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FISH AND WILDLIFE POPULATIONS AND HABITAT STATUS AND TRENDS IN THE NEW YORK BIGHT

A Report to the Habitat Work Group
for the New York Bight Restoration Plan

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OVERVIEW

The New York Bight region is one of the most intensely developed areas of the United States. It contains a human population of nearly 20 million, and a high proportion of its land area is devoted to commercial and industrial uses. The ocean, estuarine, and river waters of the Bight receive large quantities of domestic and industrial wastes discharged from treatment plants and combined sewers, and from nonpoint pollution sources. Over the past century, conversion of upland and wetland areas throughout the region has eliminated, or significantly altered, the habitat areas necessary to sustain healthy and productive populations of fish, plant, and wildlife species. Although most persons in the United States might perceive the Bight region as almost totally devoid of such populations, the Bight in fact contains a significant fish and wildlife resource. The populations of a number of species have actually increased in abundance over the past several decades. To some extent, this is attributable to the resiliency of natural communities to human-caused perturbations. However, progress has also been made in reducing water pollution; slowing the destruction of coastal wetlands and related aquatic environments; creating wildlife and habitat havens in the form of refuges, wildlife management areas, and parks; and regulating the human harvest of sensitive species.

Although habitat protection efforts have progressed over recent decades, the region experiences continuing pressure for further conversion of natural habitats to residential, commercial, and industrial uses. Large expenditures are necessary to further upgrade water

quality. Management efforts for publicly owned lands should be strengthened to protect sensitive species during critical life cycle stages. Programs need to be developed to restore degraded habitats.

This report has two objectives: (1) to describe trends in abundance or production of key fish, shellfish, marine mammal, and bird species in the Bight region; and (2) to characterize important habitat areas and values, and to indicate trends in the condition and extent of these habitats. Except for certain habitat types (e.g., tidal wetlands), published information on habitat trends is generally unavailable. The recent development of geographic information systems by New Jersey and New York will enable the mapping of key habitat areas and could serve as a basis for determining habitat trends in the future.

STUDY AREA

For the purpose of this study, the New York Bight region is defined to include ocean waters from the Rockaway-Sandy Hook transect out to the limit of the Continental Shelf; the New Jersey coastal shoreline from Sandy Hook to Cape May, and the Long Island shoreline from Rockaway Point to Montauk Point; and the back bays and estuaries of this region including their associated upland areas. The ocean area of the Bight encompasses about 15,000 square miles, and the coastal shorelines extend for 240 miles. A map of the Bight region is presented in Figure 1.

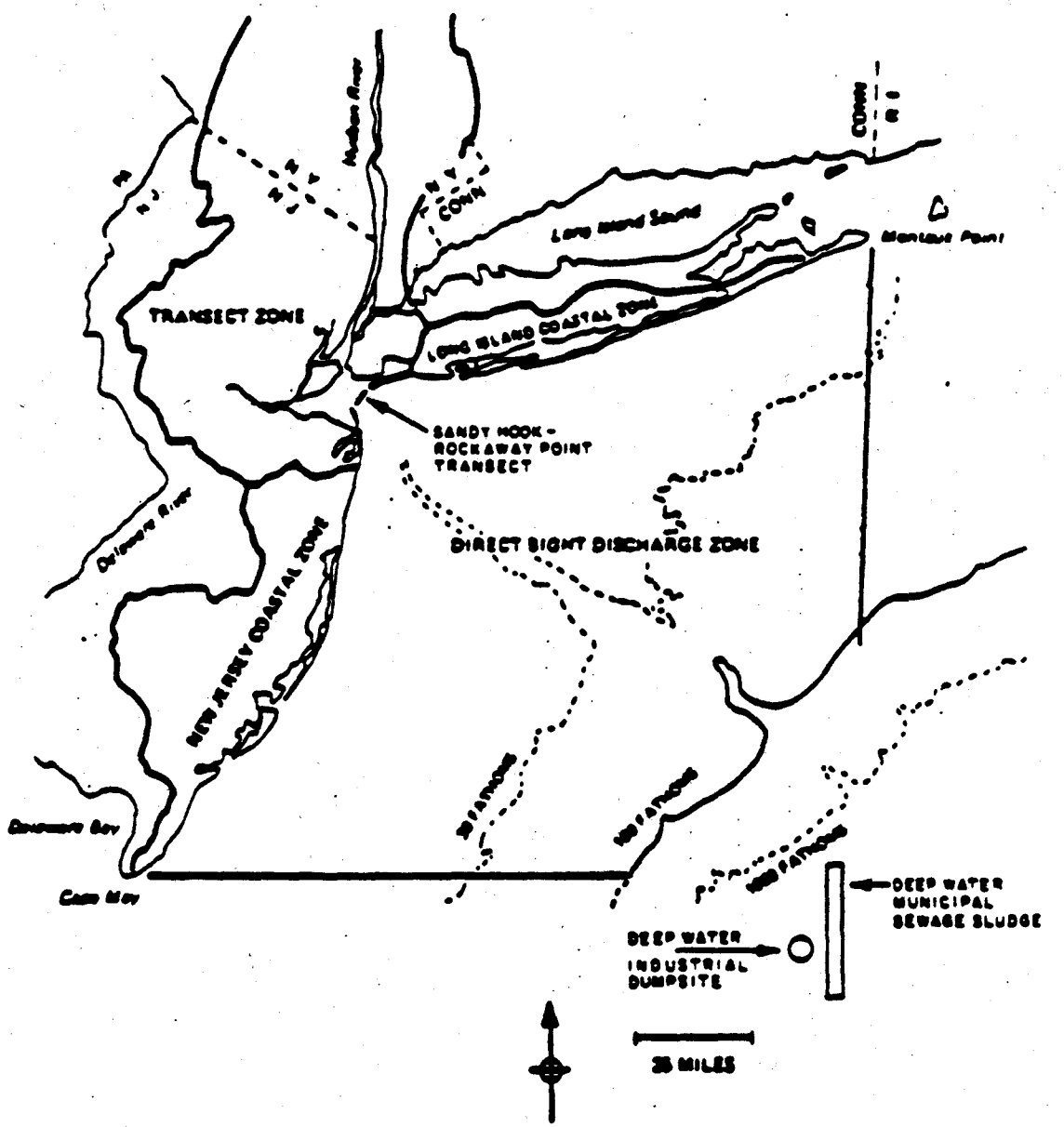

Figure 1. New York Bight Region

FISH AND SHELLFISH POPULATION TRENDS AND MARINE MAMMALS AND TURTLES

INTRODUCTION

A wide variety of fish, shellfish, marine mammals, and turtles inhabit or utilize the marine, estuarine, and back bay waters and tributary streams of the Bight region. Much of the available information about current populations and historic trends in abundance has been compiled only for a relatively few species of commercial or recreational fishery significance. However, many others have substantial ecological importance (e.g., forage fishes) or local economic significance (e.g., white perch), but information documenting trends in abundance is lacking. While the following discussion focuses on species for which trends data are available, some information on ecologically important species is included in this section and the section on Habitat Areas and Trends.

The New York Bight is one of the major U.S. commercial and recreational fishing regions. In 1989, commercial landings of finfish and shellfish totaled more than 140 million pounds valued at about $120 million (Table 1). Recreational fishermen harvested an estimated additional 55 million pounds.

The Bight fishery has passed through several phases since the late 19th and early 20th centuries. During these early years, fishing effort was primarily in the bays, estuaries, and inshore areas of the region. The period from 1890 to 1910 saw peak landings of several species, including oysters and mussels, anadromous fishes (sturgeon, shad, and white perch), and bluefish. Subsequently, overfishing in inshore areas, coupled with mechanization of fishing craft and gear, led to greater exploitation of offshore fish stocks. In the 1930s, the

Table 1. Commercial Fishing Landings Principal Species of Finfish and Invertebrates, New York Bight Area[a] (1989)

Species	Landings (thousands of pounds)	Value (thousands of dollars)
Finfish		
Atlantic herring	247	44
Atlantic mackerel	6,964	1,011
Black sea bass	164	215
Bluefish	1,599	437
Butterfish	1,231	721
Cod	673	537
Flounder, winter	919	928
Flounder, summer	1,996	3,371
Flounder, yellowtail	871	1,253
Hake, red	888	214
Hake, silver (whiting)	14,650	4,141
Menhaden	2,740	192
Scup	2,072	1,871
Shad	350	119
Swordfish	258	742
Tilefish	632	1,405
Weakfish	558	516
All others	6,026	3,089
Total	42,834	20,806
Invertebrates		
Clam, surf	50,081[b]	23,168
Clam, other	1,161[b]	8,606
Crab, blue	3,078	1,528
Crab, other	509	195
Lobster	2,370	7,363
Quahog, ocean	8,817[b]	6,723
Sea scallops	12,683[b]	46,985
Squid	20,182	5,510
Other shellfish	3,423[b]	2,427
All others	111	124
Total	102,415	102,689

[a] The New York Bight Area was defined as the National Marine Fisheries Service Statistical Reporting Areas 612, 613, 614, 615, and 616 (Figure 2).
[b] Landings in pounds of meat.

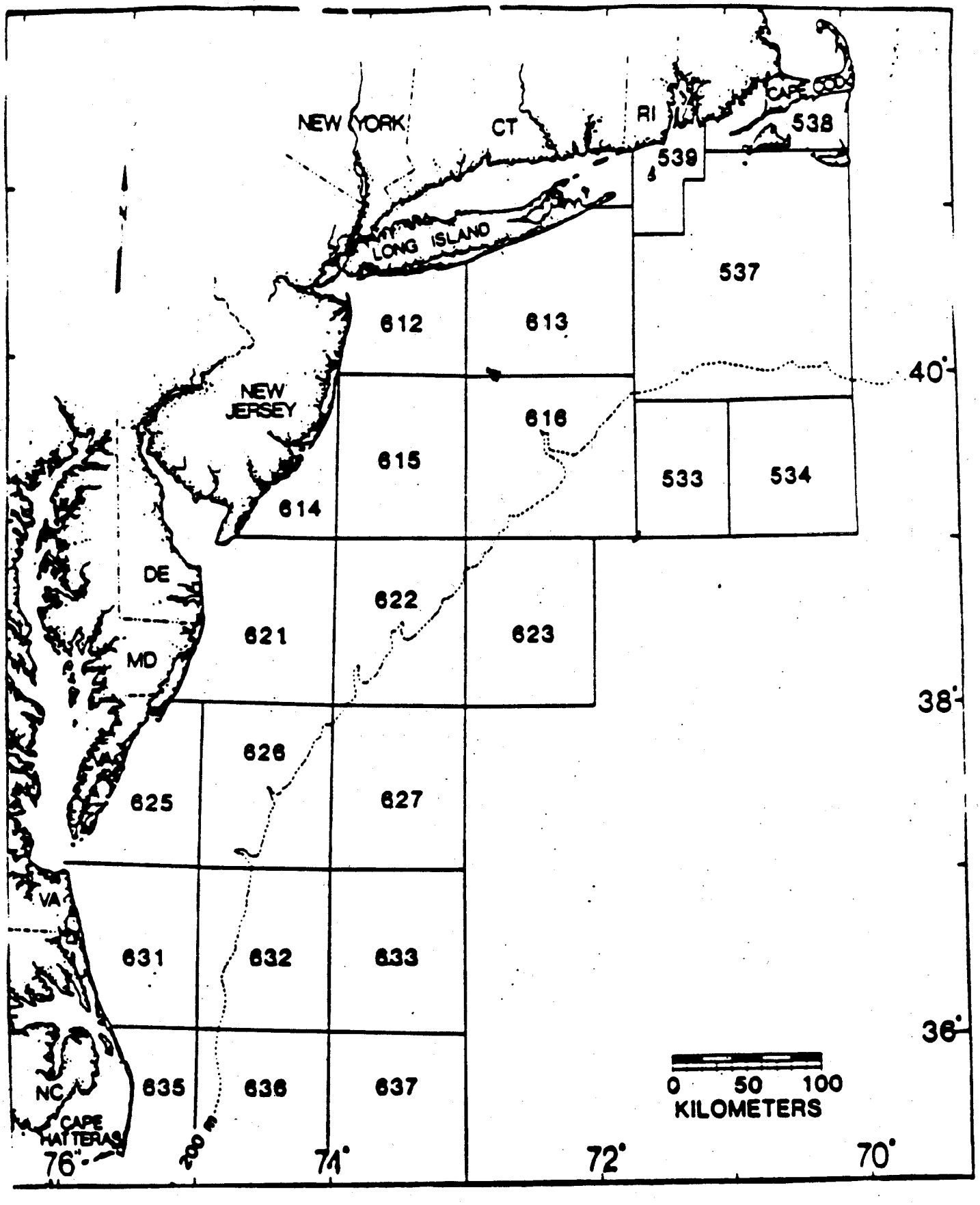

Figure 2. Commercial Fishing Statistical Reporting Areas of the Middle Atlantic Bight

wintering grounds of many species were discovered, leading to development of a year-round fishery. A higher proportion of offshore marine species made up commercial landings in the 1920-40 period as compared with earlier years.

Following World War II, recreational fishing in the marine waters of the Bight expanded rapidly and eventually accounted for a significant proportion of the total harvest of several species (e.g., bluefish). However, the most significant factor affecting fish populations in the Bight was the appearance of efficient foreign fishing vessels in the 1960s. A multinational fleet of mobile trawlers and factory processing and support vessels harvested large quantities of some 18 species important to the U.S. domestic fishery, and overfishing became a serious concern. Public response to the adverse impact of the foreign fleet led to passage of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1976. The act extended the fisheries' jurisdiction of the United States from 3 to 200 nautical miles offshore (the Exclusive Economic Zone, or EEZ), and provided for the conservation and exclusive management of all fishery resources within this area except for highly migratory species of tuna. Under the MFCMA, regional fisheries' management councils were established and charged with preparation of Fisheries Management Plans (FMPs) for species needing management.

The Mid-Atlantic Fishery Management Council (MAFMC) covers the New York Bight area, although the actions of councils in adjacent areas (the New England and South Atlantic Councils) may affect fisheries in the Bight. FMPs usually have several objectives, including the stabilization of fishing mortality on stocks and increasing yields from the fishery. Because initially there were no FMPs, the Secretary of Commerce was also

empowered to prepare Preliminary Fishery Management Plans (PMPs) that cover only foreign fishing. However, as FMPs were prepared by the councils, the PMPs remain for only a few species of concern.

By 1990, FMPs of the Mid-Atlantic New England and South Atlantic Fishery Management Councils were in place or pending for the following species:

- surf clams and ocean quahog;
- sea scallops;
- Atlantic mackerel, squid, and butterfish;
- groundfish (cod, haddock, and yellowtail and winter flounder);
- summer flounder;
- bluefish;
- swordfish;
- billfish; and
- lobster.

PMPs remain in place for waters including the New York Bight for the following:

- trawl fisheries of the Northwest Atlantic (including dogfish);
- silver and red hake; and
- sharks.

Fishery management in Bight waters has also been achieved through the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fisheries Management Program. Since the beginning of this program in 1980, FMPs have been adopted for Atlantic coastal waters for the following:

- Alewife, American shad, blueback herring, and hickory shad;
- American lobster;
- Atlantic croaker;
- Atlantic menhaden;
- bluefish;
- red drum;
- spot;
- spotted sea trout;
- striped bass;
- summer flounder; and
- weakfish.

By the beginning of the 1990s, most of the major fisheries of the New York Bight were under some form of regulation by the Mid-Atlantic and New England Councils, the Commission, the National Marine Fisheries Service, or by the States individually. The recent and historical trends for the major species of finfish and shellfish in the general area of the Bight are discussed in the following sections of this report. Much of this information is based on the following publications: U.S. Department of Commerce (1987, 1989) and Pacheco (1988). The discussion includes landings or catch data, but it should be noted that not all such landings necessarily originate in the statistical reporting areas that make up the New York Bight.

It is should also be noted that many species are considered by fishery scientists to be "fully exploited" or "overexploited." These terms describe the effects of fishing effort on

each stock, and thus, for fully exploited species, indicate that the number or weight of fish harvested from a given stock cannot be increased without reducing the biomass of that species. In the case of overexploited species, this level of effort has already been exceeded.

FINFISH

The principal finfish species presently landed in the New York Bight by both commercial and recreational fishermen include flounder (primarily winter, summer and yellowtail), silver hake (whiting), butterfish, scup (porgy), bluefish, Atlantic mackerel, American shad, squid, black sea bass, weakfish, tilefish, and tautog. Although total landings are predominantly by commercial fishermen, the recreational fishery accounts for a significant portion of the catches of several species, including bluefish (85 percent), black sea bass (50 percent), summer and winter flounder (40 percent), porgy (30 percent), and Atlantic mackerel (20 percent). In addition, recreational fishing has been significant for striped bass and tautog.

Atlantic Mackerel (Scomber scombrus)

A pelagic schooling fish is distributed in the Northwest Atlantic between Labrador and North Carolina. One of the two major spawning components of the population occurs in the Mid-Atlantic Bight during April and May. Mackerel are subject to seasonal fisheries, both sport and commercial. After implementation of the MFCMA in 1977, mackerel were managed under a PMP from 1977 to 1978; and since 1979, they have been managed by the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Total U.S., Canadian, and foreign commercial, and total U.S. recreational landings for the period

1980-88 have risen from 27,800 metric tons (mt) to 82,000 mt. However, stock biomass has risen at a faster rate, and the currently estimated long-term potential catch throughout the region is 134,000 mt. The fishery is, therefore, considered to be underexploited.

American Shad (Alosa sapidissima)

The shad is an anadromous species, and its range extends along the entire Atlantic coast. The shad migrate into rivers (including the Hudson River) for spawning in early to late spring, and then later move downstream and north along the coast to Canada where they feed during the summer. A southward migration occurs along the Continental Shelf, where shad overwinter prior to the spring spawning runs.

Peak shad landings of 22,000 mt occurred in 1896. Landings have generally declined in recent years from 3,000 mt in 1970 to less than 1,000 mt in the mid-1980s, the lowest on record. Assessment of shad populations from 12 rivers along the Atlantic coast suggests that present landings are well below maximum sustainable yield. The Atlantic States Marine Fisheries Commission has prepared a coastwide management plan for shad. Restoration plans, including construction of fish passageways and stocking programs, are presently under way and are expected to improve returns of spawning migrations and to increase coastal stocks. Improved water quality also has expanded the spawning area available for shad.

Black Sea Bass (Centropristis striata)

This species occurs off the entire Northeast Atlantic coast; the greatest concentrations are found within the Mid-Atlantic Bight. The black sea bass overwinters along the 100-meter depth contour off Virginia and Maryland; it then migrates north and west into the

major coastal bays and becomes associated with structured bottom habitat, such as reefs, oyster beds, and wrecks.

Commercial landings of about 2,600 mt were generally stable for the first half of this century. Catches subsequently peaked at 9,900 mt in 1952; since 1970, they have fluctuated between about 600 and 2,000 mt. The recreational fishery presently accounts for half of the total catches, although the proportion is much higher in some years. Some stock assessment data are available, but they are considered insufficient to allow a definitive understanding of the status of this species. However, it is thought that the black sea bass is at least fully exploited.

There are no current federal regulations or restrictions on black sea bass, although the states impose size limits. The Mid-Atlantic Council and the ASMFC are developing an FMP for this species in conjunction with other species.

Bluefish (Pomatomus saltatrix)

The bluefish is a migratory pelagic species found throughout the world in most temperate regions. Along the Atlantic coast, bluefish are found from Maine to Florida, migrating northward in the spring and southward in the fall. Total catches of bluefish peaked in 1980 at about 76,200 mt; they have generally declined since to about 60 percent of 1980 levels. Recreational catches far exceed commercial landings, and many of these catches are taken in the middle Atlantic states (New York to Virginia) by boat-based fishermen. Current data suggest that the bluefish stock off the Atlantic coast are fully exploited; maximum sustainable yield has been exceeded six times since 1976. The MAFMC

and the ASMFC have adopted an FMP for bluefish involving allocation of the fishery between commercial and recreational sectors, and establishing a recreational bag limit.

