History of Scientific Research for National Park Service Coastal and Marine Units

Volume II

Hilary Lambert Renwick

Technical Report NPS/NAR/OSS/NRTR-92/09

Department of the Interior
National Park Service
North Atlantic Region

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HISTORY OF SCIENTIFIC RESEARCH FOR NATIONAL PARK SERVICE COASTAL AND MARINE UNITS

VOLUME II

Hilary Lambert Renwick
National Park Service
Cooperative Research Unit
Rutgers-The State University of New Jersey

July 1992

National Park Service
North Atlantic Region
Office of Scientific Studies
15 State Street
Boston, Massachusetts 02109-3572

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On a park-by-park basis, we would like to thank the following people:

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Gulf Island National Seashore (GUIS)

Superintendent Jerry Eubanks; R.W. (Buck) Thackeray, former Assistant Chief Ranger (FL); Thomas Muir, Jr., Supervisory Interpreter (FL); and Theodore R. Simons, Research Biologist (MS).

Cape Cod National Seashore (CACO)

Superintendent Herbert Olsen; Jim Killian, Research Coordinator; Barbara A. Samora, Resources Management Specialist; John W. Portnoy, Staff Biologist; Michael E. Whatley, Historian and Naturalist; and Dorinda Partsch, Museum Curator.

Fire Island National Seashore (FIIS)

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Cape Hatteras National Seashore (CAHA)

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Cape Lookout National Seashore (CALO)

Superintendent Preston D. Riddell; Bill Springer, former Chief of Operations; Bob Patton and Skip Prange.

Cumberland Island National Seashore (CUIS)

Superintendent Kenneth Morgan; Dick Newgren, Chief Ranger; Kevin Kacer, former Chief Ranger; Don Hooker, Ranger, Interpretive; Bert Rhyne, Ranger and Library Curator, and Marcia Stout, Park Curator.

Cape Canaveral National Seashore (CANA)

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*We deeply regret that Clay Gifford passed away in the summer of 1985; we wish to acknowledge our appreciation for all the help and friendship he extended to our team members on their visits to Cape Hatteras.

THE BARRIER ISLANDS SCIENTIFIC RESEARCH BIBLIOGRAPHY PROJECT

Background

During the 1960's and 1970's, a series of National Seashores and National Recreation Areas were created by the National Park Service (NPS) along the nation's water boundaries. Unlike many of the more remote, traditional National Parks, many of these newer units are adjacent to or within major urban areas, and hence are subject to very heavy human use. In an effort to balance human and natural interests, the Center for Coastal and Environmental Studies (CCES), as part of its 1983 Cooperative Research Agreement with the NPS, in 1984 began an information-collecting project aimed at better resource management for the East Coast barrier island NPS units.

Purpose

For better resource management, the National Park Service needs a scientific data base. Much research of potential use to resource managers has been carried out in these parks, yet the results of this research have not been centrally located or coherently organized.

This project begins to fill the gap, by collecting published and unpublished research results from many fields of study, and providing a bibliographic guide to research and a narrative history of research for each park. As can be seen in Figure 1, seven NPS units were researched by the CCES group, and two by Morgan State University.

Methods

A team approach was used to review the wide-ranging literature appropriate to the parks. Research citations were obtained from over 100 journals and through library research carried out at each park and at regional and national NPS offices. Helpful park personnel provided responses to several research- related questionnaires. In addition, listings of aerial photographs, maps and charts were assembled for each park, along with information on any available computerized data bases.

Research citations were sorted into the following areas of research: Geology, Hydrology, Soils; Coastal Geomorphology; Vegetation; Invertebrates; Fish; Reptiles, Amphibians; Birds; Mammals; Estuarine Ecology; Cultural, Historical; Management, Legislation, Recreation, Miscellaneous; Bibliographies.

Library research for CACO, FIIS, GATE, CAHA, CALO, and CUIS was completed in December, 1984; library work for GUIS was completed in January of 1987. Incidental citations for the east coast parks are being taken as they are found, but should not be considered exhaustive from 1985 to the present. These citations will be added to the Volume I Bibliography only up until the time of final publication for each park. The computerized versions will allow the updating of any bibliography with new, or newly found, citations.

Products

The history and status of scientific research will be presented in two volumes for each of the parks:

Volume I: Bibliography of Scientific Research

These volumes provide a listing of scientific studies, published and unpublished, in standard bibliographic format. For NPS use they will be available on IBM computer diskettes as well as paper copy. General and specific keywords, title, author, etc. can be used for retrieval purposes. CCES retains an annotated, descriptive and evaluative summary for each listed citation.

Volume II: History of Scientific Research

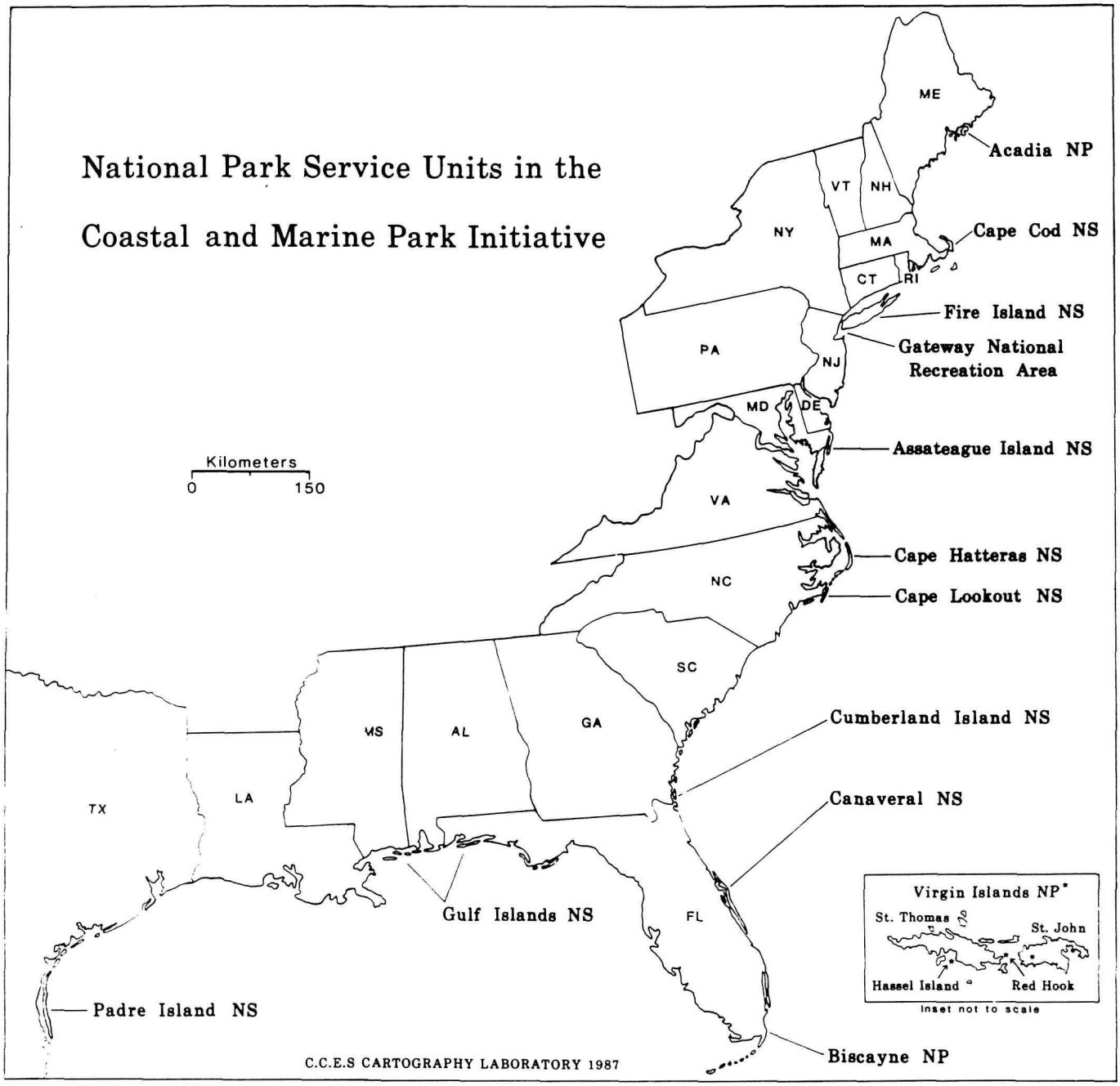
These volumes provide, first, a narrative history of scientific research in each park, organized by the categories listed above and incorporating the most significant research citations from each Volume I. Secondly, Volume II for each park provides a comprehensive listing of ongoing scientific research, environmental monitoring, and available park research facilities as of 1984.

In addition, Volume II contains a summary of maps, charts and aerial photographs available at the park and from other sources, a summary of computerized databases, and a listing of researchers, individuals, institutions, and agencies contacted in the compilation of this information.

Conclusions

This project's products will provide the basic scientific information base for any researchers working on East Coast and Gulf of Mexico barrier islands. It is hoped that these volumes will be a tool for use by both NPS resource managers and individual scientists.

Figure 1.


National Park Service Units in the
Coastal and Marine Park Initiative
ME
Acadia NP
VT
NH
NY
MA
Cape Cod NS
CT
RI
Fire Island NS
PA
NJ
Gateway National
Recreation Area
MD
DE
Assateague Island NS
Kilometers
0
150
VA
Cape Hatteras NS
NC
Cape Lookout NS
SC
MS
AL
GA
Cumberland Island NS
TX
LA
Canaveral NS
Virgin Islands NP*
St. Thomas
St. John
Hassel Island *
Red Hook
Inset not to scale
Gulf Islands NS
FL
Padre Island NS
C.C.E.S CARTOGRAPHY LABORATORY 1987
Biscayne NP

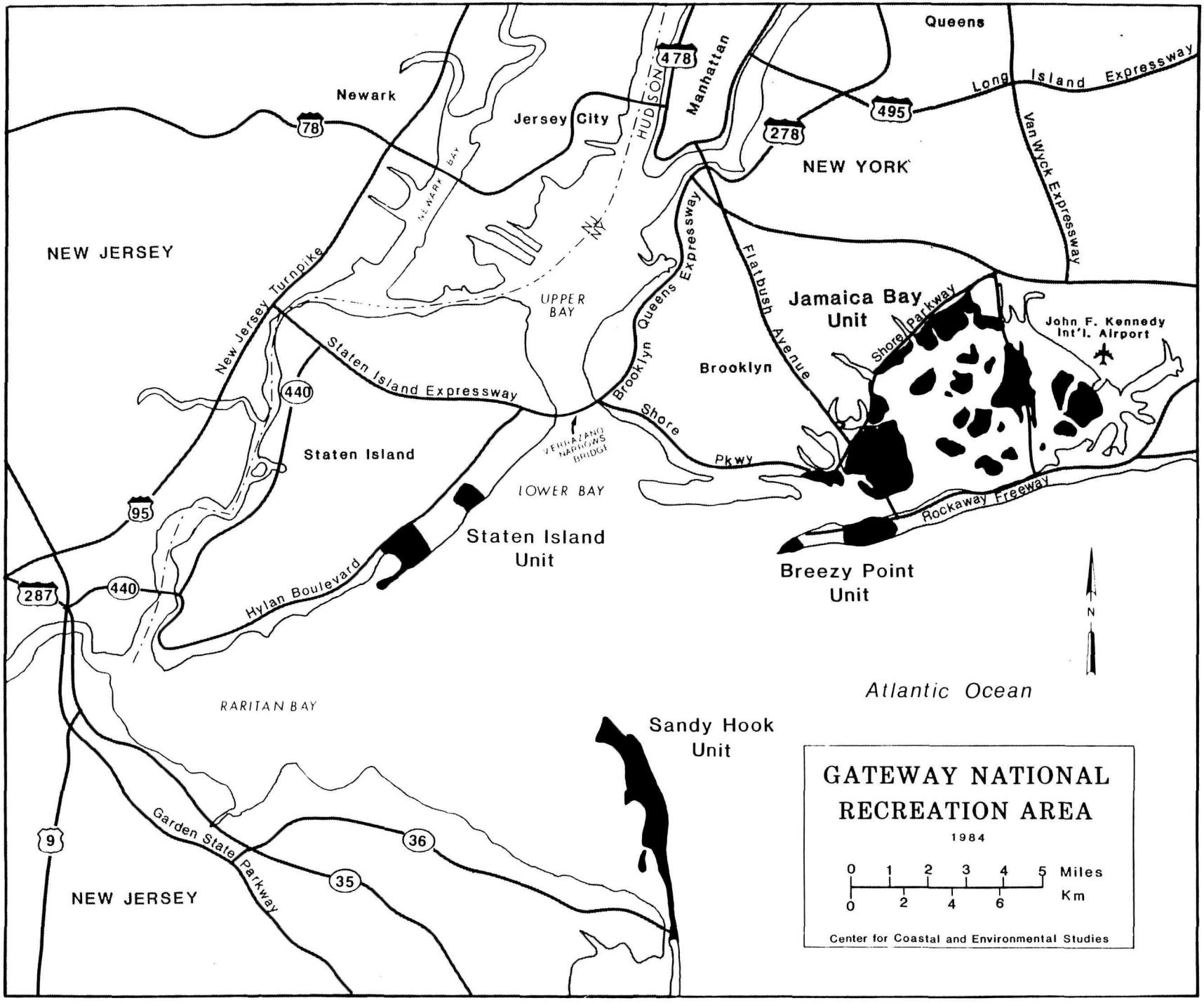

Newark
Jersey City
HUDSON
Manhattan
Queens
Long Island Expressway
Van Wyck Expressway
NEW YORK
NEW JERSEY
NEWARK BAY
NJ
NY
New Jersey Turnpike
UPPER BAY
Queens Brooklyn Expressway
Flatbush Avenue
Jamaica Bay Unit
John F. Kennedy Int'l. Airport
Shore Parkway
Brooklyn
Staten Island Expressway
Shore Pkwy
VERRAZANO NARROWS BRIDGE
Staten Island
LOWER BAY
Staten Island Unit
Rockaway Freeway
Breezy Point Unit
Hylan Boulevard
Atlantic Ocean
RARITAN BAY
Sandy Hook Unit
Garden State Parkway
NEW JERSEY
78
478
278
495
440
95
287
9
36
35
N
GATEWAY NATIONAL RECREATION AREA
1984
0 1 2 3 4 5 Miles
0 2 4 6 Km
Center for Coastal and Environmental Studies

Figure 2.

Figure 3.

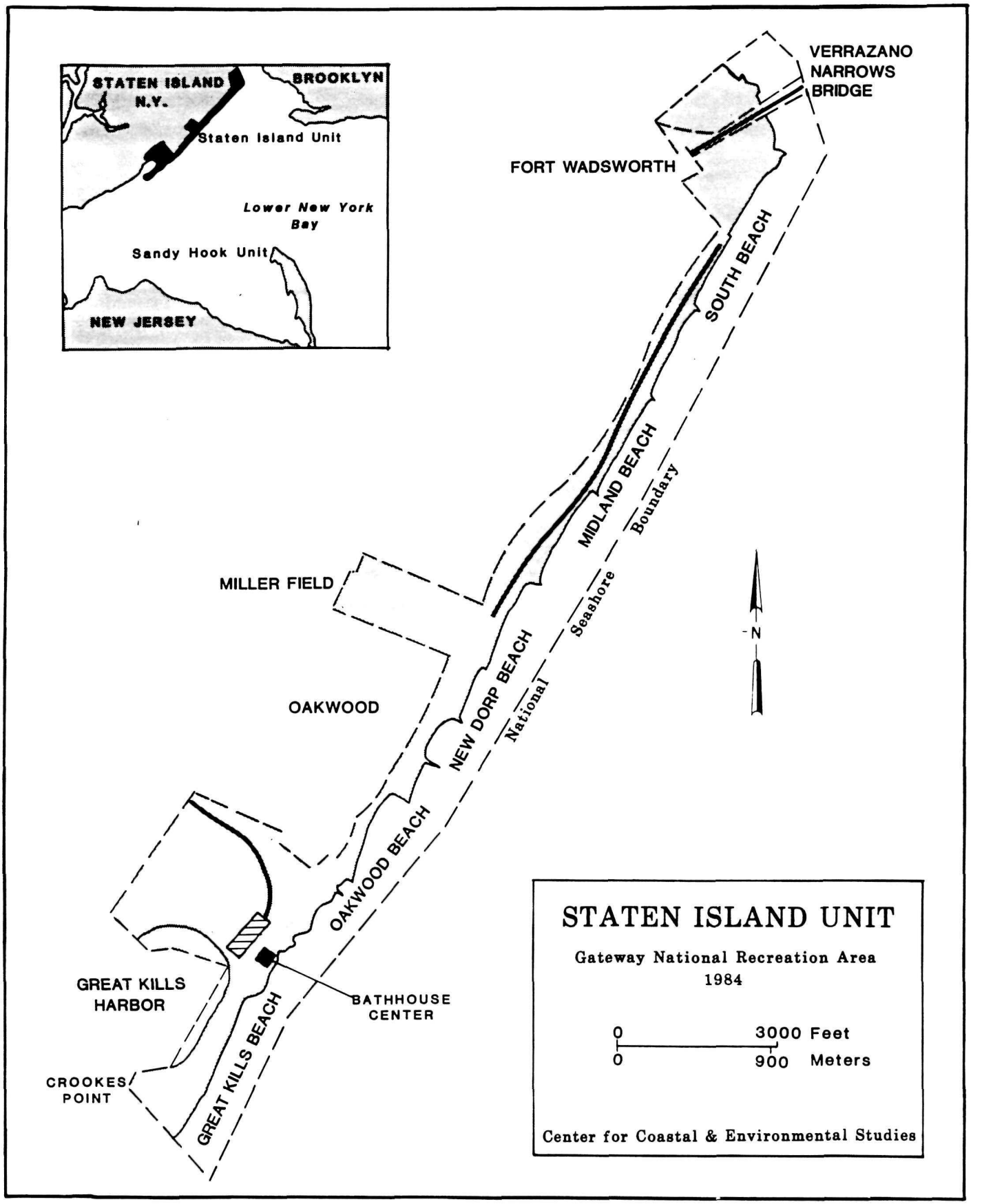

STATEN ISLAND N.Y.
BROOKLYN
Staten Island Unit
Lower New York Bay
Sandy Hook Unit
NEW JERSEY
VERRAZANO NARROWS BRIDGE
FORT WADSWORTH
SOUTH BEACH
MIDLAND BEACH
NEW DORP BEACH
OAKWOOD BEACH
GREAT KILLS BEACH
National Seashore Boundary
MILLER FIELD
OAKWOOD
GREAT KILLS HARBOR
BATHHOUSE CENTER
CROOKES POINT
N
STATEN ISLAND UNIT
Gateway National Recreation Area
1984
0 3000 Feet
0 900 Meters
Center for Coastal & Environmental Studies

Figure 4.

