MARINE SCIENCES RESEARCH CENTER
STATE UNIVERSITY of NEW YORK
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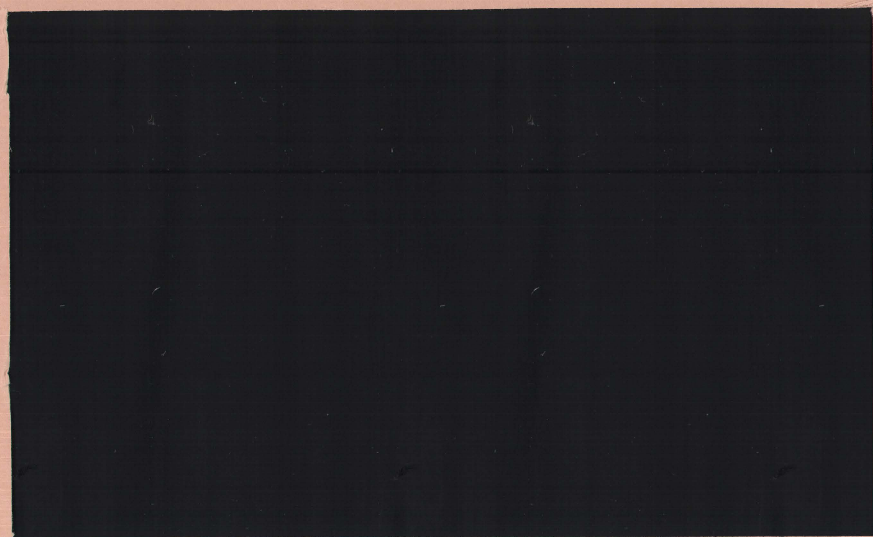
NYS PROJECT 2000

MARINE AND GREAT LAKES RESOURCES: 2000

COAST Institute
of the
Marine Sciences Research Center



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J.R. Schubel
Project Director

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PREFACE

NYS PROJECT 2000

MARINE AND GREAT LAKES RESOURCES: 2000

These reports are part of a series designed to address the future of New York's marine and Great Lakes resources in the year 2000 and beyond. In Will and Ariel Durant's book The Lessons of History, they make the observation that the future never just happened; it always was created.

These reports are intended to provide some of the information needed to create a bright future for New York's coastal environments and their living resources. Other reports will be distributed as they are completed.

J. R. Schubel
Project Director
April 10, 1991

CONTENTS

NYS PROJECT 2000 REPORT:

COASTAL EROSION AND SEA LEVEL RISE

Coastal Working Group:

Henry J. Bokuniewicz
Roger Flood
James Rine
J.R. Schubel
R.L. Swanson

EXECUTIVE SUMMARY

Conclusion: New York has a serious erosion problem which will not abate. There is not a coordinated management plan for dealing with a serious situation which will be exacerbated by an accelerated rise in sea level.

Recommendations:

1. A surveillance program must be established, as has been done in other states, to assess the state of the coast and the impact of state policies.

2. Interagency contingency plans must be developed for rapid response to catastrophic erosion which is inevitable even though the timing, location and severity are essentially unpredictable.

3. State policy must not only deal with the present situation but accommodate probable long-term changes due to an accelerated rise in sea level.

New York's shoreline is under the continuous threat of catastrophic erosion and coastal flooding. The existing danger can only be exacerbated by any rise in sea level. That sea level will continue to rise is inevitable, that it will rise more rapidly in the next 10 to 60 years is probable. To minimize the New Yorker's loss of life, property and State resources, strategies must be adopted to advert disasters whenever possible and to effectively respond to natural catastrophies which cannot be avoided.

This section addresses the character of the problems by presenting predictions of what will likely result over the next 10 to 60 years if contingency plans are not adopted. This section also presents recommended actions to lessen the adverse social and economic impacts in New York's coastal zone.

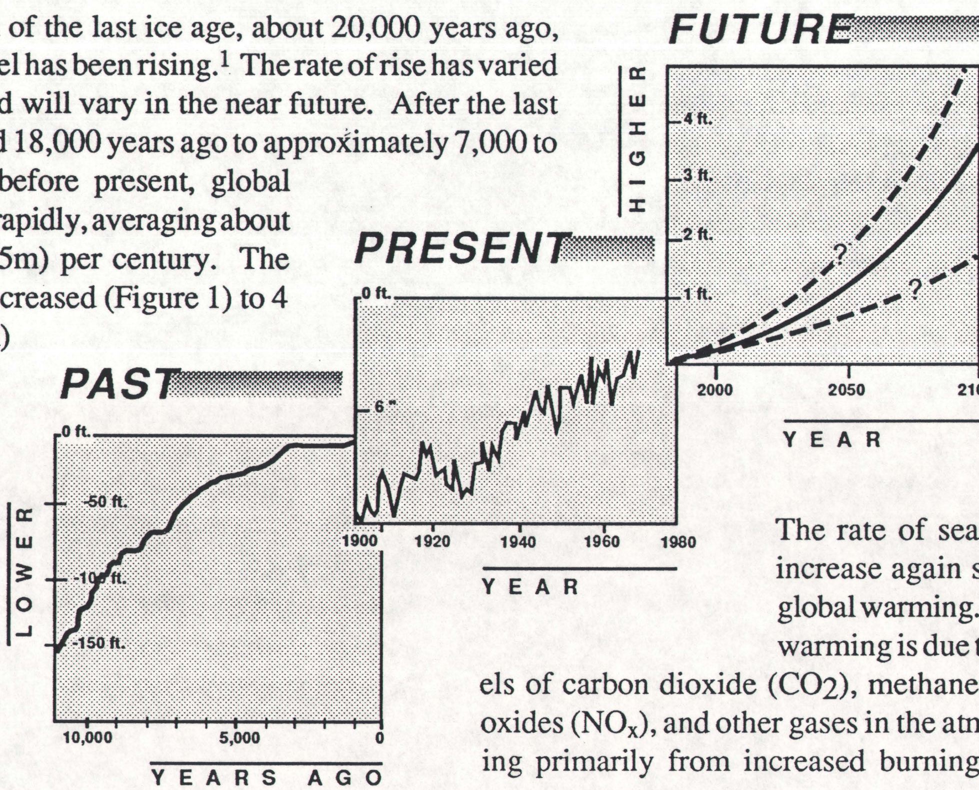
THE NATURE OF THE PROBLEM

Unpredictable Threat

History has shown that the entire shoreline is vulnerable to serious erosion. The exact location, extent and severity of the danger cannot be predicted except in a very general way. Certainly some locations are more susceptible than others, but all areas share the threat. The impacts are catastrophic in the sense that long stretches of the coast may be stable for many decades before a particular combination of circumstances leads to destruction of greater or lesser severity in one place or another. That these events will occur is certain, but coastal processes are so changeable and complicated, where and when they will occur is uncertain often until the danger becomes imminent. In the face of rising sea level, these problems will not abate.

The Sea is Rising, But How Fast?

Since the end of the last ice age, about 20,000 years ago, global sea level has been rising.[1] The rate of rise has varied in the past and will vary in the near future. After the last Ice Age ended 18,000 years ago to approximately 7,000 to 5,000 years before present, global sea level rose rapidly, averaging about 20 inches (0.5m) per century. The rate of rise decreased (Figure 1) to 4 inches (0.1m) per century.[2]



The rate of sea level rise may increase again soon because of global warming. The anticipated warming is due to increased levels of carbon dioxide (CO_2), methane (CH_4), nitrous oxides (NO_x), and other gases in the atmosphere resulting primarily from increased burning of fossil fuels since the Industrial Revolution, and to a lesser extent from deforestation. Carbon dioxide levels in the atmosphere have risen 20% since the 1800s and may be twice the pre-Industrial Revolution levels by 2050, with an associated increase in the Earth's mean global temperature of between 1.5 and 4.5^0 C.[3] Such global warming, would increase the rate of sea level rise because of two factors: increased rates of melting of polar ice and thermal expansion of the upper ocean.[4] Each of these factors would account for roughly one-half the resulting rise in sea level.

Sea level along the New York coast is presently rising at a rate of 1 inch per decade (2.5mm/year) (Figure 1). The majority of experts agree that sea level will rise at an accelerated rate over the next century. Predictions of the amount of the rise vary from 10 inches (25 cm) to 12 feet (3.7m) by the year 2100.[5,6] but the most likely estimate is about 3.3 feet (1.0m) over the next 100 years or about 4 inches per decade (1 cm/ year) (Figure 1). As has already been observed, sea level is already rising and expectations of even greater rises are based on the assumption that the release of $C0_2$ and other greenhouse gases will continue. It might be hoped that our global society will take decisive measures to reduce the emissions of these gases. Reductions in fossil fuel burning, particularly coal, would help, but it would only delay what seems inevitable. For instance, it has been theorized that even a world-wide ban on the burning of coal by the year 2000 would only delay the warming expected through 2040 by 25 years and the resulting thermal expansion of the upper ocean by 12 years. Thermal inertia of the oceans, as well as societal inertia, appear to have made at least part of the predicted rise in sea level unavoidable.