Butterfish (Peprilus triacanthus)

The butterfish is found off the Atlantic coast from Newfoundland to Florida. It is commercially important between Cape Hatteras and southern New England. In this area, butterfish migrate inshore and northward during the summer and offshore to the edge of the Continental Shelf in late autumn.

During the 1960s and 1970s, butterfish landings fluctuated widely between about 3,000 mt and 20,000 mt. Since the late 1970s, butterfish landings have shown a downward trend; they were 2,100 mt by 1988. The recreational fishery is not significant. Total landings are far lower than the total allowable catch of 16,000 mt established by the MAFMC Squid, Mackerel, and Butterfish FMP. The fishery is thus underexploited.

Winter Flounder (Pseudopleuronectes americanus)

The winter flounder or lemon sole is distributed in the northwest Atlantic from Labrador to Georgia, although abundance is highest from the Gulf of St. Lawrence to the Chesapeake Bay. Movement patterns of winter flounder are generally localized. Small-scale seasonal migrations to estuaries, embayments, and saltwater ponds occur during winter, and migrations from these locations to deeper water occur during summer. Discrete groups of winter flounder appear to exist, including one in the southern New England-Middle Atlantic area.

Since the early 1960s, commercial landings have fluctuated between 4,000 and 12,000 mt. More recently, total commercial landings have generally declined from 11,600

mt in 1981 to 4,300 mt in 1988. Recreational catches are significant, particularly in the mid-Atlantic area, and in recent years, have constituted about 40 to 50 percent of total landings. Stock assessment data are not sufficient to precisely determine the level of exploitation of this species, but it is thought to be fully exploited or overexploited.

Regulations governing minimum length and mesh sizes are in place in states in the region, although these limitations vary. An Interstate FMP for winter flounder is presently under development, and the offshore fishery is currently managed by the New England Fishery Management Council's Northeast Multispecies FMP.

Summer Flounder (Paralichthys dentatus)

The summer flounder or fluke occurs from the southern Gulf of Maine to South Carolina. It is concentrated in coastal embayments and estuaries from late spring through early autumn. An offshore migration to the Outer Continental Shelf is undertaken in autumn when spawning occurs and the larvae are transported toward coastal areas by prevailing water currents. Development of post-larvae and juveniles occurs primarily within estuaries and embayments, particularly the Chesapeake Bay and Pamlico Sound, but also in the New Jersey and Long Island Bays (Able et al., 1990).

Commercial landings of summer flounder averaged 8,300 mt during the 1950s but declined to less than 2,000 mt by the late 1960s. Commercial yields began to recover in the 1970s and reached a high of 14,500 mt in 1979. Over the 1980s, landings averaged 11,000 mt. The recreational fishery harvests a significant portion of the total flounder catch, and

in some years exceeds commercial landings. Summer flounder ranks first or second in recreational landings and angler preferences among Long Island fishermen (New York Department of Environmental Conservation, 1989).

Stock biomass is currently higher than during the late 1960s, but fishing effort is also greater. The fishery is presently considered to be overexploited. An FMP for summer flounder has been developed by the Mid-Atlantic Fishery Management Council, and that plan contains a mechanism to increase the present size limit (13 inches) if the current initiative fails to reduce fishing mortality on young flounder. However, the Mid-Atlantic Council and the ASMFC are now cooperatively working on a major amendment to the FMP to ensure that overfishing does not continue.

Menhaden (Brevoortia tyrannus)

At various periods, menhaden was by far the dominant species by weight in the mid-Atlantic region commercial fishery. As recently as the late 1950s and early 1960s, menhaden landings were between 500,000 and 600,000 mt. Most of the catch during these years was utilized for industrial purposes in the production of fish meal and oil. However, overfishing, particularly in North Carolina and the Chesapeake Bay, was thought to be responsible for a collapse of the fishery in the 1960s and early 1970s that was similar to the sudden decline of the California anchovy industry prior to World War II. Following this collapse, most of the fish-processing facilities in the mid-Atlantic and Chesapeake Bay areas closed down. By 1989, menhaden landings of 1200 mt in the mid-Atlantic area were a small fraction of their former levels, although stocks had risen somewhat in recent years. An ASMFC Fisheries Management Plan for menhaden is now being revised.

Scup (Porgy) (Stenatomus chrysops)

Scup, or porgy, occurs primarily in the mid-Atlantic Bight from Cape Cod to Cape Hatteras. Seasonal migrations occur during spring and autumn. In summer, scup are common in inshore waters between Hudson Canyon and Cape Hatteras at depths of 70 to 180 meters.

In the post-World War II period up to the early 1960s, scup was one of the primary food fishes landed in the New York Bight. Catches declined by about 75 percent after 1963. Landings gradually rose from about 4,000 mt in 1970 to nearly 10,000 mt in 1981, and were followed by a downward trend to 5,800 mt in 1988. Estimated recreational catches of scup are significant and represented about 20 to 50 percent of total catches from 1979 to 1987.

In recent years, stock abundance appeared to be considerably lower in the mid-Atlantic area than in southern New England. Downward trends in landings, catch per unit of effort, and fishery survey indices suggest that recent exploitation has reduced stock abundance significantly, and the scup population is overexploited. Although scup are currently controlled by a PMP, the MAFMC and the ASMFC have undertaken the development of an FMP for this species to reduce overfishing by domestic fishermen.

Silver Hake (Whiting) (Merluccius bilinearis)

The silver hake or whiting is widely distributed from Newfoundland to South Carolina, but is most abundant from Maine to New Jersey. Silver hake have wide geographic and depth ranges throughout the year. The major concentrations of fish vary seasonally in response to hydrographic conditions, availability of food, and spawning requirements.

Silver hake landings were at relatively high levels between the mid-1960s and mid-1970s, between about 60,000 and 110,000 mt. Restrictions placed on the distant water fleet in 1977 under the MFCMA led to a decline in landings to an average of 12,300 mt since 1980. In 1988, landings of 9,200 mt were the lowest since 1962. Over the region, recreational fishing catches are minor, although a fall and winter sport fishery exists in the New York Bight Apex (New York Department of Environmental Conservation, 1989).

The current biomass of silver hake is much lower than in the 1960s, and the fishery is considered to be fully exploited. Amendment No. 3 to the Northeast Multi-Species Plan has included the coastwide management of silver hake.

Long-Finned Squid (Loligo pealei)

This species is found in commercial quantities from Cape Hatteras to the southern Georges Bank. The long-finned squid undergo seasonal migrations, moving inshore to spawn in spring in southern Cape Cod waters and in the summer in the Chesapeake Bay. The timing and extent of seasonal migrations appear to be strongly related to the temperature preferences of this species.

Landings of long-finned squid increased from very low levels prior to 1967 to record highs of nearly 37,000 mt in 1973 as a result of heavy fishing pressure by the foreign fleet. Landings dropped afterward and have since fluctuated between 10,000 and 28,000 mt. Presently, commercial catches are almost entirely from the domestic fleet. Recreational catches are insignificant.

Fluctuating catch levels in the 1980s do not appear to be related to any trends in population abundance but to varying year-class strengths and market conditions. Recent

surveys suggest that long-term potential catches of 44,000 mt can be achieved, and the fishery is currently approaching fully exploited status. The fishery is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel and Butterfish FMP. Management is based on a total allowable catch limit.

Striped Bass (Morone saxatilis)

Striped bass or rockfish is an anadromous species distributed along the Atlantic coast from northern Florida to the St. Lawrence Estuary. It is also present as an introduced species along the Pacific coast and in inland lakes and reservoirs. Striped bass spawn in mid-February in Florida and in late June or July in Canada. In past years, the Atlantic coastal fisheries have relied on production from stocks spawning in the Hudson River, tributaries to the Chesapeake Bay, and possibly the Roanoke River in North Carolina. However, since the early 1970s, juvenile production in the Chesapeake has been extremely poor, and commercial production began a severe decline in the mid-1970s after peak landings of over 6,000 mt in 1973. During the mid-1980s, stringent measures were adopted by the states from Virginia to Maine to attempt to rebuild the Chesapeake stocks. These measures were directed at protecting the moderately successful 1982 year-class, as well as subsequent year-classes, until 95 percent of the females have had a chance to spawn once. The 1989 index of juvenile abundance in Maryland was very high, and this resulted in a limited opening of the fishery in 1990 based on a 1990 comprehensive revision of the ASMFC's coastwide FMP. However, in 1990, the juvenile index again declined, and future prospects are uncertain for any expansion of the striped bass commercial or recreational fishery.

Tautog (Tautoga onitis)

This species is distributed along the Atlantic coast from Nova Scotia to South Carolina, with the greatest abundance located south of Cape Cod and north of the Delaware Capes. They are often associated with structural bottom habitat in water depths of 10 to 25 meters. Tautog populations tend to be localized and form discrete spawning groups, even within a single bay system.

Commercial tautog landings have steadily increased over the past 10 years to approximately 600 mt. The tautog is important in the recreational fishery where catches have been as high as 9.2 million fish (1986).

No federal regulations govern the tautog fishery. Four states (Massachusetts, Rhode Island, Connecticut, and New York) have minimum size limits. The tautog is highly susceptible to overexploitation because of its slow growth and low fecundity. However, there have been no stock assessments that would allow determination of current exploitation rates.

Tilefish (Lopholatilus chameleonticeps)

This species occurs along the Outer Continental Shelf and upper continental slope from Nova Scotia to Florida. Within this range, the tilefish habitat is restricted to a narrow band of the shelf, in most places less than 17 nautical miles wide in waters 80 to 500 meters deep. Tilefish do not appear to migrate extensively; the location of fishing grounds remains consistent throughout the year, and from year to year.

About 90 percent of the commercial tilefish catch is taken in the mid-Atlantic Bight area. Landings between 1979 and 1988 fluctuated between 1,200 and 3,500 mt with a slight

downward trend toward the end of the period. There is a recreational fishery for tilefish, although it appears to be small in comparison with the commercial fishery. Recreational catches in 1987 were estimated at about 250 mt.

No state or federal laws govern tilefish harvesting, and little is known of their basic life history. However, fishing effort appears to be increasing, and regulations may be needed in the future.

Other Finfish

The foregoing discussion described trends in abundance, and in commercial landings and recreational catches, for various fish species for which these data are available. Information on trends in abundance is lacking for a number of other species present in Bight waters that have economic and/or ecological significance.

Two closely related anadromous species, blueback herring (Alosa aestivalis) and alewife (Alosa pseudoharengus), have been harvested commercially in the Bight region since colonial times and have been caught for personal consumption in many coastal rivers (McHugh, 1977). Both fishes also serve as a food source for predator species, such as bluefish and striped bass. It had been thought that spawning and nursery habitats for alewife and blueback herring had been lost over the years because of poor water quality and construction of dams that blocked historic spawning runs. While this is true to some extent, surveys in New Jersey have indicated that in most of the historic spawning streams, alewife and blueback herring continue to exhibit spawning activity (Zich, 1978). Streams in which spawning was not observed included the north branch of the Forked River and the Shark River.

Other anadromous fishes, including the Atlantic and shortnose sturgeons (Acipenser oxyrhnchus and Acipenser brevirostrum, respectively) were formerly more abundant, and peak landings of all three occurred in the 19th century. Although overfishing was a factor in subsequent declines, loss of habitat related to dam construction and poor water quality also was important (McHugh, 1977). White perch (Morone americana), also an anadromous species, is relatively abundant in the region's back bays and is a significant component of the recreational fishery in these areas (Thomas, 1973). Other species, such as mummichog (Fundulus heteroclitus), Atlantic silverside (Menidia medidia), and bay anchovy (Anchoa mitchilli), account for the major portion of the fish biomass in the bays and inshore waters of the Bight and provide an important food source for predator species (Thomas, 1973).

DISCUSSION

There is little evidence that environmental quality factors or long-term climatic changes are contributing significantly to present trends in the fishery resource abundance of most important commercial and recreational species in the New York Bight area. The National Marine Fisheries Service has indicated that, in general, fishing effort is probably the major cause of many present changes in resource abundance (U.S. Department of Commerce, 1989). This may not, however, be the case with all species. It is thought that the long-term decline in striped bass abundance in coastal waters may be partly the result of adverse water quality conditions, particularly in the Chesapeake Bay, although overharvesting was also probably a factor. As discussed earlier, juvenile production in the bay has generally been poor since the early 1970s, and striped bass are currently under some

form of protection throughout the coastal area. Atlantic shad production has been declining since the late 1960s, and even then landings of 3,000 mt were substantially below the record year catch of 22,000 mt in 1896. Factors that contributed to the early decline of shad include habitat loss resulting from impoundment of spawning streams (e.g., Conowingo Dam on the Susquehanna River) and poor water quality (e.g., in the Delaware River).

In the New York Bight, it has been noted that various diseases or conditions resulting from human activities have been associated with certain species of finfish (Waste Management Institute, 1989). For example, "fin rot" or "tail rot," among the most common nonspecific diseases of both marine and freshwater fishes, was prevalent in the early 1970s in the Bight region, particularly among winter and summer flounders. Surveys over the period from 1979 to 1983 indicated fin rot incidence of slightly over 2 percent on summer flounder in the inner Bight Apex. Incidence was much lower along the New York and New Jersey coast and in offshore waters of the Bight. Epizootics or outbreaks of fin rot had been reported earlier. In 1967, incidences of 8 percent in bluefish and 4 percent in winter flounder were found in New York Bight specimens. An even higher incidence of 70 percent was recorded for bluefish from the Raritan and Sandy Hook Bays. However, the prevalence of fin rot in winter flounder in the harbor showed a tenfold decline over the period 1973-78. The causes of fin rot are not well understood, although the disease or syndrome is most frequently found in shallow inshore waters affected by the effluents from major metropolitan areas. It appears unlikely that the disease presently affects the abundance of flounders or other species in the Bight, although the external appearance of this condition can cause reduced market demand or lowered angler preference for the species affected.

In addition to fin rot, periodic anoxic conditions in Bight waters have created stress on finfish resources. Anoxic conditions occurred in 1976 along the New Jersey coast over an 8,600-square-kilometer area, which resulted in mass mortalities of many benthic organisms, particularly surf clams, and to a lesser extent, ocean quahogs and sea scallops. However, finfishes, for the most part, avoided the areas of depressed dissolved oxygen, although some adverse effects may have occurred in eggs and larvae. Localized fish kills were reported along the New Jersey shore on a number of occasions throughout the 1970s and 1980s, but these were generally small and of short duration. These kills are presumed to be related to oxygen stress; none appear to be the consequence of toxic materials. While toxic materials are present in fishes in the Bight region, levels of PCBs and metals are highest within the Hudson-Raritan Estuary. There is no evidence available that indicates that current levels of toxics are adversely affecting the abundance of any species in Bight waters, although they have resulted in significant human use impairments for certain species (e.g., excessive levels of PCBs in Hudson River striped bass). Nevertheless, the National Status and Trends Program for marine water quality (NOAA, 1988) has described the Hudson/Raritan estuary as one of the most contaminated sites in the United States with regard to levels of chemical contaminants in surface sediments. On this basis, the possibility of direct or indirect impacts of chemical contaminants on fishes of the Bight should not be discounted.

SHELLFISH

Commercial harvesting of shellfish, predominantly mollusks, occurs from the shallow waters of the New Jersey and Long Island back bays out to the marine waters of the New York Bight 200 miles offshore. Hard and soft clams (Mercenaria mercenaria) and Mya arenaria, respectively) are the principal species harvested in the bays; ocean quahog (Artica islandica), surf clams (Spisula solidissima), and sea scallops (Placopecten magellenicus) constitute the ocean water production. In 1989, the molluskan shellfish harvest in Bight waters of the two states was valued at over $80 million.

Long Island

Hard clams are currently the predominant species harvested from the Long Island bays in the New York Bight. However, from colonial times up to the early 1930s, oysters dominated the fishery. During that period, oysters were apparently in far greater abundance and had a higher consumer preference than clams. The modern hard clam fishery began in Great South Bay around 1931, when Moriches Inlet was opened. This resulted in an increase in salinity, enabling the oyster drill and other predators to expand their range eastward into the oyster setting grounds (Coastal Ocean Science and Management Alternatives Program, 1985). Good oyster sets became infrequent, and the fishery declined rapidly. However, the altered environmental conditions seemed to be favorable to clams, and the productive clamming areas were substantially expanded. Landings of hard clams began to increase rapidly starting in the mid 1930s and rose to peak levels (over 10 million pounds of meat) in 1947. Production sharply declined to 2.5 million pounds in 1954 and increased again to around 9 million pounds in 1976. Since that time, landings have declined

to one-fourth of their 1976 levels, and prospects are poor for any significant production increases in the near future. Overfishing is thought to be a factor in the decline of hard clam production (Fox, 1982). The New York hard clam fishery in the Bight is concentrated in Great South Bay, although some clams are harvested in Moriches and Shinnecock Bays. Annual production in the two latter areas has been about 10-20 percent of that in Great South Bay. Recreational clamming is not significant in terms of total harvest and is estimated to be only about 1-2 percent of commercial landings (Fox, 1981). Commercially significant populations of hard clams are present in the central and western Hempstead Bays, but these areas are not certified for direct harvesting (Tom Doheny, Town of Hempstead, personal communication, 1991).

Management of the Long Island hard clam fishery occurs at two levels of government--town and state (one significant area of Great South Bay is privately owned and managed by a commerical shellfish concern). The towns, because they have title to the bay bottom within their jurisdictions, have some shellfish management programs that involve maintaining hatcheries and/or seed clam rearing and releasing operations, and imposing periodic or seasonal closures for stock conservation purposes. Town shellfishing laws do not supersede state laws but may be more restrictive. The State of New York is solely responsible for sanitary surveys and certification of shellfish-growing waters. The state also requires a digger's permit to take shellfish in commercial quantities or to sell shellfish in any quantity.

New Jersey

The back bay shellfishery of New Jersey is presently dominated by the valuable hard clam resource, although minor quantities of soft clams and mussels are also harvested. The most productive clamming areas are from southern Barnegat Bay southward into Little Egg Harbor Bay, Great Bay, and Great Egg Harbor Bay. In addition to the production of clams from beds in these waters, clams have also been harvested from beds in waters closed to direct harvesting (e.g., Raritan Bay) and transferred or "relayed" onto leased beds, primarily in Barnegat Bay, for depuration. Such relays have been practiced from time to time in New Jersey since the 1920s in the Navesink River and in the Atlantic City-Wildwood areas (Jenks and McCay, 1985). Improvements in water quality in the Atlantic City area in the late 1970s led to reclassification of some waters (e.g., Lakes Bay) and enabled seasonal harvesting without relay. Relays from north Monmouth County continued at least up to 1989 (Rogers, Golden, and Halpern, Inc., 1990).

Hard clam landings in the New Jersey back bays have been relatively stable over the past 12 years--between 0.8 and 1.5 million pounds. Landings have exceeded 1.0 million pounds each year since 1983, and in 1989 were 1.2 million pounds valued at $4.4 million. The fishery is closely regulated by the New Jersey Department of Environmental Protection.

Offshore Areas

Three bivalve mollusk species (ocean quahog, surf clam, and sea scallop) are major contributors to the offshore middle Atlantic fishery. Over the past 10 years, their joint landed value has been about 50 percent of the total value of all fishery products in this area.