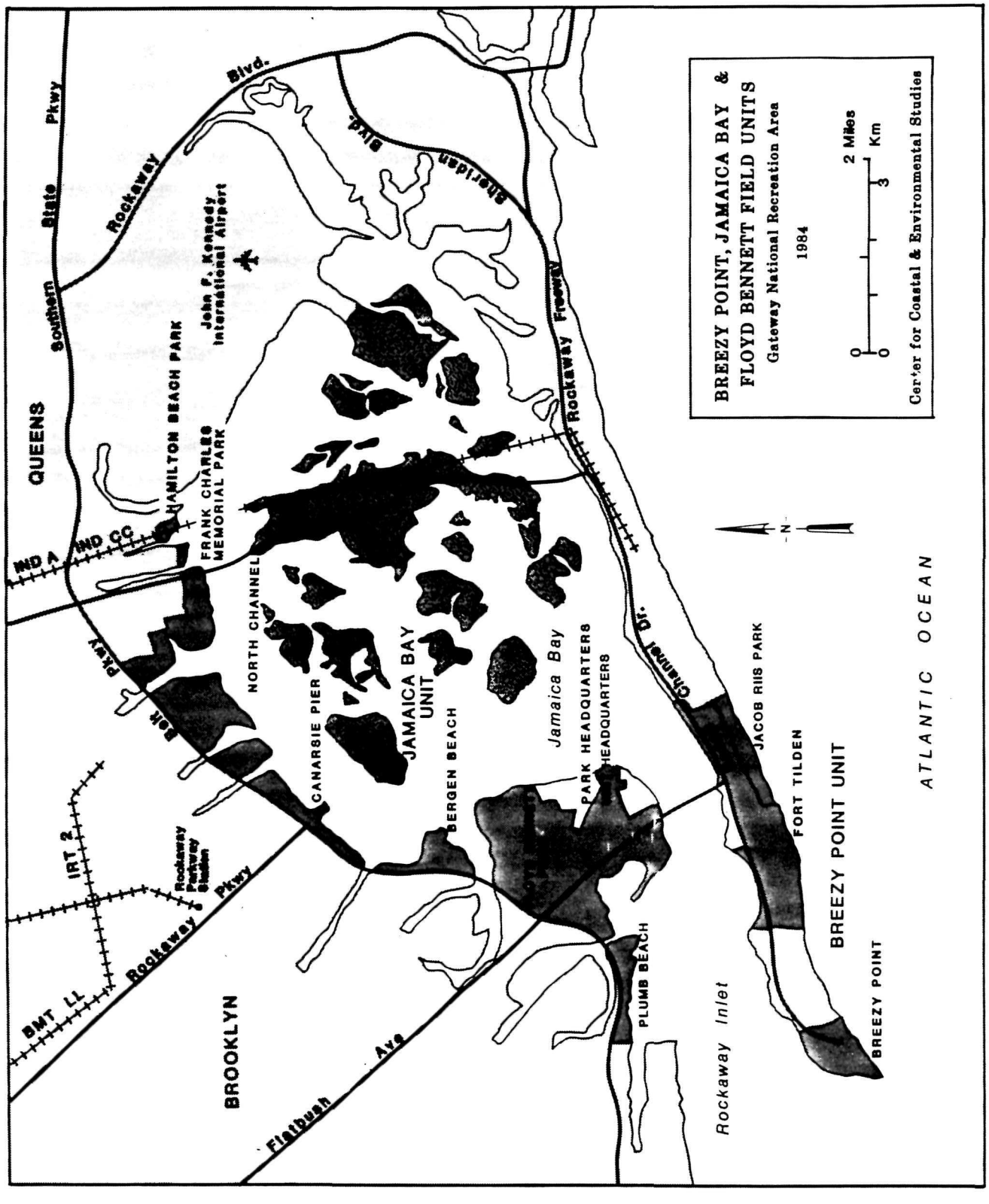
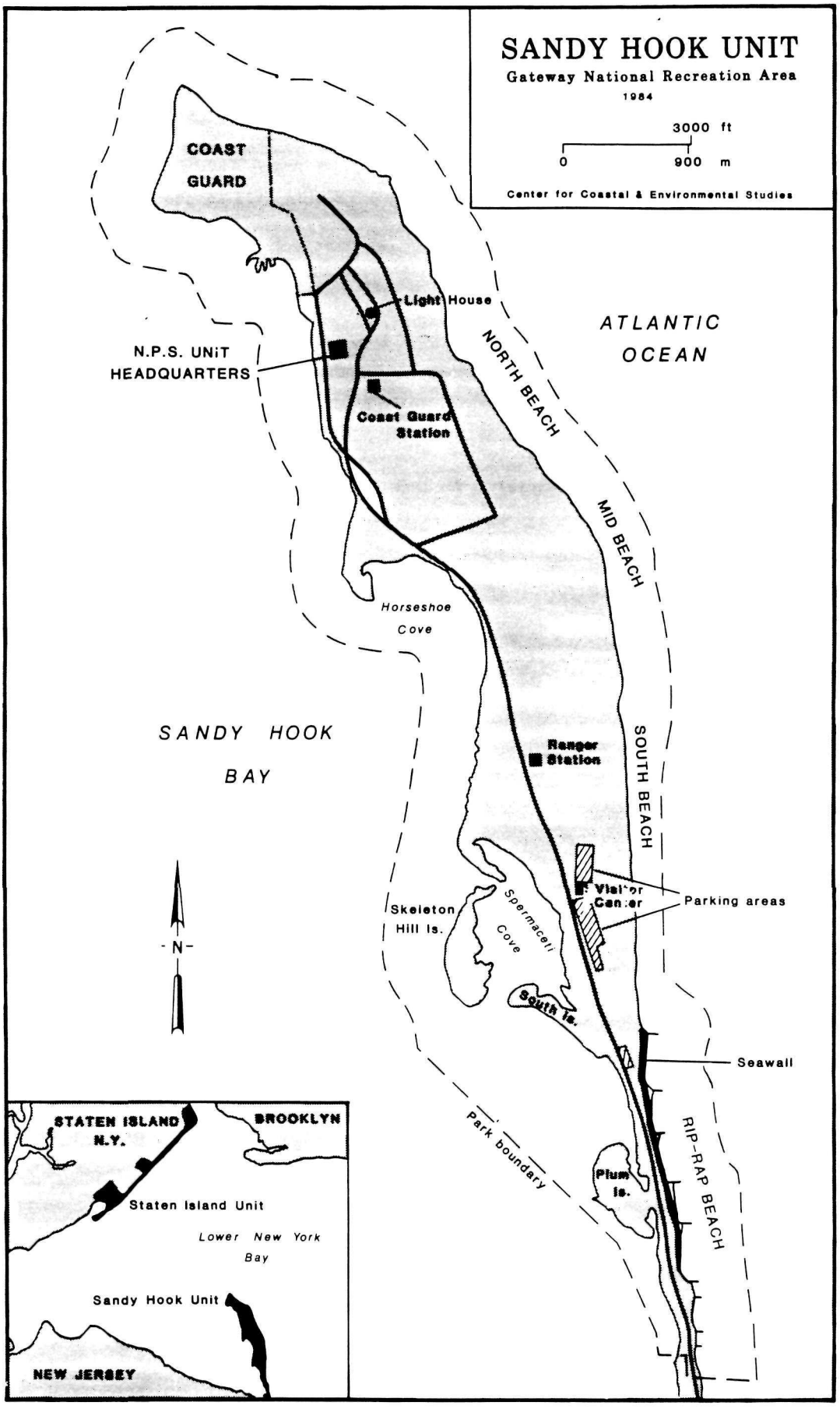

BREEZY POINT, JAMAICA BAY & FLOYD BENNETT FIELD UNITS
Gateway National Recreation Area
1984
2 Miles
3 Km
Center for Coastal & Environmental Studies
QUEENS
BROOKLYN
Southern State Pkwy
Rockaway Blvd.
Shorefdan Blvd.
John F. Kennedy International Airport
HAMILTON BEACH PARK
FRANK CHARLES MEMORIAL PARK
IND A
IND CC
Belt Pkwy
NORTH CHANNEL
Rockaway Freeway
Channel Dr.
CANARSIE PIER
JAMAICA BAY UNIT
BERGEN BEACH
Jamaica Bay
PARK HEADQUARTERS
HEADQUARTERS
JACOB RIIS PARK
FORT TILDEN
BREEZY POINT UNIT
ATLANTIC OCEAN
IRT 2
Rockaway Parkway Station
Rockaway Pkwy
BMT LL
Flatbush Ave
PLUMB BEACH
Rockaway Inlet
BREEZY POINT

Figure 5.


SANDY HOOK UNIT
Gateway National Recreation Area
1984
3000 ft
0
900 m
Center for Coastal & Environmental Studies
COAST GUARD
Light House
ATLANTIC OCEAN
N.P.S. UNiT HEADQUARTERS
NORTH BEACH
Coast Guard Station
MID BEACH
Horseshoe Cove
SANDY HOOK BAY
Ranger Station
SOUTH BEACH
Visitor Center
Parking areas
Skeleton Hill Is.
Spermaceti Cove
South Is.
N
Seawall
STATEN ISLAND N.Y.
BROOKLYN
Park boundary
RIP-RAP BEACH
Plum Is.
Staten Island Unit
Lower New York Bay
Sandy Hook Unit
NEW JERSEY

ACRONYMS USED FOR DOCUMENT LOCATIONS

U.S. Department of Interior, National Park Service Locations:

ASIS: Assateague Island National Seashore, Berlin, MD.
CACO: Cape Cod National Seashore, South Wellfleet, MA.
CAHA: Cape Hatteras National Seashore, Manteo, NC.
CALO: Cape Lookout National Seashore, Beaufort, NC.
CANA: Cape Canaveral National Seashore, Titusville, FL.
CUIS: Cumberland Island National Seashore, St. Mary's, GA.
FIIS: Fire Island National Seashore, Patchogue, NY.
GATE: Gateway National Recreation Area, Brooklyn, NY.
GUISFL: Gulf Islands National Seashore, Florida Unit, Gulf Breeze, FL.
GUISMS: Gulf Islands National Seashore, Mississippi Unit, Ocean Springs, MS.
MARO: Mid-Atlantic Regional Office, Philadelphia, PA.
NARO: North Atlantic Regional Office, Boston, MA.
NPSDC: National Park Service, Washington, DC.
NPSDSC: National Park Service, Denver Service Center, Denver, CO.
NPSSAC: National Park Service, Southeast Archaeological Center,Tallahassee, FL.
SERO: Southeast Regional Office, Atlanta, GA.

Universities, Institutions, Associations, and Other U.S. Government Agencies:

ABST: citation taken from abstract.
ADELPH: Adelphi University, Garden City, NY.
ALEX: Alexander Library, Rutgers University, New Brunswick, NJ.
AMNH: American Museum of Natural History, New York, NY.
APCC: Association for the Preservation of Cape Cod, Orleans, MA.
BIBL: citation taken from a bibliography.
CAMCO: Camden County Library, Woodbine, GA.
CCES: Center for Coastal and Environmental Studies, Rutgers University, New Brunswick, NJ.
COLUM: Columbia University, New York, NY.
DUKE: Duke University, Durham, NC.
ECU: East Carolina University, Greenville, NC.
ENT: Entomology Library, Cook College, New Brunswick, NJ.
FIRE: Firestone Library, Princeton University, Princeton, NJ.
FWS: U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.
GADNR: Georgia Department of Natural Resources, Atlanta, GA.
GAGS: Georgia Geologic Survey, Atlanta, GA.
GOOD: Ralph Good's personal library, Rutgers University, Camden, NJ.
HUSL: Science Library, Harvard University, Cambridge, MA.
JBWR: Jamaica Bay Wildlife Refuge, Brooklyn, NY.
LSM: Library of Science and Medicine, Rutgers University, New Brunswick, NJ.
MABEL: Mabel Smith Douglass Library, Rutgers University, New Brunswick, NJ.
MANN: Horace Mann Library, Cornell University, Ithaca, NY.
N.A.: document location not available.
NCSM: North Carolina State Museum, Raleigh, NC.
NCSU: North Carolina State University, Raleigh, NC.
NOAA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, DC.
OICC: Office in Charge of Construction, Kings Bay Naval Facility, Kings Bay, GA.
PANS: Philadelphia Academy of Natural Sciences, Philadelphia, PA.
PCCS: Provincetown Center for Coastal Studies, Provincetown, MA.
PEA: Pea Island National Wildlife Refuge, Cape Hatteras, NC.
POST: C.W. Post College, Long Island University, Greenvale, NY.
SFA: Sports Fishery Abstract.
SKID: Georgia Marine Science Center, Skidaway Island, GA.

STICK: David Stick's personal library, Kitty Hawk, NC.
UCT: University of Connecticut, Storrs, CT.
UFL: University of Florida, Gainesville, FL.
UGACPSU: University of Georgia, Cooperative Park Studies Unit, Athens, GA.
UGAMN: University of Georgia, Main Library, Athens, GA.
UGASCI: University of Georgia, Science Library, Athens, GA.
UMA: University of Massachusetts, Amherst, MA.
UVA: University of Virginia, Charlottesville, VA.
UNC: University of North Carolina, Chapel Hill, NC.
USC: University of South Carolina, Columbia, SC.
USGS: U.S. Geological Survey, Washington, DC.
UWF: University of West Florida, Pensacola, FL.
VIMS: Virginia Institute of Marine Science, Gloucester Point, VA.
WHOI: Woods Hole Oceanographic Institution, Woods Hole, MA.
YALE: Yale Unviersity, New Haven, CT.

GENERAL KEYWORD CATEGORIES

BIBL:	Bibliographies
BIRDS:	Birds
CGEO:	Coastal Geomorphology -- also includes climatology, meteorology, and sea level studies
CUHI:	Cultural, Historical
ESTE:	Estuarine Ecology
FISH:	Fish
GEOS:	Geology, Hydrology, Soils -- also includes limnology, hydrography, and oceanography studies
INVRT:	Invertebrates
MAMM:	Mammals
MANL:	Management Legislation -- also includes recreation and miscellaneous studies
RPTAM:	Reptiles, Amphibians
VEGT:	Vegetation -- including fungi, phytoplankton, macroalgae, submerged aquatic vegetation, saltmarsh and terrestrial vegetation studies

RESEARCH REVIEWS

GEOLOGY, HYDROLOGY, SOILS

Geology

Sandy Hook

Early surveys of the geology of New Jersey were published in the late 1800's by Cook (1885) and Clark (1892). Clark assessed the coastal plain formations of New Jersey between Sandy Hook and New Brunswick. He described the physical features and stratigraphic relations of the Raritan (Cretaceous) and younger formations, and investigated the origin of the glauconite contained in several formations.

Colony (1932) investigated the origin and sources of New Jersey and Long Island beach sands, as well as the direction of sediment transport along this section of the Atlantic coast. He suggested that the New Jersey beach sands were derived from the Cretaceous and Tertiary New Jersey coastal plain formations and concluded that Monmouth Beach acted as a nodal point on the New Jersey coast with the predominant longshore drift direction changing from northward between Monmouth Beach and Sandy Hook, to southward from Monmouth Beach to Cape May. (For a discussion of Colony's findings on the Long Island beaches, refer to the Jamaica Bay section of this report).

McMaster (1954) also analyzed the petrography and genesis of New Jersey beach sands. In addition to describing the general lithological relations of the coastal plain formations, he discussed the stratigraphy of the Sandy Hook region. On the basis of the heavy mineral suite identified in the beach sands, McMaster suggested that some of the sediments were originally derived from the Appalachian province and transported to the coast by the Shark River. Evidence indicated that the remaining sediments were transported by the Hudson River during glacial times, possibly from Staten Island and Long Island.

The Sandy Hook area contains the thickest, most complete exposure of Cretaceous through Tertiary sediments in the New Jersey coastal plain (Minard, 1969). Minard mapped and described the geology of Sandy Hook as part of a program to accurately locate, describe, and analyze the aquifers and resources of the coastal plain. He recognized seven late cretaceous formations in the area (the Englishtown, Marshalltown, Wenonah, Mount Laurel Sand, Navesink, Red Bank, and Tinton formations), and three Tertiary formations (Paleocene Hornerstown Sand, Vincentown, and the Miocene-Pliocene Cohansey sand). Quaternary deposits were found to be patchy in the area. In addition to discussing the general geology and physiography of Sandy Hook Minard described the lithology, sedimentary structures, fossil content, and general paleoenvironment of each of the formations exposed in the region.

Dorfman et al. (1975) determined the quantity and distribution of hydrocarbons in beach sands between Cape May and Sandy Hook. They found a higher concentration of hydrocarbons in the northern (Sandy Hook) beach sands, suggesting that fluctuations in hydrocarbon concentrations may correlate with variations in the use of the New York Bight for waste deposition. They recommended monitoring hydrocarbon concentrations to measure the effectiveness of pollution abatement in the coastal waters, and to determine the contaminant effect on New Jersey beaches from proposed oil drilling.

Miller (1977) compared the sedimentary features of a recent beach environment, Sandy Hook, to an ancient barrier beach sedimentary deposit, the Pennsylvania Chickies Formation. She analyzed and contrasted the texture, composition, and sedimentary structures of the two deposits and observed ongoing sedimentary processes at Sandy Hook in an attempt to identify structures in the Chickies Formation which may have resulted from analogous processes. Dahlgren (1977) presented a brief review of the geology of Monmouth County.

Bokuniewicz and Fray (1979) investigated the shallow stratigraphy and volume of sand and gravel resources in the Lower Bay of New York Harbor. Marine sands were found to overlie glacial outwash sands, which inturn were found to overlie unconsolidated Cretaceous sediments. The authors also mapped the extent and distribution of surface sediments in the

region, and in so doing, found that surface muds were confined primarily to Raritan and Sandy Hook Bays.

Sugarman (1981) measured and interpreted gravity anomalies observed in the vicinity of Raritan Bay in New York and New Jersey.

Jamaica Bay

Colony (1932) studied the origin of the Long Island and New Jersey beach sands and the direction of sand movement along the coast. He proposed that the Long Island and Montauk Point West sands were derived from the terminal moraine of the Wisconsin ice sheet and its overwash plain. He observed that decreasing heavy mineral components from Montauk Point westward indicated that the predominant direction of sand movement along the south shore of Long Island was westward.

Taney (1961) reviewed the geological history and the stratigraphy of the Cretaceous through Quaternary formations on the south shore of Long Island. his study was based on a compilation of existing accounts of the region's geology and geomorphology.

Sorea (1978) analyzed the subsurface geology and paleogeography of Queen's County, Long Island. He found evidence for the existence of a buried river valley in Queen's County, and he further suggested that the Hudson River was diverted to its present course during the Pleistocene from this relict valley.

Williams (1979) examined the geologic effects of ocean dumping on the New York Bight inner shelf. Results indicated that with the exception of sewage sludge, most materials were fairly stable and had remained in their original dump sites. Williams concluded that since its initiation in 1888, ocean dumping has resulted in significant infilling of parts of the Hudson shelf channel.

Dkulewicz (1979) conducted a petrologic analysis of the Staten Island Alpine ultramafic body. Marine Environmental Services Incorporated (1981), in cooperation with Rutgers University, analyzed sediment samples from Jamaica Bay to determine possible contamination from pesticides and heavy metals. They found the levels for both types of pollutants to be well below allowable limits.

Soils

A series of soil investigations were conducted at the Sandy Hook Unit of Gateway National Recreatio Area and are available at the North Atlantic Regional Office of the National Park Service. The consulting firms which conducted analyses of soil property factors at Sandy Hook include the United States Testing Company (1983), Monmouth Testing Laboratory (1983), Engineering International Corporation (1983), and Site Engineers Incorporated (1977).

Jaworski (1980) conducted a pedologic study of tidal marsh soils at Sandy Hook. In 1983, an investigation was undertaken to determine the environmental significance of peat deposits at Great Kills on Staten Island (Anon., 1983). This report also provided interpretations of the genetic history and source of the peat deposits.

Hydrology

Cook reported on the status of water level control devices at Jamaica Bay Wildlife Refuge. In the report, he provided water quality assessments and salinity measurements for the West Pond and Jamaica Bay.

COASTAL GEOMORPHOLOGY

Dynamic Shore Management Strategies

When Sandy Hook peninsula was used as a military base, the Army installed a series of timber groins in an effort to protect important facilities located along the northeastern shoreline of the spit (segments 2b and 3; Nordstrom, Allen, and Gares, 1979). Now that Sandy Hook is under the jurisdiction of the National Park Service, the spit is being considered for a variety of land use options including: 1) intensive recreational use (segment 1b); 2) limited recreational use (segment 2b); 3) wildlife habitat development (segment 2a); 3) wildlife habitat development (segment 2a); 4) natural area; and 5) sand reservoir for beach fill operations (Allen and Nordstrom, 1977). To meet these land use goals the National Park Service has adopted a gemorpholically compatible strategy of coastal management which balances recreational needs with available economic and environmental resources.

To provide an information base on which to develop geomorphically compatible policies, Psuty, Nordstrom, Allen and their associates at the Center for Coastal Environmental Studies have conducted a series of investigations designed to analyze the dynamics of the Sandy Hook shoreline segments and the degree of interaction between them. These investigations were then integrated to develop a mathematical computer model capable of simulating wave refraction patterns, calculating wave energies and sediment transport, and translating these processes into predicted shoreline responses for the entire spit (Nordstrom et al. 1976). The model was intended to aide in the prediction of shoreline changes resulting from human induced or natural changes in the system. Several projects were undertaken to generate the data needed to develop this model, including: 1) documentation of long-term and short-term patterns of shoreline change; 2) hydrodynamic surveys of wave regimes, longshore currents, tidal currents, and wind effects; 3) sediment movements studies both between and within shoreine segments; 4) monitoring of beach morphology changes to determine rates of storm profile and equilibrium form establishment; and 5) the gemorphological impact of various shore protection strategies.

Psuty, Nordstrom, and Allen (1976) discussed the aplication of gemorphological research to the management of coastal resources. They reviewed management objectives for Sandy Hook and they proposed possible courses of action which could be taken to achieve them. In addition, they described the general geomorphic characteristics of selected spit segments, and their suitability to the intended land uses. They suggested that beach nourishment operations should be undertaken at Segment 1, the principal recreation area, to widen the beach and and increase the carrying capacity. They recommended that beach nourishment operations be continued at segment 2b, and that the groin field between segments 2a and 2b be removed to improve the beach in segment 2b (designated for limited recreational use). Nordstrom et al. (1976) explained the development and the status of the Sandy Hook simulation model.

Nordstrom and Allen (1978) discussed the application of dynamic geomorphology to land use planning. Then, based on geomorphological and environmental characteristics, they identified potential recreational uses for three Sandy Hook segments. They concluded that the southen oceanside segment was too narrow and erosion-prone to accommodate intense recreational use. However, they considered that with the implementation of a beach nourishment program, that this land use would be acceptable. They recommended that the northern oceanside segment be set aside as a natural area because of the extensive reaches for bare sand which favored nesting birds and the rapid tidal currents which presented a hazard to bathers. They suggested that the southern portion of the northern oceanside segment be designated as a buffer zone between the wildlife area to the north and the intensive recreational area to the south. Their studies indicated that the bayside segment should be preserved for wildlife and educational uses due to the fragility of the environment.

Nordstrom and Allen (1980) discussed the geomorphic impact expected from the implementation of a dynamic approach to shoreline management at Sandy Hook. The dynamic measures they considered included beach nourishment, dune building, creation of

offshore mounds, and revegetation programs. They provided a brief overview of these measures, and in addition, they identified sites experiencing severe erosion at Sandy Hook. They concluded that dynamic methods are more environmentally compatible, increase recreational potential and provide greater protection for coastal areas than static structural solutions.

Sherman (1981) assessed shoreline protection options and management strategies at Sandy Hook.

Spit Bar Development

Sandy Hook

Antonini (1962) mapped spit bars, which he interpreted as representing stages in the historical development of a prograding shoreline, at Horesshore Cove. He concluded that the sequntial development of spit-bars on the south side of Horeshore Cove was caused by erosion of norhtwest facing sections of the coastline and subsequent trnsport of the sediment southward and eastward. The northwest facing shoreline section was receding at a rate of approximately 11.5 feet per year.

During this same time period, Yasoo (1964, 1968, 1971) conducted a series of investigations analyzing the processes influencing the geometry and development of the spit bar shoreline.

Strahler (1964) quantitatively related the evolution of beach forms to the seashore processes operating at Sandy Hook. The processes he examined included: 1) wave parameters; 2) tides; 3) currents; and 4) meteorological elements. In addition, he estimated the rate of spit growth at Horseshore Cove and Atlantic Beach. Lipman (1969) investigated spit-bar origin and growth at Plum Island. He used the orientation and imbrication of clastic grains to ? the flow directions of currents acting on various portions of the spit. From the characteristic flow directions, he identified the predominant currents influencing accretion and morphology along the spit.

Nakashima (1979) applied the allometric growth concept to a recurved barrier spit complex. He utilized data from nearshore profiles and aerial photographs to calculate linear and volumetric shoreline changes for each of the spit segments along Sandy Hook. He then compared these calculations to sediment budget measurements and beach process data which, had been collected over a three year period.

Shoreline Change

Sandy Hook and Staten Island

Pioneering studies of shoreline change and the processing controlling it are provided by Bache (1856, 1857) and Cook (1857). Bache (1856, 1857) related accretion at Sandy Hook to northward flowing currents which he had observed along both the oceanside and bayside shores of the spit. Cook (1857) described the subsidence and erosion of the coastline between Sandy Hook and Staten Island.

Strahler (1966) analyzed the summer equilibrium profile of the Sandy Hook beaches with respect to both composition and morphology. He detected minor cyclic fluctuations in the elevation, slope, and composition of the beaches which he attributed to the semi-diurnal tidal cycle.

