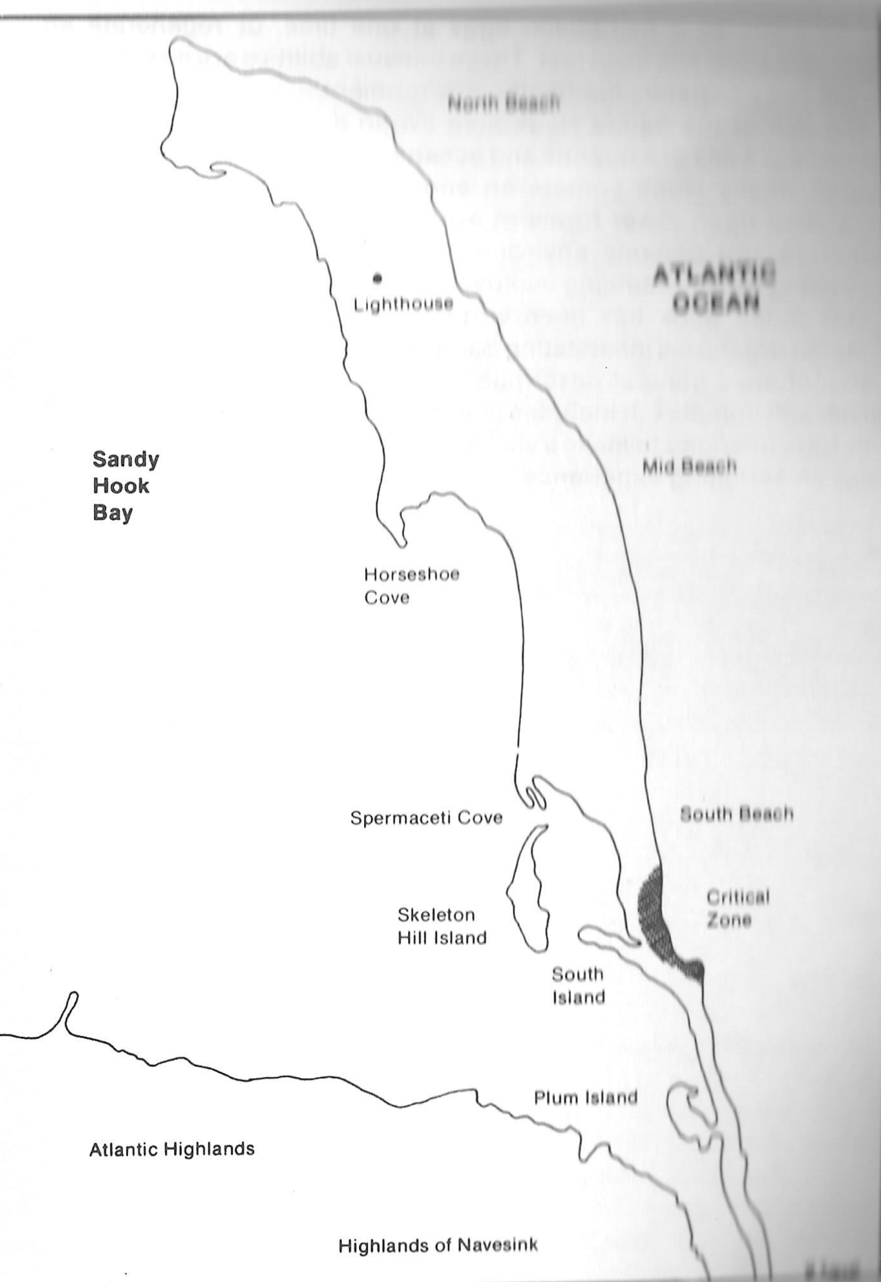


Sandy Hook as it appears at present.