Surf Clam - The surf clam is most abundant on sandy bottoms in waters 50 to 100 feet deep. Prior to World War II, there was a relatively small bait fishery for this species. Following the war, in response to increased demand and dwindling supplies of traditional clams, fishing effort shifted to the offshore waters of Long Island and northern New Jersey, and landings increased dramatically. Other offshore beds were discovered off Point Pleasant, New Jersey, and Cape May-Wildwood in the late 1950s, and these areas supported the fishery until the early 1970s. Fishing effort was then redirected to newly discovered beds off Virginia and North Carolina, and peak landings were recorded in the period from 1973 to 1975. The southern fishery collapsed shortly thereafter, and with the anoxia-related mass mortality of clams in northern New Jersey in 1976, landings dropped considerably in the late 1970s. Since then, stocks have been generally rebuilt, and currently, offshore landings in the Exclusive Economic Zone continue to be relatively stable owing to the large standing stock relative to the annual fishery quota. Surf clams are managed under a very stringent quota system by the MAFMC and are considered to be fully exploited.

Ocean Quahog - The ocean quahog occurs on bottoms of soft, sandy mud and silty sand at depths of 75 to 120 feet. Commercial harvesting began during World War II off Long Island, but landings were at relatively low levels until the mid-1970s. With the massive die-off of surf clams off New Jersey in 1976 and declines of clam stocks elsewhere, fishing effort moved to the deeper waters of the Bight, and quahog landings rose from 2,500 to 15,800 mt between 1976 and 1979. Landings in 1988 were 21,000 mt. The quahog are extremely slow-growing and long-lived, and may take up to 20 years to reach marketable size. Current landings are only about 2 percent of the estimated standing stock, but because

of their slow growth, the fishery is characterized as fully exploited in some areas. Quahogs are also managed by the MAFMC under the same FMP as surf clams, and their catch is closely regulated.

Sea Scallops - Sea scallops are restricted to the relatively deep waters of the middle Atlantic Bight, and commercially significant concentrations are usually found on hard bottoms at depths of 120 to 300 feet. Sea scallop landings in the mid-Atlantic area have been highly variable over the past 25 years, fluctuating between 1,000 and 10,000 mt. Recruitment of the 1982 to 1985 year classes was much above average and resulted in a threefold increase in stock biomass. Landings in the mid-Atlantic area in 1988 were 6,500 mt. The sea scallop resource is considered to be fully exploited, and is managed under an FMP developed by the New England Fishery Management Council, which sets size limits for landings.

Other Shellfish - Several other species of shellfish that occur in Bight waters have economic or ecological importance. The American lobster (Homarus americanus), present in both inshore and deeper waters of the Bight, is subject to intensive fishing pressure, particularly off eastern Long Island (Briggs, 1979). In 1989, lobsters ranked fourth in total value among invertebrates landed in the Bight fishery. The blue crab (Callinectus sapidus) is widely distributed in the region's bays and estuaries where it is harvested by both commercial and recreational fishermen. The horseshoe crab (Limulus polyphemus), a conspicuous member of the Bight's shellfish population, is frequently observed during its early summer spawning period on coastal beaches. Horseshoe crabs were once harvested for processing into fertilizer and animal feed, but in recent decades their ecological value

has been recognized as an important food source for migratory shorebirds that feed on crab eggs (Wander and Dunne, 1982).

Discussion

In contrast to finfishes, there is ample evidence that water quality factors, chiefly the presence of pathogens and pathogenic indicator organisms, have had a major adverse impact on shellfishing in the New York Bight.

Portions of the Bight and the New York-New Jersey Harbor Estuary area have been periodically or permanently closed to shellfish harvesting for more than 70 years. The first recorded closures occurred in 1912 in New Jersey waters (Matawan Creek in Raritan Bay) as the result of typhoid fever outbreaks traced to the consumption of shellfish from polluted areas. In 1914, New York State classified all of New York Harbor and Jamaica Bay waters, and large areas of western Long Island's south shore, as "grossly" or "seriously" polluted and therefore unsafe for shellfishing. A severe shellfish-related typhoid epidemic in New York and several other cities in 1924-25 led to a national effort to establish a system for classifying shellfish-growing waters. This resulted in formation of the National Shellfish Sanitation Program and adoption of practices to regularly monitor bacterial indicators. Subsequently, additional shellfish areas were closed along the New Jersey shores; by the late 1930s, over 23,000 acres had been affected. Between then and the late 1960s, the areal extent of closures in the ocean waters of the Bight within the 3-mile limit stabilized at about 90,000 acres in both states.

In the early 1960s, federal officials became concerned about the proximity of clam harvesting areas to ocean dumping sites in the Bight and the large projected increases in the

amount of sludge to be dumped. Studies were undertaken of these sites, and very high levels of fecal coliforms were found in seawater, indicating possible contamination from human waste sources. As a result, the U.S. Food and Drug Administration (FDA) established, in 1970, a closure area with a radius of 6 nautical miles around the 12-mile sewage sludge dump site. This area was expanded in 1974 on the landward side, resulting in closure of all federal waters from the 3-mile New York and New Jersey territorial waters out to the dump site (136,000 acres) (Figure 3). Since then, the extent of the closed areas in the Bight has not changed significantly, except that a seasonal restriction for 16,000 acres in New York waters was removed in 1988 as a result of improved water quality associated with year-round disinfection of effluents from New York City's sewage treatment plants. For the same reason, New Jersey removed the seasonal restriction for 13,000 acres in Raritan Bay in 1989. (The latter area is not included in the Bight.) New Jersey also reclassifiedsome bay areas south of Atlantic City in 1990 to allow clam harvesting in formerly closed or restricted areas (New Jersey Department of Environmental Protection, 1990). Presently, approximately 225,000 acres of potentially productive shellfish beds in the Bight are either closed or under use restrictions.

Contamination of shellfish by pathogens or indicator organisms does not, in most cases, affect their abundance. In the Bight area, substantial quantities of hard clams occur in several presently closed inshore areas (e.g., Jamaica Bay and portions of the Hempstead Bays), and surf clams and quahogs are thought to be abundant in the closed ocean waters of the Bight Apex. Some of these areas (e.g., Raritan Bay) are in fact harvested, and the clams transferred to clean waters to depurate harmful organisms prior to final harvest and

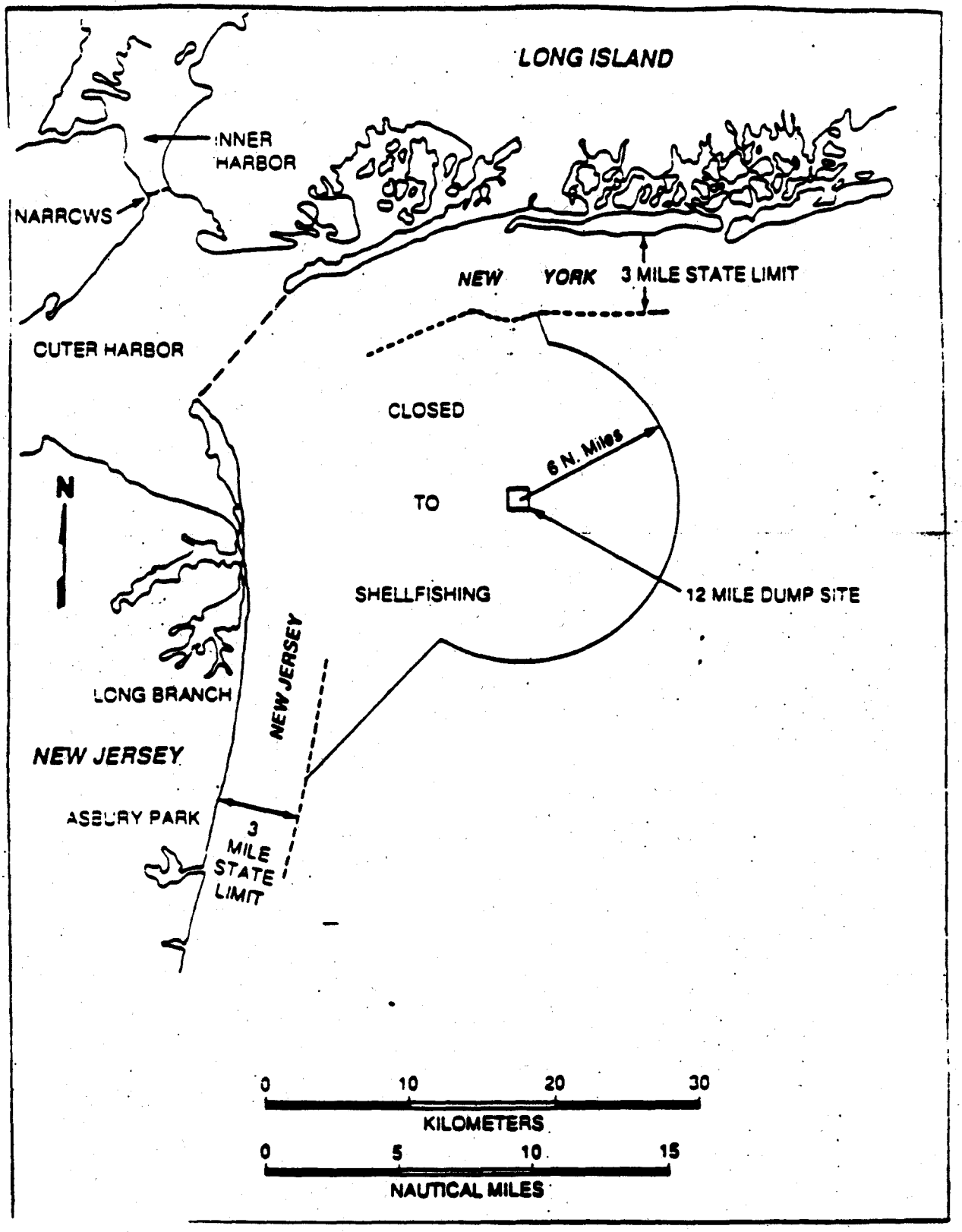

Figure 3. Shellfish Closure Areas in the Federal Waters of the New York Bight

sale. Such "relays" have been in operation between Raritan Bay and Barnegat Bay in New Jersey and, to a limited extent, Great South Bay in New York. However, the extent to which these resources can be exploited in this manner is dependent on the availability of state resources to ensure adequate inspection and surveillance of the relay operation. Also, in some instances, political factors have limited the extent of such programs.

Remedial measures for reopening closed shellfish areas have been addressed by the Pathogens Work Group of the New York Bight Restoration Plan (Pathogens Work Group, 1990). These include specific monitoring and research programs; upgrading, inspection, and enforcement of sewage treatment discharges; eliminating dry weather discharges of combined sewer overflows (CSOs) in the New York-New Jersey Harbor; treatment of wet weather CSOs; and reducing nonpoint pollutant sources. In the absence of these remedial programs, it is unlikely that the extent of closures in back bay and inshore areas can be significantly reduced. However, cessation of sludge dumping in the Bight Apex in 1987 may allow opening of these waters in the near future.

MARINE MAMMALS AND TURTLES

A number of species of mammals and turtles occur in, or migrate through, the marine waters of the Bight. Several of these have been listed as threatened or endangered under the Endangered Species Act of 1973, including the right whale (Eubalaena glacialis), humpback whale (Megaptera movaeangliae), fin whale (Balaenoptera physalus), sei whale (Balaenoptera borealis), sperm whale (Physeter macrocephalus), loggerhead sea turtle (Caretta caretta), leatherhead sea turtle (Dermochelys coriacea), and Kemp's ridley sea

turtle (Lepidochelys kempii). In addition to these species, other whales and various dolphins occur in Bight waters.

Marine mammals and sea turtles use the waters of the Bight for feeding, nursing, breeding, and as a migratory pathway north to the Gulf of Maine and south to breeding, calving, and nesting areas. Sea turtles do not use the Bight area to nest, and their occurrence is in response to food availability and/or other favorable environmental conditions (Pacheco, 1988). The leatherback sea turtle is common in nearshore and mid-shelf regions of the Bight in summer. Loggerhead turtles, the most common sea turtle species in the north Atlantic, also are widely distributed in summer in the nearshore bight waters, and in the spring and fall in shelf/slope waters. Several loggerhead nestings have been reported on New Jersey beaches (Waste Management Institute, 1989). Kemp's ridley, the most endangered sea turtle species, favors inshore shallow bays where crabs and mullusks are their major food. In the Bight, impairments to marine turtles are mainly the result of manmade disturbances, including boat kills, powerplant impingements, entanglement in fishing gear and other plastic debris, and ingestion of plastic wastes (Waste Management Institute, 1989).

Right whales are the most severely depleted large whales oceanwide, and 200-500 occur from the Bay of Fundy to Florida (Pacheco, 1988). They apparently migrate through the Bight region in the spring and fall in both inshore and offshore waters.

About 5,700 humpback whales occur in the western North Atlantic, and 300 have been identified as frequenting Gulf of Maine waters in spring, summer, and fall (Pacheco, 1988). Major summer feeding areas occur along the 100-meter contour and in an area east

of Montauk, Long Island. An important food source for humpbacks in the western North Atlantic is the sand lance (Ammodytes sp.).

Fin whales are the most abundant large whales in the mid-Atlantic, where they tend to occupy the Continental Shelf area. About 1,000-3,000 fin whales occur between the Gulf of Maine and Virginia (Pacheco, 1988). Relatively high densities of fin whales occur in waters off eastern and central Long Island during fall and winter.

The sperm whale occurs well offshore in deep waters along the 1,000-meter contour and beyond the Continental Shelf edge. They are abundant throughout the central mid-Atlantic shelf region in spring and summer. Sperm whales are deep-diving animals that feed mainly on squid and other deepwater fishes. Sei whales are generally distributed north and east of the Bight proper.

Whales are significant predators on marine resources, and their impact on fish resources is substantial and comparable to human harvests for some species (Hain et al., 1985). Human-caused impacts on whales, aside from direct and incidental harvesting, are difficult to quantify. Since some of these species are apex predators and long-lived, they are susceptible to pollutants that have accumulated in the marine environment. It is known that large whales can become entangled or entrapped in certain types of fishing gear, and injury, and disability can result from ingestion of solid marine debris.

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COASTAL AND MARINE BIRD POPULATIONS AND TRENDS

COASTAL BIRDS

Introduction

The New York Bight coastal region, while heavily impacted by man's activities, supports large numbers of resident and migratory birds. Beaches, salt marshes, spoil areas, bays and estuaries, and wooded upland provide habitats for a wide diversity of wading birds, waterfowl, raptors, shorebirds, gulls, and terns. Despite the pressure of human activities, many species have increased in the Bight in the past several decades, and others occur in substantially greater numbers now than they did at the turn of the century. Trends in coastal bird populations in the Bight from the late 19th century to the mid-1970s have been summarized in Howe et al. (1978). More recent population data, including 1989 colonial waterbird survey results, are in Jenkins et al. (1990) for New Jersey and in Downer and Liebelt (1990) for Long Island. Unless otherwise noted, the discussion below is based on these publications.

According to Howe et al. (1978), the abundance and distribution of birds in the Bight over the past 100 years have been affected by a number of factors, including commercial exploitation, habitat modification, and environmental contamination. During the latter half of the 19th century, bird populations were heavily impacted by the harvesting of birds for food and feathers. Many of the marsh and beach nesting birds of the region were nearly annihilated by the combined pressures of hunters, milliners, and egg gatherers. Market hunting, even for small songbirds such as robins, was common throughout the 19th century

and resulted in the decimation of local populations. Even more devastating was the millinery trade in New York City, which reached a peak in the 1880s. The supply of feathers for this industry resulted in the annual take of probably well over one million birds. By 1884, the thousands of common terns, least terns, and piping plovers formerly present between Coney Island and Fire Island Inlet had been reduced to a few individuals. Common and roseate terns, herons, snowy egrets, and many other species were similarly impacted.

Passage of federal protection legislation (e.g., the 1913 Migratory Bird Treaty) in the early 1900s brought to an end the era of indiscriminate exploitation of birds, and over the next several decades populations were gradually restored. Common terns and least terns recovered by the 1920s, and piping plovers were reported to be as common by the early 1940s (Cruickshank, 1942). Snowy egrets, which had been absent in New Jersey after about 1896, were found nesting in 1939 at Avalon.

Following World War II, habitat alteration and destruction became a major factor affecting the abundance of birds in the Bight, particularly certain shorebirds, terns, and skimmers. Although wetlands alterations through mosquito ditching began in the early 1900s, the period between the late 1940s and early 1960s saw the direct loss of large acreages of coastal wetlands on Long Island and New Jersey. These wetlands were drained and filled for residential development, highways, landfills, and dredged spoil disposal. Also, second home development reduced the amount of beach and dune habitat, and associated human activities caused disturbance to beach nesting species. Passage of federal and state wetlands protection laws in the early 1970s reduced the rate of additional fills and other

direct alterations of wetlands. However, habitat values were, and are still, seriously impacted by vandalism, recreational vehicles, picnicking, pest species, and other forms of human disturbance that affect beach nesters and colonial birds.

Another major factor impacting bird populations in the Bight has been environmental contamination by various pesticides, toxic chemicals, and petroleum products. Probably the most significant of these was the introduction of the insecticide DDT following World War II and the related chlorinated hydrocarbon pesticides aldrin, dieldrin, chlordane, and heptachlor. A major source of DDT to the Bight ecosystem was the extensive spraying of salt marshes for mosquito control between the late 1940s and 1966 (on Long Island) and 1972 (in New Jersey). More than any other state, the coastal marshes of New Jersey received the most concentrated DDT applications over the longest period (Henney et al., 1977).

Bioaccumulation of DDT and related pesticides in the aquatic environment resulted in extremely high concentrations of the chemical in plankton, fish, and shellfish, major food sources for many bird species (Waste Management Institute, 1989). Although direct mortality to birds seldom occurred, the effects of sublethal levels on reproductive success, particularly eggshell thickness, was widely documented (Cooke, 1973). In the Bight region, osprey was probably the species most seriously impacted, but the bald eagle and various herons were also affected. In addition, developmental abnormalities were observed in terns that may have been associated with DDT and other pollutants. Widespread use of DDT was halted in 1972, and levels found in birds in the Bight have gradually declined, although

concentrations in peregrine falcon eggs in New Jersey as late as 1984 were still three times greater than in other states (Niles et al., 1989).

Other industrial compounds, particularly polychlorinated biphenyls (PCBs), have been found in relatively high concentrations in birds in the Bight region. In the early 1970s, PCBs in wading bird eggs from New Jersey were many times higher than residues found in birds from states farther south (Niles et al., 1989). Significant concentrations were also measured in mallards, black ducks, scaup, and osprey. Over the past decade, domestic industrial use of PCBs has been phased out, but widespread contamination of these chemicals continues in such areas as the Great Lakes and the Hudson River because their chemical stability and low solubility make them highly persistent in the aquatic environment.

Contact with oil produces direct effects on birds (e.g., through soiling of feathers and ingestion) and indirect effects such as reduced egg hatchability. The adverse impacts of oil spills in the Bight region and elsewhere have been well documented (e.g., Choate, 1967; Stout and Cornwell, 1976). However, it has been estimated that only a relatively small portion (about 2 percent) of the oil in the marine environment generally originates from tanker accidents (Zeldin, 1971). More significant sources include used motor and industrial oils, ship bilge discharges, and normal tanker operations. It is not known how oil from these various sources is presently affecting birds in the Bight, but the chronic effects could be significant.

Population Trends

Birds that utilize various coastal habitats in the Bight for breeding include long-legged waders (herons, egrets, and ibises), waterfowl (e.g., American black duck), raptors

(e.g., osprey, bald eagle), rallids (e.g., clapper rail, American coot), shorebirds (e.g., piping plover and oystercatcher), and gulls and terns. Recent (1989) estimates of the abundance of some of these species (colonial waterbirds and piping plovers) in the Bight region are given in Table 2.