Caldwell (1967) investigated nearshore processes influenceing erosion and accretion along the New Jersey coastline. He suggested that the silts and clays eroded from the beaches were transported out of the beach system and permanently lost, whereas the remaining sediments were carried by littoral currents and washed inside the inlets by flood tides. He

recommended the installation at coastal engineering structures (groins, seawalls, jetties) and the emplacement of beach fill to control erosion.

Sandy Hook is composed of a series of distinct beach segmetns, each of which is characterized by a different combiantion of processes and sediment supply (Nordstrom et al, 1975). Allen, Nordstrom, Psuty and their assiciates at the Center for Coastal and Envionmental Studies csonducted a series of investigations to analyze the nature of beach response and shoreline dynamics within these beach segments, as well as the degree of interaction between them, in order to develop geomorpholoically compatible erosion control solutions.

Allen (1973) recreated the configuration of Sndy Hook spit through the application of a stochastic computer simulation. He tested the relative contribution of various wave conditions, sediment supplies, and hydrographic factors to the overalll shape of the spit. Through both the computer simulationand subsequent wave refraction analysis, he found that wave energy levels decreased toward the distal end of the spit.

Nordstrom, Allen et al (1974, 1975) developed a process-response model for the Sandy Hook beach segments to aid in the identificaion of geomorphic constraints to land use in the area. They described sediment movement within and between the segments, the complex wave and current energies actin on the segments, and observed trends in shoreline oreintation and position. They recommended that farther research be undertaken to identify critical threshold in the geomorphological system and to isolate the contributions from various physical processes (e. g. currents) to shoreline mobility. Allen and Nordstrom (1978) discussed the mechanics of this models and the inherent problems in developing an accurate computer simulation. Allen (1981) found that the wave energy patterns simulated in the model agreed well with observed shoreline mobility at Sandy Hook, and that simulated beach migrations also agreed closely with measured Shoreline Changes. The model was also found to be successful in identifying areas vulnerable to erosion and flooding, and in assessing the geomorphic effects of coastal stabilization alternatives.

Nordstrom and Allen (1978) discussed the physical processes acting on selected segments of Sandy Hook and the land uses suited to each of these segmetns. They suggested that if a beach nourishment program was completed for segment A as planned, the area would be able to accomodate intense recreational use. They argued that segment B Should be maintained as a buffer zone between the rereation area to the south (segment A) and the wildlife refuge to the norht (segment C). They found segment C to be geomorphologically and ecologically fragile, and suggested that it be preserved as a wildlife refuge.

Jannik (1979, 1980) investigated beach processes and the history of shoreline change between 1836 and the present at Sndy Hook. The wuthor observed that wave regimes generated by storms from the north-northwest directly effected the spit, whereas storms from the north-northeast were buffered by Sandy Hook and only had an indirect effect which was related to elevated tides. She identified sites of erosion and accretion along the spit, and calculated rates of beach volume change for these sites. She also documented seasonal beach and nearshore morphological variations.

Nordstrom (1975, 1980) compared cyclic and seasonal geomorphic responses of oceanside and bayside beaches at Sandy Hook. He concluded that cyclic beach variations were directly related to the energy of both storm and daily wave regimes.

Allen (1981) identified and ranked causes of erosion and shoreline change as a function of variations in the sediment budget. He found a 60% deficit in the sediment budget at the recreational areas which he attributed to: 1) refraction induced high energy local waves that increase the sediment transport rate; 2) coastal engineering structures which decrease the longshore sediment input; and 3) above normal storm wave energies in the recent past. Local variations in wave energy concentrations and temporal storm variations caused transport along the segmented shoreline of Sandy Hook spit to be pulsational in nature. Allen illustrated that the variable nature of erosion and nershore processes must be taken into account in shore protection policies.

Nordstrom (1982) concluded that each geomorphic segments at Sandy Hook displayed a characteristic response which was not in all cases a direct response to wave and current conditions; however, in general, beach erosion increased with increasing wave energy. He identified both areas susceptible to erosion from storms and those susceptible to long-term erosion. He suggested that the varying geomorphic behavior of each of the segmetns at sandy Hook indicated that different land uses are appropriate to each segment.

The development of Sandy Hook spit and the history of shoreline change in the region were reviewed by Gares (1982) and Nakashima et al (1982). Gares (1982) identified the available maps, charts, and archived data to aid park personnel in making management decisions. He presented a brief geologic history of Sandy Hook spit, a detailed description of changes in the spit configuration from 1977 to the present, and he discussed beach erosion control measures instituted prior to the administration of ther area by the National Park Service. Blth studies emphasized the dynamic nature of the barrier spit environment, and placed the erosion problems encountered today in an historic perspective. They concluded that the small-scale static protective methods have exhibited limited effectivenesss, and the study of Nakashima et. al (1982) which was based on extensive field investigations estimated that the restoration of the beach through beach-fill emplacement would require 3.2 million cubic meters of sediment.

Jamaica Bay And Breezy Point

The United States Army Corps Of Engineers (1936, 1956) reviewed the history of shoreline change at Rockaway Point. The 1936 study presented data on Accretion rates, changes in high water levels, offshore depth variations, liltoral currents, and beach profile variations for the years 1835 to 1934. The 1965 study examined nearshoreprocesses and recession of the coastline betwen East Rockaway Inlet, Rockaway Inlet, and Jamaica Bay. The Geomorphic data collected was similar to that of the previous study. Both of these studies were undertaken to provide information on Which to base erosion control and coastal management polices.

Nieter (1982) conducted a preliminary investigation into erosion at Plumb Beach, Breezy Point.

Storm Induced Erosion

Sandy Hook

An early study discussing the damaging effects of storm energy on the New Jersey coast was published by Johnson and Smith (1914). They described the role of storms in affecting shoreline change and the alleged relationship of storms to coastal subsidence.

Caldwell (1959) summarized the extent and nature of beach erosion caused by selected strms along the New Jersey coast.

The United States Army Corps of Engineers (1972) discussed the storm history of the areas surrounding Sandy Hook and Raritan Bays. Particular emphasis was placed on the historical extent of tidal flooding and storm damage. they compiled tidal height and storm surge records for selected storms occurring between the years 1950 and 1960. They also described the beach erosion control and horricane protection policies in operation at the time in the region.

Nordstrom (1975, 1980) compared cyclic and seasonal trends in beach response of oceanside and bayside beaches at Sandy Hook. He determined the amount of time it took selected beaches to recover their equilibrium profile following stroms, and he analyzed the roles of waves energy and shoreline orientation in the temporal pattern of foreshore change. In general, he found that oceanside rates of beach change were related to mid-latitude cyclonic storms, whereas bayside beach response was predominantly controoled by the prevailing westerlies. Storm erosion and recovery from storm damage was found to occur more rapidly on oceanside beaches; this was due to the fact that the lower wave energy regimes on the bayside did not have the competance required to completely modify foreshore slopes between storms.

Sherman et. al (1977) also examined the impact of extratropical storms on the Sandy Hook region in recent history. They determined the frequency and probability of storms of various magnitudes effecting the New Jersey coast on an annual basis. They suggested that storms of relatively low magnitude and high frequnecy are responsible for the maintenance of the average winter beach profile. They described the characteristics, typical developmental sequence, and conditions occurring during extratropical storms effecting the region. In addition, they described the damage incurred at Sandy Hook by the January and September 1977 storms.

Shore Protection Alternatives

Static Structural Solutions

Sandy Hook

Construction of groins and engineering shore protection structures at Sandy Hook were begun in approximately 1863 to protect United States Army military base facilities (in segments 2b and 3; Nordstrom, Allen and Gares, 1979). The first groins field was constructed in segment 3, and later in 1910, timber groins were constructed in segments 2a and 2b. Many of these groins have since been buried, and many others are either in states of disrepair or have been essentially destroyed. Only two groins have been completely functional in recent times (Nordstrom, Allen, and Gares, 1979).

Research Prior To National Park Service Aquisitons

The United States Army Corps of Engineers (1955, 1957) conducted studies to evaluate beach control alternatives and the factors controlling shoreline change along the moastal margin between Sandy Hook and Barnegat Inlet. The 1955 report measured a series of geomorphic parameters, and their data set included: 1) hydrographic ? ; 2) beach profiles; 3) shoreline and offshore depth change data; 4) storm, wind, and wave measurements; and 5) lithologic ? . The United States Army Corps of Engineers (1957) developed a comprehensive and unified plan to restore the recreational beaches, and formulate a longterm program to ensure continued shoreline stabilization. They concluded that the most economical and efficient shore protection strategy would be the installation of a more extensive grain network.

Post - National Park Service Acquisition

Traditional static shore protection measures such as grain fields, have been exceedingly costly and have been shown to have deleterious effects on downdrift beaches and possibly the sediment (storage) system as a whole (Nordstrom and Allen, 1980). With the increasing awareness that static shore protection solu'ions alone are not meeting the r ıanagement objectives of restoring and preserving the beach system, interest in the development of geomorphologically compatible shore protection strategies has increased. Teh development of these strategies demands a working knowledge of the coastal geomorphological system and the response of this system to shore protection methods.

Allen and Nordstrom (1977) studied the effects of ? on beach forms and sediment movement to provide an information resource on which to base decisions as to optimum shore protection strategies for Sandy Hook. They also discussed the suitability of various land use options for each of the geomorpholocial segments of Sandy Hook based on their findings. They found that ? and sharp changes in shoreline orientation caused longshore drift to be deflected seaward and then deposited as longshore bars. The development of these bars led to a decrease in the amount of transported into the ? shadow zone; however, the bars did act as buffers to high wave energies. Nordstrom and Allen concluded that either the existing protective structures at Sandy Hook must be modified to accomodate new land use needs, or that land use must be modified to be compatible with the characteristics of the existing structural controls (and the resultant beach form and dynamics).

Sherman and Gares (1978) presented a model designed to provide a methodology for objectively evaluating beach erosion control options. A case - Study of shore protecion alternatives at Sandy Hook was conducted to test the model.

North Beach

North Beach was designated by the National Park Service to be used as a spill-over recrational beach when South Beach reached carrying capacity. However, erosion at South Beach during recent years decreased the width of the beach and reduced its user capacity (Nordstrom, Allen, and Gares, 1979). Therefore, North Beach has had to accomodate a larger number of users than was originally anticipated. The variability of the beach width at North Beach due to episodic erosion/accretion makes it unreliable for intense recreational use (at present). The Two courses of action under consideration by the National park Service for this area are either the removeal or the alteration of the groin field to increase shoreline stability.

Nordstrom, Allen and Gares (1979) examined the effects of groin removal on shoreline stability and sediment transport at North Beach to determine if groin removal would acheive the desired results. In addition, they discussed the advantages and inherent problems of the groin fields, trends in shoreline change from 1836 to the present, offshore controls on beach change, and a general model of shoreline change for the region. They noted that historically the shoreline has been characterized by periods of long-term equilibrium with major changes occurring at times of inlet creation, changes in False Hook Shoal, or groin installation. They concluded that groin removal would decrease the variability of North Beach, and that the beach should then maintain a width between the minimum and maximum width with the groins in place.

Studies On Specific Shore Protection Methodologies

In some instances shipwrecks located off the coast of New Jersey have formed detached breakwaters on the inner continental shelf. Two examples of such occurrences have been recounted by Anonymous (1934) for shipwrecks dating from the late 1800's.

Dravo Van Houten, Inc. (1977) discussed the applications of dike construction in erosion control for Gateway National Recreation Area.

A sandbag structure was used as a temporary seawall in the critical zone at Sandy Hook in 1978-1979 to provide additional protection for the areas access road (Nakashima and Nordstrom, 1982). Nakashima and Nordstrom (1982) reviewed the design, specifications, and construction methods for the sandbag dike structure, in addition to the advantages and problems inherent in this type of temporary shore protection measure. They concluded that interim beach protection measures of this type can be successful if they are ? designed and implemented, and if they are followed soon after with more permanent solutions.

The United States Department of the Interior- National park Service (1982) reviewed the engineering design of the seawalls protecting the Gateway recreation areas.

Staten Island

Niedoroda, Coch and Godfrey (1975) conducted a preliminary investigation into erosion problems and shore protectio solution at Great Kills Park and Sandy Hook. Their analysis was based on field studies conducted one day in 1975, combined with data from published sources. At Great Kills they found the major factors influencing shorelin erosion to be land development, a human installed groin feild, and a ? deposit which acted as a natural groin. They reviewed possible shore protection alternatives for the area, and concluded that the salt ? be re-established through revegatation techniques and thereafter protected from pedestrian traffic.

The Federal Highway Administration (1980) examined the status of shoreline protection strategies and the extent of beach erosion between Crookes Point and Miller Field on Staten Island. They found that the beach had recessed to the point where sewer lines and the

beach bathhouse were in danger. They recommended that immediate measures be undertaken temporarily arrest erosion, such as the installation of: 1) cellular concrete blocks; 2) filter fabric and concrete blocks or riprap; and 3) adjacent toe and flank protection structures. However, they warned that no solution should be considered permanent because erosion in adjacent areas would eventually undermine andy structures and initiate failure in this area.

Jamaica Bay

The United States Army Corps of Engineers (1965, 1974, 1977, 1979) evaluated beach erosion control and hurricane protection plans for coastal areas between East Rockaway Inlet and Jamaica Bay. They 1974 plan provided for a hurricane barrier across the entrance to Jamaica Bay with a permanent navigation opening an tainter gates on each side of the opening in addition, it recommended the construction of dibes, ? , and floodwalls from the hurricane barrier to higher ground. Fill material was to be placed along the oceanfront floodwall. The beach erosion control portion of the plan recommended restoration and widening of the existing beach, then stabilization through periodic nourishment. In 1979, the United States Army Corps of Engineers recommended construction of an additional terminal stone on the western boundary of the existing beach protection projct at 149th Street. Their report on this recommendation included a discussion of expected environmental impact with regard to groin construction.

Athow (1976) investigated the effects of a hurricane surge barrier on the hydraulic environment at Jamaica Bay.

The environmental impact and potential benefits of dredging West Pond were evaluated by Felbel and Peterson (1976). They assessed the impact of four courses of action: 1) mechanical dredging; 2) hydraulic dredging; 3) land-based evaluation after pond de-watering; and 4) no dredging.

Hess (1980) investigated volumetric changes and barrier beach growth in response to shoreline protection structures at Jamaica Bay.

Breezy Point

Sherman, Fisher and Mizobe (1979) discussed shore protection strategies for the Breezy Point Unit of the Gateway National Recreation Area. They evaluated the environmental and community impact (expected from) a proposed groin construction project in the Breezy Point area.

Shore Protection Alternatives - Beach Nourishment

Sandy Hook

Beach nourishment is considered one of the most beneficial (advisable) shore protection methods because it acheives the goal of increasing beach width without installation of permanent human-made structures (Psuty, Nordstrom, and Allen, 1976).

Prior To National Park Service acquisition

Duane (1969) described a program sponsored by the Army Corps of Engineers to find and delineate offshore sand deposits suitable to be used as beach fill material in beach restoration and stabilization projects. His study included a sand inventory of coastal waters between New Jersey and northern New England which included data collection in the Sandy Hook region.

After National Park Service acquisition

Niedoroda, Coch and Godfrey (1975) conducted a preliminary survey of erosion problems at Sandy Hook and Great Kills. Thier analysis was based on on-site observations made one day in 1975, and was supplemented with data from existing literature. At Sandy

Hook they found natural tendency for oceanic breakthrough at the southern end of the spit had been accelerated by the presence of a groin field to the south. The groin network disrupted sediment transport resulting in a decrease of sand supplied to the beach. They noted a need for further data collection to determine whether beach nourishment using drdge spoils would significantly restore the beach areas, and if so, the scale of the beach-fill project neccessary to counteract erosion.

Nourishment On Southern Sandy Hook Beaches

The National Park Service initiated a beach nourishment program with the emplacement of approximately 145,000 cubic meters of fill at segment 2b during the summer of 1975 (Psuty, Nordstrom and Allen, 1976). The material used in this operation consisted of dredge spoil obtatined from maintenance dredging of the Sandy Hook Navigation channel. Intially, the width of the beach doubled; Psuty, Nordstrom and Allen (1976) attributed the success of the operation to the fact that the dredge spoil was clean and slightly coarser than the native beach sand.

The National Park Service decided to continue the beach nourishment program on the southern area of Sandy Hook to protect the road and integrity of the peninsula, prevent further erosion, and provide a wider beach for recreational use. The project's goal was to create a stable beach of approximately 8000 feet in length (Dravo Van Houte, Inc., 1977). Researchers at the Center for Coastal and Environmental Studies (Rutgers University) studied the environmental suitability of various beach-fill schemes (Allen and Nordstrom, 1975; Nordstrom, ? ; Sherman et. al., 1977; and Sherman, 1978), while Dravo Nan Houte, Inc. (1977) provided cost estimates and engineering evaluations for the schemes being considered.

Sherman et. al. (1977) prepared a comprehensive assessment of alternatives for beach nourishment at the southern Sandy Hook recrational beaches. They reviewed possible sources for suitable beach fill material, and analyzed the quantity and quality of sediment that could be obtained from each borrow site. The sites under considerationas beach-fill sources were Sandy Hook channel, Shrewsbury Bay, and an offshore borrow area. The authors detailed the potential biological, physical, and social impact expected from the extraction of sediment at each of these sites. They also evaluated the acceptability of various beach-fill transport techniques as well as viable combinations of sediment sources and transport methods.

Researchers at the Center For Coastal and Environmental Studies calculated the amount of fill necessary to stabilize the southern Sandy Hook beaches, the amount of fill required to maintain the beaches in the future, and identified sources for suitable beach fill. They concluded that it would require 1.0 to 1.5 million cubic yards to establish the beach. Annual losses were expected to range between 60,000 and 200,000 cubic yards/year with a possible maximum of 400,000 cubic yards/year.

Dravo Van Houte, Inc. (1977) based their cost analysis on the above estimates. After the proposed borrow sites were evaluated, three sites were decided upon for sources of beach fill material: 1) Sandy Hook Channel; 2) the northern tip of Sandy Hook itself; 3) a site approximately 2 miles east of South Beach. Dravo Van Houte evaluated possible methods of sediment dreging, transport of sediment to the beach, and beach fill emplacement, as well as providing cost estimated for the various beach nourishment schemes.

Nordstrom et. al. (1979) reviewed erosion control plans in light of the shift in management goals and land-use designations which had accompanied the change in the Sandy Hook management responsibility from the United States Army to the National Park Service. They considered beach nourishment to be the optimum method to meet the National Park Service recreational and ecological objectives. They concluded (agreed) that a large-scale beach-fill operation of approximately 1.5 million cubic ? of sand was neccessary to provide adequate long-term protection for the southern recreation beach. They recommended that dredge spoil obtained from channel maintenance operations be used as a ready source of beach-fill material.

Nakashima and Gares (1982) recalculated the quantity of sand needed to restore beach widths in the Critical Zone at Sandy Hook. The recalculated volume exceeded the previous estimate of Sherman et. al. (1977) because Nakashima and Gares utilized a different methodology and because erosion in recent years had occurred at continually accelerating rates. Their report included costs, based on price per cubic meter estimates by the United States Army Corps Of Engineers, for the newly calculated sediment volumes. Updated calculations by Nakashima and Gares using the methodology of sherman et. al. (1977) yielded an estimate of 2,250,000 cubic meters of sediment; whereas calculations using the methodology developed by Nakashima and Gares predicted 3,420,000 cubic meters requied for nourishment of the Critical Zone.

Nordstrom and Allen (1982) estimated the costs of dredging operations and ? beach nourishment programs for certain segments of Sandy Hook Recreational Area.

Approximately two million cubic meters of material dredged from the Sandy Hook and Ambrose navigation channels in New York Harbor were emplaced at South Beach between November 1982 and August 1983 (Phillips et. al. 1984,). During April and May of 1984, approximately 460,000 cubic meters of additional sediment were emplaced (Phillips and psuty, 1984). Phillips (1983), Phillips and Psuty (1984), and Phillips et. al. (1984) conducted field investigations at South Beach to reassess beach volume change, changes in offshore ? , the suitability of the dredge spil as fill material, pollutant levels in the sediments, and the overall effectiveness of the beach nourishment project. Phillips and Psuty (1984) observed that after the 1982 to 1983 emplacement of fill material, South Beach was an essentially flat expanse of sand, but that by June of 1984 the beach had developed a more natural profile and a dune system had become established. Phillips (1983) and Phillips et. al. (1984) concluded that northward longshore transport was primarily responsible for the loss of threee-quarters of a million meters of sediment from the emplaced fill material; however, eolian transport from the unvegetated expanse of new beach also contributed to this sediment loss. They also concluded that beach advancement reached a threshold past which sediment less due to increased exposure to wave energy prevented further progradaion. Phillips and Psuty (1984) considered that the nourished beach provided sufficient protection for the existing facilities, and that the only detrimental effect of the project was from the unaesthetic appearance of the pipes and machinery used during nourishment. The studies concluded that sediment losses were within expected limited and recommended the continuation of the beach nourishment program.

The United Army Corps of Engineers (1982) described maintenace dredging in the Ambrose Channel in New York Harbor, and beach nourishment at Sandy Hook.

Offshore Nourishment

The National Park Service contracted to have dredge spoil from maintenance dredging of the Sandy Hook Navigation Channel dumped offshore of the 1977 nouishment site in segment lb (Sherman, 1982). It was hoped that a ? mound built from the dumped material would act as a filter to reduce onshore wave energy and provide a potential source for beach sediments. Sherman (1982) discussed the ? for this operation and the results of similar efforts at offshore nourishment which were conducted at Long Branch, New Jersey, and Durban, South Africa. He also described a small-scale beach fill project which was conducted at ocean Bathing Area during the summer of 1977.

Dune Management

Traditional static shoreline management alternatives such as grains and seawalls have not been succesful in increasing beach widths on the New Jersey coastal margin. Gares (1979) and Gares, Nordtrom, and Psuty (1979, 1989) reminded us that coastal dunes are an integral part of the shoreline sedimentary system, and that shore protection and preservation plans must be formulated which are compatible with their dynamic nature. To meet this objective, they developed a methodology for delineating dune management districts, and they identified land use and recration practices suitable for each district. They proposed that the widths of dune management districts be delineated through analysis of wave run-up, dune

height, dune width, and erosion rates in the area. In addition to presenting a procedure for the establishment and delineation of the dune districts, they developed a methodology which could be used to analyze the degree of storm protection provided by the existing dune system.