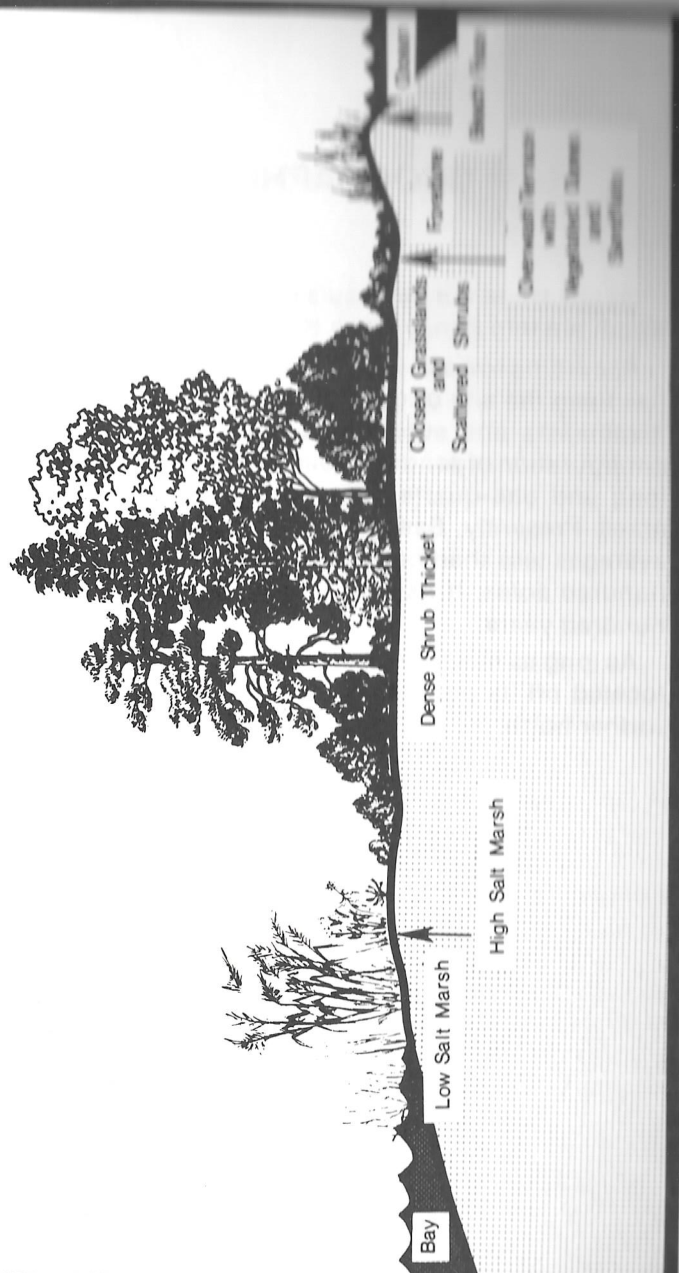
GEOGRAPHIC LOCATION

Sandy Hook is a peninsula extending from the barrier beach to the south out into Sandy Hook Bay.

According to a series of maps dating back to the 1750's, Sandy Hook has been the site of dynamic geomorphological changes. The early mapmakers and surveyors of the 1700's measured this hook-like configuration of sand and found its dimensions to be roughly one mile long and one-quarter mile wide, comprising about eight hundred acres. Presently, Sandy Hook measures almost six miles in length, averages less than one mile in width, and comprises some eighteen hundred acres. It has more than doubled in size in less than three hundred years.

As long as maintenance dredging of the Sandy Hook ship channel, located off its present tip, continues the peninsula will not migrate further north.

CROSS SECTION OF SANDY HOOK SPIT



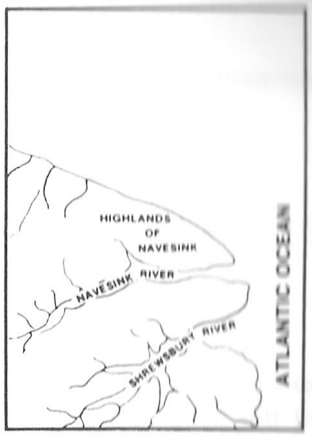
A BRIEF HISTORY

Centuries before European explorers discovered the new world, local Lenni Lenape Indians inhabited the eroding headland, later known as the "Highlands of the Navesink." The Lenape used the highland area for its prime hunting and fishing grounds, often visiting Sandy Hook for its natural resources.