Within any particular region, sea level may rise, fall, or remain steady depending upon the balance among local geological processes, global sea level rise, and climatic changes which may influence oceanic currents or barometric pressure. For example, relative sea level near Juneau, Alaska, is falling because of rebound rise of the land in response to reduction of the load of glacial ice,[7] i.e. the land is rising even more rapidly than global sea level. Geophysical data and tidal gauge data indicate that relative sea level in New York is rising at a rate of 1 inch per decade (2.5mm/year), short term variations about the trend may be substantially larger or smaller.[7]

Coinciding with sea level rise is a net retreat of the shoreline, with some areas experiencing more erosion than others while some areas may even accrete (grow seaward). Along barrier beach coastlines, such as Fire Island, it has been calculated that for every 1 foot (30 cm) rise in sea level, there will be a corresponding 100 feet (30 m) landward retreat of the shoreline.[8] Along the north shore of Long Island where numerous bluffs of sediment deposited by the glacier adjoin Long Island Sound, the landward retreat would not be as large but with a rising sea level it still would increase from the present rate. A shoreline can maintain its position or even accrete seaward during a period of rising sea level if sufficient new sediment is added to allow the shoreline to maintain itself, or to grow seaward. Hypothetically, an increased rise of sea level would erode the bluffs at Montauk at a more rapid rate, resulting in more sediment introduced into the littoral transport system and transported to the west. As a result, Fire Island could be accreting while Montauk was eroding.[9]

WHAT WILL HAPPEN WITHIN THE NEW YORK REGION IF PRESENT POLICIES AND PRACTICES REMAIN IN EFFECT?

Many agencies have responsibilities for New York's coastal land. These include the State's Coastal Zone Office, the New York State Department of Environmental Conservation, the U.S. Army Corps of Engineers, the National Park Service, the Long Island Regional Planning Board as well as local government. Unfortunately, there is no comprehensive management plan to coordinate policy decisions. Neither is there an observational program to monitor the condition of the shoreline and to see how the shoreline responds to existing policies.

The vulnerability of the coastline to erosion and other encroachments by the sea is already high. By the year 2000, sea level will rise about an inch (2.5 cm) along the marine coast of New York State. This rise in sea level is negligibly small, but it can only aggravate an already bad situation. Below is a list of probable results of maintaining present policies and practices.

1. The degree of coastal erosion and subsequent economic losses caused by major winter and tropical storms will remain high. Based on historical records over the last 300 years, by the year 2000 the marine coast of New York State will experience 12 more major storms that will substantially affect the coastline.

2. There will be a slight increase in the population along the marine shoreline of New York State, thus increasing economic losses from major storms.

3. Coastal residents will continue to rely on local shore protection structures, such as bulkheads and small groins, to protect their property, and will continue to be frustrated by the lack of guidance from their government.

4. Sensitivity of groundwater to saltwater intrusion along the coast will increase.

5. There probably will be an increased penetration of saltwater up the Hudson River with increased threat to drinking water supplies. This saline penetration will be especially evident during periods of low river flow. The "rule of thumb" used by engineers is that a 1 inch rise in sea level is translated into a movement of salt water about one and a half miles upstream.

6. Increased salinity in coastal bays and accelerated invasion of marine predators on hard clams and bay scallops are likely.

7. Without a change in attitudes there will be no preparation or even planning to mitigate the effects of catastrophic erosion or of chronic problems aggravated by the additional sea level rise in the ensuing decades.

By the year 2050 there will probably be a rise of local sea level of about 18 inches (46 cm). All the problems predicted above for the year 2000 will be compounded. In addition, other probable shoreline problems experienced in New York State in the year 2050 include the following:

1. The State will be routinely filling and nourishing sections of the barrier islands along the south shore of Long Island. The primary reasons will not be to protect the property of barrier island communities, but rather to maintain the islands as barriers to prevent Atlantic storm waves from reaching the densely populated northern shore of Great South Bay.[10]

2. Local and State governments will need to maintain active drainage systems along the north shore of Great South Bay with a nearly continuous chain of structures, mostly privately constructed, to prevent coastal flooding. The southern shore of Long Island may begin to resemble the Netherlands with dikes, and a pumping system to keep the sea off the land and to permit rain water and waste water to drain out to sea.[10]

3. Sea level rise will decrease gradients in coastal drainage systems and retard their flows to the ocean. During storm events, especially those accompanied by storm surges, stoppage or even reversal of some sewer and storm drainage systems may occur with subsequent flooding of low lying areas (e.g., airports in New York City) and underground facilities (e.g., subways).

4. Constituency groups living within coastal areas, including those bordering the Hudson River, New York Harbor, Long Island Sound, and the South Shore, will be outraged that their local and State officials were unable to plan for eventualities that had been predicted decades in advance.

WHAT SHOULD NEW YORK STATE DO?

Given the history of sea level rise and the associated long-term shoreline recession, and erosion due to episodic major storms, what can New York State do to deal more effectively with catastrophic erosion and the predicted increase in the rate of sea level rise? Are there lessons that can be learned from what other coastal states have done, particularly those along the east coast of the U.S. where the rates of relative sea level rise are similar to that of New York? These two questions are addressed in the following paragraphs.

Many other coastal states base their shorefront management plans on a stronger commitment to making appropriate environmental measurements and more uniformly enforceable regulations than does the State of New York at the present time. Information on shoreline migration and beach changes are used by other states in making and implementing policy. The costs of conducting these state programs are justified by the income from tourism (especially in Florida and South Carolina) and by the fact that all coastal states, along with the federal government, must pay out millions of dollars in insurance costs and damages each year as a result of the effects of shoreline erosion and episodic storms.

New York State needs to develop and implement long-term scientific, engineering, legal and land-use plans to live with its dynamic coastal environment. The plans should be flexible, providing for appropriate responses to new data and information as they become available. The formulation of such plans requires a clear, explicit and public statement of societal objectives and goals. Specifically, New York State needs to start now to define the magnitude and scope of the impacts of the predicted sea level rise on the region, to evaluate the most probably scenarios, to identify the full spectrum of alternative ways of responding to a rise in sea level, and to assess the advantages and disadvantages of each response.

In the absence of any additional information, certain recommendations can be made to respond to the projected sea level rise. We recommend New York take the following steps now.

1. Contingency plans should be developed and coordinated among the relevant agencies for a rapid response to inevitable, catastrophic erosion wherever it might occur.

2. Architectural designs for construction of major new facilities or modification of State and local infrastructure should take into account the probability of a sea level rise of 18 inches (46 cm) by the year 2050.

3. Existing regulations should be reviewed and revised to reflect the variability in the character of different coastal zones and their response to sea level rise. The system should be more strictly enforceable, decreasing the reliance on case-by-case assessments.

4. A program for comprehensive and periodic measurement of marine shoreline positions should be implemented. In addition, the State needs to establish a center for the gathering of information pertaining to all the marine coastline areas of the State, such as local sea surface height, local geological processes and sea water temperature, as well as, to develop the capability for predicting the effects of various management options.

5. The State should critically examine the role of state and federal support of flood insurance in certain coastal zones. The precedents being established in South Carolina following Hurricane Hugo should be followed closely.

6. A program should be initiated to construct, revise, and distribute maps of coastal areas that show present and predicted positions of shorelines and storm surge high water lines for the next thirty years. These maps should be made available to property owners, present and prospective, as well as to those charged with management of coastal marine areas.

7. The State should begin to study the effects of sea level rise on coastal aquifers and drainage systems.

8. Strategies should be developed for dealing with coastal problems that enlist local resources. For example, if large scale protection of the New York State marine shoreline is judged appropriate, we should begin to assess what role waste products could play in that plan. The northeast U.S. is rich in waste products and many of these products could be stabilized and used for construction of structures for coastal protections. Ash from the incineration of the region's garbage and trash could be an enormous resource. It is estimated that by the year 2000, ash will be produced on Long Island and in the metropolitan New York City area at a rate of about 500,000 tons/year with an increase to more than 1,000,000 tons/year by 2020. Five hundred thousand tons of ash could produce 18,000,000 concrete blocks. These blocks could, perhaps, be used to construct offshore breakwaters, artificial islands, polders, and other structures to protect New York's coastline against an aggressive sea.

CONCLUSIONS

Global sea level has been rising inexorably for about 20,000 years. The effects of this rise are being felt along the marine coastline of New York State; New York has a serious problem with coastal erosion. The rate of sea level rise is expected to increase as a result of global climate change associated with the greenhouse effect even though the projected increase is not precisely known. If nothing is done to prepare for the predicted rise in sea level, the coastal areas of New York State will experience eventual economic losses due to erosion of property and wetlands that are essential to local fisheries, saltwater intrusion into bays, estuaries and aquifers. The problems will probably not be critical by the year 2000, but may well be serious by the year 2050. The State should begin now to gather data adequate to produce the information necessary to develop a coherent plan; develop contingency plans coordinated with all relevant agencies for the inevitable, catastrophic erosion; and orchestrate present and future coastal development compatible with an accelerated rise of sea level.

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NEW YORK STATE PROJECT 2000 REPORT:

MARINE WATER QUALITY—NOW AND IN THE YEAR 2000

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INTRODUCTION

Because projected growth and development within coastal areas, particularly the eastern end of Long Island, give rise to concern about water quality, there is a general public perception that New York's marine coastal environment is deteriorating. Despite this perception, New York's citizens can determine a better future and an improved coastal environment in years to come.

Actually, the present quality of coastal waters (Figure 1) ranges from severely degraded in parts of New York Harbor to excellent on the East End of Long Island. Because a clear correlation exists between population density, associated development and environmental degradation, the nearly pristine waters of the east may well be jeopardized unless development is creatively controlled. Technological fixes may alleviate the problems to some degree, but technology alone cannot eliminate the potential for coastal degradation.