In a preliminary phase of this project, Gares (1979) examined the role of dunes as sediment sources through analysis and quantification of sediment exchange between the beach and dune. In this study, wave characteristic and wind data were related to beach and dune responses (measured using sand traps and beach profile techniques). Gares, Nordstrom and Psuty (1979, 1980) discussed the principal factors influencing sand movement in the beach/dune system and the function of dunes in shoreline dynamics. They examined the spatial variations in dune height and width characteristics along the entire New Jersey coastline, and identified areas which were particularly vulnerable to storm damage due to lack of a dune system. They also provided examples of the dune management district delineation procedure for four selected areas along the New Jersey coast based on a storm with a 50 year recurrence interval The authors utilized aerial photographic interpretation and field measurements to calculate variations in the dimensions of dunes and the dune migration zone.

Nordstrom (1981) discussed the natural processes influencing dune evolution and migration, in addition to human modification of coastal dunes. He also described the role of dunes in coastal dynamics and methods of building dunes to desired configurations.

Barrier Island Generalized

Wilson (1964) A comprehensive ? of the geomorphology and recreational potential of the Atlantic coastal margin between Assateaque and Cape Cod was conducted by the USACE (1971).

Yasso and Hartman (1976) described the geomorphology of the landforms occurring along the New York Bight. They also discussed the natural processes shaping these landforms, and the role of man-made structures in their modification.

Scheinkman and Byrne (1977) conducted an inventory of natural resources for the 2 barrier islands and 2 peninsulas forming the barrier island chains of Nw York and New Jersey. Information for the inventory was obtained from published literature and interviews with various governmental and ? agencies.

Hayden and Dolan (1979) measured a series of physical parameters for barrier islands, lagoons, and marshes between New York and Florida The Atlantic coast Barrrier islands were classified into three regions and eight subregions on the basis of variations in morphometric attributes.

Inlet and Estuarine Research

Estuarine Research

Raritan and Sandy Hook Bay

The USACE (1960) developed shore protection and hurricane contingency pland for Raritan and Sandy Hook Bay. Their data base consisted of: 1) aerial photographs; 2) hydrographic and topographic ? ; and 3) sand borings. The sand borings were used to determine foundation conditions and locate sources of suitable beach fill material. The shore protection plan they recommended outlined a program of beach nourishment, groin and levee installation, and development of interior drainage facilities.

Harper (1974, 1975) examined sedimentary dynamics at the shrewsbury entrance of Sandy Hook Bay to determine whether the Lower Bar, a prominant ? , was the result of natural physical processes or dredging operations in adjacent channels. The morphology of the ? and hydrographic conditions in the areas were monitored between 1969 and 1973 to identify spatial and temporal patterns.

VEGETATION

Introduction: an overview of Gateway vegetation

All the units of Gateway National Recreation Area; Breezy Point, Jamaica Bay Wildlife Refuge, Staten Island, and Sandy Hook have similar community types. The degree of marsh, grassland, or forestland varies from unit to unit and gives each itsown identity. Jamaica Bay Wildlife Refuge contains marsh, grassland, and woodland thicket community types. In this unit refuge management has introduced a number of upland trees in an attempt to improve food and cover resources for the avian community. Russian olive, Japanese black pine, and Japanese barberry are among the introduced exotic species. Historically the northern borders of Jamaica Bay were marsh areas. At present, most of the bay is bordered by a narrow band of salt marsh. Extensive areas of *Phragmites* and grasslands and scattered thickets and threes cover much of the rest of the area. Plum Beach contains a low salt marsh area, a dune grass system, and several scattered woodland-thickets. This area is used primarily as an environmental education area.

Floyd Bennett Field has been mostly cleared and is now dominated by extensive stands of *Phragmites*. Mixed grassland and low shrub thickets are also present in this unit.

The Breezy Point unit has undisturbed areas of beach containing typical barrier beach vegetation. The Fort Tilden section of this unit has several vegetation types. The community types include beachgrass dunes, grasslands, *Phragmites*, high and low thickets, and coniferous and deciduous forests.

In the Staten Island unit the extensive marsh system that once stretched between Great Kills and the Verrazano Bridge has been devastated by filling operations. Much of the area is dominated by *Phragmites* and the forested areas have been disturbed through heavy use. The Miller Field area contains a swamp, a white oak forest that is used as an environmental education area.

Salt marsh habitat dominates the western side of Sandy Hook. The back dune areas contain a number of small tree and shrub species. *Hudsonia tomintosa* occupies a small area on the western side of the Hook. Unique to this area of Gateway is the holly forest, dominated by *Ilex opaca*. Growing along with the holly are black cherry, hackberry, several Populus species, red cedar, bayberry, and beach plum.

Several species of plants that occur within the boundaries of Gateway National Recreation Area are protected, threatened, or endangered. These species include the marsh fern, *Thelypteris palustris*, American bittersweet, *Celastrus scandens*, bayberry, *Myrica pennsylvanica*, all local orchids, sea pink, *Sabatia spp.*, seaside spurge, *Euphorbia polygonifolia*, and caudate wormwood, *Artemisia caudata* (USDOINPS, 1976).

General studies

Taylor (1938) described the salt marsh vegetation of Long Island. Also included in this report was information on such physical parameters as tidal range, salinity and water temperature, as well as a species list and distributions for the vegetation. Patten (1962) and McCarthy (1965) reported on the ecology of phytoplankton in Raritan Bay. General studies which were either conducted in or affected all units included McCaffrey and Godfrey (1976) who reported on preliminary vegetation descriptions of all units within Gateway National Recreation Area. Silberhorn (1982) compiled a field guide of common plants of the mid-Atlantic coast. The guide provided excellent species identifications by habitat.

Hartig (1983) described the fire ecology of *Phragmites communis* at the Annual Meeting of the Middle States Division of the Association of American Geographers, West Point, NY. Hartig and Rogers (1984) again presented information on the fire ecology of *P. communis*. They suggested that in unburned stands of reedgrass, energy allocation shifted to clone margins leading to more aggressive invasion of bordering areas.

In a paper presented at the Annual Meeting of the Association of American Geographers, Washington, D.C. and the Annual Meeting of the American Association for the Advancement of Science, New York, NY, Grady and Rogers (1984) described a large-scale application of a physiognomic-ecological vegetation classification system. This test was conducted at Gateway National Recreation Area. The value of this life form approach in combination with species information is in providing baseline information from which natural and human induced changes can be determined. This type of information can in time play an important role in management and research planning.

Studies specific to particular Gateway units are discussed below under the headings of Sandy Hook, Staten Island, Jamaica Bay, and Breezy Point.

Sandy Hook

Introduction

The vegetation of New Jersey has a long history in the literature. Britton (1889) began by listing the plants found in the Garden State and Harshberger (1900, 1902) presented species lists and distributions of strand flora in New Jersey at the Proceedings of the Academy of Natural Science, Philadelphia, PA.

Chrysler (1930) examined the orgin and development of vegetation of Sandy Hook. This report contained changes in configuration, community descriptions and composition. Five areas were described: salt marsh, beach, dunes which have flora similar to adjacent areas, thickets which resemble beach yet have flora similar to the adjacent mainland, and forest which contained elements not present in the adjacent Navesink Highlands. This report represents the primary source of information on Sandy Hook vegetation.

Small (1961) presented species lists and distributions of vegetation along the seacoast of New Jersey, including Sandy Hook.

Larkin (1974) studied the dominant vegetation on Sandy Hook. This study was one of the last conducted before the area became incorporated into Gateway National Recreation Area. The study examined the vegetation through the component communities of beach, dune, backslope, salt marsh, and forest; and contained a catalog of species present. The author felt that Sandy Hook was a unique beach community and therefore merited protection.

Phytoplankton

Kawanura (1966) investigated the distribution of phytoplankton in Sandy Hook Bay with regard to the prevailing hydrographic conditions. Olsen and Cohn (1979) conducted a survey of the phytoplankton of Lower New York Bay; included was information on the development of algal blooms and seasonal species composition of phytoplankton a total of 332 species were found. Seven of these species were considered seasonal dominants, and 208 of the listed species were newly recorded to the area.

Beach vegetation

Statler (1980a) reported on the presence of *Carex kobumugi* at Sandy Hook. The previous northernmost report of this species was Island Beach, NJ. Colonies were most likely established from rhizomes carried by longshore currents from Island Beach.

Clark and Halisky (1983) reported on a destructive disease of American beachgrass (*Ammophila breviligulata*) on the coastal sand dunes in New Jersey. A Marasmiellus blight was found to be parasitizing the beachgrass. The blight could be identified by circular to oblong blowouts surrounded by dead or dying beachgrass. Study sites were found to have similar death rates (80%).

Wallace and Fairbrothers (1984) examined the flora flavenoid variation and difference in insect visitors of the prickly pear cactus, *Opuntia humifusa*. Flavenoid profiles were found to vary slightly between study populations, and Isorhamnetin-3-O glycosides were found to be responsible for the dark (quenching) coloration in the UV spectrum. Insect visitors included hymenopterans, coleopterans, orthopterans, and homopterans. Probable pollinators of the prickly pear belong to the Apidae family.

Forest vegetation

The New Jersey Department of Conservation and Economic Development (1969) listed the vascular plants at Sandy Hook State Park and Fort Hancock, N.J.

Morris et al. (1974) examined the bayberry, *Myrica pennsylvanica*, to determine whether root nodules of this species fixed nitrogen. The importance of determining whether nitrogen is fixed relates to the fact that beach systems are relatively depauperate of most essential nutrients. The study found that bayberry did in fact fix nitrogen. With this information it appears that bayberry is a key successional species in nitrogen-impoverished areas such as coastal dune systems.

Statler (1979) studied some of the ecological aspects of the holly forest, *Ilex opaca*, located at Sandy Hook. Holly is the dominant forest species on Sandy Hook and due to a combination of factors (isolation, lack of competition, shade tolerance, salt spray tolerance) it will most likely maintain its position. Statler (1981) updated the information on the plant communities of Sandy Hook. This study examined factors affecting the distribution of vegetation throughout the area. The results distinguished eighteen vegetation units:

dune grass ..... pitch pine thicket
Phragmites communis ..... transitional thicket
Hudsonia tomentosa ..... cactus
winegrass ..... forb-grassland
freshwater marsh ..... woodland
low dune thicket ..... *Ilex prunus* transitional
shrub thicket ..... bayside holly
high xeric thicket ..... holly maple
high red cedar thicket ..... black gum

Marsh vegetation

Harshberger (1909) surveyed the vegetation of the salt marshes and salt and freshwater ponds of northern coastal New Jersey, providing one of the earliest accounts of species and their distributions.

U.S. Department of Interior, Fish and Wildlife Service (1965) provided a quantitative assessment of changes in New Jersey wetlands. Their objective was to provide locations and acreages of wetlands that had been destroyed over the past five to ten years and to ascertain changes in vulnerability. They found a decrease in the rate of destruction by 1964, and attributed it to the active efforts of state land acquisition programs.

Thurlow (1975) examined the relationship between the upper limit of coastal marshes and tidal datums. Seven different biographical regions, including Sandy Hook, were examined. It was possible to delimit the upper limit of a coastal marsh based on either a constant value above the mean high water datum or as a frequency of inundation level. Two and one half feet added to the mean high water datum provided the best agreement with actual upper limits of the coastal marsh.

Staten Island

Algae

Bailey (1847, 1848) provided an extensive list of marine and fresh water algae along the Atlantic coast of the U.S. Also included were species distribution and abundances.

Forest vegetation

National Park Service Staff (USDOINPS Staff, 1975, 1976, 1978, 1979) produced species lists for Great Kills Park. These lists are available to the general public at the Park.

Statler et al. (1982) calculated density, relative density, and relative dominance for trees greater than three inches diameter at mean breast height (DBH). *Acer rubrum*, red maple, was the dominant species at both study sites. Associated species were liquid ambar, sweet gum, and pin oak. This study also established permanent quadrats that will enable future investigators to examine succession and growth rates of species at these sites.

Cerniglia (1982) inventoried all tree, shrub, vine, and herb species to determine if any rare, threatened, or endangered species existed in the Swamp White Oak Forest of Great Kills Park. No species previously listed were found to be rare, threatened, or endangered at the time. Thirteen species occurring in the forest were found elsewhere in Gateway National Recreation Area. A total of eighty-four species of shrub, vine, and herb were found in the forest. It was suggested that a very diverse and structurally complex vegetative community existed in the swamp, which should be closely monitored to identify any preeminent danger that may compromise its integrity.

In 1984, Fornino and Oppenheimer supplied the current hydrological status of the Swamp White Oak Forest. They found that depletion soil moisture had occurred by October but was replenished by March. Of the five sites sampled, only one differed from the others in vegetational species composition; it contained an iris population, whereas the other four sites ere composed entirely of hardwood species.

Jamaica Bay

General studies

A comprehensive listing of the vegetation of Jamaica Bay Wildlife Refuge was compiled by USDOINPSGATE (1982). Venezia (1982) investigated the botanical diversity of the "north-40" area of Floyd Bennett Field. A total of 39 genera were found to occur in the area. Voucher specimens have been retained in the herbarium at Floyd Bennett Field. Rogers and Brest (1983) began compiling an atlas of the vegetation at Floyd Bennett Field and in 1984, Rogers, Solecki and Vint completed the study. Included were classifications and maps. Greller (1984) presented additions to the flora of Floyd Bennett Field. Included was information on frequencies, relative frequencies, dominants and relative dominants for each group. Six families and eleven species ere identified. Stalter (1984) identified plant communities on four landfill sites in New York City. *Artemisia vulgaris* and *Phragmites communis* were the dominant species. It was concluded that high intensity fires were the most important factors in maintaining the present assemblage of vegetation in the *Phragmites* dominated areas. Rogers et al. (1985) studied the succession of bayberry (*Myrica pennsylvanica*) in a grassland. The author concluded that there may be a threat posed by the expansion of the fire prone *Andropogon* into the fire tolerant *Phragmites*.

Forest vegetation

An extensive field guide to the plants of the vicinity of New York was compiled by Gleason (1947). The guide contained species lists, descriptions, and distributions of the local flora. Barlow (1971) described the terrestial and wetland areas of greater New York City. The report contained valuable information on changes in vegetation within the undeveloped areas around New York City over the past century.

Several studies by Bridges have presented information on species composition, health, and interactions within Jamaica Bay Wildlife Refuge. Bridges (1975, 1976a) surveyed the vegetation, soil, and made estimates on plant health condition. The report included a species list of vascular plants, a vegetation map of the major community types, cover values for the community types, and an evaluation of plant health within each community. Bridges (1976b) assessed the ecological impact of Virginia creeper on the plant species in the West Pond area. The objectives of this study were to determine if the present density and distribution of Virginia creeper was in any way harmful to other plant species in the area, to describe these harmful effects, and to develop methods to correct any observed harmful effects. The results showed no significant effect of Virginia creeper on other plant species. Recommendations by the author included maintenance of natural assemblages of species and control of species introduced through human disturbance. It was also recommended that the system be maintained so as not to overload the carrying capacity through the introduction of exotics. Methods for maintaining this sytem were outlined and further research was suggested.

Cerniglia (1980) updated the Bridges (1976b) study on the effects of Virginia creeper, specifically concentrating on the effect of the autumn olive. The study surveyed the vegetation and provided a map showing relative location and ranges of the major tree, shrub and woody vine species. It also provided information on the relative status of native and introduced species and a list of bird species using Virginia creeper and autumn olive as a source of food and cover.

National Park Service Staff (1979a, 1979b, 1979c) presented yearly vegetation surveys and updating of park species lists. The report contained the common name, scientific name, and the date which the sample was found. Currently, herbarium specimens are maintained to verify all species presence within the park. Riepe et al. (1981) updated the species list for wildflowers and ferns, from 1979 through 1981. This update listed many new species not included in Bridges (1976a) or USDOINPS staff (1979b). The most recent work involved the yearly vegetation census in Jamaica Bay Wildlife Refuge by the USDOINPS staff (1984).

O'Connell (1979) examined the plants of Jamaica Bay Wildlife Refuge that are valuable food sources to the avian community. This study was undertaken to determine which vascular plant species were important as food sources to the local birds, and to ascertain which exotic species were important. The information on relative importance of exotic species was used to determine which speices should be maintained and which should be replaced by native species. The list within this study contains 253 speices; 155 native and 98 exotics.

Breezy Point

The plant communities of Breezy Point were characterized by Stalter (1982). Four major vegetation units were defined: salt marsh, brackish marsh, mixed shrub-grassland and the dune community.

INVERTEBRATES

Introduction

The extensive tidal wetlands and marshes within the boundaries of Gateway National Recreation Area provide habitats for a variety of both terrestrial and aquatic invertebrates. Surprisingly, relatively few studies have been conducted in these potentially rich habitats.

Terrestrial Invertebrates

General Insect Studies

Richards (1938) supplied the history and present status of mosquito control on Long Island. Included was information on ditching, impounding, larvicide, breeding, and a species list and information on their dispersal. Soukup (1978) studied ecosystem preservation at a basis for mosquito control. Salem (1979) reviewed methods of pest control for *Malacosona americanum* and made recommendations for management. Reipe (1980) presented a proposal to improve the habitat at South Field for butterflies and wildflowers in order to cnhance the area aesthetically and provide habitat for song birds and other wildlife. Ths U.S. Department of Health and Human Services (1981) supplied epidemiologic notes on lyme disease. The primary band of infection ran from the coastal regions of Cape Cod, MA.

Aquatic Invertebrates

Benthic Studies

Several studies were conducted on the benthic fauna of various areas within the park. McGrath (1974) conducted a preliminary census of the benthic macrofauna of Raritan Bay. Simeone (1977) also conducted a preliminary survey of the intertidal benthic macrofauna of Sandy Hook Bay. A total of 25 species were collected and two types of communities were characterized; one which was dominated by bivalves on protected fine sand beaches, and the other which was dominated by eligochaetes and nematodes on exposed coarse sand beaches. Franz and Harris (1982, 1983) conducted a study on the benthos of Jamaica Bay Wildlife Refuge. Faunal composition, diversity, density and biomass of species were analysed.

Bivalves

Dean (1957) conducted a feeding study with oysters. MacKenzie (1977) described the effects of predation on commercially important clam populations (*Mercenaria mercenaria*) by crabs in Great South Bay and Horseshoe Cove. The author found that rock crabs were able to open and consume clams as large as 15 mm. The predator to prey ratio was 1/3.8 in Great South Bay and 1.3/1 at Horseshow Cove. This study showed the need for development of management practices to cut down on predation of an economically important species. Koepp, Santoro, Nadeau, and Zimmer (1984) investigated the uptake of cadmium, mercury and lead by transplanted blue mussels (*Mytilus edulis*). They found that none of the metals were detected in excess of existing regulatory guidelines.

Miscellaneous Studies

Rafinesque (1819) described the distribution of five shallow water sponge species from the waters of Long Island and adjacent areas. Only one of the five species described in this study was found specifically on the sandy bottom substrate of Sandy Hook. In 1855, Leidy contributed a study on the marine invertebrate fauns of the coast of New Jersey. The study supplied significant historical documentation on the invertebrate fauna at Sandy Hook. Fowler (1912) described in detail the crustacea of New Jersey, the study contained species lists and descriptions. Barnes (1958) examined the factors that limited the southern most distribution of *Balanus balanoides*. He observed both adult and larval populations in the North Atlantic and Pacific and how water temperature air temperature and competition

effected their distribution. He found the southern most limit in the eastern Atlantic to be 46_N. latitude.

In addition, he found that a sudden temperature shock may synchronize breeding. Jacobson and Emerson (1971) reported on seashells from Cape Cod to Cape May with a special reference to the New York City area. Sage and Herman (1972) studied the seasonal and regional distribution of the zooplankton and selected physio-chemical factors of Sandy Hook Bay. Substantial fluctuations in the physio-chemical parameters can be attributed to the geomorphology of the area. The maximum density (5200/m_) of zooplankton was reached in mid-May and the minimum density (127/m_) was present in mid-March. Martinex (1975) studied the distribution of neiofauna on a sandy beach in New York. Nematodes and tardigrades were most abundant. Collier (1981) Collier (1981) used mud snails (*Ilyanassa obsoleta*) collected at Plumb Beach, New York to study the significance of the role of egg cytoplasm in the early determinative events of this spiralian egg.

FISH

Introduction

Estuaries like Jamaica Bay, Great Kills, and Sandy Hook Bay are extremely important as spawning, nursery, and feeding grounds for many commercial and sport fish species. Thirty-eight species of finfish have been documented in Jamaica Bay. Species which are considered to be important either commercially or for sport include spot, white perch, striped bass, and summer and winter flounders. The Breezy Point unti is less diverse in its fish fauna. Species found in the waters off Breezy Point include the bay anchovy and Atlantic silverside. Commercial and sport species in this area include summer and winter flounder.

Over thirty major species of finfish have been captured in the lower Ne York, Raritan, and Sandy Hook Bays. Sixteen species have been categorized as estuarine inhabitants, twelve as seasonal inhabitants, and others such as the American eel, Atlantic needlefish, and alewife are known to migrate through these areas to spawn in the associated streams and rivers. The important game or commercial species which utilize Sandy Hook or Staten Island estuaries include the Atlantic croaker, black seabass, and summer and winter flounders. The shortnose sturgeon, *Acipenser breverostrum*, classified as endangered by the U.S. Fish and Wildlife Service, can occasionally be found in the waters off Staten Island and Sandy Hook (USDOINPS, Statement for Management and Environmental Assessment, Gateway NRA, 1976).

General Studies

In an early study, Weigmann and Nichols (1914) noted the presence of blackfish and hake at Sandy Hook. Heintzelman (1971) investigated the rare and endangered fish and wildlife of New Jersey. The report is a state-wide listing including rare and endangered fish, amphibians, reptiles, birds, and mammals. Descriptions of habits, range, and current status as well as possible causes of distress are covered in the report.

Texas Instruments Inc. (1974) reported on the Jamaica Bay fish populations. The study was part of a larger project involving the entire Hudson River estuary. The project collected thrity-eight species. The dominant species were the striped killifish (*Fundulus majalis*), mummichog (*Fundulus heteroclitus*), young-of-the-year bluefish (*Pomatomas saltatrix*), and Atlantic silverside (*Menidia menidia*). Uncommon to New York waters was the capture of eight lizardfish, *Synodus foetens*. The study showed distinct seasonal variation in species composition within Jamaica Bay. The information obtained during this survey is important in understanding to what degree Jamaica Bay serves as a nursery area to juvenile striped bass. Wilk and Silverman (1976) examined the summer benthic fish fauna of Sandy Hook Bay. Thirty-eight species of fish were captured between July and October, eight of which accounted for 68.3% by number and 66.4% by weight. This study serves as a checklist for the benthic fish fauna of the Sandy Hook area.