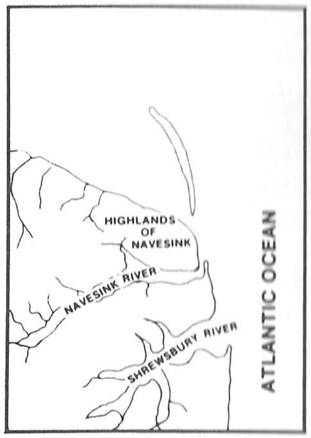
Using dried red cedar trees for dugout canoes, the Indians caught fish from the surrounding waters, while on shore they harvested clams and beach plums.

The English (1497), Spanish (1525), French (1542) and Dutch (1609) all claimed ownership of the northeast at one time or another. In December of 1663 settlers and commercial interests representing Holland and England claimed the Navesink Highlands-Sandy Hook Bay area. This claim, which included Sandy Hook, was not resolved until 1674 when England gained full control of the region. Finally, Richard Hartshorne acquired ownership in 1677, leasing the land from Sir George Carteret, English proprietor of eastern New Jersey. Sandy Hook came under control of the United States government through four transactions in 1790, 1806, 1817 and 1892-93.

During Sandy Hook's history it has functioned as a site for a lighthouse (1764), ordnance proving ground (1874), military installation (Fort Hancock, 1895), telegraph line (1854), railroad and steamboat terminus (1865), and marine fisheries laboratory (1961 to present). The present Coast Guard station was derived from the federally funded Life Saving Service established in 1849. In 1972 Sandy Hook became part of the Gateway National Recreation Area through an act of Congress.

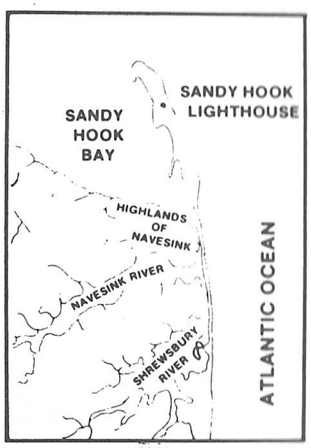


4000 yrs. before present time



1685

Geological History of the Sandy Hook Region
(After Moss, 1964)



1950

GEOLOGIC ORIGIN

Formation of the sediments of middle and southern New Jersey began during the Cenozoic Era. This Era is divided into two intervals: Tertiary, from 63 million years ago to one million years ago; and Quaternary, from one million years ago to the present.

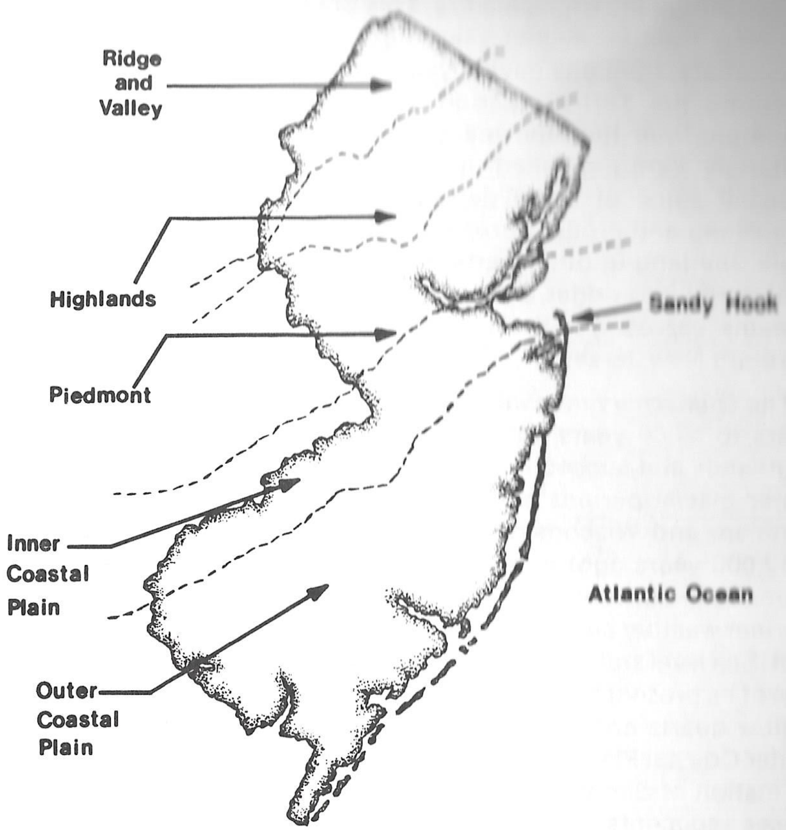
During the Tertiary period the oceans encroached upon and withdrew from the land many times. Gravel, sand, clay, and silty materials were deposited upon the land and as the ocean waters receded some of these deposits returned to the sea. While this depositing and eroding process was occuring on the Outer Coastal Plain, the land in other parts of the state was uplifted, eroded, and sculptured into ridges and valleys. Since the last uplifting, erosional streams carved out the present valleys and ridges now seen in northern New Jersey.