Water quality can be described by several different parameters, ranging from concentrations of chemicals to more tangible effects of impaired water quality on water bodies, their uses and their resources (e.g., numbers of fish killed per unit area per year and miles of beach closed to bathing). Commonly used reference values are regulatory water quality standards or guidelines, measured chemical concentrations in water, and historical values that permit comparison of current conditions with those of a decade ago. For some data, sediments provide comparisons with pre-industrial conditions. Often water quality is best discussed in terms of classification for "best uses", according to Environmental Conservation Law (Title 6, Part 701).

Resource managers who prepare for the next century and who wish to improve the coastal environment must be familiar with the fundamental problems of marine water quality in New York's marine coastal waters and with future needs. What follows is a discussion of problems and some predictions and concerns for the future.

CURRENT STATUS AND TRENDS: NEW YORK'S MARINE COASTAL WATERS

Population densities vary greatly along the coast, from 200 people per square mile in coastal towns on the East End of Long Island to nearly 48,000 per square mile in Manhattan.[1] All told some 15 million New Yorkers live, work and enjoy their recreation along the marine coastal waters of New York State. Beginning in the late 17th century, the attraction of "The Great Port" of New York City stimulated the development of the region and unfortunately contributed to the associated degradation of the nearby coastal waters. The waterways became logical conduits for the transport and dispersal of all types of wastes, domestic and industrial. Proper waste disposal and management came as an afterthought in the metropolitan area and on Long Island. Unfortunately, that practice may continue because waste disposal and management are among the first activities to be cut back in economically difficult periods, such as the recession of the early 1990s.[2]

Even today many of the coastal waters downsteam and relatively far removed from the New York-New Jersey Harbor area (See Figure 1 for details.) experience effects of the harbor and attendant pollution problems, e.g. the closure of shellfish beds along the outer coast of New York and New Jersey and in western Long Island Sound, floatables on ocean beaches, the impact of ocean dumping of sewage sludges and dredged materials in the Bight, and excess nutrients and reduced dissolved oxygen (DO) concentrations in the Bight and western Long Island Sound.[3,4,5] A recent study of imparied uses of the New York Bight prepared for the U.S. Environmental Protection Agency (USEPA) estimated that adverse impacts on beach use, fisheries, recreational boating, marine birds, mammals and turtles cost New York State the order of several billion dollars per year.[6]

A number of major issues and problems must be confronted by those who seek to improve marine water quality. We discuss them below.

I. Eutrophication

In the last decade, concern has been expressed about increased signs of severe eutrophication in portions of the New York Bight Apex (Figure 2) and western Long Island Sound (Figure 3). Inputs of nutrients from: (1) sewage treatment plants on Long Island Sound and on tributaries (According to the National Coastal Pollution Discharge Inventory[7], over 1.3 billion gallons of sewage effluent are discharged daily into the Sound and the upper East River.), (2) storm water runoff, and (3) other non-point sources contribute to low summer dissolved oxygen levels, sometimes well below 3 parts per million in the western Sound.This condition, known as *hypoxia*, became severe in the summers of 1987 - 1989; most finfish were temporarily absent from the entire area between the Throgs Neck Bridge and Greenwich, Connecticut, and lobsters trapped in pots and retained in holding pens died in great numbers in 1987.[8] Anoxia also is often experienced in the Arthur Kill, Kill Van Kull, Haarlem River and East River. Similar conditions exist in the Narrows between the East River and Long Island Sound.

During every summer of the past 5 years the deeper basins of central and western Long Island Sound and several bays along the north shore of Long Island have experienced low DO concentrations during certain periods. After a few days, or weeks, the basins and bays are recharged with oxygen through wind mixing. During the past decade DO concentrations in the bottom waters of the Harbor have actually improved somewhat, although values in some areas still fall below the NY State water quality standard9 for fish propagation (5 parts per million DO).

Improvements in DO levels in Harbor waters since the 1970s are largely a consequence of new and upgraded sewage treatment plants (STPs); however, nutrients from the STPs are dispersed from the Harbor and may cause increased biological oxygen demand (BOD) in the western Sound and the inner New York Bight through phytoplankton blooms. The upper Hudson and other rivers and streams are responsible for 25 per cent of the phosphorous and nitrogen load in the Bight[10], as well as a substantial portion of the carbon in the form of suspended solids.

Unlike the near-shore zone of northern New Jersey and western Long Island Sound, the near-shore zone of the south shore of Long Island has not experienced low DO problems to any appreciable degree—— a consequence of good circulation in the area. Low DO in the Bight apex routinely occurs in the Christiaensen Basin (Figure 4), the topographic depression at the head of the Hudson (Shelf) Valley which is located between the disposal site for dredged material and the 12-mile dumpsite formerly used for sewage sludge. While low DO conditions in the Bight apex are largely controlled by oceanographic and meteorological conditions, the oxygen demand from dumping operations and the nutrient plume of the Hudson River (enhanced by New York and New Jersey Harbor STPs) add to the oxygen stress of the area. Long term monitoring in the Bight apex fails to indicate any DO trend in bottom waters; however, hypoxia can be expected during any summer when prolonged periods of hot, dry weather and poor wind mixing produce strong stratification.[4,5]

Plankton blooms, which are aesthetically troubling, create large BODs and strongly influence public use of coastal waters. Such blooms occur naturally, and they are increasingly fueled by nutrients from sources such as human wastes and fertilizers. For example, export of nutrients from the Hudson and the New Jersey coast fuels blooms in the Bight.

Because of the massive quantities of algal cells during a bloom, affected waters take on a distinct coloration. Green tides and red tides have been observed in the Bight in recent years. Brown tide was dominant in bay waters of the South Shore of Eastern Long Island, in Great South Bay and in the Peconic Bays from 1985 through 1988. The Brown tide was responsible for the collapse of a million dollar bay scallop fishery and a massive loss of eel grass.[11] Brown Tide appears to have diminished in 1989 and 1990, and repopulation of bay scallops through seeding was noted in September of 1990. Natural events and human activities have been considered as likely triggers for the Brown Tide bloom. Possible factors include: (1) higher than average salinities in the bays during the early summers of 1985 and 1986, (2) essential growth compounds supplied by pulses of freshwater runoff and groundwater seepage, (3) reduced grazing by zooplankton early in the blooms, and (4) retention of large populations of Brown Tide cells because of natural and meteorological conditions.[12]

II. Toxic Substances and Pathogens

In addition to nutrients, municipal sewage treatment plants contribute many pollutants to New York marine waters. Direct industrial discharges currently make up only a small fraction of the discharges of all pollutants; indirect discharges and sewage treatment plants dominate loadings of most human pathogens, heavy metals (i.e., mercury, cadmium, zinc, lead), organic carbon and most synthetic organics. PCBs may also have their origins in those sources, although new studies suggest that the toxic contribution of the Hudson River to the marine system is significant, too.[13]

Urban runoff is also a significant source of toxic contaminants to New York Harbor, contributing about 35 per cent of the oil and grease plus some heavy metals; Urban runoff is also the largest contributor of pathogens to the Harbor. Rivers and streams together with urban runoff contribute more than 20 per cent of the total marine loadings of arsenic, lead, nickel, selenium and zinc to the Bight..[14] The quantity of oil and grease routinely reaching New York Harbor and coastal waters over a three month period is equivalent to the amount of oil lost in the 1989 Exxon Valdez oil spill! Through the entire Hudson watershed and marine district, atmospheric deposition of certain pollutants is significant. Such deposition impinges directly on water surfaces and contributes indirectly as a non-point source contribution through land runoff. For example, the atmosphere may contribute 10 to 15 per cent of the lead inputs to coastal marine waters regionally.[15]

Toxic contamination of marine waters may present health threats to marine resources and to consumers of seafood. Primarily because of PCB concentrations which exceed U.S. Food and Drug Administration (USFDA) guidelines, (i.e. 2 ppm PCBs in fishes such as eels and striped bass), the New York State Department of Health has issued health advisories for fish harvested in the tri-state area and put restrictions on commercial fishing. From 1986 until 1990, New York prohibited the sale of striped bass from all state waters. Commercial fishing is banned in the Hudson from the Troy Dam to the Battery in New York City and on many embayments and sections of embayments for all species except American shad, large Atlantic sturgeon and carp.

Since the early 1970s, Harbor waters have shown improvement and lessened contamination by human pathogens as indicated by coliform counts. Nevertheless, Western Sound waters conformed to bathing water standards based on pathogens only 63 per cent of the time during the summer of 1986, and most beaches in New York Harbor are currently closed to bathers.[16]

The entire New York Harbor and Long Island Sound east to Hempstead Harbor is closed to shellfishing because of the presence of human pathogens, as indicated by concentrations of coliform bacteria. Westward from eastern Long Island to New York Harbor concentrations of pathogens increase. In the New York Bight, a shellfishing closure of 240 square nautical miles has been established around the former 12-mile dumpsite for sewage sludge. Shellfish harvesting is prohibited in 192,000 acres of New York's marine waters; in the New York waters of Long Island Sound 18 per cent of all potential areas, some 82,400 acres, have been closed as of January 1990.[16] With few exceptions, beds in the Hudson-Raritan Estuary have been closed to harvest for direct consumption for over 60 years. The Harbor itself has been completely closed for over 30 years.[6] Areas closed for shellfishing almost always remain closed for direct harvest, although shellfish may be transplanted from such areas to replenish areas which are clean but depleted.