Mayer (1982) reported on the effects of pollutants on fish in the New York Bight. Morin and Able (1983) investigated patterns of geographic variation in killifish (*Fundulus heteroclitus*) eggs. Collections were made near Cape Hatteras, NC and Sandy Hook, NJ.

REPTILES AND AMPHIBIANS

Most of the reptile and amphibian research at Gateway consists of species surveys; no scientific studies were available for this section. However, inventories provide valuable information to future researchers. The earliest survey was conducted by Reilly (1957). Included in this leaflet were descriptions and range maps for each species. This study provided an overview of the entire state of New York. Babcock (1971) compiled a species list of New England turtles. Included in his study were descriptions, distributions and behaviors of each species. The National Park Service (1975) put out a field guide of the reptiles and amphibians occurring at Great Kills Park. Cook (1979) presented a proposal for increasing the numbers of reptiles and amphibians at Jamaica Bay Wildlife Refuge. He proposed reintroducing native species that were previously known to exist at the Refuge but at the time of his study were rare or not present. He suggested a diversification of the present habitats by the addition of a freshwater pond and hibernation sites.

BIRDS

Introduction

Gateway National Recreation Area includes many important nesting and migratory areas found in the northeastern United States. It serves as a permanent home to many species of waterfowl, shorebirds, raptors and songbirds, most of which utilize the area as a migratory stop-over. Much of the published material relating to bird research has been in the form of censuses; only in recent years have havitat use or behavioral studies been attempted.

Sightings

References to sightings by local amateur birders have been published seasonally in Kingbird. This compilation has been useful to the bird watchers of the area, mostly with regard to which species may be found at certain times of the year. The articles include Lauro, 1978; Spencer, 1978a, 1970b, 1979a, 1979b, 198la, 198lb, 1982; DiCostanzo, 1982; and Peterson, 1982.

Sandy Hook Area

Two general species lists of the area were provided in 1967 and 1975 (authors unavailable). A report on shorebird banding for the area was provided by Knorr (1972). Some of the species that were banded were plovers, sandpipers, dowitchers and terns. A species list of waterbirds was compiled by Fisher (1976). Several Christmas bird counts for the area were produced (Anonymous, 1972, 1976, 1977, 1978). These one-day censuses employ park personnel and interested members of the public to tally the number of individuals present of the species known to exist within the unit.

Jamaica Bay Area

Several general species lists have been compiled (Meacham, 1968; Davis, 1976; Burger, 1982), addressing species distributions, habitat, seasonality and breeding behavior. Felkel et al. (1977) provided estimates of the breeding birds in Jamaica Bay and Breezy Point. The data provided have proven useful for plotting future trends. Davis (1982) compiled lists of arrival dates for adult and juvenile shorebirds of Jamaica Bay Wildlife Refuge. A total of 36 speices of shorebirds were noted between June and October, 1981. The author found that these species exhibited a bimodal migration pattern in autumn.

Miscellaneous

Buckley (1959) reported range extensions for some species of southern New York and New Jersey. Cunningham (1976) provided a nesting species count for the Gateway area. Coastal bird colonies were censused in June, 1976 by Kane and Farrar, utilizing figures and tables to show the total number of adult birds observed. They also included a recent history of previous relevant breeding data. O'Connell (1977, 1978) also conducted a census of coastal waterbirds. The numbers of breeding gulls, terns, herons and skimmers at Breezy Point and Jamaica Bay were estimated. Numbers of breeding colonial waterbirds, numbers of birds banded at Jamaica Bay and Breezy Point and recommendations for management were reported by Post (1978). Later, Post (1979) followed his previous study with a survey of selected avian species breeding at Gateway. Again, management recommendations were included as were location, numbers and nesting success of observed species. Erwin (1979) compiled information on coastal waterbird colonies from Maine to Virginia. Approximately 350,000 nesting pairs were observed on 844 colony sites. The population and colony site trends of Long Island waterbirds were compiled by Buckley and Buckley (1980) over a five-year period. Finally, Richard and Richard (1983) listed 26 species of birds that have nested at Ft. Tilden.

Habitat Studies

Several researchers have studied the importance of artificial dredge spoil islands to nesting waterbirds in the Gateway area. Buckley and Budkley (1974) investigated the dredge

spoil islands as nesting habitat for colonial waterbirds along the Atlantic seaboard. They confirmed the importance of these artificially established islands to the ecology of the estuary and strongly recommend protecting these valuable habitats. Buckley et al. (1978) reported on the use of dredge islands by colonial seabirds and wading birds in the New Jersey area. They detailed vegetation community and several stages of 21 dredge islands, and once again stressed habitat protection. Soots (1978) also provided information on the importance of dredge spoil islands to nesting waterbirds. The author supplied management information, recommendations for existing islands and information on the creation of new islands.

Buckley (no date) outlined possible future research trends regarding avian use patterns at Jamaica Bay. Burger (1978) reported on avian use patterns at Jamaica Bay Wildlife Refuge. Abiotic variables were examined for several groups of birds over a one-year period to determine their effect on abundance and distribution of birds in the study area. All species were found to be influenced by tides to some extent. Most groups of birds used all three census areas (tidal bay, East Pond and West Pond) under varying environmental conditions. In a follow-up report (1979) and progress report (1980), Burger summarized the present stage of the avian use study and a review on some of the seasonal and tidal effects on the birds.

Avian Botulism

A serious problem facing the bird populations at Gateway is avian botulism. Although many birds serve as natural epizootic reservoirs for several diseases, avian botulism can have a total effect. Cunningham (1976) offered some possible suggestions of sources of the disease at Jamaica Bay Wildlife Refuge. A pathological approach to the problem was begun by Reipe (1979), when 392 sick and dead birds were tested, but the tests were inconclusive. Then, Soukup (1980) pinpointed avian botulism as the cause of the birds' sickness and death. Reports by the National Wildlife Health Laboratory (1981, 1983) described pathological testing of the dead gull and waterfowl carcasses, revealing the presence of botulism C toxin. Park personnel were trained in testing limnologic conditions of East and West Pond and were urged to remove carcasses immediately to reduce transimssion by carrion feeders. Later results (1983) revealed a reduced death rate. An updated bibliography on the occurrence of avian botulism was supplied by Wilson and Locke (1982).

Shorebirds

An early field account by Jacobson (1947) described a stranded Herring Gull that had become entangled in beach refuse. Buckley (1966) reported on foot-paddling, behavior observed for the first time in Bonaparte's Gulls (*Larus philadelphia*). Common in ducks, paddling behavior may serve to uncover small invertebrates in marshy areas. Beatley (1976) examined the interrelationship between Herring Gulls at West Pond in Jamaica Bay. Later (1978), Beatley surveyed the sea gull population at Jamaica Bay Wildlife Refuge. He conducted a population growth analysis to determine the seasonal growth patterns at selected areas of the refuge and investigated food resources and predation by gulls upon other bird species. He found no evidence to suggest a serious gull predation problem. The following prey items were noted: *Spisula* spp., *Mytilus* spp., *Callinectes* spp., *Uca* spp. and *Limulus* spp. A breeding colony of Laughing Gulls was discovered by Post and Riepe (1980) on JoCo Marsh. Twelve to fifteen pairs of birds were found nesting; the first documentation of breeding species in the area since they were extirpated by overzealous eggers and plumage hunters near the end of the Ninteenth Century. Burger (1981a) studied the movements of juvenile Herring Gulls at Jamaica Bay Wildlife Refuge, finding that the young remain in the vicinity of the breeding colony during the early winter and then disperse into the surrounding area. Further studies of Herring Gulls by Burger (1981b, c) examined the behavioral responses of the species to aircraft noise and the effects of human disturbance on the breeding success of colonial waterbirds, particularly gulls, at Jamaica Bay Wildlife Refuge, respectively. She supplied several non-obvious means of lowering the breeding success of a colony. Among them were decreased incubation and attendance, entanglement of chicks in vegetation, greater energy expenditures for territorial defense and attraction of predators to nest sites. Lastly, Burger (1983) investigated how abiotic factors determined the abundance and distribution of gulls in Jamaica Bay Wildlife Refuge and found that temporal variables were important to Great Black-backed Herring Gulls and that tidal variables were important to these two species as well as Ring-billed and Laughing Gulls. In addition, temperature, wind velocity and wind direction were important factors for all species.

Terns

Post and Gochfeld (1978) examined the recolonization of nesting sites at Breezy Point by Common Terns. Until 1971, as many as 2,000 pairs of terns had nested in the area but fire and flooding caused the birds to abandon the site. Goodrich (1980) discussed ways to enhance the reproductive success of the Least Tern in New Jersey through a program of nest site protection, habitat management and designation of critical areas. Post (1982) conducted an experiment on tern colonies at Breezy Point to determine the influence of control burning of specified areas to attract nesting terns, and recommended bulldozing the burned area. Site stability of nesting Least Terns was investigated (Burger, 1984) from 1976-1982. Results showed high site fiedlity and a low site turnover rate with an average of 22 sites occupied per year, and that the stable sites were most vulnerable to predation. The author suggested that human disturbance accounted for the low reproductive rate of this species.

Skimmers

Cummins (1975b) reported on Black Skimmer nesting at Sandy Hook. About 50 Black Skimmers established a breeding colony in the area during the summer of 1975; 18 nests were successful. However, 12 nests were destroyed by vandalism. IN a follow-up, Cummins (1975b) investigated the extent of damage to the nests and offered suggestions on what may have caused it. Twelve immature Black Skimmers were found decapitated and ten eggs had been destroyed. Children and dog footprints were observed in the area. Burger (1982a) discussed the role of reproductive success in colonly site selection and abandonment in Black Skimmers. In a northern publication the same year, Burger (1982b) investigated the factors effecting the distribution of Common Terns and Black Skimmers at Jamaica Bay Wildlife Refuge. She examined temporal, tidal and weather variables as they effected bird behavior. Feeding methods of each species seemed to account for distributions.

General Colonial Studies

Galli (1978) provided a review of the goals and objectives of the New Jersey States Monitoring program for waterbirds. The goal of the project was to protect and manage specific areas of the N.J. Coastal Zone for perpetuation of colonial waterbirds. Emphases was placed on the preservation of areas that are critical nesting habitats for Least Terns, Black Skimmers and Great Blue Herons. The author recommended continuation of surveys to monitor the status of waterbirds in New Jersey. Burger (1982) provided an overview of factors affecting the reproductive success of colonial waterbirds in Jamaica Bay Wildlife Refuge. In 1983, Burger more specifically investigated the effects of tidal, temporal and weather variables on the distribution of Ibises, Egrets and Herons at Jamaica Bay Wildlife Refuge. She found that the tidal cycle was the most important variable in distribution of these species. Wind velocity and direction were alos important. In the same year Burger (1983b) conducted a study on the flocking behavior of shorebirds in freshwater impoundments and tidal bays. She found that feeding flocks were more likely to be monospecific, where as roosting flocks contained many species. In addition, the number of flocks and the number of species in the flock were influenced by location, activity and environmental variables. Another study by Burger (date unavailable) examined the effect of abiotic factors on the distribution and behavior of marine birds during the year.

Timing and location of the reproductive activities were recorded. Of the more than 230,000 shorebirds consused, 66% were found at East Pond 27% on the bay and 7% at West Pond. A total of thirty-one species ere observed. Shorebirds were found to concentrate on the bay at low tide and then move into East Pon at hightide. Wind, cloud cover and temperature were also considered as factors in distribution.

Waterfowl

Waterfowl at Gateway fall into two categories: permanent residents and transitory migrants. Little research has been done on migrating waterfowl, aside from some censuses and distributional information. The N.J. Bureau of Wildlife Management (1974) conducted aerial surveys to locate wintering waterfowl populations and their distributions for the entire state of

New Jersey. As a result five maps were developed showing the overwintering habitats of ducks, geese and brant. Burger (1983a) investigated the spatial, temporal, tidal and weather factors that influenced the abundance and distribution of brant and Canada Geese at Jamaica Bay Wildlife Refuge. She found that the brant preferred the tidal bay habitat, while the Canada Geese preferred the freshwater ponds. In a similar study Burger (1983b) investigated the factors that affected the distribution of migrating scaup on the freshwater ponds and/or the tidal bay. She found that the freshwater ponds make an impaortant contribution to habitat diversity. Depending on the time of year, position of tide, temperature or wind velocity either the bay or pond was used. And finally, another study by Burger (1984) booked at the factors affecting the distribution and abundance of ducks at Jamaica Bay Wildlife Refuge. She concluded that abiotic factors would influence both the abundance and distribution, and that tidal factors especially should be considered for management of the wintering population of ducks.

Raptors

Several species of raptors are commonly seen at Gateway with the Osprey being the largest, and the hawks being most numerous. All studies in the past have centered on Ospreys. Efforts to establish breeding and protect them were started in the early 1970's. Cummins (1974) reported on the declining population of Osprey on Staten Island. Of the ten nest sites located, only four were successful in raising their young. In a similar survey conducted at Sandy Hook, Griffin (1974) also found ten nest sites, but only four hatchlings were fledged. Also at this time an egg replacement project was undertaken to observe hatching success. The following year, Griffin (1975) replaced eggs existing in two nests with six eggs from the Maryland Osprey program. The four eggs that were removed were artificially incubated and all hatched. In addition hatching of the implanted eggs was monitored. For the 1975 survey, Griffin listed eight nests, five of which were active. In a later survey, that same year, Cummins (1975a) found immature birds in each of the five previously reported active nests. Cummins (1975b) supplied a summary report on the 1975 Osprey nesting season. He identified a total of six immatures produced from four nests (three were taken from the transplant program).

Miscellaneous Studies, Rare Sightings

Bull (1964) discovered a dead Red-billed Tropicbird on a Long Island beach. The bird, which is a pan tropical species, was probably blown off course during a tropical storm. In 1965, Bull determined which bird species visit JFK Airport and attempted to find out why birds were attracted to this area. He found that presence of garbage, sewage outlets, tidal flats and vegetation attracted the birds. Species considered hazardous to aircraft were Herring Gulls and Greater Scaup. Later in 1976, U.S. Fish and Wildlife Service conducted a similar study. They assessed relative hazards to various bird species with regard to overall ecology of the airport area. Recommendations for measures to alleviate bird hazards were also made. Connell (1977) investigated the death of birds due to algal poisoning at Jamaica Bay Wildlife Refuge. It was discovered that the deaths were attributable to the blue green algaes *Gomphosphaeria aponina* and *G. lacustris*. The presence of these algaes indicated outrophication of the lakes, which resulted in oxygen depletion of the hypolimnion. Siebenheller and Siebenheller (date unavailable) reported on the breeding of Pine Siskins on Staten Island. Photographs of New York state rarities include an observation of the rare Wilson's Plover by Davis (1979) and the sighting of a Sharp-tailed Sandpiper by Davis (1981). Burger (1981) examined both the direct and indirect effects of human activity on non-breeding waterbirds. Different responses were noted for the various species; gulls and terns were least disturbed, ducks relocated and herons, egrets and shorebirds flushed and then flew to distant marsh areas. Cooperband (1982) investigated the applications of island biogeography to three islands in the Jamaica Bay Wildlife Refuge with regard to avifauna. Species area, species distance, and species diversity equations were applied to the data that was collected from field observations. The early flat curve that resulted for the species area was attributed to the relative proximity and similarity of the habitats sampled.

MAMMALS

Although Gateway National Recreation Area is situated in a northeastern shore area that is rich in fauna, very little has been written on its mammalian inhabitants. A general work by Conner (1971) lists mammals which are permanent residents and infrequent visitors to the salt marsh and scrub areas which comprise much of this area. Four detailed maps show ranges of the more common species and the sightings of rarer ones.

A similar publication, by the National Park Service (1975) supplied identification, habitats, occurrence, and behavior of more than twenty-five mammals found in the Staten Island, New York area.

Only one study by Medici (1976) focused on a single species, the Eastern Grey squirrel. This survey type research proposed to estimate the population size and distribution within Jamaica Bay Wildlife Refuge. The results revealed a population that appeared to be healthy, (not rabid) and not in direct competition with any previously established species.

The most recent mammalian research was conducted by O'Connell (1980). He investigated abundance and distribution of mammals at Jamaica Bay Wildlife Refuge, Breezy Point and Sandy Hook. In addition a soil analysis was taken at each site to determine nutrient levels and lead concentrations. The results showed low nutrient levels and high lead levels in marsh communities and along roadways. The most common mammal in the New York sites was *Mus musculus*, whereas the most common mammal at the N.J. site was *Peronyscus eucopus*.

ESTUARINE ECOLOGY

Introduction

Gateway National Recreation Area consists of several component parts: the Jamaica Bay Wildlife Refuge, Breezy Point, Staten Island, and Sandy Hook units. Each unit of the park has its own estuarine identify distinct from the other sections. Jamaica Bay Wildlife Refuge, a 9,155 acre area, includes uplands and lowlands surrounded by saltwater, freshwater, and brackish impoundments. The refuge contains two artificial ponds, East Pond (100 acres) and West Pond (44 acres), created in an attempt to increase the variety of available habitats. In Jamaica Bay, the major estuarine system in this area, thirty-eight species of finfish have been observed. The major commercial and sport fish in this are are spot, white perch, striped bass, and summer and winter flounder. The Bay historically has provided vast quantities of shellfish and today still maintains a high density of hard clams, but due to decrease in water quality harvesting is prohibited.

The Breezy Point unit is characterized by numerous groins, jetties, and intertidal sand flats that provide habitats for many aquatic organisms. The most common fish species in this area are bay anchovy and Atlantic silverside.

The Staten Island unit contains tidal wetlands which include rock jetties and groins. The jetties and groins of this area support thriving barnacle- algae-mussel communities. The intertidal areas off the southeastern coast of Staten Island contain several small clam beds. At one time shellfishing was prevalent in this area, but due to the increase in water pollution the clam beds have been closed to the harvest of shellfish.

Sandy Hook tidal areas include mud flats, beaches, jetties, and salt marshes. The mud flats provide a habitat for a variety of invertebrates such as hard clams, polychaete worms, and many mollusc species. The coastal waters of this area suffer from an outbreak of dinoflagellates (red tide) on an unpredictable basis. These organisms if in large enough numbers can cause extensive fish kills. The improvement of water quality may in time prove to be the solution to the red tide penomenon (Gateway National Recreation Area Statement for Management, USDOINPS, 1976).

An early study by Martin (1929) inventoried dinoflatellates from marine and brackish waters in New Jersey. Two studies evaluated the phytoplankton populations in and around the Raritan Bay. McCarthy's (1965) study was of an ecological nature, whereas Kawamuras (1966) study was more of a physical nature. He investigated the relationship between the hydrographic conditions in Sandy Hook Bay and the distribution of phytoplankton populations. Sage and Herman (1972) studied the seasonal and regional distribution of the zooplankton and selected physio-chemical factors of Sandy Hook Bay. Substantial fluctuations in the physio-chemical parameters were attributed to the geomorphology of the area. The maximum density (5200/m_) was present in mid-March. The catch was dominated by calanoid copepods (81%) with cladocerans comprising 8% and samplii 4%. Simeone (1977) conducted a preliminary survey of the intertidal benthic macrofauna of Sandy Hook Bay. A total of twenty five species were collected. Two types of communities were characterized; one dominated by bivalves on protected fine sand beaches, and the other dominated by oligochaetes and neinatodes on exposed coarse sand beaches. The author concluded that low species diversity may have been an indication of past and present poor water quality of Sandy Hook Bay. Weinstein (1977) compiled an atlas of the biological resources of Hudson estuary. Such basic information as abundance, frequency of occurence, seasonal variation and distribution of the vegetation and animal species found over a 120 km stretch from N.Y. Harbor and Poughkeepsie was recorded. Olsen and Cohn (1979) conducted a four year survey of the phytoplankton of Lower New York Bay and its associated coastal areas the most intense sampling was carried out near Sandy Hook. A total of 332 species, representing nine classes of algae were recorded. Seven species were considered seasonal dominants, and 208 species were newly recorded for the area. Brinkhuis (1980) assessed the effects of suspended sediments on various faunal elements within Jamaica Bay. Sand-mining strategies which minimized suspended sediments to within reported tolerance ranges of "critical species" were evaluated.

The Lower Bay was found to be relatively ? with respect to its faunal component. There appeared to be an undetectable impact of sand-mining pits on species abundance. It was concluded that sand-mining has little effect on the biota although it may have an impact on circulation patterns, tidal currents, tidal amplitude. In a series of studies on the benthic fauna of Jamaica Bay, Franz and Harris (1981, 1982a, 1982b, 1983) determined diversity, density and biomass of the community. The molluscan populations appeared to be at their highest density during the spring and the peack coincided with the period of greatest run off. The authors also found the presence of heavy metals in some molluscs at the National Park Service benthos survey station. Makowski (1982) compared the protogoan populations of West Pond and Jamaica Bay areas. This study examined diversity of genera and compared the macro and microenvironmental parameters on a general basis. The major macroenvironmental difference discovered was the overabundance of *Phragmites sp.* in West Pond, presumably due to a decrease in salinity.

CULTURAL, HISTORICAL

Introduction

Gateway National Recreation Area is a composite of coastal areas from two states, and spans over 100 miles; including acreage in one of the largest and busiest cities in the world, New York City. Curiously, this park area, one of the most visited in the country, has relatively little documentation of its long and interesting past.

The sketchy background that does exist has, for the purposes of this report, been divided into the following groupings: general works dealing with the Gateway unit as a whole; and works dealing with each individual unit; Sandy Hook, Jamaica Bay, Breezy Point, and Staten Island.