Waders - Long-legged waders that nest in the Bight region include the tricolored (Hydranassa tricolor), great blue (Ardea herodias), little blue (Florida caerulea), and green (Butorides virescens) herons; the black-crowned (Nycticorax nycticorax) and yellow-crowned night (Nyctanassa violacea) herons; cattle (Bubulcus ibis), great (Egretta albus), and snowy (Egretta thula) egrets; and the glossy ibis (Plegadis falcinellus). According to Howe et al. (1978), populations of wading birds in the Bight were reported to be thriving in the mid 1970s, whereas many species had been absent for decades following exploitation by the 19th century millinery trade. Also, several species that were not known to nest in the Bight, or were very rare, had become relatively abundant by the 1950s (e.g., great egret, little blue heron, tricolored heron, and cattle egret).

Over the past decade, the predominant wading birds have been the snowy egret, glossy ibis, black-crowned night heron, and great egret. Together, these species accounted for about 80 percent of the total wading bird population in the Bight in 1975, estimated at just under 10,000 breeding pairs. Recent surveys of New York Harbor-Long Island (Downer and Liebelt, 1990) indicate about the same composition, although the population of cattle egrets is higher now than in the mid 1970s, but down from the levels of 1985. With the exception of cattle egrets (and black-crowned night herons in New Jersey), wading bird populations in the New York area of the Bight have been generally stable over the period

Table 2. Abundance of Nesting Colonial Waterbirds and Piping Plovers, New Jersey (Atlantic Coast) and Long Island, 1989 (number of adults)

Species	New Jersey	Long Island[a]
Little blue heron	209	66
Black-crowned night heron	209	2,925
Yellow-crowned night heron	48[b]	19
Tricolored heron	238	52
Green-backed heron	none	79
Double-crested cormorant	none	3,624
Great egret	463	530
Snowy egret	2,681	1,183
Cattle egret	62	168
Glossy ibis	1,017	888
Common tern	9,620	40,593
Least tern	--[c]	4,177
Forsters tern	1,863	2
Roseate tern	none	2,628
Herring gull	7,300	22,299
Laughing gull	58,722	455
Great black-backed gull	303	9,478
Black skimmer	1,100[d]	1,081
Piping plover	88[e]	315

[a] Long Island numbers include colony counts in the New York Harbor, East River, and northern Long Island, which are not part of the New York Bight study area.

[b] Undercounted in 1989; numbers in 1985 were 109.

[c] Least terns not counted in 1989.

[d] Undercounted in 1989; 1983-85 numbers were about 1,100.

[e] 1987 numbers.

SOURCE: Jenkins et al. (1990); Downer and Liebelt (1990).

1985-89. The major wading bird colonies in New York are in the Harbor (in Staten Island, North and South Brother Islands in the East River, and Jamaica Bay), western Long Island Sound (Huckleberry Island), Gardiners Island (located in Gardiners Sound in eastern Long Island Sound), and South Pine Marsh in East Bay, Nassau County. Only the latter is in the New York Bight region.

Wading bird colonies are more widely distributed along the shoreline in New Jersey in comparison with New York. Colonies are present from northern Barnegat Bay (Island Beach State Park) south to Cape May Inlet. Three of the four dominant species of wading birds (snowy egret, glossy ibis, and great egret) observed in 1975 accounted for 85 percent of the wading birds observed in New Jersey in 1989. The black-crowned night heron count of 206 birds in 1989 was a major decline from the 1978 count of 1,470 birds and was down 50 percent from 1985 levels. As a result, it has been recommended that this species be reclassified from "declining" to "threatened" in New Jersey (Jenkins et al., 1990). Cattle egrets and glossy ibis have also declined from 1978 levels. Populations of the tricolored heron (Hydranassa tricolor) and little blue heron have been relatively stable over this period.

Shorebirds - Shorebirds, which include plovers, sandpipers, and oystercatchers, make up much of the migrant bird population of the Bight region, but the piping plover (Charadrius melodus) and American oystercatcher (Haematopus palliatus) are the predominant Bight-nesting species. Both were common breeders until the mid-19th century but nearly disappeared by the turn of the century as a result of excessive hunting. The piping plover repopulated the Bight region in large numbers and were considered common

by the early 1940s. In 1939, the Long Island population was estimated at 500 pairs. However, the population again declined through the 1950s and 1960s, apparently the result of beach development and human disturbance. In 1986, the Atlantic Coast piping plover was federally listed as a threatened species.

In New Jersey, the estimated number of piping plover pairs fluctuated between 78 and 106 between 1976 and 1987 (Niles et al., 1989). The Long Island population, estimated at 191 pairs in 1989, has shown no particular trend since 1984 (Downer and Liebelt, 1990). The principal Long Island nesting sites are the Westhampton and Jones Beach areas, and the western end of Rockaway Beach. In 1989, the New Jersey and Long Island piping plover populations together represented a significant portion (about 44 percent) of the total U.S. Atlantic coast piping plover population of 721 breeding pairs (Melvin et al., 1991).

Piping plovers nest and feed on beaches and are thus highly susceptible to human disturbance. Moreover, they are solitary rather than colonial nesters, and protection during the breeding season is quite difficult in popular recreational areas.

The American oystercatcher returned as a Bight nester in the late 1940s in southern New Jersey and in the late 1950s at Gardiners Island on Long Island. It subsequently expanded to several locations on Long Island in Great South Bay and Jamaica Bay. In 1975, 46 pairs were estimated to be present on Long Island; between 1986 and 1989, the estimated number of pairs fluctuated between 194 and 256. The population in New York is thought to be increasing.

Raptors - Ospreys (Pandion haliaetus) are by far the most common coastal raptor in the Bight region, although the bald eagle, marsh hawk, and short-eared owl have historically

nested in or near Bight habitats. Ospreys have nested along the entire New Jersey coast and on Long Island from Peconic Bay east to Montauk Point. Ospreys prey almost exclusively on live fish and are dependent on a healthy fish population for their existence. As discussed earlier, the high levels of chlorinated hydrocarbon pesticide levels in fish in the Bight area led to reproductive failures and population declines beginning in the late 1940s. For example, the number of active osprey nests on Gardiners Island declined from about 300 in 1948 to 34 in 1971. In New Jersey, the number of breeding osprey pairs dropped from 500 in the early 1950s to 50 in 1970 (Howe et al., 1978).

The osprey population in the Bight has generally recovered because pesticide levels were reduced and nesting structures were erected. The number of occupied nests in New Jersey rose from 97 in 1982 to 137 in 1987 (Niles et al., 1989). Steadily increasing numbers of osprey migrants have been reported at Cape May (Dunne and Sutton, 1986).

It is not clear that there has been extensive breeding of bald eagles (Haliaeetus leucocephalus) in the Bight region, although it was reported to be a relatively common nester in southern New Jersey in the 19th century. The last reported nesting on Long Island, at least up to the late 1970s, was in 1930 on Gardiners Island.

In 1957, about 10 to 15 bald eagle pairs were estimated to be breeding in southern New Jersey. Subsequently, nesting success dropped apparently due to egg thinning caused by pesticides, and no successful nesting occurred between 1967 and 1973. Only one bald eagle nest was present in New Jersey between 1974 and 1987, and it was incapable of producing young. In 1987, eggshells were still reported to be very thin (Niles et al., 1989).

It is thought that the expanding Chesapeake Bay population could overflow into the Bight and that some bald eagles would be established in the southern reaches of the region.

Both the northern harrier (Circus cyaneus) and short-eared owl (Asio flammeus) have declined in the Bight, although census data to confirm the magnitude of these trends are not available. The decline of these two species, both ground nesters, is thought to be the result of predation by skunks, raccoons, etc. (Joseph J. Dowhan, U.S. Fish and Wildlife Service, Charlestown, RI, personal communication).

Gulls - Gulls are a conspicuous component of the Bight bird assemblage, and three species breed locally--the herring gull (Larus argentatus), great black-backed gull (Larus marinus), and laughing gull (Larus atricilla). The herring gull is one of the most abundant breeding birds in the Bight; the largest numbers occur on Long Island. It was first found nesting on Long Island in 1931 and rapidly spread westward along the south shore. By 1974, the breeding population on Long Island was estimated to be about 16,000 pairs. The first herring gull nest in New Jersey was located at Stone Harbor in 1946. In 1979, in New Jersey, there were an estimated 5,900 adults. The herring gull population on Long Island is currently somewhat higher than in the mid 1970s and fluctuated between 17,000 and 24,000 between 1985 and 1989. The New Jersey population in 1989 was estimated at about 7,300 birds.

Herring gull colonies are primarily located on dredged spoil/fill areas that are slightly elevated above marsh level. Although primarily a fish-eater, the herring gull is an adaptable consumer and obtains much of its diet by scavenging. The increase in abundance of these birds is thought to be associated with the proliferation of garbage dumps and landfills in the

Bight, which provide a ready food source. Herring gulls can have negative effects on other colonial waterbird colonies through competition for nesting sites and predation on eggs and young.

The laughing gull has always been common or abundant in breeding colonies in New Jersey. In the early 1900s, colonies apparently occurred only in two locations in Cape May County, but 75 colonies were present in 1979, including several in Barnegat Bay. However, about 53 percent of the nesting adults occurred at one site--the Ring Island area of Cape May County. The New Jersey laughing gull population in 1979 was estimated at 45,000 adults. Numbers in recent years are somewhat higher, slightly less than 60,000, and the laughing gull is more widely distributed along the coast than in earlier years.

Howe reported no instances of laughing gull breeding on Long Island since 1900, although nonbreeding, summering birds were common in the vicinity of New York Harbor. However, laughing gull colonies have been present in recent years in Jamaica Bay. Between 1985 and 1989, there were 2,600-3,000 pairs in this area.

Laughing gull colonies typically occur directly on marsh islands. A major threat to these populations is natural flood tides, which can periodically devastate marsh colonies.

The great black-backed gull is a relatively recent breeder in the Bight region. It was first found breeding in 1942 in Gardiners Bay on Long Island and rapidly spread westward along the south shore of Long Island. In 1977, there were estimated to be 1,700 breeding pairs, and by 1989, the number of pairs had reached nearly 10,000. Gardiners Island supported over 50 percent of Long Island's breeding population; other key areas were on Staten Island, the Brothers Islands in the East River, and Plum Island in Long Island Sound.

The great black-backed gull was considered a rare winter visitor in New Jersey early in this century. The first breeding record was in 1966 in Absecon Bay, and by 1977, 103 pairs bred at 21 sites. Numbers have increased since the late 1970s; in 1989, 303 of these birds were counted in coastal New Jersey.

Colonies of the great black-backed gull are found on saltwater nonbarrier islands on spoil or fill areas, often in association with herring gulls. It is an omnivorous feeder, including the young of other species of birds with which it is associated. It could, therefore, become a significant predator on herring gulls and young terns.

Terns and Skimmers - The common and least terns and black skimmer are common in the Bight, nesting mainly on sandy beaches and islands. Forsters and gull-billed terns are also present but rare as breeders. The roseate tern occurs on Long Island.

The common tern (Sterna hirundo) is the most prevalent nesting tern in the Bight region. Following the period of exploitation in the late 19th century, common terns again became abundant in the 1920s. Thereafter, development and recreational use of beaches caused terns to desert many colonies, but population trend data are not available. Surveys on Long Island have indicated that about 10,000 to 11,000 pairs were present in the mid-1970s. By 1989, an estimated 25,000 common tern pairs were present on Long Island. Principal colonies in the Bight area are at Jones Beach, Cedar Beach, Warner Islands in Shinnecock Bay, and East Inlet Island in Moriches Bay.

Common tern populations in New Jersey were estimated in 1977 at 5,700 adults in 44 colonies from Cape May north to Lavallette and Chadwick. In 1979, approximately 9,600 adults were counted, about the same number as in 1989.

The common tern nests on sandy beaches on barrier islands and on wrack mats on nonbarrier back-bay islands. Many of the presently successful colonies are located on protected reserves or refuges. Competition for nesting space may be a key factor in limiting the present level of abundance of the common tern.

The roseate tern (Sterna dougallii), a federally listed endangered species, occurs in the Bight almost exclusively on Long Island, which supports one of the largest breeding populations in the western hemisphere. The large majority occur on Great Gull Island in Long Island Sound outside the Bight area. Only one recent record of breeding in New Jersey has been published--a single pair in 1971.

In the mid-1970s, there were an estimated 1,000 to 2,300 pairs on Long Island, although numbers dropped to 981 and 608 pairs in 1976 and 1977, respectively. Between 1984 and 1989, estimated pairs rose from 918 to 1,362. About 90 percent were located on Great Gull Island in Long Island Sound. A smaller (104 adults) breeding population occurred at Cedar Beach on the Jones Beach Strip and East Inlet Island in Moriches Bay.

Roseate terns nest in association with common terns, but in areas with somewhat denser vegetation. Like the common tern, this bird is a fish eater and thus subject to exposure to environmental contaminants, but crowding at the few roseate breeding areas is considered to be of greater current significance in limiting their numbers.

The least tern (Sterna antillarum) is distributed throughout the Bight region. Like other Bight species, it was severely depleted by the turn of the century but began breeding again in Long Island and New Jersey in the early 1920s. Populations rose until the least tern was the second most common breeding tern on Long Island in 1975, when

approximately 2,400 pairs were found. About 430 breeding pairs were found in New Jersey in 1973.

Between 1982 and 1989, least tern populations on Long Island averaged about 4,000 pairs with a slight upward trend over this period. In New Jersey, an estimated 1,750 adults were present in 1979, and these numbers gradually increased to slightly over 3,000 in 1987.

Least terns nest in a variety of peninsula, barrier island, and shoreline habitats on sandy beaches and spoil/fill areas. Since least terns are colonial nesters, they are amenable to protection measures. Considerable effort has been made in applying such measures as fencing and wardening to protect nesting sites (Burger, 1989). For example, 46 percent of least tern sites on Long Island have been posted and 43 percent fenced (Downer and Liebelt, 1990). These measures have been effective in both states in helping to maintain populations of these birds. Least terns are listed by both New Jersey and New York as endangered species.

The black skimmer (Rynchops nigra) began recolonizing in southern New Jersey in the 1920s and on Long Island at Gilgo Island in the 1930s. By 1973, there were at least eight colonies along the south shore of Long Island, and in 1975, 458 pairs were counted throughout Long Island. Between 1984 and 1989, the number of Long Island pairs fluctuated between 715 and 1,124 at 10 colonies. The principal colonies were at Jones Beach and Cedar Beach.

The largest black skimmer colonies reported from southern New Jersey in the 1950s and 1960s were at Tuckerton (2,000 pairs) and Avalon (1,000 pairs). In 1979, an estimated 2,135 adult black skimmers were present at 23 locations in southern New Jersey. Numbers

have declined since that time, reaching a low of 870 in 1989. Predation and human interference, and nesting space competition with herring gulls, are thought to be the most important factors affecting breeding success. The black skimmer is listed by New Jersey as an endangered species.

Waterfowl - The American black duck (Anas rubripes) was, historically, the only species of waterfowl to nest commonly in the Bight region. Blue-winged teal (Anas discors) and red-breasted mergansers (Mergus serrator) were present but rarely recorded as nesters. By the mid-1970s, eight additional species nested regularly in the Bight including the gadwall (Anas strepera), ruddy duck (Oxyura jamaicensis), and northern shoveler (Anas clypeata). The increase in breeding populations of these species has been attributed to the creation of wildlife refuges, which maintain brackish or freshwater impoundments with controlled water levels. These impoundments provide stable habitats, which are suitable as breeding sites. In addition, several species have been established in the Bight region through introduction by man, including the mute swan (Cygnus olor), mallard (Anas platyrhynchos), and redhead (Aythya americana).

The American black duck nests in a variety of coastal habitats and is widely distributed in the Bight. It has been considered to be the most common nesting duck in the region. The gadwall has increased substantially since it became established in New York and New Jersey in the late 1940s, and breeding populations occur in J.F. Kennedy Wildlife Refuge at Tobay, in Jamaica Bay, and at Gardiners Island. The ruddy duck has also naturally colonized impoundments along the coast in the Bight from Jamaica Bay to

Brigantine. The northern shoveler has been a successful breeder in the southern portions of the Bight, including Brigantine.

The mute swan, which is native to Eurasia, was introduced to southeastern New York around 1910 and is the only common species of swan in the Bight region at any season. They nest on small ponds and impoundments along the coast in summer, and in winter are found in large flocks in bays, particularly on eastern Long Island. Canada geese and mallards nest on freshwater marshes and ponds throughout the Bight region. Redheads, as of the mid-1970s, bred only at the Jamaica Bay Wildlife Refuge.

Wintering Birds - Large numbers of various bird species overwinter in the Bight region; the majority are species that breed north and northwest of the Bight. The most conspicuous of the winter populations are the large flocks of waterfowl present in bays, estuaries, and coastal waters. About 24 species occur in the Bight region. Loons and grebes spend the winters in similar habitats as well as in offshore waters. The resident herring and great black-backed gull populations are augmented by northern migrants in the winter. Pelagic birds also overwinter in the Bight but only occasionally appear near shore.

Population estimates of wintering birds are generally not available except for waterfowl, which are regularly canvassed by the states in cooperation with the U.S. Fish and Wildlife Service. Also, data are available from the Christmas Bird Counts sponsored by the National Audubon Society. A summary of the Counts for the Bight region over the period 1955-74 indicate that the herring gull and brant made up over one-third of the wintering population in the Bight. There were, however, local variations in the distribution of birds. American black ducks were relatively common along western Long Island, the common

grackle along the northern New Jersey shore, and the greater scaup (Aythya marila) in Barnegat Bay.

Waterfowl populations in the Bight have undergone several major changes over the past two decades. In 1975, Canada geese wintered in moderate numbers, about 6,000, in the Bight. Later midwinter inventories in New Jersey estimated that Canada geese populations increased from 23,200 in 1981 to 124,000 in 1990, a record high for the state (Ferrigno, 1990). However, since the total Atlantic Flyway population of Canada geese generally declined over this period, increased numbers in New Jersey appear to be the result of the displacement of geese from states to the south, particularly Maryland.

Snow geese populations have similarly increased. Between the early 1950s and 1970, total New Jersey populations never exceeded 20,000 birds. Since that time, the population has steadily increased and the flock has dispersed from its sole site at Egg Island to other coastal areas (e.g., Brigantine). Total New Jersey midwinter populations in 1990 were a record high 80,000, although the majority were present in Delaware Bay (Ferrigno, 1990). These trends follow those for the total Atlantic Flyway population, which had peak numbers in 1989 and 1990.

The brant was formerly the most abundant goose in the Bight and one of the few birds whose winter range is nearly confined to the Bight region, primarily at Brigantine National Wildlife Refuge in southern New Jersey. In the mid 1970s, the brant population averaged about 170,000 birds. These numbers dropped sharply as a result of starvation losses to a low fall population of 44,000 in 1978-79. The total brant population has since

recovered, and by 1989-90 the fall population had increased to about 169,000 (Ferrigno, 1990).

Overwintering ducks in the Bight region include greater scaup, American black duck, bufflehead (Bucephala albeola), canvasback, mallard, and common goldeye (Bucephala clangula). The greater scaup, the most common of the wintering diving ducks, occurs throughout the Bight coastal area. Total Bight populations were about 85,000 in 1975. Between 1981 and 1990, scaup populations in New Jersey averaged 61,400 birds. Numbers reported in 1987, 1988, and 1990 were about 40 percent below the 10-year average, although total Atlantic Flyway numbers in 1989 and 1990 were well above the 10-year average of 374,000 birds (Ferrigno, 1990).

In 1975, the American black duck wintering population in the Bight was estimated at 70,000, slightly below that of the greater scaup. Overall Atlantic Flyway trends indicate that the average numbers of black ducks were slightly lower (12 percent) between 1981 and 1990 as compared with the 1972-80 period. However, populations in New Jersey were generally higher in recent years, while New York's were essentially unchanged.

The other four wintering ducks occurred in much lower numbers in the Bight in 1975 in comparison with the above species. Estimated numbers were as follows: bufflehead (12,000), canvasback (11,000), mallard (10,000), and common goldeye (5,500). Atlantic Flyway trends were generally stable for each species between 1981 and 1990, as they were in New Jersey. Of the four, populations of goldeye appear to be somewhat higher in the Bight area in New Jersey than they were in 1975 (Ferrigno, 1990).