A. Possible Effects of Contamination

Two fish diseases probably induced by pollutants, liver cancer and "fin rot", are prevalent in the lower Hudson and New York Harbor. In 1983-1984 most Atlantic tomcod sampled by the NYSDEC[17] from the lower Hudson near Garrison exhibited liver cancer. Extensive chemical analyses of the livers revealed cadmium, lead, zinc and synthetic organic compounds typical of an industrial estuary. Erosion and progressive death of fin tissue or fin rot has been observed in 22 species of finfish of the Harbor and the Bight. Fin rot has been described in fish from polluted marine waters throughout the world. Its cause is uncertain, but several studies indicated that fin rot may be initiated by contact with contaminated sediments.[18]

Some laboratory studies have also linked diseased shellfish to human waste. Crabs, lobsters and shrimp in the Bight exhibit erosion of chitinous exoskeletons by bacteria and fungi. Such "shell disease" in crustacea has been found in up to 30 per cent of the shrimp species from the most contaminated areas of the Bight. Reports mention erosion in Jonah crab and red crabs taken from several submarine canyons northwest of Deepwater Dumpsite 106. A linkage between shell disease and ocean dumping of sewage sludge at the 106-

mile site has not yet been found, but allegations by fishermen have been very strong. Shell disease can be documented from Nova Scotia to North Carolina, going back over a century, long before significant pollution was noted. The disease appears to be a function of the size and age of the organism and, in only a few circumstances has it appeared to be harmful to the organism . There are no known public health effects, but the disease can make the organism aesthetically displeasing.[19]

III. Floatable Wastes

Floatable wastes come from a variety of sources, but the most objectionable are associated with sewage. Diaper liners, condom rings, tampon applicators and grease balls are aesthetically objectionable and raise concern among beach users about public health risks, Most recently, floatable medical-type wastes caused a public outcry, and floatables quickly became a water quality issue. The introduction of the plastic polyethylene terephthalate (PET) bottle in 1977 contributed significantly to the magnitude of the floatable waste problem. Ecological concern has been focused on plastics in the form of devices that entangle birds, fish and turtles. In some cases plastics have been ingested by marine organisms, interfering with digestive processes and even causing death.

All beaches in the area are littered to some degree, and occasionally the problem is so severe that closure due to floatable wastes occurs. In 1988 some 56 statute miles of beachfront on both the north and south shores of Long Island and Westchester County were closed for hours or days at various times because of such wastes.[20] In 1976 closures occurred along 50 miles of Long Island's South Shore beaches, and similar problems have been documented as early as the late 19th century.[3] Although bathing water quality standards based on coliform counts are seldom exceeded during floatable events, the public tends to avoid all beaches during and following such events, causing significant economic impacts on beach-related businesses.

Major floatable events are confined to the Bight apex. They occur when persistent winds concentrate Harbor floatables into slicks and strand them on beaches.[3] Storm sewers and combined sewer overflows (CSOs) in the metropolitan area are apparently the greatest contributors of floatables; litter left on beaches by beachgoers also contributes. The best way to reduce the magnitude and severity of the floatables problem is to reduce the quantity of material entering marine systems at the sources. The USEPA's Floatables Action Plan, carried out in conjunction with the U.S. Coast Guard, the U.S. Army Corps of Engineers, the states of New York and New Jersey, and New York City, has apparently reduced the problem on an interim basis. However, the implementation of long term solutions, as described in the Marine Sciences Research Center's Floatables Management Plan,[21] is critical .

FORECAST FOR THE FUTURE

I. Eutrophication

The upgrading of sewage treatment plants to conform to secondary standards and implementation of CSO abatement plans in the metropolitan area should further improve dissolved oxygen concentrations in bottom waters of the Harbor and the East River. On the Sound the extent of the improvement is lesscertain, but one Long Island Sound model predicts a modest 0.3 ppm DO improvement at the bottom of the Western Narrows when all sewage is subject to secondary treatment.[22]

Western Long Island Sound, because it is eutrophic, and at times hypoxic and, in places, anoxic, is the marine system of greatest concern with regard to eutrophication in the coming years. Anoxia and hypoxia could occur more frequently, cover larger areas and last longer. Unfortunately, the upgrading of sewage treatment plants in the city and on both sides of the Sound to secondary treatment standards reduces nutrient inputs by only a few per cent, and the remaining nutrients are still available to phytoplankton. The situation in the Sound warrants scrutiny, and remedial measures such as the removal of nitrogen from sewage treatment plant discharges may be required. Improved technologies and vigorous attention to non-point sources may also be important.

Although there are hypoxic areas along the New Jersey coast and localized areas of oxygen depletion are still experienced in the Bight apex, there is no indication of a decreasing trend in bottom DO levels in the latter area overall . Physical processes seem to dominate the annual cycle of DO in bottom waters. If anything, there might be some future improvement in summertime bottom DO here as a consequence of moving the dumping of sewage sludge from the 12-mile site to the 106-mile site.

The population immediately surrounding New York State's marine waters may increase somewhat in the next century. A 6.4% population increase around Long Island Sound has been predicted by the year 2030.[23] However, the redistribution of the population is perhaps more important than sheer numbers with regard to marine water quality. Development will apparently continue to move away from the central city and into the suburban counties, particularly toward the eastern end of Long Island. On a positive note, introduction of industrial pretreatment programs, improvement in CSOs, and the continued move of industry from the city, all strongly dependent upon economic factors, could cause some improvement in the water quality of the Upper and Lower Bays of New York Harbor, the East River and western Long Island Sound.

II. Toxic Substances and Pathogens

As a result of major pollution control measures for pathogens, such as best management practices, CSO abatement, and disinfection of CSO discharges, some beaches and shellfishing areas that are now closed could conceivably be re-opened. A reduction of toxic materials discharged into these waters could trigger a reduction of the concentration of these materials in marine organisms; however, bans and public health advisories will very likely still remain in place because toxic substances and compounds ultimately reside in the marine sediments, and sediments will continue to be a major source of contaminants to marine organisms. It is also possible that New York State and EPA regulations along with FDA guidelines will become more restrictive as agencies and researchers learn more about the harmful effects of consuming contaminated seafood, make new risk assessments, and develop new standards.

Diseases in fish and shellfish may decline somewhat if water quality improves and contamination of sediments is reduced. In fact, there was a tenfold decline in the prevalence of fin rot in winter flounder in New York coastal waters over the period 1973-1978, although the decline may not have been related to improvement of water quality.[18]

III. Programs and Plans

Fortunately some major marine and estuarine problems are now targeted by the multimillion dollar National Estuary Program (NEP). New York-New Jersey Harbor, including Jamaica Bay, Raritan and Newark Bays, and Long Island Sound are all integral parts of the program conducted by USEPA and by the states adjoining these waters. The Peconic Bays may be included in the NEP during the early 1990s as well. The ultimate charge of the Program is to develop a Comprehensive Conservation Management Plan for every estuary of national significance, as defined by the Clean Water Act. In fact, these Management Plans, designed to restore and protect the coastal estuaries through the regulation and control of sources of pollutants, should be put into place during the 1990s. If they are implemented, the beneficial effects may be detected early in the coming century. The New York Bight Restoration Plan, currently in effect, is also part of this scheme of improvement. These plans involve New York's sister states, New Jersey and Connecticut, as well as other federal and interstate entities, i.e. National Oceanographic and Atmosperic Administration, the Port Authority of New York and New Jersey and the Interstate Sanitation Commission. Coordination among all participants at all levels is essential for the success of the plans. A continuing long-term committment is also required because the lack of such a commitment has been the downfall of similar programs in the past.

Additional action at all levels of government will be necessary to achieve the goals set by the NEP. Perhaps the most important actions will be pollution prevention policies now evolving within governments.

Governmental incentives to use less energy and less polluting chemicals in manufacturing will also be critical in shaping such policies.

IV.Summary and Final Comments

Despite optimistic views, it would be naive to believe that the New York Harbor area will become a more desirable area, particularly for water-contact recreational activities overnight. Many difficult problems remain. Seepage of contaminants from landfills, intentional and accidental spills, atmospheric deposition, urban runoff, poor waste disposal, inappropriate land use, and careless practices at the individual and small business level continue to plague the waters that surround the City and Long Island. Adequate funding for operation and maintenance of the water quality infrastructure will remain a difficult problem and may lag far behind optimum levels because of the expense involved.

The New York Bight apex and western Long Island Sound would be prime beneficiaries of improvements in the Harbor because the harbor complex is a major source of contaminants to these systems. Tributaries are also a major source of nutrients and contamiants to Long Island Sound. Nutrient input must be limited or reduced in some situations: In fact, the current managment plan for Long Island Sound, calls in the initial phase for no net increase in nitrogen inputs.[22] Continued eastward development on Long Island will stress the south shore bays and central and eastern Long Island Sound and may reduce water quality noticeably in those areas. More frequent beach and shellfish bed closures might be expected on Eastern Long Island. Although no new sewage treatment plants are planned at the time of writing in 1990, increased phytoplankton blooms due to current sewage treatment systems on Long Island and along the Connecticut shore may nevertheless be expected unless control technologies for nutrient removal are strictly and consistently applied. Obviously non-point source reductions, control of coastal development and effective land use planning are additional keys to improved water quality in coastal marine waters.

There may be improvement in the Bight apex, too, as a consequence of the improved quality of the Hudson-Raritan plume and the cessation of dumping of sewage sludge at the 12-mile site. Perhaps the area closed to shellfishing will be reduced to some degree, but effects of local coastal development could mask any improvements due to the plume or the cessation of dumping at the 12-mile site.