The Quaternary interval included a period of glaciation four million years to 5,000 years ago which affected the origin of the Atlantic Highlands and subsequently the formation of Sandy Hook spit. Four major glacial periods occurred, known as the Nebraskan, Kansan, Illinoian, and Wisconsin ice ages. The Wisconsin advance (35,000—12,000 years ago) is most recent and important to Sandy Hook's formation. Between successive ice advances, extended periods of warmer weather caused glacial recession and sea levels rose some 300 feet. Sea level stabilized approximately 4,000 years ago to within a few feet of its present height. During these interglacial periods, patches of yellow quartz and gravel were deposited on parts of the Inner and Outer Coastal Plains, providing a sedimentary source for the eventual formation of Sandy Hook and the barrier beach chain to the south. These sediments were initially deposited from New Jersey's coast out to the edge of the Continental Shelf, presently 90 miles offshore.

A belt of hills separates the Inner Coastal Plain from the Outer Coastal Plain. These hills extend in a southwesterly direction from the Atlantic Highlands (Highlands of the Navesink) overlooking Raritan Bay to the Delaware River lowlands in the southwest. The Highlands of the Navesink, which border the Shrewsbury and Navesink Rivers are remnants of a particular landform geologists call a cuesta. These cuestas on the Highlands of Navesink are made up of sand and gravel cemented together to form a rock-like cap on the headlands. Deposits of marl (glauconite — a clay-like limestone) are also found scattered throughout the headlands and down to the ocean's edge, and constitute another source of sediment for Sandy Hook.

Wind, wave, current and tidal action eroded the headlands (Highlands of Navesink) which projected into the Atlantic Ocean some 4,000 years ago. Since that time, the headlands have become more rounded because of the vast amount of sediments eroded away and transported

PHYSIOGRAPHIC SECTIONS OF N.J.
(After Widmer, 1964)



north along the coast (littoral drift). From the time sea level stabilized 4,000 years ago to the early 1600's, unconsolidated sediments accumulated into a split-like projection.

On Sandy Hook, the northerly-drifting sediment deposits are composed mainly of quartz, glauconite, calcium carbonate from shell fragments, magnetite, garnet, hornblende, muscovite, hematite, and organic materials. Deposits of these sediments during the spring and summer beach-building phases, accompanied by the transportation effects of wind and wave action, eventually caused Sandy Hook to curve westward, thus forming a hook-like projection of sand. As Sandy Hook continued to grow at its northern end, it left behind older hooks which formed coves on the bayside portion of the spit (e.g., Spermaceti and Horseshoe Coves). It is an excellent example of a dynamic barrier spit environment, becoming an island five times, twice attaching to the Navesink Highlands, and otherwise attaching to the barrier island to the south known as Sea Bright.

Secondary sediment sources responsible for adding to the sand buildup on Sandy Hook after its initial formation 4,000 years ago were provided by erosion of the Shrewsbury and Navesink River estuary systems which flow into Sandy Hook Bay. Buildup of sediment from these sources was limited by the lesser wind, wave and current energy on the bay side. Transported by river water, small-sized sediment grains, mud, clays, silt, and organic debris accumulated on the bay side of the Hook. In time, these river deposits, or mud flats, were exposed during low tide and eventually provided the substance for salt marsh development.