Discussion

Despite the presence of intense human activities, the population of many species of coastal birds that breed or overwinter in the New York Bight appear to have remained stable or actually increased over the past several decades. A variety of factors have influenced these trends. In some cases (e.g., osprey), increasing populations are attributable to a decline in chemical contaminants (e.g., DDT) that formerly limited breeding success. In others, recent increases represent a shift in the geographical distribution of some species (e.g., Canada geese) into the Bight region from other areas. The establishment of preserves in the form of publicly owned areas has acted to protect bird habitats, and management of such areas to prevent nesting disturbances has helped to maintain sensitive species such as least terns (Berger, 1989). In addition, the regulatory programs of both states and the federal agencies have substantially reduced the direct alteration of wetlands habitat, and habitat protection considerations are included in the States' coastal management programs.

There are, however, continuing concerns about protecting the extent and quality of important habitat areas. High levels of toxic materials still exist in the sediments of the New York-New Jersey Harbor and in the Bight Apex, and it is not known if such materials are present in significant quantities in organisms consumed by coastal birds. Periodic oil spills in the Harbor and the continual low-level release of petroleum products into Bight waters could also have adverse impacts. The uncontrolled human use of beaches, dunes, and wetlands during the nesting season is still a major problem in some areas. For example, at Smith Point County Park on Moriches Bay, once an important nesting area for least terns

and piping plovers, an average of 400-800 offroad vehicles use the beach daily on summer weekends.

Pressures for additional coastal development will also pose difficulty in protecting existing habitats. Such development includes the conversion of presently undeveloped areas to residential and commercial uses, increased demand for maintenance dredging and dredged spoil disposal, and the proliferation of marinas and boating activities. While some of these will result in direct habitat loss, the associated human disturbances to bird feeding and nesting will compromise habitat values, even on otherwise protected publicly owned areas.

MARINE (PELAGIC) BIRDS

Introduction

Large flocks of pelagic birds migrate over the open ocean areas of the New York Bight at various times of the year, but primarily between April and November. The highest concentrations of these species seem to occur near the Outer Continental Shelf where upwelling of nutrient-rich water provides a food source in the form of small invertebrates, squid, and fish. The most common migratory pelagic birds in the Bight area include shearwaters, petrels, phalaropes, and jaegers.

Other pelagic species overwinter in the Bight, and some of these also occasionally move to inshore coastal areas to feed. Overwintering pelagic birds include loons, gannets, black-legged kittiwake, and various species of gulls and alcids.

The only published account of the pelagic distribution of marine birds throughout the Bight is that of Powers (1983). The report summarizes bird observations recorded throughout the year over the period January 1978 to February 1980 in shelf waters off the northeastern United States. Data were collected from ships taking part in oceanographic monitoring and assessment surveys. Subsequent surveys in the same geographical area have been made by investigators at the Manomet Bird Observatory, and the results will be published later in 1991.

Following is brief description of the predominant species of pelagic birds in the Bight. Unless otherwise noted, this information is from Powers (1983) and Howe et al. (1978).

Loons - Two species of loons, common (Gavia immer) and red-throated (Gavia stellata), winter in both pelagic and coastal areas of the Bight. Loons are pursuit-divers; they feed on fishes, crustaceans, mollusks, and aquatic insects. In the Powers survey, loons were recorded most frequently offshore during the spring and fall migration. The vast majority of sightings were identified as common loon in both spring and fall. No population estimate of loons was calculated.

Shearwaters - Several species of shearwaters migrate through the Bight region. These include the greater shearwater (Puffinus gravis), Cory's shearwater (Calonectris diomedea), sooty shearwater (P. griseus), Manx shearwater (P. puffinus), and Audubon's shearwater (P. sherminieri). The most abundant of these species is the greater shearwater, which breeds in the South Atlantic (on the Tristan da Cunha island group) and on the Falkland Islands and migrates to the western North Atlantic, arriving in the Georges Bank area in June. Although some individuals overwinter in the North Atlantic, the vast majority will have

moved out of the region by mid-November. These birds feed as tertiary carnivores on fish and cephalopods and as secondary carnivores on crustaceans.

Powers estimated that about 1.3 million greater shearwaters were present in shelf waters off the New England coast in the summer, and large numbers were present in the pelagic waters of the Bight.

Cory's shearwater also occur in the Bight area during the summer but in lesser numbers. This species breeds on islands in the eastern North Atlantic (e.g., the Canaries and Azores) and reaches peak abundance in July on shelf waters from the western Georges Bank south to Cape Hatteras. Cory's shearwater feed at or near the surface as secondary and tertiary carnivores on fish, cephalopods, and crustaceans. Powers estimated that about 161,000 Cory's shearwaters were present in the shelf waters off the northeastern United States during summer and fall.

Sooty shearwaters have about the same feeding and migration patterns as Cory's shearwaters, although they tend to arrive and leave earlier in the North Atlantic. Powers estimated that about 235,000 sooty shearwaters were present off the New England coast in early summer when peak densities were reached.

The Manx shearwater is uncommon in Continental Shelf waters but is present in low densities in shelf waters in March. Powers estimated that approximately 5,000 Manx shearwaters were in shelf waters of New England during summer. Similarly, Audubon's shearwaters are uncommon in shelf waters of the Georges Bank and Bight from August to October, and were present in slope water from early June to November. Shelf populations in summer were estimated at 2,000 birds.

Petrels - Two petrels, Wilson's storm-petrel (Oceanites oceanicus) and Leach's storm-petrel (Oceanodroma leucorhoa) are spring and summer migrants in the Bight.

Wilson's storm-petrels breed off South America and Antarctica and are present from November to mid-April in these areas. They feed mainly at the surface as secondary carnivores on zooplankton, euphausiids and amphipods, and as tertiary carnivores on small fish and cephalopods.

Wilson's storm-petrels first move into the Bight area in April, and by June the summer population peaks in the Gulf of Maine. However, these birds have a relatively stable population from May through August in the Bight region. Densities decline substantially in September.

Powers estimated that about 1.5 million Wilson's storm-petrels were present in shelf waters off the northeastern United States, and thus were the most numerous birds in these waters during any single season.

Leach's storm-petrels breed primarily in eastern Newfoundland, although colonies exist from Cape Cod to southern Labrador. They feed at the surface as secondary and tertiary carnivores, chiefly on planktonic crustaceans, mollusks, and small fish. They appear in Bight waters in the summer in relatively small numbers; their principal summer distribution is on the southern shelf section and seaward of the Continental Shelf break. Powers estimated that the population of Leach's storm-petrels in shelf waters of the New England coast was about 22,000 in summer.

Northern Gannet - The northern gannet (Sula bassana) remains in the Bight throughout the winter, although peak numbers occur during spring and fall migration.

Gannets feed as tertiary carnivores mainly on schooling fish and to a lesser extent on squids. They also scavenge offal from fishing vessels.

North American breeding populations of gannets are currently found only off eastern Newfoundland and in the Gulf of St. Lawrence. During summer, gannets frequent boreal and southern low-arctic waters adjacent to their breeding colonies off eastern Canada. During winter, they move to subtropical waters off the eastern United States, Gulf of Mexico, and Caribbean Sea. Population estimates of gannets are varied but Powers indicated that the size of the North American breeding population should be about 120,000 to 125,000 birds.

Black-Legged Kittiwake - The black-legged kittiwake (Rissa tridactyla), a small gull, is one of the most common pelagic species in the Bight. In eastern North America, kittiwakes breed on arctic sides of Baffin Bay, on the arctic coasts of Newfoundland and the northern Gulf of St. Lawrence, and in northern Nova Scotia. The species feeds in near surface waters on crustaceans, fish, and squids, and scavenges on fishing vessel offal.

The pelagic distribution of kittiwakes in the western North Atlantic is widespread from the high arctic waters off west Greenland to subtropical waters north of the Gulf Stream. The greatest densities off the northeastern United States are somewhat north of the New York Bight--in the Gulf of Maine and Georges Bank. Highest densities of the black-legged kittiwake recorded by Powers in the Bight area were in the spring. The population of kittiwakes off the northeastern United States has been estimated at about 1 million birds; over 90 percent occur north and east of Cape Cod.

Gulls (Larus spp.) - Several species of gulls occur in eastern North America. The glaucous gull (L. hyperboreus), iceland gull (L. glaucoides glaucoides), and Kumlien's gull (L. glaucoides kumlieni) are generally found in areas north of the Bight. The most common gulls in the Bight are the great black-backed gull (L. marinus) and herring gull (L. argentatus). Both breed in boreal and arctic areas of eastern Canada and Greenland and south to Virginia and North Carolina. They are omnivorous, feeding as secondary, tertiary, and upper level carnivores on crustaceans, insects, squids, birds, and eggs, and as scavengers on offal and carrion.

The herring gull tends to have a more southerly distribution and thus is found in higher concentrations in Bight waters than the great black-backed gull. Both have lowest seasonal abundance in the summer.

The pelagic distribution of these birds seems to be greatly influenced by fishing activity, and greatest densities are associated with fishing fleets. For this reason, population estimates are difficult, although it is believed that both species have substantially increased in abundance over the past 40 years. According to Powers, these gulls are among the most abundant species off the northeastern United States from fall through spring.

Laughing gulls (L. artricilla) breed from Texas to southern Nova Scotia. They are tertiary and upper level carnivores that feed on small fish in surface waters, take tern eggs on land, and scavenge on offal from fishing vessels.

Laughing gulls are mainly coastal inhabitants of subtropical areas from New Jersey to the Gulf of Mexico. They are common in the New York Bight from March to October.

Powers estimates the laughing gull population at 7,000 to 8,000 in spring and summer and 40,000 in the fall.

Other gulls, including the ring-billed gull (L. delawarensis), Bonapartes gull (L. philadelphia) and Sabine's gull (Xema sabini), were observed in the Bight area but at much lower densities than those discussed above. However, the ring-billed gull is the most abundant wintering gull in inshore areas (R. Dieterich, U.S. Environmental Protection Agency, New York, NY, personal communication, 1991).

Alcids - Alcids, which resemble small ducks, inhabit pelagic waters and feed mostly on fishes and crustaceans. Their abundance in the Bight varies greatly from winter to winter, depending on food availability and winter storm patterns. According to Howe, only three species of alcids regularly occur in the Bight: the dovekie (Alle alle), razorbill (Alca torda), and thick-billed murre (Uria lomvia). Other alcids, including the common murre (Uria aalge), black guillemont (Cepphus grylle), and common puffin (Fratercula arctica), are rarely observed. In the Powers study, none of the observed alcids were in Bight waters except for spring sightings of razorbills off Long Island. Similarly, while Howe described the dovekie as by far the most common alcid in the region, Powers observed none in the Bight.

It is noted that as a group, alcids, because they are diving species, are perhaps the most severely affected by oil pollution and have been known to die in large numbers after major offshore spills. Other species, such as gulls, actively avoid oil slicks.

Skuas (Catharrata spp.) - The only other pelagic bird that seems to occur regularly in the Bight during the winter is the skua. These large gull-like birds pirate prey fish from

other birds such as jaegers and gulls and also feed on crustaceans, fish, terrestrial mammals, eggs, and birds.

According to Howe et al., skuas are now regularly seen along the Continental Shelf. Powers reported several low-density concentrations of skuas in winter and spring in Bight waters along the shelf.

Northern Fulmar (Fulmarus glacialis) - Northern fulmars breed in arctic areas of North America and are present off the New England Coast throughout the year except in August. They feed at the surface as secondary and tertiary carnivores and as scavengers. They are opportunists that consume a variety of zooplankton, fish, and squid, and are often observed in association with fishing vessels.

Northern fulmars occur in highest numbers in the Bight area in the spring, although peak numbers of about one million birds are present in shelf waters off New England during the winter.

Jaegers (Stercoraius spp.) - Three species of jaegers, pomarine (S. pomarinus), parasitic (S. parasitious), and long-tailed (S. longicaudus), occur in relatively low numbers in the Bight. The pomarine and parasitic jaegers breed in northern Canada and West Greenland. Jaegers feed by seizing prey at the surface or by pirating gulls, terns and other birds. They are also secondary and tertiary carnivores on crustaceans, fish, and cephalopods.

The pomarine jaeger was the most commonly observed jaeger off the coast of the northeastern United States during spring and fall. Their numbers in the Bight area were highest in late October. Parasitic jaegers were present but uncommon in spring and fall; long-tailed jaegers were rare with only a few sightings recorded.

Phalaropes - Red (Phalaropes fuliciaria) and red-necked (Phalaropes lobatus) phalaropes occur in Bight waters in spring (April to June) and fall (August to October), although they are found off the northeastern United States throughout the year. Both breed in the North American arctic and have circumpolar distributions. They feed at the surface as secondary carnivores on planktonic crustaceans and on eggs and larvae of fish and squid.

During spring, red phalaropes were most abundant in the mid-Atlantic in late April along the outer edge of the Continental Shelf in apparent association with zooplankton concentrations. According to Powers, spring densities of red phalaropes off the northeastern United States were often spectacular with flocks of hundreds to thousands locally common.

Spring migrations of red-necked phalaropes coincided with movements of reds except that fewer numbers were recorded. During spring, about 620,000 red and 16,000 red-necked phalaropes passed off the coast of the northeastern United States. Numbers recorded in the fall were substantially lower.

Discussion

Ten species dominate the seabird population in shelf waters off the northeastern United States as follows: northern fulmar, Cory's shearwater, greater shearwater, sooty shearwater, Wilson's storm-petrel, northern gannet, red phalarope, great black-backed gull, herring gull, and black-legged kittiwake. On a seasonal basis, these species represent more than 97 percent of the total density of seabirds on the shelf from Cape Hatteras to Nova Scotia.

The Gulf of Maine/Georges Bank region supported higher densities of birds than the Middle Atlantic Bight region throughout the year, although species composition within each

family group and seasonal trends in abundance within each region are similar (Powers, 1983).

In spring in the Middle Atlantic Bight-southern New England regions, gulls, jaegers, skuas, phalaropes, gannets, and fulmars were the dominant species. In summer, shearwaters and storm-petrels were most abundant, while in fall gulls, jaegers, skuas, and shearwaters were predominant. The gull group and gannets represented most of the winter birds.

Powers attributed the differences between southern and northern bird densities in the northwestern Atlantic area to food availability and hydrographic conditions. He notes that both regions are most similar during winter and spring when waters overlying the shelf are well mixed by gales and cold air temperatures. During summer and fall, when there is a three- and fourfold difference in density and biomass between regions, there is a corresponding difference in hydrographic conditions. Middle Atlantic Bight waters are well stratified due to increased solar insolation and less frequent wind events; tidal currents over the shallow shoals of Georges Bank maintain vertical mixing, and only a weak thermocline may develop.

Food availability is associated with the capture of the spring phytoplankton by large copepods that rise from deep water during spring in the Barents Sea and with differential microbial activity during the summer in the North Sea. During spring in the New York Bight, the subsurface chlorophyll maxima are found just seaward of the shelfbreak when wind events favor upwelling conditions. Peak zooplankton biomass in this area occurs offshore shortly after the spring phytoplankton bloom. As hydrographic stratification increases and the frequency of storms diminishes during summer in the New York Bight,

the area of high chlorophyll moves onshore with a corresponding inshore zooplankton maxima in July. In contrast, the greater topographic complexity of Georges Bank and its tidal mixing over shallow depths seems to provide for continuous nutrient replenishment from the deeper surrounding waters, thus maintaining high rates of productivity throughout the summer months. Powers notes that the passage of zooplankton-feeding phalaropes and storm-petrels along the outer shelf of the Middle Atlantic Bight during the peak period of zooplankton biomass tends to support this view of the pelagic food web.

As mentioned earlier, there are not sufficient published quantitative observations of the pelagic distribution of marine birds to enable the development of population trends. Moreover, there are inherent difficulties in censusing these birds over the entire northeastern Atlantic area. These include year-to-year variations in storm patterns that affect bird distribution within the region, the propensity of some species to be highly associated with fishing vessel activities, and variations in species identifications among observers. However, the forthcoming (1991) atlas of marine birds to be published by the Manomet Bird Observatory is expected to provide a basis for trends analysis and may result in some changes in the earlier population distributions reported by Powers and summarized here.

It is noted that concern has been expressed in the past about the impact of chemical contaminants on marine offshore birds. Many of these birds tend to be largely fish-eating species and thus seem to have a greater propensity for contaminant uptake than do most landbirds. Also, the pelagic species are mainly surface feeders, and the sea surface is where highest concentrations of contaminants such as DDT are found. In the late 1960s and early

1970s, very high levels of both DDT and PCBs were found in pelagic birds in the Bight region (Risebrough, 1971). It is not known if such concentrations had an adverse impact on these species.

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HABITAT AREAS AND TRENDS

HABITAT AREAS

Introduction

The New York Bight study area includes the entire South Shore of Long Island east of Rockaway Point, the New Jersey coast from Sandy Hook south to Cape May, and the ocean waters from the Rockaway-Sandy Hook transect to the edge of the Continental Shelf. It contains a variety of habitats, including ocean waters, inshore shallows, beaches and dunes bays, wetlands, mudflats, tributary streams, and associated uplands. Although the coastal margins of the Bight region are highly urbanized, a number of these habitats are generally intact; however, many are subject to human disturbances and various use impairments.

Long Island

The Long Island South Shore area is characterized by barrier islands, which protect an extensive system of interconnected bays and marshes on their landward sides. This system includes the Hempstead Bays (West, Middle, and East Bays), South Oyster Bay, Great South Bay, Moriches Bay, Shinnecock Bay, and Mecox Bay. The South Shore generally is an important spawning and/or nursery area for a number of fish and shellfish species and supports an active recreational and commercial fishery. The beaches, bays, and inlets of the region are important nesting, stopover, and wintering areas for shorebirds, wading birds, and waterfowl. Principal nesting colonial waterbirds are terns, gulls, and herons. Other nesting birds include Canada goose, black duck, mallard, clapper rail, and marsh wren. Large numbers of waterfowl overwinter in the bay complexes; these include

brant, scaup, and black duck, and lesser numbers of Canada geese, red-breasted merganser, common goldeye, oldsquaw, bufflehead, canvasback, and mallard.

Following is a description of habitats in the Long Island South Shore bays and the barrier islands and beaches. Unless otherwise noted, the discussion is based on a study of significant coastal habitats conducted by the New York Department of State (1990).

Hempstead Bay - The Hempstead Bay complex is about 14,000 acres and includes extensive areas of undeveloped salt marsh, tidal flats, dredge spoil islands, dredged channels, and generally shallow (less than 6 feet) open waters. Tidal wetlands constitute nearly 8,000 acres and account for over 50 percent of the South Shore's total tidal wetlands area (O'Connor and Terry, 1972). The predominant wetlands species in the early 1970s was Spartina alterniflora, although Phragmites australis has probably increased in abundance since then. Lands surrounding the three bays are heavily developed in residential, marine, commercial, and industrial uses. Oil terminals are present in West Bay.

The bay is a nursery and feeding area for bluefish, winter and summer flounder, kingfish, weakfish, blackfish, snapper, scup, and blue crab, as well as for a number of forage species such as Atlantic silverside and menhaden. The bay is also inhabited by shellfish including hard clams, soft clams, ribbed mussels, and blue mussels. Hard clams are present in commercially significant quantities; however, most of the bay waters are not certified for commercial shellfishing because levels of bacterial indicator organisms exceed the standards for harvesting. Eelgrass beds have historically been present in East and Middle Bays (Dennison et al., 1989). Wintering waterfowl use of the area is relatively high, and Middle Bay supports the largest wintering population of brant in New York State. Black duck and

scaup are the other principal overwintering waterfowl species. All of the three bays are open to waterfowl hunting, and the area supports regionally significant hunting pressure.