The dumping of sewage sludge and industrial wastes at the 106-mile site remains a major public and political concern, while land disposal sites for sludge continue to generate controversy. Long-term monitoring of the effects should be continued until and after ocean dumping is phased out in 1992 as a consequence of the Ocean Dumping Ban Act of 1988.

In recent summers the public has become especially sensitive to the need for a clean and safe marine environment. Oceanographers are working closely with economists and social scientists to analyze costs associated with degraded coastal environments. The realization that New York loses several billion dollars annually because of the degradation of its coastal environment is alarming. Those who would otherwise use the coastal resource peceive the degradation quickly and turn elsewhere. Obviously, it pays for the state to invest more time and money on its coastal resources— in order to rehabilitate, to protect, and to preserve all of its coastal environment.

CONCLUSIONS AND RECOMMENDATIONS

Many or most of the following conditions should be met to achieve improved water quality in the marine coastal area of New York in the next century.

A. General Conclusions and Recommendations

1. With 70 per cent of New York's population residing in coastal counties along the Great Lakes and in the New York City greater metropolitan area and Long Island, New Yorkers must consider themselves residents of a coastal state. As the density of the coastal population increases and as the population of the metropolitan area continues to shift toward the marine coast, coastal development must be carefully managed in order to avoid any further degradation of the marine environment.

2. Individual coastal projects must be judged by their contributions to cumulative effects, not merely by incremental impacts of each individual project.

3. Land-use planning should be regional in scope. Environmental protection and economic development must be balanced; in different areas, different strategies will be required.

4. Discharges from point sources should be monitored and reduced throughout the entire state, and non-point source (NPS) abatement measures should be instituted as well. New York and its neighboring states should measure the same parameters in the same way.

5. A coastal ethic and clear coastal policies will be necessary to improve water quality. Goals of coastal policies should be defined in terms of the values that an environmentally conscious society wants, e.g. sustaining a shellfish industry by declaring a policy of no net loss of shellfishing areas.

6. Economic incentives must be used to achieve water quality goals.

7. Increased public education about the coast is absolutely necessary. The majority of people who live on Long Island and in Metropolitan New York City do not appreciate sufficiently either coastal resources or the economic value of the coast. Currently, according to experiences of those familiar with the Long Island Sound Study and those familiar with reports by the International Joint Commission on the Great Lakes, the public in the marine district appears to settle for poorer water quality than the public around the Great Lakes. This situation should be changed.

8. Laws should be made flexible enough to accommodate the application or demonstration of new technologies and technological advances that protect the environment, e.g. low flush or composting toilets and biological nutrient removal at sewage treatment plants.

9. Regional collaboration between researchers and managers in the form of roundtables ought to be promoted. Unified voices and consensus are required.

10. More moneys must be spent on environmental conservation and rehabilitation. Dedicated funds should be established and employed for water quality improvement so valuable to future generations. All investments should be understandable to an educated and critical public.

B. More Specific Conclusions and Recommendations

1. Authorities and researchers must continue to monitor hypoxia closely and to implement appropriate remedial measures to reduce the likelihood of further persistent declines in dissolved oxygen and the probability of *anoxia*, the complete absence of oxygen, in the western Sound and New York Bight.

2. The first priority in the operation of STPs should be making them actually perform up to their effluent design criteria and meet their hydraulic load demands. The combined sewer overflow (CSO) abatement program in New York City should be continued, and stormwater management should be utilized in other urban areas along the coast.

3. Industrial processes should be altered to promote recycling and the reduction and reutilization of toxic wastes. Although pollution from toxic substances will respond to pretreatment and source controls, NPSs will remain a problem in terms of toxics and nutrients. Economic incentives for pollution prevention should be widely implemented.

4. Some non-structural NPS controls ought to be initiated in straightforward fashion, e.g. thorough street cleaning in metropolitan areas and restrictions on lawn fertilizers.

5. Comprehensive long-term aquatic monitoring programs that exploit data already available in NOAA's Status and Trends program, in EPA's Environmental Monitoring and Assessment Program (EMAP) and other similar programs should be developed. These should focus on goals which the public comprehends. Funds for interpretation of data, often ignored as part of monitoring programs, must be provided.

6. As populations increase in formerly rural areas along the coast, cesspool operations which contaminate coastal harbors and bays must be curtailed. Advanced STPs with extensive nutrient removal may be needed. Land use planning along with strong regulations should limit development of rural coastal areas.

7. Water conservation should be encouraged and mandated; sewage treatment costs can be reduced if the volume of water requiring treatment is reduced. Conservation will be necessary in order to keep pace with increased freshwater demand. New metering laws in New York City are a step in the right direction, and individual users should be metered as soon as possible. Water skimmed from the Hudson and freshwater diverted from the Great Lakes are extremely problematic sources for the future, and otherwise usable groundwater supplies may be contaminated because of landfills, agricultural chemicals and nearby hazardous waste sites.

8. To avoid impacts on living marine resources and the decline of important recreational and commercial fisheries, nutrient inputs to Long Island Sound will have to be reduced substantially. Physical habitat including wetlands must be maintained.Future benefits are expected following initial investments in nutrient reduction.

9. Contingency and prevention plans must be developed for spills of hazardous materials.These plans must reflect coordination among agencies whose jurisdictions overlap. Funds should be provided to respond to all types of marine environmental crises, and for research, management and remediation as well.

10. Regardless of any bias toward any one environmental medium (air, land, or water) as a site for sewage sludge disposal, a scientific basis for selecting the best option for sludge disposal should be developed through a rigorous assessent of environ mental, public health and economic advantages and disadvantages. Offshore islands for siting typical unpopular "not-in-my-backyard" (NIMBY) projects might be considered in the future.

FIGURES

Figure 1. New York Marine Coastal Waters. Map from p. 61 of Swanson, R.L. and R.L. Zimmer, "Meteorological Conditions Leading to 1987 and 1988 Washups of Floatable Wastes on New York and New Jersey Beaches and Comparison of These Conditions with the Historical Record." Estuarine, Coastal and Shelf Science, v. 30, pp. 59-78, 1990.

Figure 2. Oxygen Depleted Bottom Water in New York Bight and off the New Jersey Coast. Shown on p.2 as Figure 1-1 in Sindermann, Carl J. and R. Lawrence Swanson, Oxygen Depletion and Associated Benthic Mortalities in the New York Bight, Ch. 1, "Historical Perspective", NOAA Professional Paper 11, 1976.

Figure 3. Dissolved Oxygen Levels in Bottom Waters of Long Island Sound. Shown as Figure 6c, pg. 11 in Draft: "Long Island Sound Study Status Report and Interim Plan for Hypoxia Management", November 1990.

Figure 4. Major Dump Sites in the New York Bight. Appears on p.2 of U.S. Department of Commerce MESA Special Report, Long Island Beach Pollution: June 1976., 1977.

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NYS PROJECT 2000 REPORT:

FISHERIES AND AQUACULTURE

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EXECUTIVE SUMMARY

Conclusion: New York's fishery stocks are harvested at or above optimum sustainable yields. For some species, this situation is compounded by degradation and destruction of habitat, which presumably has reduced the biological carrying capacity of the aquatic ecosystem.

Recommendations:

1. Devise, implement, and enforce management plans that sustain the stocks of all target species. Successful management of these species requires that all levels of government act together.

2. Diversify the harvest base to include species that have previously not been marketed by New York fishermen.

3. A major research effort is needed to improve our understanding of the use of habitat by important species and how critical types of habitat are affected by various development activities.

4. Promote the wholesomeness and sanitary quality of local fish and seafoods to expand consumer demand for New York-produced fish.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The marine waters of New York State support extensive commercial and recreational fisheries. These fisheries provide important economic, social, and cultural benefits to New York and their future is an issue of great concern to the State. Both commercial and public aquaculture augment stocks of species of commercial and recreational importance. This brief analysis presents the current status of the fisheries and aquaculture industries of New York and makes recommendations for revised State policies and programs to encourage the expansion, and where necessary, the rehabilitation of these industries over the next decade. Commercial fishing and aquaculture are only a small portion of the extensive seafood industry.

EXISTING CONDITIONS

Recreational Fisheries

New York's living marine resource industries consist of recreational and commercial fisheries and aquaculture. Of these, recreational fishing is by far the largest in terms of contributions to local and State economies, employment, and the number of businesses involved. According to the most recent data available from the National Marine Fisheries Service (NMFS*) and study conducted by the New York Sea Grant Institute (NYSGI)[1], approximately 800,000 to 1 million individuals participate annually in recreational fishing in New York's marine waters. The estimated total catch by these anglers in 1989 was over 20 million fish (Figure 1). Of those, over 12 million fish were landed while the remainder were released (according to the last 3 years of NMFS data, 60.5% of the fish caught were landed). The important species include bluefish, sharks, cod, scup, striped bass, winter and summer flounder (fluke), and various tunas (Table 1).

Partly because New York's recreational fishing industry is so large and is comprised of many different types of businesses (i.e. bait, tackle, charter boats and rental boats), it is difficult to obtain accurate data. A reasonable estimate of direct total annual expenditures from marine recreational fishing in New York was $1.1 billion in 1987[1]. An additional $20-40 million is generated by tourists from upstate New York. A telephone survey revealed that New Yorkers in about 583,000 households fish recreationally in the State's marine waters.

* See appendix for list of acronyms.