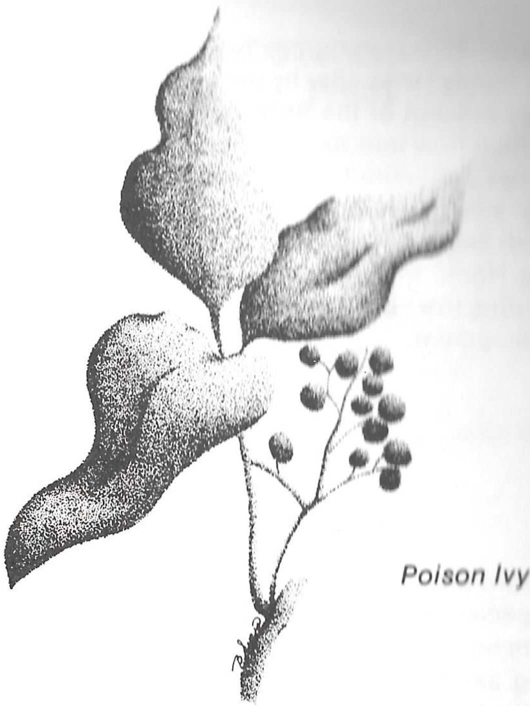
THE SAND DUNES

Long before the Indians began visiting Sandy Hook, birds of many different species made this strip their home. With them came seeds carried from the mainland, and vegetation began to grow and stabilize the shifting sands of the recurved spit. These plants were hearty varieties with deep, spreading roots, able to grow in substrates lacking humus-type soil and with the ability to withstand high salinities from salt spray, repeated burials, overwash, exposure to heat and sunlight, and limited fresh water.

Because growth and propagation were rapid, pioneer plants such as beach grass (*Ammophila breviligulata*) began to stabilize the beach above the high water mark. As these plants grew, sand grains were blown across the beach and trapped by the stems, burying the pioneer plants. But because grass grows rapidly, repeated burials enhanced the formation of a primary sand dune barrier, thus reducing erosion by the ocean waves. In times of extreme high tides (spring tides and storm surges), ocean water may breach this primary dune line and carry sand into the interior portions of the spit in a spreading projection known as an overwash fan. During intense storms accompanied by high winds and spring tides, entire sections of the spit may be submerged and sand deposited along the bayward side. In this way these overwash fans help widen and build up the interior portions of the spit.

As these dune plants die, their decomposing mass provides a nutrient base for new plant growth. These plants develop and, as the dune ridge stabilizes, a variety of thickets, shrubs, and eventually trees grow behind it. Beach plum, winged sumac, wild black cherry, eastern red cedar, holly, and poison ivy are the predominant species in the interior portions of Sandy Hook.

These trees and shrubs further stabilize the shifting sands and are well adapted to this seashore environment.



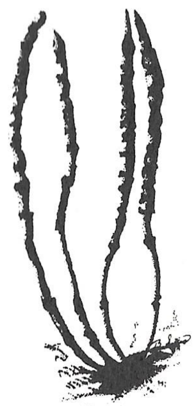
Poison Ivy

THE MARSHES

Salt marsh development on the bay side of Sandy Hook began in much the same manner as dune grass development did on the ocean side. Seeds, deposited from the mainland by drifting sands and birds, established themselves on the mud flats exposed above low tide level. Nutrients for salt marsh plants are then brought in by the incoming tides and waste materials are removed by the outgoing tides *(see below).

Sandy Hook contains both salt and fresh water marshlands, the latter being found in the interior of the spit. Fresh water for the interior marsh area comes from rainfall and subsurface springs, which are beneath all barrier islands. Due to these water reserves, freshwater marshes can maintain themselves through periods of drought and therefore survive the coastal environment.

Sandy Hook marshes comprise about 210 acres on which grow a variety of species. The low marsh areas above the low tide level are dominated by cordgrass (*Spartina alterniflora*) which help stabilization by preventing serious erosion from receding tides. In the high marsh areas salt hay (*Spartina patens*) abounds, accompanied by rushes (*Juncus roemerianus*), saltwort (*Salicornia virginica*), and orache (*Atriplex arenaria*) which in turn stabilize and expand the marsh.