Colonial nesting birds are present on many of the islands; these include common and Forster's tern, herring gull, and American oystercatcher (Downer and Liebelt, 1990). Heronries occur on Lawrence Marsh, North and South Green Sedge Islands, Smith Meadows, South Pine Marsh, and Black Banks Hassock. Nesting species present include black and yellow-crowned night heron, green-backed heron, little blue heron, tricolored heron, great and snowy egret, and glossy ibis. The area is one of the few locations on Long Island where yellow-crowned night heron, tricolored heron, and little blue heron have been found nesting.

South Oyster Bay - The bay encompasses 7,700 acres and is generally defined by the Gilgo Cut Boat channel on the east and by Zach's Bay and the Wantagh Causeway right-of-way to the west. Habitats are similar to Hempstead Bay although the proportion of open water areas to wetlands is much higher in South Oyster Bay. There are about 900 acres of tidal wetlands, primarily S. alterniflora, located mainly along the southeast bay shore (O'Connor and Terry, 1972). Other habitat areas are dredged-spoil islands, which are used by some nesting birds. The north shore of the bay has extensive residential development and small boat harbor facilities; the south shore is relatively undeveloped.

South Oyster Bay provides nursery and feeding habitat for the same finfish species that utilize Hempstead Bay. Shellfish species present are soft and hard clams, scallops, ribbed mussels, and blue crab. Much of the north shore waters of the bay are not certified for commercial harvesting. Historically, South Oyster Bay had the highest proportion (61

percent in 1967) of eelgrass distribution of any of the Long Island embayments, although the distribution diminished to 19 percent by 1988 (Dennison, et al., 1989).

Numbers of overwintering waterfowl are somewhat lower than Hempstead Bay, although the most abundant species (brant, black duck, and scaup) are similar. South Oyster Bay is open to public waterfowl hunting.

Nesting birds in the bay include herring gull, great black-backed gull, common tern, least tern, and American oystercatcher. The American oystercatcher population is one of the largest on Long Island. Important nesting areas include North Island, North and Middle Line Islands, and several small islands north of West Gilgo Beach. In addition, green-backed heron were recently (1989) found to be nesting on Goose Island, and a number of other heron species (e.g., snowy egret, great egret, black-crowned night heron, and green-backed heron) feed in the bay area (Downer and Liebelt, 1990). Cedar Creek Park, in the northeast corner of the bay, has been one of the most important least tern nesting sites on Long Island.

Great South Bay - This is the largest of the south shore embayments and covers about 64,000 acres. The bay is largely open water, although it includes about 3200 acres of tidal wetlands, most of which occur along the bay side of the barrier island. Wetlands vegetation is dominated by S. alterniflora and S. patens, but populations of Phragmites australis and Distichlis spicata occur in the north shore embayments (O'Connor and Terry, 1972). Several sub-embayments (e.g., Bellport Bay and Nicoll Bay) are locally recognized components of the bay system. Water depths are generally shallow, mostly less than 12 feet in the eastern half of the bay and less than 6 feet in the western reaches. Lands

surrounding the bay on the north are in relatively dense residential and commercial uses, including extensive marina and harbor facilities. The southern coast is in low-density residential development on Fire Island or in state and federal park lands (e.g., Fire Island National Seashore).

The bay is a major spawning, nursery, and feeding area for winter flounder, kingfish, blue crab, and various forage species. It receives heavy recreational fishing pressure of statewide significance. Winter and summer flounder predominate the sport fishery catch, although localized areas are important for weakfish and scup. There is a commercial fishery for Atlantic silverside and white perch in Bellport Bay, and for baitfish in shoal areas near Fire Island Inlet. Swan River, which empties into the bay near Patchogue, is one of the few free-flowing spring-fed streams on Long Island and provides habitat suitable for natural reproduction of brook trout. Sea-run concentration of brown trout occur in the downstream tidal reaches of the river during the fall spawning period. The Carmans River flows into the bay east of Brookhaven and also supports a naturally reproducing population of brook trout. In addition, it contains populations of rainbow trout, brown trout, and white and yellow perch. The tidal segment of the river is unique on Long Island because of the extensive salt marshes on both sides of the river. A significant concentration of sea-run brook trout also occurs in the tidal portions of Beaverdam Creek, which enters the bay near Bellport just west of the Carmans River.

The shellfish resource of the bay, primarily hard clams, is of statewide significance and historically was one of the principal hard clam fisheries in the United States (Coastal Ocean Sciences and Management Alternatives Program, 1985). In addition to clams, there

are local concentrations of the American oyster, and a population of bay scallops was reintroduced into Clam Pond on the bayside shore of Fire Island. Also, the islands along the south shore support soft clams and ribbed mussels. Most of the bay waters are certified for shellfish harvesting, although there are persistent closure areas along the north shore which are attributable to nonpoint sources of pollution.

Historically, eelgrass has been abundant in the bay and, in 1967, covered about 37 percent of the bottom, mainly in the southwest and southeast reaches. In recent years, populations have declined to 17 percent coverage of the bay, although the spatial distribution is about the same as in 1967 (Dennison et al., 1989).

Great South Bay supports the largest wintering waterfowl concentration in the state and is one of the most important areas for diving ducks in the northeastern United States. The principal species using the bay are scaup, red-breasted mergansers, black ducks, brant, common goldeneye, and Canada geese. Nearly all of the bay is open to public hunting, although hunting pressure is only locally significant in the eastern section due to the limited amount of emergent wetlands.

Many species of migratory birds are found nesting or feeding in the salt marshes, spoil islands, and natural areas of the bay shoreline, although there have been historic shifts in specific nesting sites. Common tern, American oystercatcher, and herring gulls have recently (1989) nested on islands (e.g., Gilgo, Elder, and Nazeras) in the western portion of the bay (Downer and Liebelt, 1990). However, whereas a large breeding population of common terns were reported nesting on Seganus Thatch in the early 1980s, none were observed in 1989, and the colony had apparently become inactive. Herring gull nesting

occurs primarily on Captree Island. Great black-backed gulls nest at nearby Islip Spoil Island. Least tern colonies occur only in the eastern reaches of the bay at Smith Point and at a spoil/fill area on the shoreline near Patchogue. Only one active heronry was noted in 1989; this was on East Fire Island.

Moriches Bay - The bay is an 8,900-acre area of shallow open water habitat. It includes about 900 acres of tidal wetlands and a few dredge spoil islands. Wetlands plant species include S. alterniflora and S. Patens and, in the north shore embayments, P. communis and Typha spp. (O'Connor and Terry, 1972). Water depths are generally less than 6 feet, and about 40 percent of the bay is 3 feet or less. The bay is directly connected to Atlantic Ocean waters by Moriches Inlet and is relatively well-flushed in comparison with the bays to the west. Moriches Bay is connected to Shinnecock Bay on the east by the Quoque Canal, and to Great South Bay via Narrow Bay. The bay is bordered by moderate density residential areas, although there were some undeveloped shorefront parcels as of 1981.

Fish populations in the bay are similar to the other Long Island embayments, although tomcod and American eel are also present. Species of recreational and commercial significance are winter and summer flounder and baitfish. Shellfish populations are hard clams, bay scallops, and ribbed mussels. Although most of the bay waters are presently certified for shellfishing, the uncertified areas have generally expanded over the past 20 years. Clam production and abundance in the bay has been relatively low, apparently a result of the lack of setting of the clam larvae, which may be related to the large tidal exchange in the bay (Coastal Ocean Sciences and Management Alternatives

Program, 1985). There is no recent information available on the stock size of clams in the bay.

In recent years, eelgrass populations have increased somewhat and, in 1988, covered about 19 percent of the bay bottom (Dennison et al., 1989).

Winter waterfowl populations in Moriches Bay are similar to other Long Island bays. Scaup, black duck, red-breasted mergansers, brant, Canada geese, and mallards are the principal waterfowl present. The bay area is open to public hunting.

The bay is also an important bird nesting area for common and roseate tern, American oystercatcher, and black skimmer. Breeding populations of common tern at Carters and East Inlet Islands, and of roseate terns at East Inlet Island are among the largest in the South Shore bays (Downer and Liebelt, 1990).

Shinnecock Bay - The bay is a 9,000-acre area of mainly open water with about 700 acres of tidal wetlands generally located on the south shore along the barrier island. S. alterniflora is the dominant wetlands species (O'Connor and Terry, 1982). Water depth is somewhat greater than Moriches Bay but is still less than 10 feet. Shinnecock Inlet, which connects Shinnecock Bay to the Atlantic Ocean, was formed by a breach in the barrier beach in 1938 and was stabilized by stone jetties by 1954. The bay is also connected to Great Peconic Bay on the north via the Shinnecock Canal, and to Moriches Bay on the west. The shoreline is generally in moderate to high density residential use. Some undeveloped areas exist along the barrier beach on the south.

Finfish populations are similar to Moriches Bay, although a population of harbor seals occurs in the bay during the winter. Shellfish present are hard and soft clams, bay

scallops, and ribbed mussels. A commercial hard clam fishery exists in the bay, but production is relatively low, and successful setting of clam larvae has been sporadic (Coastal Ocean Science and Management Alternatives Program, 1985). Only a small portion of the bay is closed to shellfishing.

Populations of wintering waterfowl are regionally significant. Principal species are scaup, brant, black ducks, red-breasted mergansers, and buffleheads. Warner Island provides nesting habitat for common tern, American oystercatcher, roseate tern, great black-backed gull, and herring gull. Common tern nesting also occurs on Sedge Island and Greater and Lesser Greenbacks Islands. Piping plover and least tern have nested on a spoil area near Middle Pond Inlet.

Mecox Bay - This is a shallow (generally less than 3 feet), 1,100-acre area of predominantly fresh to slightly brackish water. It contains scattered wetlands dominated by Typha spp. and Phragmite communis (O'Connor and Terry, 1972). A channel connecting the bay to the ocean is open intermittently. The bay shoreline is bordered by light to moderate residential development, and the drainage area includes some undeveloped agricultural land.

The bay is an important waterfowl wintering area, and populations of Canada geese are of statewide significance. It contains populations of many estuarine fish and shellfish species, including soft clam, American oyster, blue crab, and white perch. Shellfish production is limited because bay waters are often uncertified during periods when the ocean inlet is closed. A locally important commercial fishery exists for white perch.

Coastal Beaches and Shorelines - The south shore coast is dominated by an extensive barrier island system extending from Rockaway Point at the mouth of Jamaica Bay to Southhampton at the eastern end of Shinnecock Bay. The western reach of the barrier islands is generally heavily developed, but much of the remainder is in public ownership and relatively undeveloped. However, most of these areas receive heavy recreational use, and associated human activities can have an adverse impact on habitat values, especially bird nesting. Since these beach areas are critical bird nesting habitats, use conflicts frequently occur.

In their natural state, the barrier islands consist of lower and upper sand beaches, dunes, sparsely vegetated areas on the landward side of the dunes, and salt marsh and mudflat communities on the bay shore. While development and human activities are generally detrimental to wildlife habitat values, some kinds of developed areas provide enhanced habitats. For example, abandoned parking lots have provided nesting areas for piping plovers and least terns (e.g., at Jones Beach). Similarly, dredge spoil deposition may improve nesting habitat by setting back vegetative succession.

Critical habitats on the barrier islands are primarily those used for bird nesting. Principal nesting species are common, least, and roseate terns; piping plover; black skimmer; American oystercatcher; and herring and great black-backed gull.

Common tern nesting colonies are located mainly west of Fire Island Inlet at Cedar Beach, Jones Beach, and at Breezy Point in the Gateway National Recreation Area. All three areas receive heavy recreational use, but some form of colony protection (posting, fencing and/or patrolling) has been instituted (Downer and Liebelt, 1990).

Least tern nesting colonies are more widely distributed and occur throughout the barrier island and the far eastern coast. Principal nesting sites are Breezy Point, Silver Point County Park on the west end of Atlantic Beach, Gilgo State Park, Cedar Beach, Westhampton and Southhampton Beaches, Cupsogue County Park at Moriches Inlet, and the beach area at Georgica Pond, a coastal embayment at Wainscott.

Piping plover are usually found nesting in small numbers in association with least tern colonies. Nesting sites occur throughout the island and coastal area, but largest numbers seem to be found at the least tern colony sites mentioned above. Other important nesting areas are Jones Beach, Democratic Point at the Fire Island Inlet, and Smith County Park on the south side of Moriches Bay.

Most of New York's roseate terns nest at Great Gull Island on the outer reach of Gardiners Bay. However a significant nesting population has been established at Cedar Beach on the south shore barrier island.

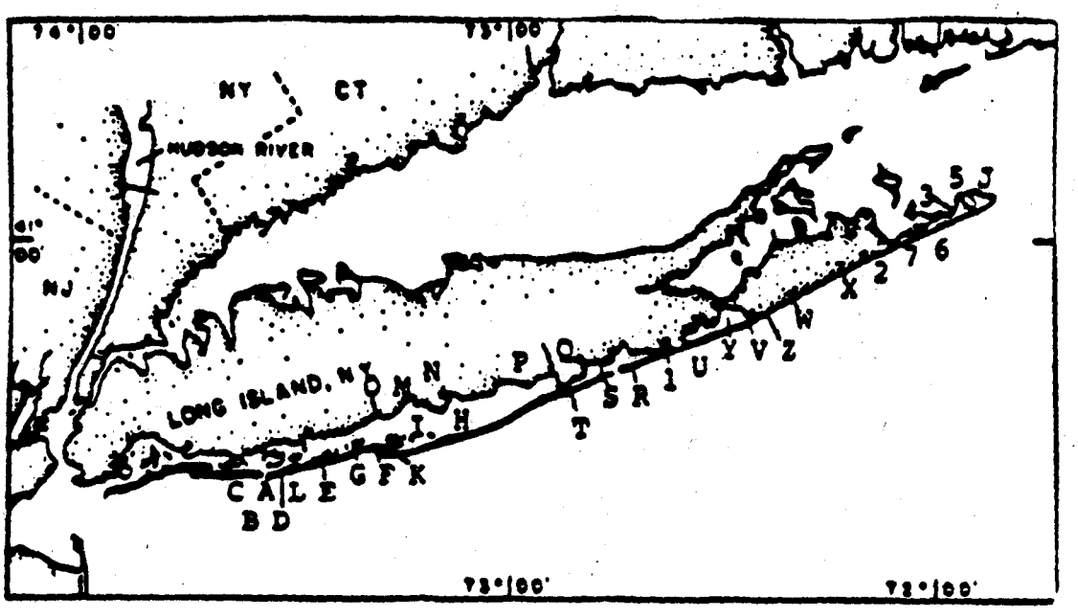
Black skimmer colonies occur in only a few areas along the coastal beaches. Largest nesting populations are at Cedar Beach and Jones Beach. American oystercatchers generally nest on the saltwater non-barrier islands, but nesting does occur in some of the beach areas, including Democrat Point and Tiana Beach.

The great black-backed gull also tends to nest on the non-barrier islands, although relatively high populations occur at Overlook Beach, located east of Cedar Beach. The only significant herring gull colony is at Jones Beach.

A heron rookery has been present at Jones Beach, but numbers have declined in recent years, and the population appears to have moved to the adjacent island on dredged spoil habitats.

Other significant coastal fish and wildlife habitats on the barrier beaches identified by the New York Department of State (New York Department of State, 1990) include Guggenheim Pond at Tobay Sanctuary (high wintering waterfowl use, northern harrier breeding); Smith Point County Park on Fire Island (fall migration corridor for raptors); Oak Beach Marsh near Fire Island Inlet, the only major unditched tidal wetland on the south shore of Long Island; Sunken Forest on Fire Island; Atlantic Double Dunes at Easthampton Beach (relatively undisturbed interdune plant community with a diverse animal population); Napeague Beach (unique flora and faunal assemblage); and Sagaponack Inlet (relatively undeveloped beach/inlet system). The designated Significant Coastal Fish and Wildlife Habitats on Long Island's south shore are listed in Figure 4.

The Montauk Peninsula on the far eastern tip of Long Island also has important fish and wildlife value for wintering waterfowl and colonial beach nesting birds and for regional biological diversity. In addition, offshore eastern Long Island waters may be an important developmental habitat for the highly endangered Kemp's ridley marine turtle (Lepidochelys kempi). Only one nesting beach, located in Mexico, is known to be used by this species. The Kemp's ridley appears in the Bight in late June and early July and remains at least until December, and juveniles are relatively common in these waters (Waste Management Institute, 1989). The endangered fin whale also occurs seasonally offshore of the Montauk Peninsula (McKenzie and Nicolas, 1988).



Federally approved Significant Coastal Fish and Wildlife Habitats on the south shore of Long Island.

A. Short Beach
B. Storehouse Beach
C. West End Beach
D. Parking Lot 9 (Jones Bch)
E. Tobay Sanctuary
F. Cedar Beach
G. Gilgo Beach
H. Great South Bay-East
I. Great South Bay-West
J. Big & Little Reed Ponds
K. Sore Thumb
L. South Oyster Bay
M. Champlin Creek
N. Connetquot River
O. Orowoc Creek
P. Beaverdam Creek
Q. Carmans River
R. Cupsogue County Park
S. Moriches Bay
T. Smith Point County Park
U. Dune Road Marsh
V. Far Pond and Middle Pond Inlets
W. Mecox Bay and Beach
X. Sagaponack Inlet
Y. Shinnecock Bay
Z. Southampton Beach
1. Tiana Beach
2. Atlantic Double Dunes
3. Fort Pond
4. Hither Hills Uplands
5. Lake Montauk
6. Napeague Beach
7. Napeague Harbor

Figure 4. Significant Coastal Fish and Wildlife Habitats on the South Shore of Long Island

New Jersey

The New Jersey shore is characterized by a high-energy beach on the north, and extensive bays and estuaries protected by barrier islands along the coast to the south. Much of the productive habitat in the area is in the back bays, islands, mudflats, and wetlands behind the barrier islands, at Sandy Hook in the Gateway National Recreation Area, and at the few publicly owned coastal beaches south of Mantoloking. The system of bays, estuaries, and inlets extends from northern Barnegat Bay south to Cape May. These areas provide important habitats for fish and shellfish and support large populations of breeding and migratory birds. The Intracoastal Waterway extends throughout this coastal reach, which requires extensive dredging and spoil disposal activities.

It is noted that some important habitat values are in the Manasquan and Metedeconk River areas. Hard clam populations are high in the Manasquan and moderate in the Metedeconk; blue mussels and soft clam beds are present in the Manasquan, and soft clams are also found in the Metedeconk (New Jersey Department of Environmental Protection, no date). However, both rivers are either closed to shellfish harvesting or have areas with special restrictions (harvesting only for further depuration). Both river systems also are anadromous fish spawning streams and support spawning runs of alewife and blueback herring (Zich, 1978). In addition, these areas have locally significant waterfowl populations of mallard, scaup, and buffleheads (Ferrigno, 1990).

Barnegat Bay - The largest of the bays is Barnegat Bay, which includes about 48,000 acres between Mantoloking to the Route 73 bridge at the middle of Long Beach Island. A study of environmental conditions in the bay was recently completed for the Barnegat Bay

Study Group by Rogers, Golden, and Halpern, Inc. (1990). Unless otherwise noted, the following description of the bay is based on this study. The bay is generally shallow; 44 percent of the surface area is less than 3 feet in depth. Tidal wetlands are widely distributed along the bay shoreline and islands, although most of the wetlands on the barrier beach side occur adjacent to publicly owned acres on Long Beach Island. The wetlands are dominated by Spartina alterniflora, S. patens, Juncus gerardi, and Salicornia virgnica. Phragmites australis is also present. The total area of tidal wetlands is not precisely known, but there were 26,000 acres in Ocean County in 1973, and about half of these were in the bay area. Between 1953 and 1973, extensive filling of wetlands occurred, and about 10,000 acres of wetlands were lost primarily to residential development. Much of the bay's shoreline on the barrier island side is in residential development except for the Island Beach State Park complex. The western shore is somewhat less developed, and large tracts along the southern shoreline are in public ownership (e.g., Barnegat National Wildlife Refuge). Also, the U.S. Fish and Wildlife Service is developing a proposal for acquisition of 2,000 acres in the Reedy Creek Area of the northern bay to provide relatively undisturbed habitat for brant, canvasback ducks, and scaup. The area will become part of the Edwin B. Forsythe National Wildlife Refuge complex.