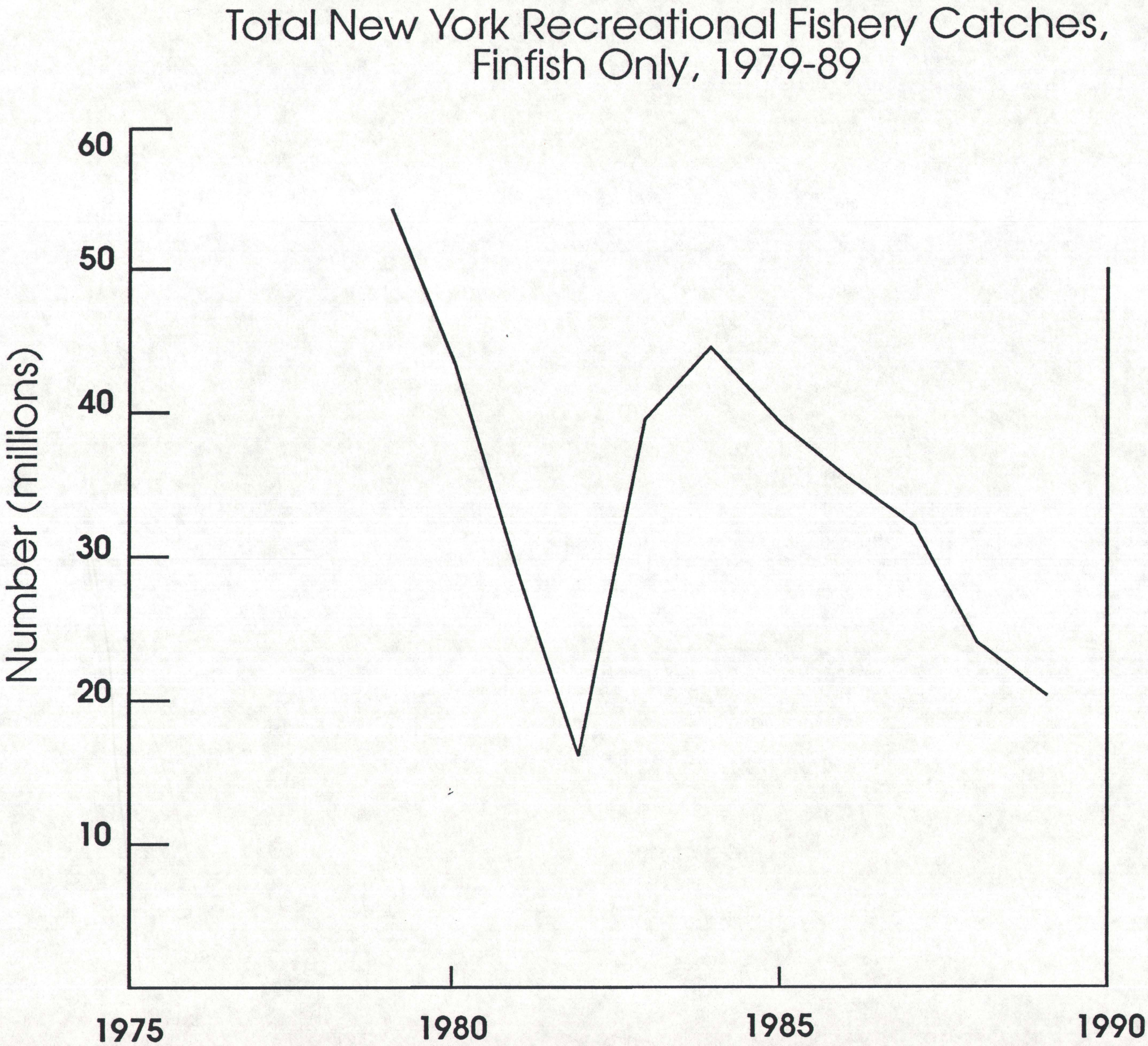

Figure 1. Total number of fishes caught by recreational fishermen in New York waters (landings plus release), 1979 - 1989 (NMFS statistics).

Table 1. New York recreational fishery catches in 1989. Catch type A+B1 = landed fish; catch type B2 = released and not landed (e. g. undersized fish or surplus catch) (NMFS preliminary statistics).

	Catch A+B1 (No. x 1000)	Weight (Tons)	Catch B2 (No. x 1000)
Bluefish (Pomatomus saltatrix)	3714	1319	1328
Cod (Gadus morhua)	231	425	109
Cunner (Tautogolabrus adspersus)	299	22	1365
Dolphins (Coryphaena sp.)	57	93	
Eels (Anguilla rostrata)	6	2	
Flounder, Winter (Pseudopleuronectes americanus)	1999	454	1571
Flounder, Fluke (Paralichthys dentatus)	330	153	120
Flounder, Other	30	5	54
Hake, Red (Urophycis chuss)	220		
Herring, Atlantic (Clupea harengus)	116	20	
Mackerel (Scomber scombrus)	145	59	
Marlin (family Istiophoridae)			
Pollock (Pollachius virens)	48	176	
Puffers (Sphoeroides maculatus)	22	3	90
Scup (Stenotomus chrysops)	3162	381	777
Sea Bass (Centropristis striata)	714	173	192
Sea Robins (Prionotus sp.)	95	15	746
Sea Trout (Cynoscion regalis)	6	10	
Sharks (order Squaliformes)	17	516	371
Skates/Rays (order Rajiformes)	1	2	117
Striped Bass (Morone saxatilis)	13	52	367
Tautog (Tautoga onitis)	696	305	461
Toadfish (Opsanus tau)	3	<1	30
Triggerfish/Filefish (Family Balistidae)	29	20	
Tunas (Thunnus sp. and Euthynnus sp.)	114	1420	
Other Finfish	285	254	

Total	A+B1 Catch	12,342,000 fish
	A+B1 Weight	5,800 tons
	B2 Catch	7,876,000 fish

Commercial Fisheries

Commercial fisheries are active on the marine coast of New York. Prior to the mid-1960s fish meal and oil, processed on eastern Long Island, contributed substantially to New York's commercial fishery landings (Figure 2). The abrupt decline in total marine commercial landings in the late 1960s reflects the closure of several processing plants. Landings after 1970 are basically of food finfish and shellfish, although small quantities of fish continue to be landed for industrial or bait purposes. Total landings of finfish and shellfish for food have been relatively stable since 1970, averaging 14,333 - 18,743 tons (13,000 - 17,000 metric tons) (Figure 3). Landings in New York. State in 1989 were 17,590 tons valued at $47.7 million. The retail value of seafood products in New York has been estimated to be worth $1 billion annually[2]. Important finfish by catch include bluefish, cod, various flounders, scup (porgy), tilefish, various tunas, swordfish and whiting (Table 2). Major shellfish species are lobster, hard clams, surf clams, oysters, and squid.

New York's marine commercial fisheries can be generally divided into inshore and offshore components. The offshore fishery has expanded significantly since extension of US fishery jurisdiction to the 200 mile wide Fishery Conservation Zone (FCZ) by the Magnuson Fishery Conservation and Management Act (MFCMA - PL94-265) in 1976. In March 1983, President Reagan declared the FCZ to be congruent with the Exclusive Economic Zone (EEZ) of the United States, thereby claiming the sovereign rights in addition to management rights, over the marine resources in this area. Several of the major inshore fisheries, such as hard clam and bay scallop, have undergone significant declines during this same period. The result has been a relatively stable picture of total landings.

Aquaculture

Although aquaculture in some forms has been practiced for many years in the United States, it is generally regarded as a new industry with significant growth potential. Nationally, aquaculture production increased by an estimated 165% between 1980 and 1985. New York was home to some of the earliest experiments with marine aquaculture and continues to support substantial public aquaculture and limited commercial culture on Long Island[3]. As part of their shellfish management programs, several towns on Long Island are engaged in culturing shellfish to augment wild stocks. While these practices are being undertaken using the best available scientific and technical information, it is unclear whether significant contributions are being made to natural shellfish populations. Five commercial aquaculture firms operate on Long Island, producing mainly clams and oysters for market (Table 3). In the past decade several shellfish aquaculture companies on Long Island have closed. A variety of technical, economic, and socio-cultural problems continue to hamper the further expansion of commercial marine aquaculture in New York[4].

