan lay out to enhance or maintain dunes?
4. Why have these dunes been built at the present locations?
5. What was the original impetus for building dunes?
6. Have there been any attempts for more dune policies or ordinances?
7. Is there a budget for dune management?
8. Have you ever received funding from the state for dune building?
9. Have you had to follow any FEMA or CAFRA guidelines in order to receive funding?
10. Has FEMA or CAFRA influenced your dune management in other ways?

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