Finfish populations in the bay are dominated by forage species, chiefly Atlantic silverside and bay anchovy. The bay serves as a nursery area for juvenile bluefish, menhaden, weakfish, and summer flounder (Able et al., 1990). Other marine species that occur in the bay include striped bass, winter flounder, and sand lance. Estuarine species

present include American eel and white perch, and a small commercial fishery exists in the bay for both species and for winter flounder.

Shellfish in the bay are mainly blue crabs and hard clams. Some soft clams occur at the mouth of the Metedeconk River. Blue crabs are distributed in the bay in a manner similar to other estuaries. Immature crabs generally migrate throughout the bay, mature males are found more frequently in the lower salinity waters of the upper bay, and mature females are in greatest abundance near the higher salinity waters of the Barnegat Inlet. Blue crabs in the bay are harvested by both commercial and recreational fishermen.

Hard clams are the most economically important species in the bay and occur in greatest abundance in the southern two-thirds portion. (A clam relay station has existed in the northern section of the bay at Swan Point between the Metedeconk River and Kettle Creek.) Commercial hard clam landings have been relatively stable over the past decade and average about 260 metric tons per year or 40 to 50 percent of the state's total back bay hard clam landings. Waters restricted for harvesting due to exceedances of shellfish harvesting water quality standards are generally those from Toms River northward where clam abundance is lowest. About two-thirds of the highest density shellfish beds are in areas approved for harvesting, and an additional 20 percent are in areas with seasonal restrictions where clams may be harvested between January 1 and April 30. Shellfish restrictions appear to occur in areas mainly influenced by nonpoint sources of indicator organisms and by marinas and other areas of boat congregation.

The bay is an important staging and overwintering area for waterfowl. Principal species utilizing the bay are bufflehead, mallard, Canada geese, black duck, canvasback,

brant, and scaup. Total numbers counted in the 1990 midwinter waterfowl inventory were about 30,000 in the bay proper and an additional 8,000 in the adjacent Little Egg Harbor Bay (Ferrigno, 1990).

Several species of colonial waterbirds nest in the bay including great egret, snowy egret, glossy ibis, little blue heron, tricolored heron, and black- and yellow- crowned night heron (Jenkins et al., 1990). Colonies are present on several of the bay islands, particularly Sedge Island northwest of Barnegat Inlet and Highbar Island south of the inlet.

Other colonial nesting species in the bay are herring, great black-backed and laughing gulls, common tern, and black skimmer. Large colonies occur on Pettit and Clam Islands; they are as follows: Cedar Creek (common terns), Highbar and Clam Islands (laughing gulls and herring gulls), and Thorofare Island (herring gulls and great black-backed gulls).

Some water quality data are available for the Barnegat Bay and its tributaries although long-term time series information is lacking except for total coliforms, which are monitored for classifying shellfish-growing waters. Based on overall conditions described by the water quality index used by the New Jersey Department of Environmental Protection, water quality in the central bay is considered to be excellent. However, it has been suggested that the bay is currently in a moderately eutrophic state resulting in high levels of phytoplankton growth and turbidity. This condition could adversely impact the bay's population of submerged aquatic vegetation. Nutrient inputs are primarily from nonpoint sources. These inputs could increase substantially in the future as development in the bay's watershed is expanded. The Rogers, Golden, and Halpern, Inc., study estimated that if all

potentially developable land in the watershed were built as currently zoned, a 40 percent increase in total nitrogen loadings would result.

Habitat information comparable to that for Barnegat Bay is generally unavailable for the bays and estuaries to the south. However, these areas have significant habitat values for fish, shellfish, waterfowl, and other wildlife populations and include a number of refuges, wildlife management areas, and other publicly owned/protected sites. This reach of the coast includes Little Egg Harbor, Great Bay, and Mullica River; the Absecon-Reeds Bay-Little Bay complex; Great Egg Harbor and River; and a series of smaller bays from Corsons Inlet to Cape May.

Little Egg Harbor Bay - Little Egg Harbor Bay is the southern extension of Barnegat Bay from the Rt. 73 bridge between Manahawkin and Ship Bottom, south to the tip of Long Beach Island at Beach Haven Inlet. The physical and biological characteristics of Little Egg Harbor are similar to Barnegat Bay. The harbor contains extensive hard clam beds most of which are in waters approved for commercial harvesting. Seasonally restricted waters occur only along the Long Beach Island shore (New Jersey Department of Environmental Protection, 1990).

There are seven heron colonies in Little Egg Harbor at Goosebar Sedge, Story Island, Middle Island, Marshelder Island, Bunting Sedge, Flat Island, and Cedar Bonnet (Jenkins et al., 1990). Species nesting at these sites in 1989 were the great and snowy egret, glossy ibis, and little blue, tricolored, and black-crowned night herons. About one-fourth of New Jersey's coastal population of common terns occurred in the harbor in 1989 in some 17 colonies. Great black-backed gull, laughing gull, Forster's tern, and black skimmer

colonies are also present. Principal overwintering waterfowl species are black duck, ruddy duck, and brant (Ferrigno, 1990).

Great Bay - Great Bay is a shallow estuary at the mouth of the Mullica, Wading, and Bass Rivers. It is bordered by extensive tidal marshes and mudflats. Forested freshwater wetlands are present in the upstream areas. Much of the tidal wetlands and island habitats are in public ownership, and some of the wetlands have not been altered by mosquito control ditches. Publicly owned areas include the Edwin Forsythe National Wildlife Refuge, the Great Bay Boulevard Wildlife Management Area, and the Great Bay Natural Area. The Forsythe Refuge is the largest in the Bight region and includes over 34,000 acres. It was established in 1984 by combining the existing Brigantine and Barnegat National Wildlife Refuges. Earlier, these refuges had been established to preserve habitats for brant, black duck, and rails. The Forsythe complex also provides habitat for the bald eagle, peregrine falcon, osprey, piping plover, and for colonial waterbirds discussed below.

Fish populations in the bay are dominated by forage species (bay anchovy, Atlantic silverside, mummichog, and banded killifish) but also include summer flounder and weakfish (Thomas, 1973). Striped bass overwinter in the bay, and white perch occur and spawn in the Mullica River (Huff, 1973). The Mullica, Wading, and Bass Rivers are considered to be anadromous fish spawning streams primarily for alewife. There is some evidence that the Mullica once supported spawning runs of American shad, but these no longer exist (Zich, 1978).

Hard clams occur throughout the bay and in the Mullica River upstream to just above the mouth of the Bass River, although waters of the Mullica above the mouth of

Ballengers Creek had seasonal or special harvesting restrictions in 1990 (New Jersey Department of Environmental Protection, 1990). None of the waters of the bay proper had harvesting restrictions in 1990, and it is one of New Jersey's principal hard clam producing areas. Several small oyster seed beds also occur in the Mullica River and Nacote Creek (New Jersey Department of Environmental Protection, no date). The benthic fauna diversity and macrobethos density of the bay are relatively high in comparison with other eastern U.S. estuaries (Durand and Nadeau, 1972).

There is one principal heron colony in the immediate bay area at Little Beach in the Forsythe Refuge (Jenkins et al., 1990). Species present are black-crowned and yellow-crowned night herons, great egret, snowy egret, cattle egret, and glossy ibis. There are no major gull colonies in the bay, but Tow Island supported about one-fourth of the state's black skimmer breeding populations in 1989. Wintering waterfowl utilizing Great Bay include black duck, mallard, and brant. One of the few wintering populations of tundra swan in the state occurs in the Wading River area (Ferrigno, 1990). This expanding population has exhausted its natural food supplies and has moved into nearby commercial cranberry bogs, causing extensive economic losses. The winter black duck concentrations at the Forsythe Refuge were the largest of any area in the state in 1990, and the Refuge also supported large numbers of snow geese in the fall. A large breeding population of clapper rail has existed in the marshes along Great Bay Boulevard (Pokras and Pokras, 1973).

Reed, Absecon, Lakes, and Scull Bays - These bays are located south of the Great Bay behind the coastal barrier islands extending from Brigantine Beach to Longport. With the exception of the North Brigantine Natural Area, the barrier islands are heavily

developed and include the Atlantic City-Ventnor City-Margate City urban areas. The bay side shoreline is also highly developed.

The open-water areas of these bays are shallow, generally less than 3 feet in depth, and include large areas of mudflats. About one-half of the total surface area is in tidal wetlands, most of which have been ditched for mosquito control purposes. Reeds Bay and Scull Bay are approved for shellfish harvesting; most of Absecon and Lakes Bays are approved for seasonal harvesting (November 1 through April 30) (New Jersey Department of Environmental Protection, 1990).

Despite the heavily developed nature of the surrounding areas, these bays are major centers of gull and tern breeding (Jenkins et al., 1990). There are nearly 40 breeding colonies in the bays, which support about 20 percent of the state's laughing gull and herring gull breeding populations. There are also eight heronries. Snowy egret is the predominant species. The bays are a major wintering waterfowl area. Nearly half of the State's brant population occurred in this area in 1990. Other principal species were black duck, bufflehead, and mallard. A contributing factor to the large brant populations is the availability of sea lettuce (Ulva sp.) as a food source (Ferrigno, 1990).

Great Egg Harbor Bay - The Great Egg Harbor River is a 59-mile river which originates in the Pinelands National Preserve and flows into Great Egg Harbor. Ocean waters enter the harbor through an inlet between Longsport and Ocean City. The river proper upstream from the Garden State Parkway, and portions of the major tributaries, are being considered for designation into the National Wild and Scenic Rivers System (National Park Service, 1989).

The lower tidal reaches of the Great Egg Harbor River and the Harbor Bay above the Garden State Parkway bridge are primarily tidal wetlands interspersed with smaller rivers and creeks. This area is largely in public ownership in New Jersey's Lester G. McNamara Wildlife Management Area. Much of the shoreline is not highly developed. Below the Parkway Bridge, the bay is mainly shallow open water, small marsh islands, and tidal mudflats. The barrier beach island bay shorelines and the northern bay area around Somers Point are heavily developed in residential and commercial areas.

The tidal portions of the River (below Mays Landing) serve as nursery and spawning habitats for anadromous fishes and as a nursery area for resident and transient estuarine and marine fish, including striped bass. There are also commercially significant hard clam beds in the upper bay and commercially important quantities of seed oysters in the Tuckahoe and Great Egg Harbor Rivers (National Park Service, 1989). The open waters of the bay up to about one mile above the mouth of the Tuckahoe River are generally approved for shellfish harvesting. Areas with seasonal or special restrictions mainly occur adjacent to the developed shoreline areas.

One major heronry in the bay at Cowpens Island supports relatively large numbers of great egret, snowy egret, and glossy ibis (Jenkins et al., 1990). Major gull nesting sites are also at Cowpens Island and at Shooting Island and Rainbow Thorofare in the southwest portion of the bay. The lower Great Egg Harbor River and its tributaries provide breeding habitat for the peregrine falcon and overwintering habitat for the bald eagle at the McNamara Wildlife Management Area. The area is also the site of a successful osprey recovery program. The Tuckahoe/Corbin River area is one of the state's major nesting sites

for northern harriers (Dunne, 1986). Principal waterfowl species wintering in the bay are black duck and brant. In addition, about 3,000 scaup were present in 1990 (the only occurrence of this species south of Little Egg Harbor Bay) (Ferrigno, 1990).

The extent of publicly owned protected lands in the Great Egg Harbor River system has recently been expanded through the designation by the U.S. Fish and Wildlife Service of the 15,000-acre Cape May National Wildlife Refuge. The refuge includes Great Cedar Swamp and Cedar Swamp Creek, a tributary to the Tuckahoe River. Lands are presently being acquired within the designated refuge area.

Southern Bays - The southern bays and sounds (e.g., Ludlum Bay, Townsend Sound, Great Sound, Jenkins Sound, and Grassy Sound) are a 2- to 3-mile-wide open water-marsh complex extending for about 20 miles behind the coastal barrier islands from Corsons Inlet to Cape May Inlet. The area contains about 25,000 acres of tidal wetlands, many of which are in a natural (unditched) condition. The barrier islands are moderately to heavily developed largely for vacation homes and related commercial uses. Except for the Wildwood area, the barrier island bay shoreline is generally less modified than those of bays farther north (e.g., Barnegat Bay). The western shoreline is traversed by the Garden State Parkway. There are no major tributary streams entering into the bays or sounds.

Most of the aquatic portions of this area have commercially significant hard clam resources. In the past, many of these waters were prohibited for harvesting because of poor water quality. In 1990, as a result of a new regional water treatment facility coming on-line in Cape May County, improved water quality led to the reclassification of some of this area (New Jersey Department of Environmental Protection, 1990). In Great Sound, 281 acres

were reclassified from Seasonal to Approved. In the Great Channel-Jenkins Sound-Grassy Sound areas, nearly 3,200 acres were changed from Prohibited to Seasonal. Commerical harvesting was initiated in these areas in 1991, and hard clam production is expected to be significant (Gene LoVerde, National Marine Fisheries Service, personal communication, 1991).

The bays are one of the state's major colonial waterbird concentration areas (Jenkins et al., 1990). There are about 13 heronries, which account for from one-third to two-thirds of the state breeding population of herons (little blue, tricolored, black-crowned night, and yellow-crowned night), egrets (great, snowy, and cattle), and glossy ibis. Principal colonies are at Stone Harbor and Sedge Island in the Great Channel area, and Middle Thorofare located west of Townsends Inlet. A major colony of yellow-crowned night heron is present at Avalon. The area is also an important gull, tern, and black skimmer nesting area. Over half of the State's breeding population of laughing gull, Forster's tern, and black skimmer occur here, and there are nearly 40 colony sites. Major colonies occur in back of Stone Harbor (White Island, Ring Island, Great Flat Island, and Muddy Hold Island), Swain channel in Jarvis Sound and Old Man Meadow in lower Great Sound.

The bays and sounds are also a major waterfowl area and, in 1990, accounted for about one-third of New Jersey's brant and black duck overwintering population. Buffleheads and mallards were also present in significant numbers.

There are a number of publicly owned sites in this area, including individual units of the Cape May Wetlands Wildlife Management Area which occur throughout the Corsons

Inlet-Cape May Inlet region and the Cape May Wetlands Natural Area behind Sea Isle City in Townsend Sound.

Coastal beaches and shorelines - Most of the coastal and barrier island beaches along New Jersey's shoreline have been developed, and relatively few natural areas remain. These latter areas are largely in public ownership and include the Sandy Hook unit of the Gateway National Recreation Area (National Park Service) and other federally owned areas at Sandy Hook; the state park, natural area and wildlife sanctuary on Island Beach; E.B. Forsythe National Wildlife Refuge; North Brigantine Natural Area; Corson's Inlet State Park; Strathmere Natural Area; and portions of the Coast Guard Center facility at Cape May. The principal habitat feature of these sites is breeding areas for the threatened piping plover.

Major piping plover nesting complexes and the number of observed nesting pairs in 1987 included Sandy Hook (10), Holgate/Little Beach (8) (the latter is part of the Forsythe Refuge), Brigantine/Peters Beach (12), the beaches at Corson's Inlet and the adjoining Whale Beach (23), Avalon/Stone Harbor (2), and the Coast Guard sites at Cape May (4). These areas supported about 60 to 80 percent of the state's plover breeding populations between 1976 and 1987. All principal nesting complexes receive some form of protection during the nesting season (JoAnne Frier-Murza, personal communication, 1991).

In addition to piping plovers, the New Jersey ocean beaches have on several occasions been used for nesting by the threatened loggerhead turtle (Caretta caretta). Such nestings occurred at Island Beach State Park in 1980 and at Ocean City in 1972, but none have subsequently been reported (Waste Management Institute, 1989).

HABITAT TRENDS

Introduction

Development in the post-World War II period in the coastal areas of the Bight region has been extensive, but there are relatively few data available that enable the quantification of the effects of this development on habitats. In some instances, important habitats such as wetlands were destroyed and converted to other uses. Similarly, specific individual habitats for nesting birds or shellfish were physically altered by beach development or by dredging activities. Other habitat impacts were less direct and included human disturbances (affecting bird nesting activities) or development within the coastal drainages that caused accelerated nonpoint source pollution.

Some information is available on habitat status on trends in the Bight region that are related to wetlands, submerged aquatic vegetation, and other special habitat areas. These data are discussed below.

Wetlands

Substantial losses of tidal wetlands occurred in coastal waters of New York and New Jersey in the post-World War II period. Although there undoubtedly were earlier losses, the extent of these has not been documented. A summary of the later changes follows.

Long Island - The U.S. Fish and Wildlife Service (Bureau of Sport Fisheries and Wildlife), in cooperation with the states, undertook a national inventory of coastal wetland trends in 1953-54 (U.S. Fish and Wildlife Service, 1956). The survey was prompted by concerns among wildlife biologists in the later 1940s and early 1950s about the effects of coastal wetland losses on waterfowl habitat. This inventory included Long Island but was

limited to only wetlands over 40 acres in size. It indicated that in 1954 the coastal marshes east of the New York metropolitan area were largely intact. In 1955 an additional survey was made to determine the vulnerability of wetlands to destruction. This survey indicated that almost 80 percent of Long Island wetlands were threatened with destruction in the foreseeable future.

A resurvey of New York wetlands was conducted by the Fish and Wildlife Service in 1959 and again in 1964. The latter survey was characterized as covering marshes of high, moderate, low, and negligible value to waterfowl, but it is not clear that all wetland areas were identified.

The 1954 survey indicated that there were 14,130 acres of wetlands in Nassau County and 20,590 in Suffolk County. Between 1954 and 1964, 4,635 acres (33 percent) were lost in Nassau County and 3,582 acres (17 percent) in Suffolk County. In both jurisdictions, fill for housing accounted for about 40 percent of the losses, followed by miscellaneous fill, and industrial, recreation, and maritime-related facilities. The 1964 survey placed about one-fourth of the remaining wetlands in the two counties in the "vulnerable to destruction" category.

A further survey of coastal wetlands on Long Island was made in 1971 (O'Connor and Terry, 1972). The results indicated that between 1964 and 1971, an additional 4,300 acres were lost in Suffolk County (about 25 percent of the 1964 acreage) and 130 acres in Nassau County. The lower losses in Nassau County were attributable to the high proportion of these wetlands that were in public ownership. No information was provided on the causes of the losses observed. The report concluded that in 1971, 12,725 acres of tidal

wetlands remained in Suffolk County and 9,363 acres in Nassau County. Of this total, 14,437 acres were on the south shore of Long Island in the geographic region of the Bight. No later information on any subsequent tidal wetlands losses has been published, but it is generally believed that the rate of loss declined substantially following adoption of New York's Tidal Wetlands Act in 1972. In recent years, direct wetlands alterations by permitted activities have been minor, but the extent of illegal or unpermitted filling is not known (Charles Hamilton, NYDEC, personal communication, 1990). In addition, no information is available that would characterize the condition and extent of degraded wetlands or of shoreline areas that have been altered by bulkheads, docks, and piers.

There is no published information on historic freshwater wetlands losses or alterations on Long Island.

New Jersey - A similar set of post-World War II surveys was done for New Jersey's coastal marshes. However these earlier surveys were subsequently updated so that alterations were estimated for the 20-year period from 1953 to 1973 (Ferrigno et al., 1973). In the coastal or back bay areas of the four Atlantic Coast counties constituting the New York Bight study area, it was estimated that there were approximately 134,000 acres of tidal marshes in 1953. By 1973, over 22,000 acres (17 percent) had been lost. In Ocean County, nearly one-third (about 11,000 acres) of the 1953 wetlands had been filled. These losses were largely fills along the Metedeconk River and northern Barnegat Bay associated with housing (especially finger canal residential areas), roads, and marina development. Over 6,000 acres of fill occurred in Atlantic and Cape May counties, largely for residential uses.