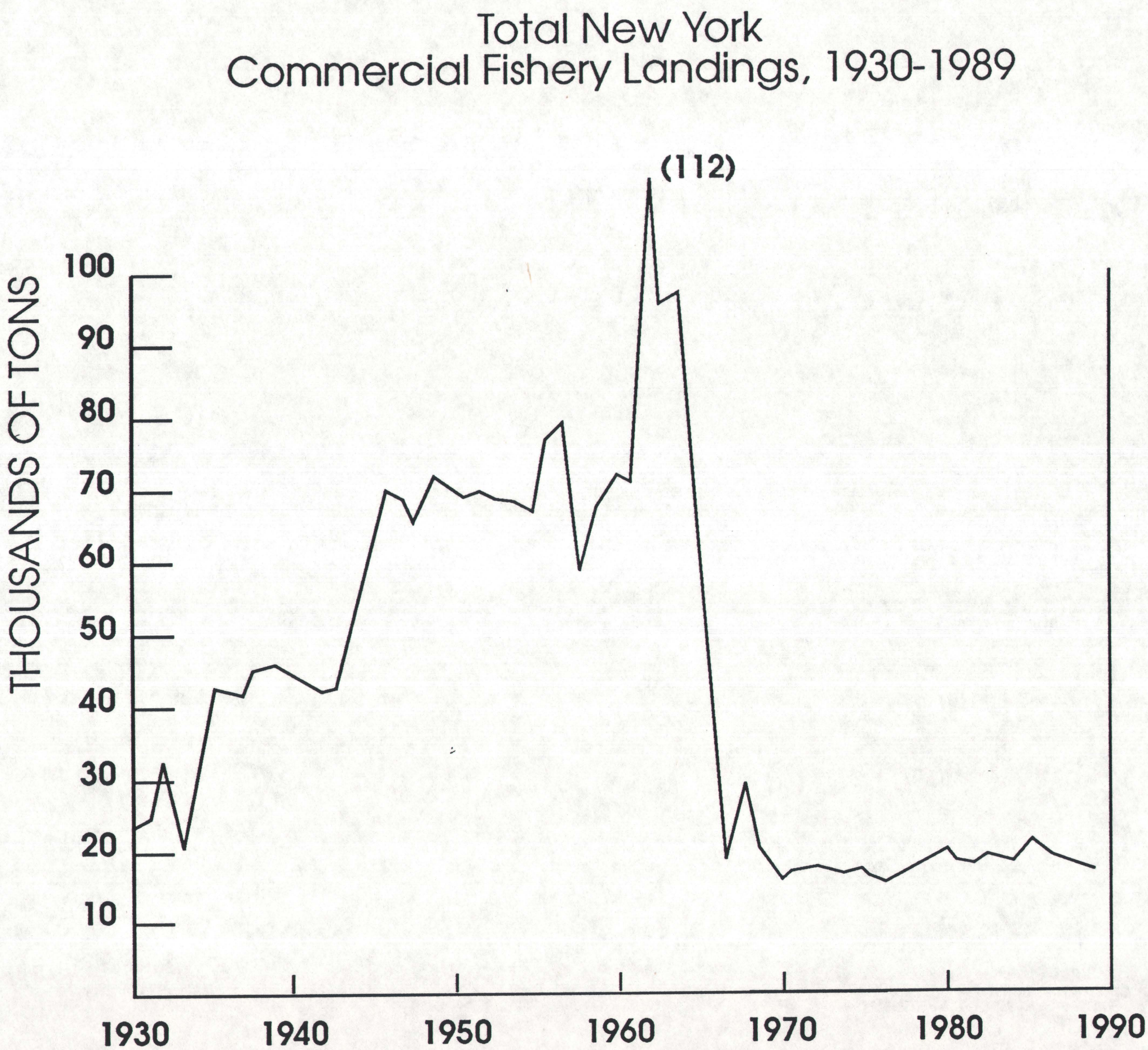

Figure 2. Total New York marine commercial fishery landings, 1930 - 1989.
1 ton = 0.907 metric ton (NMFS statistics).

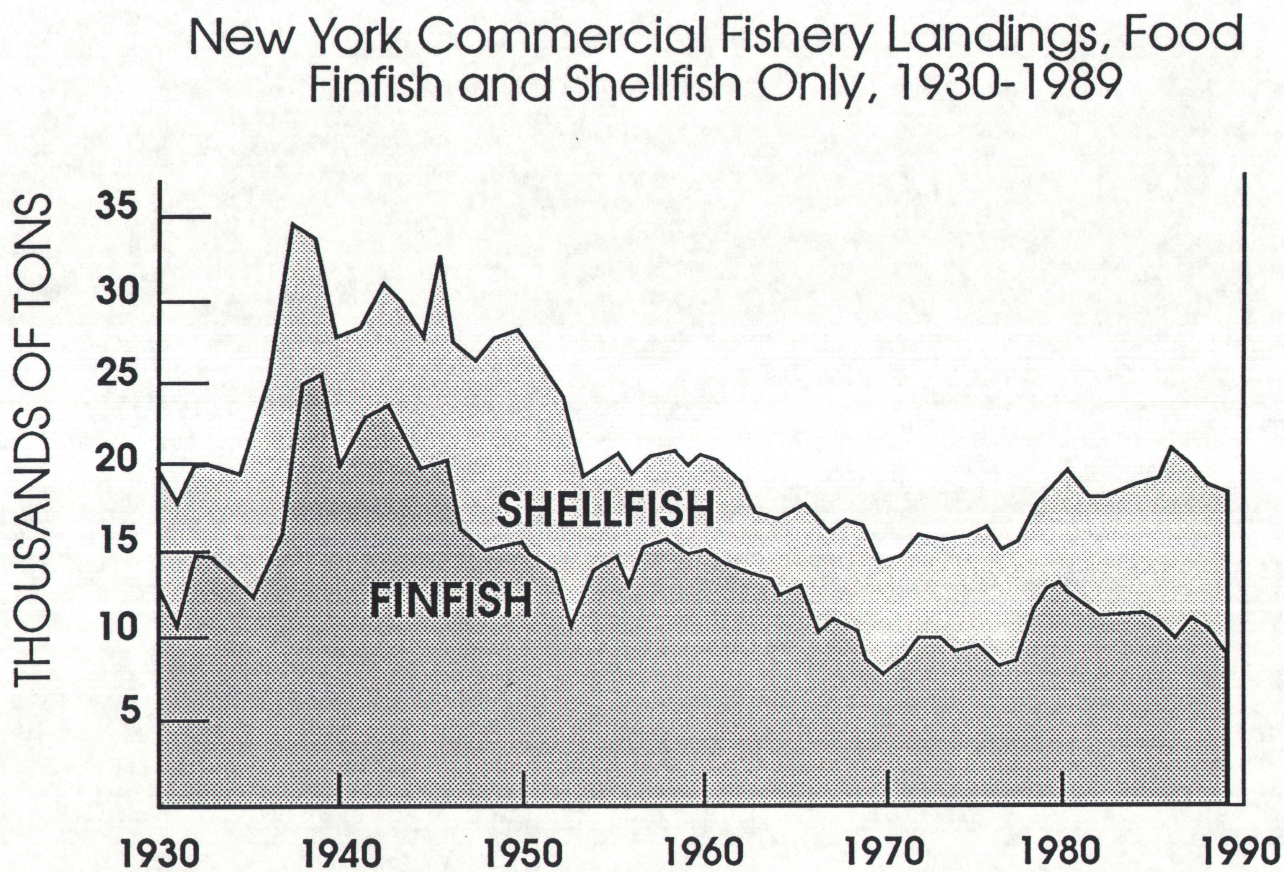

Figure 3. New York commercial fishery landings, food finfish and shellfish only, 1930 - 1989 (NMFS statistics).

Table 2. New York commercial fishery landings in 1989 (NMFS statistics).

	Catch (Tons)	Value ($x1000)
FINFISH		
Anglerfish (Lophius americanus)	209	250
Bluefish (Pomatomus saltatrix)	191	120
Butterfish (Peprilus triacanthus)	242	355
Cod (Gadus morhua)	389	633
Flounder, Winter (Pseudopleuronectes americanus)	356	791
Flounder, Fluke (Paralichthys dentatus)	669	2300
Flounder, Windowpane (Scopthalmus aquosus)	59	25
Flounder, Yellowtail (Limanda ferruginea)	424	1239
Hake, Red (Urophycis chuss)	104	67
Herring, Atlantic (Clupea harengus)	10	3
Mackerel (Scomber scombrus)	64	43
Marlin (family Istiophoridae)	146	28
Scup (Stenotomus chrysops)	505	1283
Sea Bass (Centropristis striata)	30	95
Sea Trout (Cynoscion regalis)	46	108
Sharks (order Squaliformes)	18	27
Swordfish (Xiphias gladius)	172	992
Tautog (Tautoga onitis)	59	70
Tilefish (Lopholatilus chamaeleonticeps)	275	1174
Tunas (Thunnus sp. and Euthynnus sp.)	375	1599
Whiting (Merluccius bilinearis)	4255	2684
Other finfish	178	236
TOTAL FINFISH	8776	14122
SHELLFISH		
Crabs, Blue Hard (Callinectes sapidus)	202	244
Lobster, American (Homarus americanus)	637	4088
Clam, Hard (Mercenaria mercenaria)	1390	21131
Clam, Soft (Mya arenaria)	63	377
Clam, Surf (Spisula solidissima)	3162	2353
Conch (Busycon sp.)	58	136
Mussel (Mytilis edulis)	29	65
Oyster (Crassostrea virginica)	169	1955
Scallop, Sea (Placopecten magellanicus)	19	185
Squid (Logio pealei)	3080	2984
Other Shellfish	5	29
TOTAL SHELLFISH	8814	33547

GRAND TOTAL 17,590 tons and $47,667,780

Table 3. Commercial shellfish aquaculture firms on Long Island, 1990.

Firm	Location	Product
Bluepoints Co.	Sayville	Hard Clams
F. M. Flower Oyster Co.	Bayville	Oysters & Hard Clams
Ocean Pond Corp.	Fishers Island	Oysters
Shinnecock Indian Tribal	Southhampton	Bay Scallops & Oysters
The Clam Farm, Inc.	Fishers Island	Bay Scallops & Hard Clams

CURRENT POLICIES AND TRENDS; IMPROVING THE FUTURE

Offshore Commercial and Recreational Fisheries

The major issues that must be dealt with to secure productive offshore marine fisheries are (1) to devise, implement, and enforce management plans that sustain the stocks of all target species; (2) to diversify the harvest base to include species that have heretofore not been marketed by New York fishermen; and (3) to provide adequate shoreside fishery support facilities to service the fleet and process/handle the harvest. With respect to the first issue, preserving or rehabilitating offshore stocks, the State cannot effectively do this alone.