General Works

Rattray (1973) traced the beginnings of the Life Saving Service in the New York area. A cultural history of the New York units of Gateway (Breezy Point, Jamaica Bay, and Staten Island) National Recreation Area was compiled by Wrenn (1975). More detailed surveys, especially of archeologic sites and structures was included in a technical report by the National Heritage Corporation (1977). A cultural resources inventory was compiled by Roberts (1978). The National Park Service (1978) Cultural Resource Management Division compiled a listing of the classified structures of historical interest in all the Gateway Units. A popular account of the recreational aspects of the Gateway units was written by Levanthes (1979). In addition to heautiful photographs, the article pointed out how the parks are easily accessible to the handicapped. Several useful bibliographies pertaining to the entire park include: an annotated bibliography of cultural resources supplied by the Office of New Jersey Heritage (1980), a bibliography of archeological surveys compiled by the New York Archeological Council and the New York State Historic Preservation Office (1980), and finally a cultural resource management bibliography compiled by Pitchaithley (1984).

Sandy Hook

The New Jersey coastline is rich in history. Smith (1963) provided a brief history of the Sandy Hook area and its development. Included was information on early explorers such as Henry Hudson and John Cabot. In addition, native indians of Monmouth County, the early white settlers in the area Fort Hancock, and the twin lights were discussed just to name a few. Moss (1964) provided a comprehensive history of Sandy Hook, including its role in the American Revolution. The U.S. Army Corps of Engineers (1964) provided a factoral history of selected structures along the New Jersey coast from Sandy Hook to Cape May. In addition, Esselborn (1965) have also provided a descriptive history of the Sandy Hook area.

Sandy Hook has many sites of interest due to its long use as a fortified trading and recreation area. Roberts (1977b) compiled an inventory of sites of cultural interest at Sandy Hook. Bianchi and Rothschild (1978) surveyed archeological sites at Sandy Hook. In that same vein Linch (1980) conducted an archeological survey at North Beach. The National Park Service (1981) conducted a physical resource inventory of the area. Fortification played an important role in Sandy Hooks' history. Several publications have dealt with Fort Hancock and other associated structures (Hoffman, 1975; Banchi and Rothschild, 1978b; Simpson and Sulam, 1979; Sulam, 1979; Walter and Sulam, 1979 a,b; and Bearss, 1981, 1982b, 1983 a,b).

The first lifesaving station in the national was established at Spermaceti Cove in 1848 (USDOINPS, 1976). Several other outposts were established along the Hook. Bennett (1976) provided an historical account of the lifesaving services on Sandy Hook, in addition he also supplied an historical account of several shipwrecks that occurred in the area from 1871-1906. Hoffman (1976) also wrote of the U.S. Lifesaving Service at Sandy Hook. In 1980, Bennett more specifically looked at the Spermaceti Cover lifesaving station. Bearss (1982) reported on the intricate lighting system that was established for the lighthouse beacon and the inhabitants' quarters. Later in 1983, Bearss conducted an historical resource study at Spermaceti Cove.

Jamaica Bay

An inventory of the cultural resources of Jamaica Bay was compiled by Roberts (1977d). An informative history of the area was compiled by Black (1980). In this report Black discussed the historical beginnings of Jamaica Bay. The area had originally opened up as a result of trading between the Canarsie Indians and the early Dutch settlers. The area flourished as a trade center up through the Civil War and then was greatly developed for trade and transportation, centering around the Canarsie Pier. Unfortunately due to the industralization of the area, pollution levels increased considerably. Jamaica Bay was long known as a sewage dump site, and the problem still exists today. As New York City grew, the area surrounding Jamaica Bay was opened up by new roads and bridges. The park service began setting aside this valuable natural resource in the 1930's. Black (1981) traced the cultural history of Jamaica Bay. He reported on human use of the area from 1600-present documented in agriculture, commercial exploitation of shellfish and the recreational use of the area by the urban population.

Military outposts within the Jamaica Bay Unit have greatly influenced its history. Floyd Bennett Field was constructed on Barren Island. It never achieved financial success, however its remoteness made it ideal for several pioneer aviators; Wiley Post, Admiral Byrd, Howard Hughes and Amelia Earhart, to name a few (USDOINPS, 1976). Several reports focused on the historic value of Floyd Bennett Field, they include, Homes, 1979; Blackemore, 1981; Blackemore and Finch, 1981; and Simpson, 1981.

Breezy Point

Previous to its present development, Breezy Point was a natural barren sandbar. Lofaro (1973) compiled a history and provided a sociological profile of the inhabitants of the ethnic community at Breezy Point. His paper has included interviews and provided a very readable dissertation on the cause and affects of creating a private cooperative community with Breezy Points' special geographical isolation. Roberts (1977c) conducted an inventory of the cultural resources of the Breezy Point Unit. Two resort communities have developed into permanent towns; Rockaway and Breezy Point. Rockaway which was developed earliest, contains residential and commercial areas. This area has recently seen a revival in government renewal funds and a new interest in port and waterway areas. Kopper (1979) documented a dredging project for East Rockaway Inlet.

Fort Tilden has served both U.S. Army and the U.S. Coast Guard, it was named for the 1876 Democratic presidential candidate Samuel J. Tilden and duuring WWII served as an important coastal defense installation (USDOINPS, 1976). Two historic structure reports are available on this landmark (Torres, 1980) and (Linck, 1981).

In 1912 the city acquired the land that is presently called Jacob Riis Park, which was named for a 19th century journalist. In 1937, it was officially opened to the public (USDOINPS, 1976). This large beach area is well known for its large stadium-like stone beach house. Riis Park has reflected the times as presented by Williams and Kornblum (1974). This report along with an associated paper by Williams (date unavailable) outlined segregation at the park. Patterns of integration and segration were analyzed and spatial organization of users was established on the basis of group characteristics i.e. white, black, gay, straight, and latin. In addition two reports focused on structural resources and provided renovation suggestions for Jacob Riis Park (Linck, 1980) and (Unrau, 1981).

Staten Island

Staten Island was first discovered by Verrazano in 1524, then 85 years later rediscovered by enry Hudson. In the mid 1600's the area began to be settled by the Dutch. It wasn't until the completion of the Verazano Narrows Bridge in 1964 that the island really began to develop into a commercial and residential area (USDOINPS, 1976). Roberts (1977c) provided a cultural resources inventory for the Staten Island Unit. The Park Service (1977) compiled a list of some ecologically and culturally sensitive areas near Millers Field. Lipson (1978) provided a cultural resource reconnaissance. Bougher-Perlin (1980) reported on

historical land use patterns on Staten Island. The author concluded that more archeological work was needed at Fort Wadsworth and at Miller Field.

Most of the historical sites at Staten Island are military in nature. Two reports centered on the cultural and historical aspect of Fort Wadsworth; (Scott, 1980) and (Black, 1983). Miller Field, another military landmark, was developed in 1918 as a site for hydroplane hangars. Several studies have been conducted on this historical resource as well; Unarau, 1978; Unaru and Powell, 1979; Powell and Unaru, 1981; and Syneuki, 1981.

MANAGEMENT, LEGISLATION, RECREATION, MISCELLANEOUS

Gateway: Studies concentrating two or more units

Introduction

This section includes reports concerning two or more units of Gateway National Recreation Area. Most of the reports deal with in-park management policies and strategies or management of the coastal area in general.

Park Management

In 1975, the National Park Service supplied a Statement of Management for Gateway. The following year (1976), the Park Service provided an update of the previous years management guidelines and an environmental assessment of the area. In 1977, an interpretive prospectus for all four units was compiled by the Park Service. Hoffman (1978) proposed a wayside exhibit for Gateway. Leatherman et al. (1978) analysed the management strategies for several of the northeastern seashores, including Gateway. The dynamic character of barrier islands was discussed; it was felt that the "let nature take its course" policy coudl only be effectively applied to those areas where natural processes have not been severely interupted. Soukup (1978) reported on mosquito control policies in the North Atlantic region. The National Park Service (1978) published two management documents concerning the general management plan of the park. One, a draft environmental statement, provided a guide to overall park management and development for many years in the future; and the second, a decisions paper, discussed some of the more controversial decisions made by the Park Service such as; the protection of tern nesting sites by snow fences and signs and the use of the holly and deciduous forests, by reservation only. In 1979, Held and Mizobe studied the impact of auto emissions from park visitors on the air quality in New York and New Jersey. Results indicated that there was a decrease in auto emissions due to the change in auto emission laws. Stone et al. (1979) reported on fire management policies at Gateway. This park has had more reported fires than any other National Park. Also in 1979, the Park Service published another environmental statement as a part of the General Management Plan. Risk (1980) reported on the interpretive services of several sites in the North Atlantic region, including Gateway. And finally in 1981, resource management plan was published. Topics included erosion and shoreline dynamics, fish and wildlife management, wetlands preservation, and cultural resource management among others.

Land-Use

Leone (1975) investigated tolerance of vegetation to landfill conditions. Also included was a discussion of ongoing experiments dealing with vegetation and landfill soils Kornblum (1975) reported on land use and population trends in the Gateway area. Several authors have investigated the possibility of the revitilization of the New York City waterfront area. Moss and Drennan (1976) analysed municipal ownership and leasing of the public land in the area. The New York City Department of City Planning (1982, 1984) investigated revitilization possibilities in the waterfront area. In Staten Island, freshwater wetlands, Last Chance Pond and the South Beach Boardwalk were considered for planning and at Jamaica Bay, the Plumb Beach area was considered.

Visitor Use

Palmer (date unavailable) supplied a status report on off-road vehicle use in coastal National Parks, including Gateway. The Tri-state Regional Planning Commission (1973) investigated a plan for the acquisition of land for recreational use. Gateways first summer season was evaluated by Canavan and DiFazio (1974). Kornblum (1974) supplied a social profile of the park visitors by personal interviews. The results indicated that the poor and carless do not use Gateway much. Linday, Kornblum and Williams (1975) reported on special interest groups at Gateway.

Carls (1978) gave an overview of recreation in the New York Bight area, included was a discussion of available facilities. The National Park Service (1979) put out a series of reports dealing with public involvement, population trends and visitor use and activities at Gateway. And finally, the most recent publication concerning visitor use at Gateway was written by Vernon (1981). It consisted of a popular account of the recreational aspect of the park area.

Coastal Zone Management

Psuty et al. (date unavailable) compiled a guide to the decision-making processes involved in planning and development of the New York Bight shore area. Godfrey (1975) presented comments on the current beach management philosophy as it related to Gateway National Recreation area. He re-emphasized the current policy - "let nature take its course" and pointed out that it needed to be applied selectively to certain areas of the park.

Management of the New York shore zone was investigated by Heikoff (1978). He supplied overviews of the following management areas; geography, land-use regulation, hazardous areas, shellfish, wetlands, recreation and water quality. The author has supplied a good integration of physical, biological, economic and social impacts on the shore areas of New York. A two volume report on the coastal management program of New York was prepared by the New York Office of Coastal Zone Management (1982 a,b). Included was a comprehensive management program for coastal land and water use. The authors stated that the program will improve the decision-making processes used in determining the appropriateness of certain actions in the coastal area. Also existing laws and regulations were presented. Tanacredi (1983) explored the implementation of management activities at Gateway. In particular, beach and marsh stabilization, water quality of public beaches, improvement of wildlife habitats and research priorities at the park were investigated. Also included were descriptions of each of the six management zones at Gateway; 1) protection, 2) use by reservation, 3) beach, 4) unstructured recreation, 5) structured recreation, and 6) development.

Resource Inventories

Dames and Moore (1976) compiled a resource inventory of the Gateway area. The result was a compendium of information on shore habitats, flora, fauna, geology, water quality and climate of the park area. A later report also prepared by Dames and Moore (1979) consisted of environmental inventories of the area.

Pollution

Due to Gateways' proximity to a major metropolitan area, pollution and waste management are everpresent problems. Klashman et al. (1967) reported on pollution control practices in the Raritan Bay area. With the results of water pollution sampling over a two and a half year period the authors concluded that municipal treatment facilities should provide a minimum of 80% removal of suspended solids, and in addition; industrial plants should provide maximum reduction of pollutants, as well as waste treatment facilities on all vessels in the bay. Hubert (1971) reported on sewage and waste disposal for New York City. The New York City Department of Environmental Protection (1978) published a summary on an areawide waste treatment program. The objective was to improve water quality in New York Harbor and adjacent waterways. The study identified wastewater related problems and deficencies and developed economic and environmentally sound management strategies to be implemented. Marks and Levy (dat unavailable) investigated an alternate means of removal and disposal of heavy debris from the Jamaica Bay and Breezy Point units. This report identified the types of debris found; such as old automobiles, construction debris, driftwood, barges and old boats and then supplied recommendations for their removal and disposal.

Miscellaneous Reports

Zinn (1975) compiled a field guide for beachcombers that included information on the ecology, habitats and wildlife of the area. Psuty and Hanna (1983) presented a proposal to establish a cooperative agreement between then North Atlantic Regional Office of the National Park Service and Rutgers University. The main proposal consisted of a series of technical

proposals that demonstrated the range of research interests and experience that ecisted at Rutgers University. Tanacredi and Farrugio (1984) discussed a beach nourishment project that entailed dune development by planting beach grass for stabilization.

Gateway: Sandy Hook Unit

Introduction

The Sandy Hook unit has approximately 4,600 acres of land contained in the peninsula at the northern end of the New Jersey coast (USDOINPS, 1976). Most of the studies done in this unit concern beach nourishment projects and in-park management.

Park Management

The Bureau of Outdoor Recreation (date unavailable) published a report on development alternatives for the preservation of Sandy Hook for outdoor recreation. McCaffrey et al. (1977) prepared a natural resource management plan for the Sandy Hook unit. A recreation capabilities plan was prepared by Howard, Needles, Tammen and Bergendoff Gruzen and partners (1979) for Sandy Hook. And also in 1979, the National Park Service put together a general management plan for the Sandy Hook unit.

Coastal Zone Management

The New Jersey Department of Environmental Protection (1980) presented their proposal for the New Jersey coastal management program and in addition, provided a draft environmental impact statement. Their objective was to determine and describe a strategy for the protection and development of the New Jersey coast.

Beach Nourishment

Beach nourishment is an important issue for Sandy Hook. Several programs have been implemented to preserve the beach and protect against breakthroughs. In order to keep Sandy Hook accessable for visitor use these types of programs must be a continual part of the parks operation (USDOINPS, 1976). Sherman (1977) and Sherman et al. (1977) compiled an inventory of nourishment alternatives for the South Beach area of Sandy Hook and then assessed each of them as a possible means of protection. In 1978, Sherman analysed the public response to the previous years assessment of alternatives for the restoration of South Beach. The National Park Service (1978) also provided an assessment of the alternatives for the reestablishment and maintenance of the South Beach area. Nordstrom (1979) provided management considerations with regard to beach nourishment at Sandy Hook. The authors concluded that fill materials available through channel maintenance should be used on a regular basis to replace the sand that is continually eroded from South Beach. And finally, in 1932, Nordstrom et al. provided two volumes that assessed shoreline management problems and strategies at Sandy Hook.

Pollution

DeFalco (1967) provided a report on pollution of the Raritan Bay and adjacent waters. The Monmouth County Environmental Council (1979) reported on the environmental quality of Monmouth County, New Jersey. Included in the report were results that pertained to the water quality of Sandy Hook. In 1977, the Denver Service Center of the National Park Service published information pertaining to wastewater disposal alternatives for Sandy Hook.

Miscellaneous Reports

Mekenian (1968) inventoried the flora and fauna within the Sandy Hook unit and tied in implications of rthe management of recreation and visitor use within the park. The Monmouth County Planning Board (1971) provided an open space plan for a fifteen year period which included several sites within Sandy Hook. In 1983, the U.S. Army Corps of Engineers

provided an environmental impact statement that dealt with the disposal of dredged material from the ports of New York and New Jersey. Included were anticipated problems during heavier than normal dredging, areas of controversy, costs of disposal, current disposal methods, federal legislation, public conern, recent court decisions and unresolved issues.

Gateway: Jamaica Bay Unit

Introduction

Land-Use

Freund (1971) discussed land-use options for Floyd Bennett Field (FBF), in addition to providing a brief history of the area he disucssed competing land-use proposals for the area and its suitability for recreation. Hammerschlag (1977) also reported on planning efforts for Floyd Bennett Field. This report consisted of a discussion of research needs and development plans, in addition a description of the physical nature of the area was provided. Several consulting firms (Friedberg and Partners, Hardy Holzman Pfieffer Associates, Edwards and Kelsey, Inc. and the Trans Urban East Organization, 1980) supplied an environmental inventory and preliminary land-use program for Floyd Bennett Field. The purpose was to provide a data base of information necessary for future planning and decision-making. Physical data on soil conditions, groundwater, toxic wastes, air quality and erosion were included. In 1982, Alderstein prepared a development concept plan and assessment for Floyd Bennett Field. Cook (1984) proposed the creation of a small freshwater pond to increase habitat diversity.

Visitor Use

Schonhaut (1975) reported on human activity at Canarsie Pier. Single et al. (1975 a,b) investigated visitor use and impact at Jamaica Bay Wildlife Refuge. And later in 1979, the National Park Service also filed several reports regarding visitor impact at the Refuge.

Wildlife Refuge

Dunkesan and Cunningham (1976) prepared a natural resource maintenance plan for the Jamaica Bay Wildlife Refuge (JBWR). Management problems and strategies concerning the garden areas, vegetation control, avian botulism, water quality, visitor control, fire management and stray animals were discussed. Another environmental assessment which conerned the resulting impacts of dredging West Pond was provided by Felkel and Peterson (1976). The objective was to assess the impacts of all possible alternatives (mechanical dredging, hydraulic dredging, land-based evaluation after pond de-watering or no action). Single (1976) conducted a one year visitor use and impact study at the refuge. Results showed that peak visitation occurred during bird migration season, especially on weekends and during the morning hours. Cunningham and Nebel (1979) prepared a status report on the refuge. Included was a discussion on the acquisition of JBWR from the New York City Parks Department, avian botulism, technical problems involving water quality, public relations needs and visitor use of the area. Cook (1981) provided a status report on water level control devices at JBWR, in particular the pipes in West Pond which are used to prevent salt water intrusion. Also included in this report were useful statistics on the salinities of Jamaica Bay and West Pond. And finally in 1983, Cook reported on fire management at JBWR. Opinions on fire management policy and procedure were discussed.

Pollution

The New York City Department of Health (1954) conducted a sewer outlet survey in order to determine the extent of pollution from the sewage discharge of private and municipal structures. Results showed that the majority of the privately owned type were not included on the governmental maps. The New York State Conservation Department (1967) examined hard and soft shell clams from Jamaica Bay for microbiological analysis. Armstrong et al. (1970), using Jamaica Bay as an example, discussed the necessity of incorporating basic ecological

principles into the planning and policy making of water pollution control. Ludwig and Associates (1974) compiled a three year two volume report on the Spring Creek Auxillary water pollution control project. Results showed that the effluents of water pollution control facilities were the major sources of organic and nutrient materials being discharged into Jamaica Bay. In addition it was found that the combined sewage outfalls represented a significant source of solids and coliforms into the bay. It was also found that Spring Creek Auxillary aided in reducing overall pollution from the combined sewage outfalls into Jamaica Bay. Feurstein and Maddaus (1976 a,b) also investigated the environmental quality of Jamacia Bay. They specifically examined the water and soil quality of the Bay. In 1982, Parsons Brinckerhoff-Cosulich investigated evidence that a private waste hauling company was illegally disposing of liquid chemical wastes at a New York City landfill between 1974-1979. Results did not indicate that there had been a large scale dumping of industrial wastes, all leachate concentrations met EPA toxicity standards.

Miscellaneous Studies

Carroll (1968) supplied a general report on the preservation of Jamaica Bay. The author discussed the need for a balance between urban development and maintenance of natural areas. Such topics as industry, housing development, airport expansion and sewage disposal were included. It was concluded that the inner bay area should be preserved at all costs for its wildlife value, and that no channel improvements should be made within the area. In addition, it was suggested that boat traffic be discouraged. The Jamaica Bay Environmental Study Group published two volumes that dealt with the ecological effects on Kennedy Airport, on the adjacent Jamaica Bay ecosystem. They concluded that the airport was "a great environmental hazard to the surrounding area" and that construction and operation of Kennedy Airport had adversely affected the ecological viability of the Bay. McGrath (1971) also examined the airport problem. He presented a multidisciplinary approach to tackling the specific problem of competing demands on the environment from air transportation, housing, and recreation, which all converge in the Jamaica Bay area. Howard, Needles Tammen and Bergendoff (1981, 1982, 1983) provided several reports that concerned the replacement of the North Channel Bridge and subsequent environmental problems expected to occur. Gay and Tanacredi (1982) examined the possibility of shoreline stabilization through marsh restoration. The U.S. Naval Base (1982) provided a preliminary assessment for the proposed homeporting of four ships at the Floyd Bennett Field Naval Air Station. They concluded that the proposed docking would not significantly affect the existing local environment. Copeland and Crowley (1984) conducted a survey of activities being carried out in the bay area recommendations were made in an effort to assist the National Park Service in improving the environmental quality of Jamaica Bay.

Gateway: Staten Island Unit

Introduction

Park Management

Two shore protection studies were undertaken with regard to the Great Kills bathhouse at the Staten Island Unit. The FederalHighway Administration (1980) developed a concept study for beach protection at Great Kills Park and the National Park Service (1983) provided a draft environmental assessment along with maps of the area.

Environmental Impact Studies

The U.S. Coast Guard (1974) published an environmental impact statement for the Port of New York, Hudson River and Long Island Sound in reference to vessel traffic in the area. Kassner and Company, Inc. (1975) evaluated the existant sanitary and storm water sewers of the Oakwood Beach area. Godfrey and McCaffrey (1976) provided a review of the beach erosion control and hurricane protection projects for Richmond County, New York. A project manual for dike construction at Great Kills was compiled by the Denver Service Center of the National Park Service (1979). Tanacredi (1981) reported on the running of a sewer line through the

ecologically sensitive Swamp White Oak Forest at Miller Field. The Denver Service Center (1981) reported on dike construction at the Staten Island Unit. And finally, an environmental impact statement for the area between Fort Wadsworth and Arthur Kill was prepared by the U.S. Army Corps of Engineers (date unavailable).

Miscellaneous Reports

Weingarten et al. (1969) surveyed the William T. David Wildlife Refuge. The National Park Service (1983) provided a design analysis for Great Kills Park.

Gateway: Breezy Point Unit

Introduction

Park Management

An environmental assessment of off-road vehicle use at Breezy Point was provided by the National Park Service (date unavailable). Included were descriptions of administrative problems and the environment, also several alternatives to the off road vehicle problem were reviewed. Godfrey (1975) made several recommendations regarding proposed ORV use in the unit. His primary recommendation was for no vehicle access, however, he stated if there must be access, it would be best to make it the shortest distance from the departure area to the point. He also recommended that whatever route was finally chosen that it should not pass through any salt marsh areas. Campbell et al. (1977) presented an environmental assessment of possible development in the Breezy Point Cooperative.