According to the Fish and Wildlife Service (Tiner, 1985), coastal wetlands losses prior to the early 1970s averaged about 3200 acres annually. Immediately following passage of the 1970 New Jersey Wetlands Act and the Federal 1972 Clean Water Act, these losses were reduced to about 50 acres per year. In more recent years, such losses have been even smaller--probably fewer than 10 acres (Bruce Halgren, NJDEP, personal communication, 1990).

Information on historic freshwater (mainly palustrine) wetlands losses in New Jersey do not exist. However, some estimates were made in the National Wetlands Inventory (NWI) by comparing lands classified by the Soil Conservation Service as having hydric soils versus mapped NWI trends (Tiner, 1985). These comparisons suggest slight losses in Atlantic and Ocean counties (4 and 8 percent, respectively), substantial losses in Monmouth County (56 percent) and no change or (unexplained) gains in Burlington and Cape May Counties. The losses in Monmouth County probably occurred in the Navesink-Shrewsbury drainages, which are included in the New York-New Jersey Harbor Estuary Study Area.

These NWI estimates are thought to underestimate actual freshwater wetlands losses in New Jersey's coastal counties. The state's freshwater wetlands are now being resurveyed in conjunction with the 1988 New Jersey Freshwater Wetlands Protection Act, and the NWI data may be subject to correction.

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV), primarily eelgrass, is present in the New Jersey and Long Island embayments. Eelgrass beds are among the most productive plant communities in the world, provide a habitat and nursery for fish and shellfish, and a food

source for waterfowl, and serve other important ecological functions. Eelgrass beds frequently harbor large populations of hard clams and bay scallops.

In New Jersey, eelgrass beds are distributed from the northern reaches of Barnegat Bay near Normandy Beach to the southern reach of Little Egg Harbor at Beach Haven (New Jersey Department of Environmental Protection, 1990). Beds generally occur on the eastern side of these embayments adjacent to the barrier island. Eelgrass also was formerly present in the bays around Atlantic City in the 1950s (Pokras and Pokras, 1973). On Long Island, largest eelgrass populations are presently found in Great South Bay, although beds also exist in Hempstead, South Oyster, Moriches, and Shinnecock Bays.

Eelgrass populations have, historically, undergone wide fluctuations in abundance usually related to natural causes. In the 1930s, a mass mortality of the entire north Atlantic eelgrass population occurred, which was attributed to "wasting disease." Later, in the 1960s, eelgrass abundance increased to the point that efforts were considered to reduce its abundance to facilitate small boat traffic. Such increases were documented in South Oyster Bay on Long Island and Chesapeake Bay. Declines in eelgrass populations have occurred since that time, although the causes are varied. In the Chesapeake Bay, declines of 80 percent or more from 1960s levels have been documented and appear to be associated with decreased light penetration resulting from increased nutrient loading and phytoplankton growth (Kemp et al., 1983). In the Long Island bays, eelgrass covered about 125 km^2 in 1967, but this area was reduced to 65 km^2 by 1988. A "brown tide" bloom of the micro alga Aureococcus anophagefferens, which occurred during the summers in 1985-88, reduced light availability in Great South Bay and Peconic Bay. This may have resulted in some reductions

in eelgrass populations during that period, but declines had already occurred between 1967 and 1978 when blooms of this species were not known to occur. Eutrophication may be a factor in recent declines by stimulating the growth of phytoplankton and of eelgrass epiphytes. It was noted that there has been an increase in eelgrass populations in Moriches and Shinnecock Bays, which have more effective water exchange with ocean waters than do the western bays. However, no water quality data are available to indicate increased eutrophic conditions in those waters.

Other Habitat Areas

As discussed above, there is a relatively good understanding of the extent of tidal wetland losses and alterations in both states, and a substantial body of information exists on general tidal wetland values and functions. Similarly, there is some information on the loss or impairment of specific habitats or communities (e.g., nesting bird sites, shellfish beds) that have resulted from coastal development, human disturbance, or adverse water quality. Many of the latter were discussed in the previous section.

Much less quantitative information is available on the functions of, and trends in, other habitat types. For example, intertidal habitats, such as sand and mudflats, comprise an important component of aquatic habitats in the Bight. These areas support economically important organisms (e.g., clams and crabs) and others that provide a food source for fishes (e.g., winter flounder). In addition, many species of shorebirds rely heavily upon tidal flats for feeding and resting sites (Whitlatch, 1982). Man-induced activities that are known to adversely impact on these areas are dredging and channelization, spoil disposal, and discharge of pollutants. The extensive dredging and channelization operations in the Bight,

particularly in the back bays and estuaries, almost certainly have had an adverse impact on these intertidal communities, but such impacts have not been quantified. The same is true for subtidal habitats.

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SUMMARY AND CONCLUSIONS

SUMMARY

Although the New York Bight is one of the nation's most heavily developed regions, it includes extensive, functioning habitat areas and supports large and diverse fish and wildlife populations.

Ocean Waters

The ocean area of the Bight is one of the United States' major commercial and recreational fishing regions. However, these waters receive large quantities of domestic and industrial wastes, primarily via the Hudson River plume. The Bight Apex and the northern New Jersey coast are the principal areas affected by the Hudson River discharges. Impairments to fish and shellfish in these areas have included incidences of fin rot on summer flounder in the inner Bight Apex. The causes of fin rot are not well understood, but the disease or syndrome is most frequently found in shallow, inshore waters that are influenced by the effluents from major metropolitan areas. The prevalence of fin rot declined between 1973 and 1978 and does not appear to have affected the abundance of flounders or other species in the Bight.

Periodic anoxic conditions have occurred on a number of occasions in the 1970s and 1980s in the near-coastal waters of the Bight, primarily off the New Jersey coast. These conditions have resulted in localized fish kills, although such events have generally been small and of short duration. A major anoxic event occurred off the New Jersey shore in 1976, which affected an 8,600-square-kilometer area and resulted in mass mortalities to

many benthic organisms, particularly surf clams. Losses to the commercial shellfish industry were substantial and were estimated to be at least $70 million. It is thought that a combination of unusual meteorological events was responsible for this condition. However, it is possible that anthropogenic additions of carbon and nitrogen may have aggravated this event, as well as other localized anoxic and hypoxic conditions that have occurred before and since that time.

Over the years, the large quantities of wastes discharged into the harbor and the Bight Apex have resulted in high levels of toxic materials in the bottom sediments of these waters. The Hudson/Raritan estuary has been described as one of the most contaminated sites in the United States with regard to chemical contaminants in the bottom surface sediments. Despite these conditions, there is no evidence to indicate that present levels of toxics are adversely affecting the abundance of finfish or shellfish in Bight waters. However, it is known that high levels of synthetic organic compounds in coastal fishes may reduce the number of eggs produced or cause various organ diseases. Thus, the possibility of toxic compound effects on fish populations in the Bight should not be overlooked.

In general, concentrations of organic compounds (e.g., PCBs) and metals (e.g., cadmium and mercury) found in fish and shellfish in Bight waters are currently below action levels set by the U.S. Food and Drug Administration. However, New York and New Jersey do have health advisories in effect for some areas of the Bight for bluefish, striped bass, and American eel, and the Hudson River striped bass fishery is likely to remain closed for several decades owing to high levels of PCBs in these fishes.

The principal use impairments associated with fish and shellfish in ocean waters of the Bight have been shellfish closures in the Apex and, to a lesser extent, restrictions on harvesting around the outfalls of sewage treatment plants. Closures in the Apex have been caused by sewage treatment plant and CSO discharges into the New York-New Jersey Harbor and deposition of sewage sludge at the 12-mile municipal sludge dump site. A reduction in such impairments has occurred with the phasing out of the sewage sludge dump site in 1987, which may allow reopening of formerly closed areas in federal waters of the Bight Apex in the near future. Also, year-round disinfection of municipal wastewater discharges into the Harbor was implemented in 1989, which has allowed the reopening of shellfish waters off Rockaway Beach and in Raritan Bay. Further improvements are expected with elimination of dry weather discharges (leakages) from CSOs in the harbor, which are expected to be completed in the mid-1990s, and from CSO treatment, which may be implemented in the early 2000s. It is recognized that while these actions will greatly reduce concentrations of bacterial indicator organisms in the Bight Apex, there is likely to be continuing concern over the presence of human-derived viruses in shellfish from these waters because viruses are less affected by the disinfection process and have a higher level of survival in the marine environment. Closures at the ocean outfalls of sewage treatment plants are not significantly affecting overall shellfish production in the Bight and, as a matter of prudence, are likely to remain in place.

Overall, it appears that finfish and shellfish populations in the marine waters of the Bight are predominantly influenced by fishing effort by both commercial and recreational fishermen, and by natural perturbations in oceanic or meteorological conditions. Most of

the major finfish and shellfish species in the Bight are under some form of management by the various regional fisheries councils, by the National Marine Fisheries Service, or by the states individually. However, many of these stocks are fully exploited or overexploited, and fishing pressure will remain high as worldwide demand for fishery products and local demand for recreational fishing opportunities continue to increase.

The status of marine birds in the Bight is unclear, although some information on species composition and population size is available for the period from 1978 to 1980. An update of this information is expected to be published in 1991 by investigators at the Manomet Bird Observatory, which may indicate population trends over the past decade. Concern has been expressed about the presence of toxic chemicals in these birds, since many of these species are heavy fish consumers and tend to concentrate pollutants (e.g., PCBs) from such food sources.

Beaches and Back Bay Areas

The fish and wildlife populations of the coastal, back bay, and estuarine areas of the Bight have undergone major fluctuations over the past century, and the factors contributing to these changes have been quite varied.

The region's coastal bird populations were generally devastated in the latter half of the 19th century by a combination of market and recreational hunting and egg gathering. Many formerly abundant species had largely disappeared from the Bight region by the turn of the century. Following passage of federal protection legislation in the early 1900s, populations gradually became restored, although for some species, significant population levels were not attained until the 1940s or even later.

The explosion in growth of the metropolitan New York area following World War II led to the rapid loss of major habitats in the Bight. Although much of the region's tidal wetlands had earlier been altered by mosquito ditching practices, the period from the late 1940s to the late 1960s saw destruction by fill of large acreages of tidal wetlands in Nassau and western Suffolk Counties on Long Island and throughout New Jersey's back bays. In addition, second home development along the region's coastal beaches led to the direct and indirect loss of breeding habitat for beach nesting birds and to the loss and alteration of dunes and related beach communities. As a result, some beach nesting species shifted to isolated bay islands that were being used for dredged spoil disposal.

While these extensive habitat losses were occurring, DDT and related compounds were also being widely used for mosquito control in the region's wetlands and for general insect control on farmlands and home gardens. These pesticides bioaccumulated in the aquatic environment, resulting in high concentrations in plankton, fish, and shellfish, which were major food sources for many bird species. These chemicals dramatically affected the reproductive success of osprey, bald eagle, and various herons. Although use of DDT was halted in 1972, concentrations of the chemical in peregrine falcon eggs in New Jersey were still three times greater than in other states as late as 1984. Other industrial compounds, particularly PCBs, have been found in relatively high concentrations in birds in the Bight region. Populations of some bird species most affected by these chemicals, particularly osprey, have gradually recovered. However, until very recently, there has been no successful nesting of bald eagles in New Jersey since the mid-1950s.

By the early 1990s, available habitat areas for birds were largely stabilized, occurring mainly in the various publicly owned refuges, natural areas and parks, and on the islands and tidal wetlands remaining in the back bays and estuaries. Populations of waterfowl in the region have been generally stable over the past decade, and some species (e.g., Canada geese) have increased substantially, largely due to displacement from other areas. Similarly, populations of colonial waterbirds have been somewhat stable in recent years, but this has been the result, in part, of concerted efforts to protect colonies during the nesting season by posting, patrolling, fencing, and other active protection methods. Least tern, black skimmer, and roseate tern colonies and piping plover nesting sites are being protected by these means. However, it is not clear that all major colonies or nesting sites are receiving adequate protection. For example, on Long Island, 63 percent of wading bird colonies, 21 percent of least tern colonies, and 24 percent of piping plover nesting areas receive no management (Downer and Liebelt, 1990). In New Jersey, some form of protection was in place in 1987 for most least tern, black skimmer, and piping plover nesting sites (New Jersey Department of Environmental Protection, 1989).

Information on fish and shellfish habitats in the back bays and estuaries prior to World War II is generally lacking. However, it is known that water quality has limited the extent of shellfish harvesting since the early part of the century. As early as 1914, most of Hempstead Bay and inshore portions of Great South Bay and Moriches Bay were classified by the New York State Department of Health as "seriously polluted" and unsafe for harvesting. Even earlier, the duck farming industry had caused water quality problems in Moriches Bay. In New Jersey, shellfish closures or harvesting restrictions began to be

imposed in the 1920s and, by 1938, affected the Manasquan and Metedeconk Rivers, inshore portions of Barnegat Bay, and most of the bays from Ocean City to Cape May. In addition, on Long Island, major changes in the shellfish resource base occurred with the opening of the Moriches Inlet in 1931. This action altered the salinity regime in the bay and resulted in conditions more favorable to hard clams, which shortly replaced oysters in abundance.

Following World War II, the wetlands losses and alterations described above directly and indirectly affected fish and shellfish habitats in the bays. In addition, aquatic areas were affected by shoreline modifications (e.g., bulkheading and marina construction) and destruction of naturally vegetated buffers; extensive dredging and dredge spoil activities; upland development, which altered hydrologic regimes and led to elevated loadings of nutrients, sediments, and bacterial indicator organisms from nonpoint sources; and direct point source discharges. The net effects of these activities on fish and shellfish populations are not known, and much of the long-term water quality information for the bays is limited to bacterial indicator data collected for the purpose of classifying shellfish waters.

On Long Island, shellfish closures are still in effect for most of Hempstead Bay, and the extent of closed or restricted areas in Great South Bay is somewhat greater than in the early 1970s. Hard clam production in the bay has been affected mainly by overfishing and fluctuations in clam spawning success. In Moriches Bay, the impact of the commercial duck farming industry peaked in the late 1950s, and most waste discharges have been stopped, although large quantities of organic sludge remain in many of the bay's tributaries. Hard clam stock sizes in Moriches Bay are not known, and production has been relatively low, apparently the result of lack of setting. In Shinnecock Bay, closure areas are a very small

proportion of the bay, but successful clam sets have been sporadic and production is also relatively low.

Information on finfish and blue crab abundance in the Long Island bays is not available. It is known that these areas provide nursery and feeding areas for marine fishes (e.g., winter flounder, fluke) and receive heavy recreational fishing for flounder, scup, weakfish, and white perch.

Some concern has been expressed about accelerated trends in eutrophication, particularly in Great South Bay, with the recent decline in the bay's population of submerged aquatic vegetation. However, the causal factors for this decline are not clear, although algal blooms over the period 1985-88 are thought to be a contributing factor.

In the New Jersey bays, water quality information is also dominated by data collected for shellfish classification purposes. In this regard, areas open to year-round or seasonal harvesting appear to be greater in extent in 1991 than has been the case for many decades. This is attributable to a state policy, adopted in the 1970s, of closing sewage treatment plant discharges into the bays and directing the effluents to the major oceanfront treatment facilities. For example, this policy enabled the reclassification of about 3,000 acres of shellfish-growing waters in the southern bays in 1991 as a result of a new regional wastewater treatment facility coming on-line in Cape May County. In general, the extent of closed areas in most of the state's back bays now appears to be associated with nonpoint pollution sources, including marinas and other areas of boat concentration. Nevertheless, these sources have resulted in increasing harvest restrictions in certain areas (e.g., the Metedeconk and Toms Rivers). Moreover, accelerated residential and commercial

development is occurring in the drainage areas of many of the bays, which may lead to greater loadings of bacterial indicators in the future.

As in Great South Bay on Long Island, concern has been raised in New Jersey about the effect of nutrient additions to the bays, particularly Barnegat Bay. Barnegat has been described as currently in a moderately eutrophic state, and turbidity levels are such that light levels on the bay bottom are very low. However, no information is available on recent trends in nutrient concentrations or in populations of eelgrass and other submerged aquatic vegetation that are sensitive to the low light levels observed. In the future, a 40 percent increase in nitrogen loading to the bay is possible if the watershed area is built out to present zoning densities.

Shellfish production in New Jersey's bays has been relatively stable over the past decade, and this may be attributable, in part, to the dominant state role in shellfish management in comparison with the Long Island fishery.

Recreational fishing in the bays is intensive, and effort is focused on blue crabs, weakfish, flounders, and white perch. Winter flounder, white perch, American eel, and blue crab are the predominant commercial species harvested. No information is available on trends in abundance for these species. It is known that most of historic anadromous fish spawning streams continue to support spawning runs of alewife and blueback herring.

CONCLUSIONS

As a heavily developed urban region, the New York Bight presents problems that differ from those of the more pristine areas where resource protection measures have been

adopted in advance of, or in concert with, intensive shoreline and inland development. Much of the development and destruction of the coastal habitats of the Bight occurred prior to passage of modern state and federal environmental and water quality regulations and programs. The extent and condition of the remaining habitats are largely the result of the public acquisition and management of key areas, and of the implementation of protection regulations in the early 1970s. Although coastal habitats have been destroyed and degraded, and ocean waters are receiving large quantities of municipal and industrial discharges, the ecological and economic values of the fish and wildlife resources of the Bight are enormous. Commercial and recreational fishing, hunting, and passive recreation contribute hundreds of millions of dollars annually to the region's economy. Populations of breeding birds (e.g., piping plover, roseate and least tern, black skimmer) and waterfowl (e.g., brant, black duck) are of regional and national significance. The continued existence of these populations and their habitats also contributes in important ways to enhancing the "quality of life" of metropolitan area residents. By any measure, maintaining and improving natural habitat values is an important regional and national objective. To accomplish this purpose, the following recommendations are proposed:

Ocean Waters

- Determine the extent to which anthropogenic nutrient loadings to the Bight Apex have in the past, or may in the future, significantly contribute to periodic anoxic events in these waters, particularly those along the New Jersey coast.

- Address the public health issues associated with reductions in bacterial indicator loadings that may be expected from correcting CSO leakages and treating CSO discharges, and which will enable shellfish harvesting in presently closed waters in the Bight Apex.
- Continue ongoing research to develop a human-specific indicator that more closely approximates the survival of viruses in the marine environment.
- Maintain or strengthen the management of important finfish and shellfish stocks so that a balanced and stable fishery can be sustained in the future.
- Assess soon-to-be published information on marine bird distribution and abundance in the Bight region to determine any significant trends over the past decade.

Bays, Estuaries, and Beaches

- Determine the adequacy of existing protection efforts for colonial nesting waterbirds and piping plovers. If such measures are inadequate, develop a strategy for instituting more effective programs, including any additional funding necessary to accomplish this purpose.
- Define and implement a "no-net-loss" policy for the region's tidal and freshwater wetlands programs.
- Ensure that key habitat areas (e.g., bird nesting and overwintering sites, threatened and endangered species habitats, shellfish beds, areas of submerged aquatic vegetation, fish spawning areas) are explicitly protected in

the coastal planning and regulatory processes; adopt a "no-net-loss" policy for such areas.

- Improve mapping efforts so that all significant habitat areas are identified for planning and regulatory purposes.
- Improve monitoring efforts, particularly in the bays and estuaries, so that trends in key water quality parameters are more readily available.
- Assess the potential impacts of future inland development on the water quality of the bays and estuaries; develop strategies for limiting, or mitigating the impacts of, such development.
- Determine the feasibility of retrofitting already developed areas to address existing nonpoint source pollution problems.

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