Saltwort

Spartina patens - Salt Hay

Spartina alterniflora - Cordgrass

Seaside Golden Rod

*Fresh and salt marsh areas found on Sandy Hook serve as feeding and breeding grounds for a great variety of waterfowl, birds, and small animals.

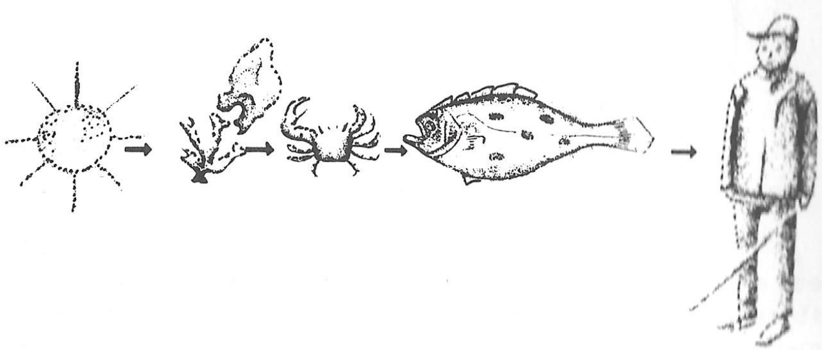
THE ESTUARINE SYSTEM

An estuary is defined as an area in which fresh water meets and mixes with sea water. At Sandy Hook, the Shrewsbury and Navesink Rivers (both fresh water) flow into Sandy Hook Bay (salt water), creating the estuarine system adjacent to Sandy Hook. The densities of these two water masses differ greatly: 1.00 gram per cubic centimeter (g/cm^3) for fresh water; 1.024 to 1.027 g/cm^3 for sea water. Fresh water, because it is lighter, lies on top of the salt water. Between the two layers is an area of "brackish" water, or water that has a lower salinity. Sea water entering the bay and river areas moves under the fresh water in a wedge-like form commonly known as a "salt wedge." As the waters mix, some of the salt water rises to the surface, where it returns to the ocean. The mixing of the fresh and salt water masses recycles essential nutrients, plants, and animals back into the estuarine system, thus creating a rich "soup" in which animal and plant life can flourish.

During the course of a year, the amount of dissolved salt in the water (salinity) constantly changes. Variations in rainfall, evaporation, and land temperature affect salinity at Horseshoe Cove and in Sandy Hook Bay. In these areas salinity levels average 16-18 parts per thousand whereas sea water averages 35 parts per thousand.

Certain species of fish can tolerate large variation in salinity, while others cannot survive at levels which are too high or too low. Species such as striped bass (*Morone saxatilis*), weakfish (*Cynoscion regalis*), and menhaden (*Brevoortia tyrannus*) rely on the estuary's brackish water to raise their young. The Sandy Hook estuarine system provides a protected environment for them during the warmer months before they emigrate in the fall to the ocean.

Both free-swimming (pelagic) and bottom-associated (benthic) organisms live in the estuarine portion of Sandy Hook. These organisms are an essential part of the food chain.



LONGSHORE CURRENTS

When the prevailing southeasterly winds cause waves to strike Sandy Hook beaches, part of their motion parallel to the beach initiates a northerly longshore current. This longshore current causes sediments to move along the shore commonly called "littoral drift." The littoral drift moves more than 370,000 cubic yards of sand per year along New Jersey beaches. Loose beach sediments, removed by the force of water or by solution processes, can move back and forth many times and are constantly pounded by ocean waves. Once these sediments are ground fine enough by the ocean waves they are carried out and deposited on offshore sand bars.

It is this combination of tides, waves and currents that continuously alters Sandy Hook, and summer and winter conditions often create different beach profiles. Coastal currents are generally stronger in summer than in winter. Long ocean swells usually deposit sediments to build beaches, while short, steep, storm waves are more destructive, moving sand to deeper water. Thus, Sandy Hook beaches build up during calmer summer weather and erode in winter. Its profile is continually changing in response to variations of wind, current and sediment supply.