Jacob Riis Park

Human activity at the west end of Jacob Riis beach was investigated by Cook (1975). Beyer, Blinder and Belle (1983) studied the conditions of the bathouse at the park. McIntosh (1983) investigated the possibility of partial closure of Bay 1 at Riis Beach. Heavy use at this section of the beach was thought to have presented a threat to visitor safety. However, the author found no significant impact and concluded that an environmental impact statement not be prepared.

Transportation

Baker (1974) discussed public transportation access to Breezy Point. Several possible modes of transportation were presented; bus, ferry, subway and helicopter. The final recommendation was for an express bus service between Avenue U on the Brighton Beach line to Jacob Riis Beach. Two independent consulting firms, Morrissey-Johnson Consulting Engineers (1978) and Basil Engineering Corporation (1981) evaluated possible waterborne transportation from Coney Island to Breezy Point. Such factors as cost, environmental impact and possible docking sites were discussed. Fort Tilden was recommended as a possible site for development of docking facilities. Also as a part of this water transport study, Antosca (1982) investigated possible impacts of Ft. Tilden Pier reconstruction on the surrounding area. No significant impact was found.

Miscellaneous Reports

The U.S. Army Corps of Engineers (1977) filed several reports that concerned the monitoring of borrow areas with regard to the Rockaway Beach erosion control project. The National park Service (1979) completed several reports on the Breezy Point Cooperative.

BIBLIOGRAPHIES

Bibliographies provide important information sources especially for seashore such as Gateway which contain several scattered units. The Environmental Science Information Center (1974) compiled a bibliography of publications concerning the New York Bight, which included hundreds of listings intended to aid the scientist, planner or decision maker. Hundreds of citations are categorized and cross-indexed by subject, geographic location and objective. Information is included from the New York Bigh coastal zone, which extends from Montauk Point, New York to Cape May, New Jersey. The office of New Jersey Heritage (1980a,b) compiled two bibliographies of cultural interest. The first was a cultural resource survey; the other an archeological survey. Jamaica Bay Wildlife Refuge which is situated inside New York City is probably the most metropolitan park area. It is faced with unique problems or urbanization and much research has been done in the area during recent years. Two bibliographies (Black, 1980) and (Deacy, date unavailable) contain listings of most of this research. A large reference work by the Ocean Assessments Division of NOAA at Stony Brook (1983) included such topics as environmental and coastal geomorphology as well as other issues. The Marine Science Research Center of the State University of New York (1984) published an annotated bibliography of the Hudson-Raritan estuarine system. This compilation updated much of the research concerning coastline management and pollution control. Pitcaithley (1984) compiled a cultural resource management bibliography for the northeast region of the U.S. Tiedemann (1984) compiled a bibliography of non-technical marine environmental topics concerning New Jersey and New York. Also included were maps of the area and a complete listing of field guides related to the area.

MAPS, CHARTS, AND AERIAL PHOTOGRAPHS

Order of contents

ABBREVIATIONS

AIRPHO	Air-Photographics, Inc.
ANON	Anonymous
ASCS	Aerial Photography Field Office
CACO	Cape Cod National Seashore
CCES	Center for Coastal and Environmental Studies
DMA	Defense Mapping Agency
EROS	Earth Resources Observation System
GATE	Gateway National Seashore
MANN	Mann Library, Cornell University
MONCPB	Monmouth County Planning Board
NARO	North Atlantic Regional Office
NASAJS -	
NOS	National Ocean Survey
ROBASI	Robinson Aerial Surveys, Inc.
SCS	Aerial Photography Field Office
TXAERO	Aero Service Corporation
TXPIC	Petroleum Information Center
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDOIFWS	United States Department of Interior, Fish and Wildlife Service
USDOINPS	United States Department of Interior, National Park Service
USDOINPSDCS	United States Department of Interior, National Park Service, Denver Service Center
USDOINPSNARO	United States Department of Interior, National park Service, North Atlantic Regional Office

Aerial Photographs

Introduction

Aerial photographs are listed in chronological order in the following format: Producer, Date, Location, Scale, Type, Source.

Producer: listed as found in citations, indexes, and on photographs. If producer is not given it is listed as an Anon.. Addresses of producers are included in the Source address list.

Date: xxxx(xx/xx), year of overflight, month, and day if known.

Location: given by present-day towns and feature names.

Scale: given as the representative fraction (i.e. 1:24,000) or as unknown.

Type: indicates if photo is black and white (BW), black and white infrared (BWIR), color (COL), or color infrared (CIR). If photos of the same date are available in two different types this is indicated.

Sources: indicates the agency from which aerial photographs may be purchases, copied, or viewed. Unless otherwise noted the sources are the same as the producers. Addresses of sources are included in the Source address list.

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Format: author, date, title, scale, contous, field survey, revision dates, etc., publisher, source.

Author: person or group that did cartography

Date: taken from citations and maps

Title: taken from citations and maps

Scale: given as the representative fraction (i.e. 1:24,000) or as unknown

Contour: information given where appropriate

Field survey: field survey date, given where appropriate

Revision date, etc.: date revisions were made of previous copy

Publisher: first name given after scale (or after contour, field survey, and revision date, where appropriate) if two are presented. Many times this will be missing and only source will be give. Addresses will be given in source address list.

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Topography Maps

Gateway National Seashore is divided up into 4 units: Breezy Point; Jamaica Bay; Sandy Hook; and Staten Island.

- Breezy Point - Coney Island quadrangle
- Jamaica Bay - Brooklyn Quadrangle
Coney Island Quadrangle
Far Rockaway Quadrangle
Jamaica Quadrangle
- Sandy Hook - Sandy Hook Quadrangle
- Staten Island - Arthur Kill Quadrangle

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The National Ocean Survey (NOS) was formerly known as the United States Coastal and Geodetic Survey. Copies of original plane table surveys of the National Ocean Survey can be obtained from the National Archives by specifying place name, county, and state location. Surveys and charts are listed in chronological order.

NOS Hydrographic Surveys

Format: year, number of map, title, scale

Year - year of survey

Number of map- number used for identification

Title - area covered by chart

Scale - given as the representative fraction (i.e. 1:24,000)

Source - charts can be obtained from the United States Coastal and Geodetic Survey and older surveys from the National Archives Addresses included in the source address list.

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Jamaica Bay

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1928, T-4408, Interior of Jamaica Bay, 1:10,000
1928, H-4869, Interior of Jamaica Bay, 1:10,000

Sandy Hook

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A description of the National Ocean Survey (NOS) is given in the previous section. Charts are listed in chronological orders.

Format: date, title, number, scale, number of historical editions.

Date: date of latest edition

Title: area covered by chart

Number: present number, date of number change, previous number

Scale: given as the representative fraction (i.e. 1:24,000)

Number of historical editions - number of historical editions and time span.

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NOS, 1981, Raritan Bay and Southern Part of Arthur Kill, as of 9/74 #12331 070174. 1:15,000, 22 historical editions 1924-1979, NOS
NOS, 1982, approaches to New York, Nantucket Shoals, Loran A-C, 1:400,000, 1 historical edition 1980, NOS
NOS, 1982, Cape Sable to Cape Hatteras - Loran A-C, as or 8/74 #13003 070174 previously #1000, 1:1,200,000, 32 historical editions 1900-1978, NOS
NOS, 1982, New York Harbor, as of 2/75 #12328 070174, 1:40,000, 16 historical editions 1963-1980, NOS
NOS, 1982, New York Harbor, US East Coast, as of 7/74 #12327 070174, 1:40,000, 37 historical editions 1940-1980, NOS
NOS, 1982, Sandy Hook Bay New York Harbor - Lower Bay, as of 8/74 #12330 070174, 1:10,000, 10 historical editions 1969-1980, NOS
NOS, 1982, West Quoddy Head to New York, as of 8/74 #13006 previously #60, 1:675,000, 22 historical editions 1935-1980, NOS
NOS, 1983, Approaches to New York, Fire Island Light - Loran A-C, as of 10/74 #12326 070174, 1:80,000, 33 historical edition 1914-1981, NOS
NOS, 1983, Jamaica Bay and Rockaway Inlet New York, as of 12/75 #12350 070174, 1:20,000, 36 historical editions 1924-1980, NOS
NOS, 1983, Sandy Hook ot Little Egg Harbor, NJ, as of 12/74 #12324 070174, 1:40,000, 18 historical editions 1962-1980, NOS

Topographic Maps

Topographic maps are divided up by quadrangle and then listed in reverse chronological order.

Format: producer, year, title, scale, contour, field survey, photo survey, revised, source.

Producer: agency that produced the map

Date: year map was published

Title: taken directly from topographic map

Scale: given as the representative fraction (i.e. 1:24,000)

Contour: contour interval given in feet

Field Survey: year that area was field checked

Photo Survey: year that area was phot revised.

Revised: year that information was revised from previous editions.

Sources: indicates the agency where the map may be purchases. Addresses of sources are in the source address list.

Gateway National Seashore is divided up into 4 units: Breezy Point; Jamaica Bay; Sandy Hook; and Staten Island.

- Breezy Point - Coney Island quadrangle
- Jamaica Bay - Brooklyn Quadrangle
Coney Island Quadrangle
Far Rockaway Quadrangle
Jamaica Quadrangle
- Sandy Hook - Sandy Hook Quadrangle
- Staten Island - Arthur Kill Quadrangle
The Narrows Quadrangle

General topography

Dripps, Mp., 1872, Map of Staten Island (Richmond Co.) NY, 1:21,120, publisher not given, MANN

Lockwood, Kessler, Bartlett, Inc., 1979, Gateway National Recreation Area Topography Survey Barren Island Marine, 1:480, Lockwood, Kessler, BartlettInc., GATE

Slatkin, D., 1954, Plumb Beach - Burough of Brooklyn - Topographical Map, Dept. of Publish Works, Area Emmons Avenue - Sheepshead Bay, 1"240, City of NewYork, Dept. of Parks, NARO

Topographic Maps

New York and Vicinity

USGS, 1961, Brooklyn, 1:24,000, contour 5' - 10' - 20', USGS
USGS, 1961, Sandy Hook, 1:24,000, contour 20', USGS
USGS, 1961, Staten Island, 1:24,000, contour 5' - 10', field survey 1955, USGS
USGS, 1955, General area, 1:24,000, contour 20', USGS
USGS, 1954, General area, 1:24,000, contour 10' - 20', USGS
USGS, 1947, General area, 1:24,000, contour 10' - 20', USGS
USACE, 1943, New York Harbor/Lower Bay, 1:125,000, contour 50', field survey 1938, photo survey 1938, USGS
USGS, 1913, Long Island, 1:250,000, contour 20', USGS
USGS, 1892, New York-New Jersey, New York sheet, 1:62,500, contour 20', USGS

New York

DMA, 1979, 1:250,000, contour 25' - 50', field survey 1977, photo survey 1977, revised 1979, USGS
DMA, 1971, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
USGS, 1975, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
DMA, 1964, 1:250,000, contour 25' - 50', field survey 1960, USGS
USGS, 1962, 1:250,000, contour 25' - 50', field survey 1946, USGS
DMA, 1960, 1:250,000, contour 25' - 50', field survey 1960, USGS
USGS, 1958, 1:250,000, contour 25' - 50', field survey 1946, USGS
DMA, 1951, 1:250,000, contour 25' - 50', field survey 1946, USGS

New York - Sandy Hook

DMA, 1979, 1:250,000, contour 25' - 50', field survey 1977, photo survey 1977, revised 1979, USGS

USGS, 1975, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
DMA, 1971, 1:250,000, contour 25' - 50', field survey 1960, revised 1969, USGS
DMA, 1964, 1:250,000, contour 25' - 50', field survey 1960, USGS
USGS, 1962, 1:250,000, contour 25' - 50', field survey 1946, USGS
DMA, 1960, 1:250,000, contour 25' - 50', field survey 1960, USGS
USGS, 1958, 1:250,000, contour 25' - 50', field survey 1946, USGS
DMA, 1951, 1:250,000, contour 25' - 50', field survey 1946, USGS

Newark to Sandy Hook

USGS, 1975, 1:250,000, contour 100', field survey 1945, photo survey 1944, revised 1969, USGS
DMA, 1971, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1969, USGS
DMA, 1968, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
DMA, 1964, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
DMA, 1960, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS
DMA, 1950, 1:250,000, contour 100', field survey 1947, photo survey 1944, revised 1947, USGS

Staten Island

USACE, 1921, 1:62,500, contour 20', field survey 1897, revised 1910, USGS
USGS, 1959, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1946, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1932, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1926, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1920, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1913, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1909, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1908, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1906, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1904, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1902, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1900, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1899, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1891, 1:62,500, contour 20', field survey 1889, USGS

Arthur Kill Quadrangle

USGS, 1976, 1:24,000, contour 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1969, 1:24,000, contour 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1962, 1:24,000, contour 10', field survey 1955, photo survey 1954, USGS
DMA, 1957, 1:24,000, contour 10', field survey 1955, photo survey 1954, USGS
DMA, 1957, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
DMA, 1949, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
USGS, 1947, 1:24,000, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS

Brooklyn Quadrangle

USGS, 1979, 1:24,000, contour 10', field survey 1967, photo survey 1977, revised 1977, USGS
USGS, 1975, 1:24,000, contour 10', field survey 1967, photo survey 1966, revised 1967, USGS
USGS, 1970, 1:24,000, contour 10', field survey 1967, photo survey 1966, revised 1967, USGS
USGS, 1966, 1:24,000, contour 10', field survey 1956, photo survey 1954, USGS
USGS, 1966, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
USGS, 1963, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
USGS, 1961, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
USGS, 1960, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
USGS, 1959, 1:62,500, contour 20', field survey 1897, revised 1924, USGS
DMA, 1958, 1:24,000, contour 5' - 10', field survey 1956, photo survey 1954, USGS
USGS, 1955, 1:24,00, contour 10', field survey 1943, photo survey 1940, revised 1947, USGS
DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1940, revised 1947, USGS
USGS, 1948, 1:62,500, contour 10', field survey 1897, revised 1924, USGS

USGS, 1945, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
USGS, 1938, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
USGS, 1931, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
USGS, 1928, 1:62,500, contour 10', field survey 1897, revised 1924, USGS
USACE, 1921, 1:62,500, contour 10', field survey 1897, revised 1913, USGS
USGS, 1916, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1910, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1908, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1906, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1905, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1903, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1900, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1899, 1:62,500, contour 20', field survey 1897, USGS
USGS, 1896, 1:62,500, contour 20', field survey 1889, USGS
USGS, 1891, 1:62,500, contour 20', field survey 1889, USGS

Coney Island Quadrangle

USGS, 1979, 1:24,000, contour 5', field survey 1966, photo survey 1977, revised 1977, USGS
USGS, 1976, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
USGS, 1975, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
USGS, 1968, 1:24,000, contour 5', field survey 1955, photo survey 1954, revised 1966, USGS
DMA, 1957, 1:24,000, contour 5', field survey 1955, photo survey 1954, USGS
DMA, 1949, 1:24,000, contour 5', field survey 1943, photo survey 1940, revised 1947, USGS

Far Rockaway Quadrangle

USGS, 1977, 1:24,000, contour 5', field survey 1969, photo survey 1966, USGS
USGS, 1971, 1:24,000, contour 5', field survey 1969, photo survey 1966, USGS
USGS, 1966, 1:24,000, contour 5', field survey 1943, photo survey 1941, revised 1956, USGS
DMA, 1956, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS
DMA, 1949, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1947, USGS

Jamaica Quadrangle

USGS, 1979, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1977, revised 1977, USGS
USGS, 1976, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1970, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1966, 1:24,000, contour 5' - 10', field survey 1957, photo survey 1953, USGS
DMA, 1959, 1:24,000, contour 5' - 10', field survey 1957, photo survey 1953, revised 1947, USGS
USGS, 1956, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS
DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS

The Narrows Quadrangle

USGS, 1982, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1976, revised 1981, USGS
USGS, 1976, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1969, 1:24,000, contour 5' - 10', field survey 1966, photo survey 1966, revised 1966, USGS
USGS, 1965, 1:24,000, contour 5' - 10', field survey 1955, photo survey 1954, USGS
DMA, 1957, 1:24,000, contour 5' - 10', field survey 1955, photo survey 1954, USGS
DMA, 1949, 1:24,000, contour 5' - 10', field survey 1943, photo survey 1941, revised 1947, USGS

Sandy Hook Quadrangle

DMA, 1983, 1:24,000, contour 20', field survey 1954, photo survey 1975, revised 1975, USGS
USGS, 1977, 1:24,000, contour 20', field survey 1943, photo survey 1970, revised 1970, USGS
USGS, 1972, 1:24,000, contour 20', field survey 1943, photo survey 1970, revised 1970, USGS
USGS, 1969, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS
USGS, 1962, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised1954, USGS
USGS, 1957, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1954, USGS

USGS, 1950, 1:24,000, contour 20', field survey 1943, photo survey 1941, revised 1947, USGS
USACE, 1921, 1:62,500, contour 10', field survey 1910, USGS
USGS, 1919, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1912, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1909, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1907, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1904, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1901, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1898, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1893, 1:62,500, contour 10', field survey 1884, USGS
USGS, 1888, 1:62,500, contour 10', field survey 1884, USGS

Zoning/Land Use-Cover

General

USGS, 1979, New York Land Use/Land Cover, 1:250,000, field survey 1973, USGS
USGS, 1977, New York Land Use/Land Cover, 1:250,000, field survey 1973, 3 sheets: 1 - political units overlay, 2 - hydrologic units overlay, 3 - census-subdivisions overlay

Breezy Point

Caselli, P., 1977, Environmental assessment of development in the Breezy Point Cooperative, 3 sheets: 1 - Roxbury Unit, 2 - Breezy Point, East, 3 - Breezy Point - West, land use, building, zoning, city streets, proposed buffer zone, 1:24,000, CCES - Rutgers University, New Brunswick, NJ, CCES

Staten Island

Anon, 1979, Survey of Property in Gateway National Recreation Area From New Dorp High School to Poultney Avenue, 1:80 publisher not given, GATE

Government Agencies from which Maps and Aerial Photographs can be obtained

The Agricultural Stabilization and Conservation Service (ASCS) of the Department of Agriculture has probably the largest collection of aerial photographs. Both contact prints and a variety of enlargements are available on either paper or on a polyester base. Local ASCS offices (state and county) hold the most recent coverage for their area. A personal visit is recommended to review photography before placing an order -

ASCS - USDA
2505 Parley's Way
Salt Lake City, UT 84109

Defense Meteorological Satellites provide data in the visible/near infrared (0.4 to 1.1 μm) and the infrared (8 to 13 μm). Positive transparencies of both high and low resolution are available for both the visible and infrared and can be obtained from -

DMSP Satellite Data Library
Space Science and Engineering Center
1225 W. Dayton St.
Madison, WI 53706

The Earth Resources Observation System (EROS) Program is administered by the Geological Survey and operates a Data Center to provide access to aerial photography resources. This is imagery acquired by the U.S. Department of the Interior, NASA, LANDSAT imagery and photography, Skylab, Apollo, and Gemini spacecraft, and from research aircraft. A free computer search can be requested by giving the geographic coordinates or path/row designated by EROS.

User Services Unit
EROS Data Center
Sioux Falls, SD 57198

Mosaics of LANDSAT imagery of the US have been prepared by the Soil Conservation Service. They are not available from the Date Center, and should be order from -

Cartographic Division
Soil Conservation Service
Federal Center, Building No. 1
Hyattsville, MD 20782

The National Archives and Record Services has available aerial photography dating from the middle 1930's. They also have the old U.S. Coast and Geodetic Survey charts of the Atlantic coast. These are the original plane table surveys, many of which date back to the 1840's. Information on what they have available can be requested by giving county and state name in which the area of interest is located. They have no listing of records by area (i.e. specific name) -

John A. Dwyer
Assistant Chief, Cartographic & architectural Branch
General Services Administration
National Archives and Records Service
Washington, DC 20408

The National Cartographic and Information Center (NCIC) collects and sells information relative to the cartographic holdings (including imagery) of many federal agencies as well as state, county, and private organization. A computer search can be requested by supplying the geographic corrdinates of an area.

National Cargographic and Information Center (NCIC)
U.S. Geological Survey
536 National Center
Reston, VA 22092

COMPUTERIZED DATA BASES

With the advent of computerized systems for data management, a powerful tool became available for integrating many types of diffuse information into a coherent and useful base of knowledge. The National Park Service has undertaken several projects of this nature.

In 1982, Gary S. Waggoner of the NPS Geographic Information Systems (GIS) Field Unit at Denver, CO, became project manager for a new computerized data base called NPFLORA. The base makes use of the latest checklists of vascular plants available from each park to form a dynamic resource base containing information on presence and distribution of both exotic and native species, and rare, threatened, or endangered species. Information may be accessed in taxonomic groups, within or between park units, and in a variety of other ways. The analysis package, SYSTEM 2000, was chosen for its flexibility of design and for its capacity for update and revision.

As of early 1986, 108 park units including Cape Hatteras have been added to NPFLORA. For inquiries or updates, please contact:

Mr. Gary S. Waggoner
Manager, NPFLORA Data Base
U.S. Department of the Interior
National Park Service
Geographic Information Systems Field Unit
P.O. Box 25287
Denver, CO 80225-0287

The Rutgers NPS Bibliographic Research Team will be producing a computer diskette of Volume I, Bibliography of Scientific Research, for each park using Pro-Cite Personal Bibliographic Software available for both IBM and Macintosh computers. This software will allow for rapid search by general keyword, specific keywords, authors, and date, or a combination of these. As with the NPFLORA, this data base will be most useful if it is periodically updated with new citations for each park. The diskettes (as well as the printed versions of Volumes I and II) are available from:

U.S. Department of Interior
National Park Service
North Atlantic Regional Office
Office of the Regional Chief Scientist
15 State Street
Boston, MA 02109
1-617-223-5129

For a computerized data base concerning marine mammal strandings in the U.S.; with most extensive information available from 1975-1988. Contact:

James Mead
Marine Mammal Events Program
NHB-108
Smithsonian Institution
Washington, DC 20560
(202) 357-1920

Computerized data bases for List of Classified Structures (LCS) and Cultural Resources Management Bibliography (CRBIB) are available through the Cultural Resources Division of the regional Park Service offices. Contact:

Alicia Weber
Park Historic Architecture Division 422
National Park Service
U.S. Department of Interior
P.O. Box 37127
Washington, DC 20013-7127
Telephone: (202)343-8149

Species collections and archeological artifacts collected at Cumberland Island National Seashore are in the process of being catalogued (as of the Summer of 1988) by the Park Curator, Marcia Stout. A computerized database should be available sometime in the near future.

ADDITIONAL INFORMATION SOURCES

The following list provides researchers with additional sources of information relevant to Cumberland Island:

Fort Fredrica National Monument, St. Simons Island, GA. Contact: Eugenia Price - historian.

Kings Bay, Office in Charge of Construction (OICC), Trident Missile Base, Kings Bay, GA. Contact: Nancy Bomgarten - environmental planner.

Information regarding archeology and the impacts of dredging on the environment are available only for the duration of the project (see Management section for background information)

Camden County Library, Woodbine, GA

National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA. (703) 487-4650

Cooperative Park Studies Unit, Institute of Ecology, University of Georgia, Athens, GA. Contact: Dr. Susan Bratton, Director.

St. Simons Lighthouse Library, St. Simons, GA.

University of Georgia, Institute of Marine Science, Sapelo Island, GA 31327. Contact: Dr. James J. Alberts, Director

Savannah State Marine Algal Herbarium, Savannah State College, Savannah, GA.

Skidaway Institute of Oceanography, P.O. Box 13687, McWhorter Drive, Skidaway Island, Savannah, GA 13416. Contact: Dr. David W. Menzel, Director

Woodbine Courthouse, Woodbine, GA. Information on deeds and land ownership available.

Florida State Museum, Gainesville, FL. Contact: Dr. J.T. Milanich, Director. Archeological artifacts from the dredging of the Kings Bay area are housed at the museum.

Mrs. Lucy Ferguson - permanent Cumberland Island resident. Personal library contains specimens of island flora and fauna, historical photos, and unpublished research.

Mrs. Mary Miller - part time resident of Cumberland Island for 60 years. Amateur historian.

The Georgia Conservancy, 711 Sandtown Rd., Savannah, GA 31410. Contact: Dr. Hans Neuhauser, Coastal Director.

ONGOING SCIENTIFIC RESEARCH AT GATEWAY NATIONAL RECREATION AREA

What follows is a listing of ongoing research at Gateway National Recreation Area as indicated by park personnel in spring of 1984 on an Ongoing Research Questionnaire. Also included are summary comments on other ongoing research, as received from correspondents and through other sources. Several of these correspondents made comments regarding future directions for Gateway research; these will be incorporated into Volume III, on the future of scientific research at Gateway National Recreation Area.

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

   Name: Dr. Raul Cardenas

   Institution: Polytechnic Institute of New York

   Department of Civil Engineering

   Address: 333 Jay Street

   Brooklyn, New York

2. Funding Agency: National Park Service

3. Subject

   Project Title: Comparability Study of Water Quality Techniques for Total/Fecal Water Quality Analysis

4. Location

   List stations or research sites within the Park:

   Park wide bathing beaches and waters of park

5. Status

   Date project started:

   Date project is to be finished: November 1983

   Have progress reports been submitted to NPS? If so, list date of submission: Final Report submitted Nov. 1983, titled " Evaluation of Water Quality, Summer Study, 1983," Volumes I and II. Report available from Dr. Cardenas

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

Name: Drs. David Franz and William Harris

Institution: Brooklyn College

Biology/Geology Departments

Address:

2. Funding Agency: National Park Service

3. Subject

Project Title: Macro-benthic Inventory and Biocontaminant Survey, Jamaica Bay

4. Location

List stations or research sites within the Park:

Jamaica Bay only

5. Status

Date project started:

Date project is to be finished: April 1984

Have progress reports been submitted to NPS? If so, list date of submission:

This major study concerns the distribution and diversity of macrobenthos in Jamaica Bay (Gateway NRA) in relation to sediment structure, sediment organic content and heavy metals. This research was done under contract with the U.S. National Park Service, Contract No. CX1600-1-0031. The final report of this study is now almost completed and should be available from the Park Service by the 1st of the year, if not before.

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

Name: Dr. Andrew Greller

Institution: Queens College, CUNY

Address: Biology Department

2. Funding Agency: National Park Service

3. Subject

Project Title: Detailed Vegetative Survey and Herbarium Reference File Corroboration, Floyd Bennett Field, Brooklyn, NY

4. Location

List stations or research sites within the Park:

Mainly Floyd Bennett Field, Brooklyn. However, all specimens parkwide are being reviewed

5. Status

Date project started:

Date project is to be finished: 1 May 1984

Have progress reports been submitted to NPS? If so, list date of submission: March 1984

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

Name: Dr. Garry Rogers

Institution: Columbia University

Address: Geography Department

2. Funding Agency: National Park Service

3. Subject

Project Title: Photographic Mapping North 40 Floyd Bennett Field and Vegetative Trend Plots

4. Location

List stations or research sites within the Park:

Floyd Bennett Field, Brooklyn

5. Status

Date project started:

Date project is to be finished: 1 May 1984

Have progress reports been submitted to NPS? If so, list date of submission: March 1984

Research in progress: (citations listed are in V. I, Bibliography).

1. Vegetation classification, mapping, and repeat photography: This is a continuing project documenting the terrestrial vegetation of the natural area portions of Floyd Bennett Field (Rogers and Brest, 1983; Rogers et al., 1984; Grady, 1984).

2. Effects of fire on the growth of Phragmites australis: Quantitative comparisons of burned and unburned stands of Phragmites are being made at Floyd Bennett Field (Hartig, in prep.).

3. Competition between Myrica pensylvanica and Phragmites australis: Aerial photographs and field observations are being used to measure changes in abundance in zones of overlap by the two species (Rogers et al., submitted).

4. Population ecology of Prunus serotina: A detailed description and analysis is being made of a unique grove of black cherry that provides evidence of successional development of closed canopy forest at Floyd Bennett Field.

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

   Name: Dr. Richard Stalter

   Institution: St. John's University

   Environmental Studies Program

   Address:

2. Funding Agency: National Park Service

3. Subject

   Project Title: Floral Inventory and Upgrading Herbarium

   (Parkwide)

4. Location

   List stations or research sites within the Park:

   Parkwide

5. Status

   Date project started:

   Date project is to be finished: 1 May 1984

   Have progress reports been submitted to NPS? If so, list date of

   submission: March 1984

ONGOING RESEARCH AT GATEWAY NATIONAL RECREATION AREA

This form is designed to record yet-to-be completed ongoing research at the Seashore, and not-yet-published results.

1. Principal Investigator

Name: Dr. Christopher Brand

Institution: U.S. Fish & Wildlife Service

National Fish & Wildlife Health Laboratory

Address: 1655 Linden Drive

2. Funding Agency: National Park Service

3. Subject

Project Title: Incidence of Avian Diseases Jamaica Bay

Wildlife Refuge (Avian Botulism)

4. Location

List stations or research sites within the Park:

Jamaica Bay Wildlife Refuge

5. Status

Date project started:

Date project was finished: 1/7/83

Have progress reports been submitted to NPS? If so, list date of

submission:

Other ongoing research

Civil and Environmental Engineering

Dr. Raul Cardenas (see "Ongoing Research," previous section) states that: The major ongoing research trends in these parks appear to be related to Jamaica Bay, specifically the Bay as an ecosystem and as affecting the surrounding park. Research work, or more properly studies, are now in progress in this area.

Dr. Cardenas adds: I have water quality data from the New York City Department of Health, New York City Bureau of Water Resources and a 1966 New York University Study on California. We have used the lab facilities at the Polytechnic [Polytechnic Institute of New York, 333 Jay St., Brooklyn, NY 11201] for water quality studies.

United States Army Corps of Engineers

Samuel P. Tosi, P.E., (Chief of the Planning Division, Environmental Analysis Branch, U.S. Army Corps of Engineers, New York District, 26 Federal Plaza, New York, NY 10278-0090) states that: The New York District's Environmental Analysis Branch Staff has compiled a bibliography of documents and other available information pertinent to the Fire Island National Seashore and the Gateway National Recreation Area. In order to clarify our role in this matter let me state that the Corps generally evaluates an area in response to its legal jurisdiction. For instance the Corps may propose research in response to a proposed construction project, or the operation and/or maintenance of a Corps facility, or because an individual or corporation has applied for a construction permit. An Environmental Impact

Statement or other relevant information is then developed and published according to Federal regulations and made available to the public as appropriate. All information attached is available at the New York District office. I hope that the aforementioned information is suitable for your purposes. Should you have any further questions please contact Mr. Robert Dieterich of Environmental Analysis Branch (212) 264-4662.

The references provided by Mr. Tosi are listed in Volume I, Bibliography of Scientific Research at Gateway N.R.A. In addition, the following research and information sources were included in the Corps of Engineers listing:

I. Future Plans for Studies and Projects

1. Atlantic Coast of New Jersey - Sea Bright to Ocean Township Beach Erosion Control Study.
2. New York Harbor Collection and Removal of Drift Project: Sandy Hook and Jamaica Bay Reaches.

II. Additional Resources

1. American Littoral Society, Sandy Hook, New Jersey.
2. Marine Sciences Consortium, Sandy Hook, Jersey.
3. Lionel Walford Library - Managed by the National Oceanic and Atmospheric Administration, Sandy Hook, New Jersey.

III. Corps of Engineers Cultural Resource Projects in Subject Areas

Staten Island

Phase I: Cultural Resource Reconnaissance. Beach Erosion Control and Hurricane Protection Project at Staten Island. C. Lipson et al., of the Museum of Archeology at Staten Island (1978).

East Rockaway Inlet

Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York, Steve Kopper (1979).

IV. Additional Sources of Cultural Resources Information

New Jersey State Historic Preservation Officer
Office of New Jersey Heritage
Department of Environmental Protection
CN 402
Trenton, NJ 08625
(609) 292-2028

New Jersey State Museum
Bureau of Archaeology
205 West State Street
Trenton, NJ 08625
(609) 292-8594

New York State Historic Preservation Office
New York State Dept. of Parks & Recreation
Historic Preservation Field Services Bureau
Agency Bldg. 1, Empire State Plaza
Albany, NY 12238
(518) 473-3176

V. Archeology and Cultural Resource Survey Reports

A Bibliography of Archaeological Survey Reports Filed at the State Historic Preservation Office Through May 1980 a joint publication by the New York Archaeological Council and the New York State Historic Preservation Office (updated at least once). Also, Annotated Bibliography of Cultural Resource Survey Reports Submitted to the New York State Historic Preservation Officer through December 31, 1979. This is published and updated annually by the Office of New Jersey Heritage, listed above. These are the most complete lists in existence.

VI. Research facilities at the Corps of Engineers

Mr. Tosi has also supplied the following about Corps of Engineers research facilities:

The New York District has a central library and both Environmental Impact Statements and photographic slides of project areas can be found there. Our "Photography Laboratory" unit maintains a historical file of photographic negatives that are chronologically and numerically ordered. These files can be accessed and copies can be ordered. Additional files of project plans and aerial photographs can be found in the District's flat files, and various support information is available from the Hydraulics, Economics, and Foundations Sections. The Chiefs of these sections and project managers working in the geographic areas of concern should therefore also be contacted.

Estuarine ecology

David R. Franz (Professor of Biology, Brooklyn College, Brooklyn, NY 11210) whose contract work with Dr. William Harris (Geology Department, Brooklyn College) is discussed in "Ongoing Research" above, provides the following perspective on ongoing research trends: In the Gateway NRA, most ongoing research appears to be related to public health problems, specifically, dangers caused by contamination of waters and marine organisms by PAH's [polynuclear aromatic hydrocarbons], heavy metals, etc.

National Ocean Service, Atlantic Office of Oceanography and Marine Assessment, NOAA

Dr. Garry F. Mayer, Senior Ecologist with the Atlantic Office of NOAA's (National Oceanic and Atmospheric Administration) Office of Oceanography and Marine Assessment (Central Hall, SUNY, Stony Brook, NY 11794), states:

To date, the environmental studies overseen by the Atlantic Office have not focused on or been limited to specific park areas. Instead, we have attempted to examine problems on a regional or process-oriented basis. Thus, while many of our studies may mention or be pertinent to areas under NPS jurisdiction, neither the titles nor the abstracts of these publications necessarily refer by names to specific parks. For example, NOAA Technical Memorandum OMPA-6, "Analysis of Residual Chlorinated Hydrocarbons, Aromatic Hydrocarbons and Related Compounds in Selected Sources, Sinks, and Biota of the New York Bight," by W.D. MacLeod, Jr. et al. (1981) includes mussel toxicant body burden data taken off Sandy Hook, off southern Staten Island, in the Jamaica Bay region, and off the Long Island south shore, in or adjacent to NPS areas, yet these data are only a small part of the total suite of information contained in the publication. Similarly, NOAA Technical Memorandum OMPA-21, "Contaminant Inputs to the Hudson-Raritan Estuary," by J.A. Mueller et al. (1982) speaks in several sections to environmental conditions and pollution sources in Jamaica Bay and the Lower Bay Complex, yet the Gateway facilities are not singled out for discussion per se.

The Atlantic Office library is open for research use at any time. While we cannot provide copies of all of the reports and publications associated with our work over the years, copies of most are available in our library for examination by the public on week days between the hours of 8:00 a.m. and 4:30 p.m. A part-time librarian is in charge of the collection and is generally available on Mondays and Tuesdays.

Included in Volume I, Bibliography of Scientific Research at Gateway NRA, is a 1983 NOAA/Ocean Assessments Division Bibliography from the Stony Brook Office. Also listed and available from Stony Brook's Marine Sciences Research Center is the two-volume Annotated Bibliography of New York Bight, Hudson-Raritan Estuarine System and Contiguous Coastal Waters: 1973-1981. Also available is Tiedemann (1984) The marine environments of New Jersey and New York: an annotated bibliography.

Avian research

Joanna Burger (Professor, Department of Biological Sciences, Nelson Biology Labs, Rutgers University, New Brunswick, NJ 08903) has done a great deal of avian research at Gateway NRA. She directed a survey of avian use at Jamaica Bay. Citations of this work are listed in Volume I; more papers are forthcoming. She has been involved with the New Jersey

State Survey of Least Terns, involving colonies at Sandy Hook. A report is available from the Endangered and Non-Game Species Project, New Jersey Department of Environmental Protection, Trenton, NJ. Professor Burger also coordinated the N.J. State shorebird surveys of the Raritan and Delaware bays. A report is available from the New Jersey Department of Environmental Protection, Trenton. In this survey shorebirds were censused weekly from April through October 1982, and included Sandy Hook. Publications are forthcoming. Other personnel on this project included R. Kane of New Jersey Audubon, and W. Wander.

American Littoral Society

Derry Bennett (Director, American Littoral Society, Sandy Hook, Highlands, NJ 07732) states that he has done research on the vegetation, birds, and some samples of fish populations within Gateway, and can provide further information on this work.

U.S. Fish and Wildlife Service

Christopher J. Brand (Research Epizootiologist, U.S. Fish and Wildlife Service, National Wildlife Health Laboratory, 6006 Schroeder Road, Madison, WI 53711) states that: In response to your request for information on scientific information on coastal parks, I am enclosing a final report to the NPS of a study conducted by the National Wildlife Health Laboratory (NWHL) under contract with the NPS at Jamaica Bay Wildlife Refuge, Gateway NRA, during 1981 and 1982. The study was to gain a better understanding of the epizootiology of avian botulism at the refuge, and recommend management strategies to prevent this disease. A manuscript on the results of this study is planned. In addition, an updated bibliography on avian botulism (enclosed), and an informational brochure on avian botulism (currently being printed by GPO) were published as part of this project. [See Volume I, Bibliography of Scientific Research at Gateway NRA, for citations of this work]. The NWHL, U.S. Fish and Wildlife Service, provides services to USDI [U.S. Department of the Interior] agencies, including the NPS in dealing with disease outbreaks and diagnosis of mortality in wildlife on USDI lands or lands under their stewardship.

Northeast Fisheries Center

John B. Pearce (Chief, Division of Environmental Assessment, Northeast Fisheries Center, Sandy Hook Laboratory, Highlands, NJ; after November 1, 1984: Director, NOAA Estuarine Program Office, Washington, DC) states:

The Sandy Hook Laboratory and the Northeast Fisheries Center, generally, have been involved with environmental studies of habitat quality and fishery resources in areas that bound the Cape Cod, Fire Island, and Gateway National Recreation Areas or Seashores. Our research has been concerned with long-term changes in habitat quality as well as with monitoring the changes which occur over periods of years or decades.

Our Resource Assessment Division has done the vast majority of research concerned with assessing standing stocks of fish and shellfish populations in waters over the continental shelf. Our environmental research has been conducted over the entire continental shelf and has also been carried on within certain of the major estuaries such as Long Island Sound, Raritan Bay, Delaware Bay, and other major embayments. Research citations from Northeast Fisheries Center are available in Volume I, Bibliography of Scientific Research at Gateway National Recreation Area.

Vegetation research

Dick Stalter (Director, Environmental Studies Program, St. John's University, Jamaica, NY 11439) has done floristic studies of Sandy Hook and Floyd Bennett Field. Citations are in Volume I.

Garry F. Rogers (see "Ongoing Research," previous section) offers a viewpoint regarding current research: Research at Gateway has not focused on the dynamic nature of the habitat. Repeated observations were not possible in the past because sample locations were not

marked. Place-independent research, promoted by funding agencies seeking ever greater generality, does not appear appropriate in valuable areas such as parks. Perhaps a common refrain, but obviously not common enough.

SCIENTIFIC RESEARCH FACILITIES AND IN-HOUSE DATA COLLECTION

The following pages provide a detailed accounting of facilities available in or near Gateway, for use in conducting scientific research. Also included is a summary of Gateway-directed data collection efforts. This information was provided by Gateway personnel in the spring of 1984 in response to the Research Facilities and In-House Data Collection Questionnaires.

RESEARCH FACILITIES AT GATEWAY NATIONAL RECREATION AREA

The purpose of this questionnaire is to summarize facilities available to researchers at or near the Seashore.

1. Primary contact

Please list the name, address and phone number of the primary contact at the Seashore for questions about available research facilities.

Name: John T. Tanacredi

Address: Division of Professional Services

Gateway NRA - Headquarters Building

Floyd Bennett Field, Brooklyn, NY 11234

Telephone: 212-338-3516, 3730

2. Research labs

a) Are wet or dry lab facilities available at the Seashore? If so list location and size:

Location: Division of Professional Services

Hangar B, Floyd Bennett Field

Brooklyn, NY 11234

Size:

b) What laboratory equipment is available?

Oceanographic sampling equipment (Kemmerer water sampler etc.); bacteriological water quality analysis (Millipore filtration); plankton trap, nets; research quality microscopes (video and photographic capabilities); centrifuge, microtome and other tissue culture (plant) support.

3. Field equipment

a) Please list available field equipment including nets, surveying gear, traps, etc.

(See #2)

b) Are boats available on site? If so, list type, size, and location.

1. type Boston Whaler 2. type --

size 17' size 18'

location Floyd Bennett Field (Jamaica Bay Wildlife Refuge)

location Floyd Bennett Field (Professional Services)

c) What type of vehicles are available to outside researchers? List number and type.

None

4. Housing and storage

a) List the location, number of beds, and kitchen and laundry facilities available for temporary housing.

1. Three rooms (Bldg. 272) at Floyd Bennett Field (total of 5 beds) - kitchen; 2. Some rooms on a first-come/first-served basis at Sandy Hook

b) Is covered, locked storage available for lab and field equipment? If so please note location.

For lab equipment, there is a limited quantity above what is already stored and used in Floyd Bennett Field lab

c) Is secure, outside storage available for vehicles, boats, and gear? If so note location and size.

Limited. Some space for boats in Hangar B at Floyd Bennett Field. Presently working with US Coast Guard air station to upgrade and repair a small dock at Floyd Bennett Field

5. Herbaria and species collections

a) What collections are available at the Seashore?

Herbarium Specimen Cabinet at lab (Division of Professional Services)

b) Where are the nearest collections containing significant specimens from the Seashore? Please list instituion, location, and type of collection.

"Urban" species available at NY Botanical Gardens Reference file/ herbarium. Gateway herbarium has over 350 species documented

6. Other facilities

a) Are computer facilities available at the Seashore? If so list make and model, available software and whether or not connections to a main frame computer are available.

Computer system to be implemented sometime in FY '85. Only finance has system

b) Is there a library of relevant literature at the Seashore? If so please identify scope and size.

A small "library" will be established at Division of Professional

Services in the laboratory - 5 journals; some 125 reference
documents including Environmental Impact Statements and
environmental texts

c) Are there cooperative agreements between the Seashore and other nearby laboratories, collection, libraries or computer systems which are available to researchers? If so, please list the location, type of facility, and restrictions, if any, on use.

Gateway Institute for Natural Resource Sciences is in the process
of establishing a Cooperative Agreement with six local academic
institutions: Columbia, Queens College, St. John's, Stony Brook,
Hunter College, St. Francis, and several others. Call John
Tanacredi for more information

IN-HOUSE DATA COLLECTION

Data collection by NPS personnel may prove useful to outside investigators. This questionnaire identifies information collected during the day-to-day operation of the Seashore by NPS staff.

1. Visitation records

For how long have these records been kept? 1974

Can you provide a breakdown of the categories of information
collected on visitation? Our Public Information office would
best have this information (Mr. Manny Strumpf)

List locations where visitations are recorded:

Each of the Gateway Units

2. Other

What other types of information are collected regularly, for example, bird censuses, well logs, motorized traffic? Please provide a list, with short explanation for each item.

1. Hawk migration (Breezy Pt./Ft. Tilden) Volunteers - Bird Banding
Labs, MD.

2. Tern Colonies (Units); 3. Meteorological data (U.S. Weather
Service logs); 4. Mosquito larvae (Breezy Pt. Tip area)

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Library research was conducted by these workers as well as by Martha Gulick, Patricia Claxon, Enid Lotstein, and Craig Liska. Editorial revisions were made by Sharon A. Boeglin, Richard Paperno and Patricia Claxon.

As the nations's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility of the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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