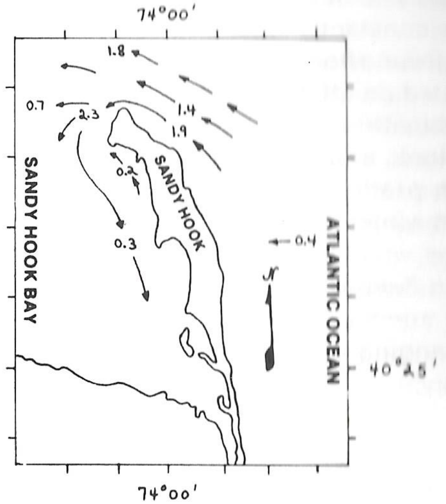
TIDES

Tides are the result of gravitational forces exerted on the earth by the sun and the moon. The sun, larger and much further away from the moon exerts only 0.46 times the amount of pull on the earth in comparison to the moon.

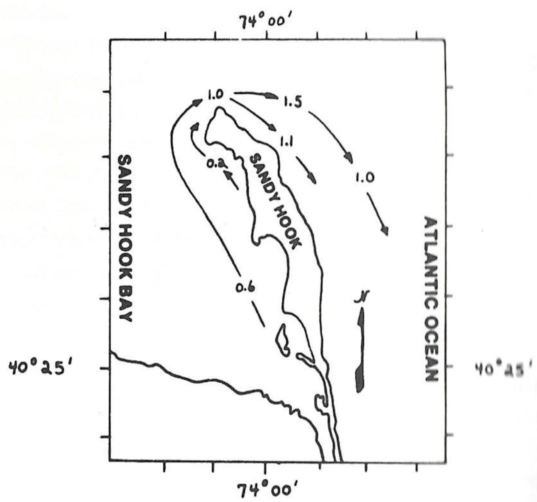
When the sun and moon are in a direct line with the earth, their gravitational pull is combined, producing higher (spring) tides. Sandy Hook's tidal levels have an average range of 4.3 feet, but in times of severe northeast storms which can produce strong surges along the coast, these tidal levels may reach as high as nine feet above normal. If these storm surges accompany spring tides, they conceivably could devastate the coastal environment.

Tide tables list the times of high and low tides for ports all over the world. These tables are compiled from tidal data recorded over the years at a particular port and have proved highly accurate. While Sandy Hook has two high and two low tides every 24 hours (diurnal tide cycle), some coastal areas have only one high and one low tide per day.

Tidal currents help transport fresh supplies of nutrients into the estuarine and salt marsh systems. Tidal currents flow out towards the ocean (ebb tide) or in towards the shore (flood tide). Ebb tides occur between high and low tide, with the maximum ebb current greatest one or two hours before low tide. At this point during a tidal cycle, the outgoing flow of water is concentrated in major ebb channels, which are usually bordered by salt marshes or mud flats. Likewise, flood tides occur between low and high tide, reaching a maximum velocity one to three hours before high tide. Maximum current speeds and flow directions for Sandy Hook are illustrated in the accompanying illustrations.



Current speed and direction in knots.
5 hours after low water. (NOS, 1977).



Current speed and direction in knots.
3 hours after high water. (NOS, 1977).

GREEN SEAWEED

Phylum: Chlorophyta

Green seaweed or algae ranges in size from microscopic to fifteen or more inches in length. There are over 7,000 species of green algae, thirteen percent of which are marine species. Many of these species cannot be properly identified without the aid of a microscope, but most forms found by Sandy Hook beach visitors can be identified quite easily on the basis of size, shape and location.

These seaweeds are grassy green due to a predominance of the green chlorophyll pigment. This pigment is found in all photosynthetic plants, including the brown and red algae species. Green seaweed plants need plenty of light to attain their color, and sometimes may be tinged with yellow, blue, and/or black.

Green algae are an important base in many biological food chains. The species can be safely consumed by humans, and are commonly seen along the Atlantic coast at high intertidal levels or in subtidal shallow waters.