In the EEZ off New York (3 - 200 miles offshore), jurisdiction over fishery resources (excluding tunas which are highly migratory) and responsibility for their management lies with the federal government in the form of the Mid-Atlantic, New England, and South Atlantic Fishery Management Councils as per the MFCMA. The Councils are charged with the responsibility of preparing single- or multi-species fishery management plans (FMPs) to govern domestic and foreign harvests of those species which frequently undertake extensive seasonal migrations. New York State assists in the fashioning of these plans through its participation on the Mid-Atlantic Fishery Management Council, but the responsibility for implementing and enforcing their provisions lies with the federal government.

Cooperative management plans for migratory species principally taken in New York State waters are implemented by the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fisheries Management Program (ISFMP). This program was initiated through a cooperative agreement with the NMFS in 1980 and promotes cooperative management of marine, estuarine and anadromous fisheries in state waters of the United States East Coast.

As noted before, effort in New York's offshore marine commercial fishery has expanded considerably in the past 14 years, as has the effort of the offshore fleets of neighboring mid-Atlantic and New England states. Their combined harvesting capacity now meets and may even exceed that of the foreign fleets of the early 1970s. Many of the most important finfish and shellfish in New York's offshore fishery, both commercial and recreational, are being harvested at or above sustainable yields[5]. Abundances of these species are generally low and stocks of many of the most important groundfish and flounders are at historic lows. Catch per unit effort levels in the commercial trawl fishery are declining and this segment of the offshore fishery in particular is heavily overcapitalized.

Offshore recreational fisheries also have expanded dramatically in the past decade, a result of the increasing sophistication of recreational fishing boats, tackle, and various fish-locating and navigational gear. Offshore recreational fishing concentrates on large, highly migratory species such as various tunas, billfishes, and sharks. These anglers are frequently at odds with commercial fishermen, particularly over the impact of long line fisheries on tuna and other species.

Unless federal fishery management in the EEZ can improve its record of controlling fishing mortality and thus sustain or rehabilitate key species, the recent expansion of the offshore commercial and recreational fisheries will be short-lived as target resource species decline.

Even with improved management and restrained harvests, it is unlikely that dramatic increases in the harvests of traditional offshore fishery resources of commercial importance to New York will occur, therefore fishing effort has turned to the underutilized species. Efforts by the regional fishery development foundations and NMFS to increase utilization of previously underutilized species, such as butterfish and long-finned squid (Logio pealei) have been highly successful. Now, species such as long-finned squid, and whiting can be fully exploited. Inability to increase utilization of mackerel is largely due to unwillingness of US consumers to eat them and a lack of an export market; in addition, there has been little national or international demand for short-finned squid (Illex illecebrosus). Significant decreases in offshore commercial fishing effort will be necessary to rebuild and maintain all offshore stocks. To the extent this happens, future increases in stock abundance will be utilized by, and provide a benefit to, a reduced number of fishermen.

A more diversified offshore commercial fishing industry will require a variety of shoreside facilities. Recently, efforts by Suffolk County have resulted in expanded dock space and support services in Hampton Bays (Shinnecock Inlet) and Greenport. The list of coastal policies promulgated by the State's Coastal Management and Waterfront Revitalization Program include explicit support for adequate fishery support facilities. A major need continues to be the development of secondary processing capacity. Installation of such capacity is essential for the expanded utilization of some non-traditional species, which are not readily marketable in the traditional round or filleted form characteristic of New York's fisheries.

Increased harvests of non-traditional species will require the development of new and additional markets for New York-caught fish and seafood. The State Department of Agriculture and Markets is the appropriate agency to provide marketing assistance to New York fishermen, but little such support is available. Over the years, a number of temporary, regional groups established for the purpose of marketing seafoods have arisen and subsequently disappeared. The recently-created New York Marine Resources and Products Council is an industry-led attempt to promote the wholesomeness and sanitary quality of local fish and seafoods and to expand consumer demand for New York-produced fish. However, marketing of non-traditional species is mostly for export. Therefore, export development is essential to marketing underutilized species.

Inshore Marine Commercial and Recreational Fisheries

New York's inshore fisheries share some of the needs and problems of the offshore fishery, but also possess other, quite distinct needs, and are generally more amenable to State policies and actions directed at influencing their future development. Among the priority issues that constrain the development of inshore marine fisheries are (1) habitat destruction and water quality issues; (2) over harvesting and the need to rebuild stocks of some species; (3) the need for increased intergovernmental cooperation in the management of some finfish and shellfish resources; (4) the presence of contaminants in key species; and (5) the need to allocate resources and space between commercial and recreational fishermen and other users of the marine environment.

Healthy stocks of finfish and shellfish require a healthy environment. Much of Long Island's inshore marine habitat has been extensively impacted by human uses of the shoreline and the adjacent land. These impacts range from the direct removal of critical habitat by dredging or filling to the degradation of water quality from point and non-point sources of pollution. A multitude of laws, regulations, and ordinances at all levels of government are designed to protect the marine environment from continued active or passive despoilment. Their effectiveness in doing so is unknown.

Assuring adequate habitat is arguably a critical need of New York's inshore fisheries and will be one of the most difficult needs to meet. We have a poor understanding of the critical habitat needs of many of the important inshore fish and shellfish species. This is compounded by a dearth of knowledge regarding the impacts of various development activities on critical habitat types. This applies to individual cases and, more certainly, to the aggregate impact of many individual actions. Development on Long Island continues. Substantial projects are underway or are being planned to redevelop urban waterfront areas in the New York-New Jersey Harbor. At this time, we cannot predict what effect this development will have on inshore marine habitats and the fishery resource species they sustain. A major research effort is needed to improve our understanding of the use of habitat by important species and how critical types of habitat are affected by various development activities.

As with some offshore fishery stocks, several of the most important finfish and shellfish species in New York's inshore fisheries are seriously depleted. The most glaring and significant example is the hard clam, whose production has fallen substantially since the mid-1970s. Over harvesting of beds in the Great South Bay during the mid-1970s apparently exacerbated a natural decline in abundance that began at that time, resulting in greatly reduced stocks by the early 1980s. On the local level, with the possible exception of the Town of Islip, shellfish management programs have been unsuccessful in preventing the decline of the hard clam. Their task is now to reestablish and sustain the stocks at acceptable levels of abundance. Unless the performance of these programs is improved, the hard clam is unlikely to recover to its former abundance in New York waters, although the monetary value of the catch remains high (see Table 1). Previously certified harvest areas that have become uncertified also have had a great impact.

Those involved in hard clam management at the town, county, and State level have access to the best scientific and technical information available on the basic biology of the hard clam, its interaction with predators and other aspects of its environment, and methods of artificially augmenting natural clam stocks[6,7,8]. The recent development by Suffolk County of a series of recommendations to improve hard clam management on Long Island integrates this information in a form consistent with the goals of town management programs[9]. These recommendations should be implemented by cognizant authorities at the local and State levels. Regardless of other steps taken, constraints on the number of shellfishing licenses issued will be necessary to fully protect the stocks from over harvesting. Improvement of water quality leading to recertification of closed areas also is a priority.

The bay scallop, another important inshore shellfish, was nearly eliminated from Long Island waters (1985-1989) by the repeated occurrence of a widespread phytoplankton bloom known as "the brown tide". The extent to which the brown tide is an entirely natural phenomenon or has some connection with an anthropogenic influence on the inshore marine system of Long Island is uncertain[10]. Research is underway to resolve this question. In 1990, scallop spawning was reported to be excellent throughout the Peconic Bays with the exception of Flanders Bay. The State, county, and East End town governments should begin now to design a program to monitor spawner distribution of bay scallops and reproductive success; to relocate potential spawners to a wide variety of spawning areas in the spring; and to selectively reintroduce bug scallops when sufficient spawning stock cannot be located.

Many of New York's inshore marine finfish and shellfish fall under the jurisdiction of more than one government. In the case of finfish such as striped bass, weakfish, and bluefish, several states are involved because these fish are migratory. Even for species as sedentary as the hard clam, however, management authority can be dispersed among town, county, and State governments. Successful management of these species requires that these governments act together. This has not often occurred.

While there have been successful effort to identify fishery management recommendations that should be implemented cooperatively, the record indicates that there has been insufficient progress in actually implementing such recommendations. As management of these species reaches crisis proportions, the inclination to cooperate becomes more evident, as has been the case with the hard clam and the striped bass.

Closely connected with the question of habitat destruction and water quality degradation of inshore fishery habitat is the contamination of inshore finfish and shellfish with pathogens and chemical contaminants such as PCBs, heavy metals and pesticides. While these substances apparently pose little direct threat to the affected stocks of several species of shellfish and striped bass and bluefish, they can render them unacceptable for human consumption. The ultimate long-term solution to this problem may be the removal of the sources of contaminants from inshore marine waters. For the short and intermediate terms, two needs are paramount: mechanisms for the quick and reliable identification and quantification of these substances in fish and shellfish tissues; and a management response system that can incorporate this information, assess the risks to public health, and respond in a predictable, measured, and effective fashion.

A final need for improvement of New York's inshore marine commercial and recreational fisheries is the development of a set of clearly-stated goals, objectives, and policies that delineate the State's interest in marine fishery resources. This would form the foundation for the development of more meaningful, consistent management practices and decisions dealing with the State's fisheries. This foundation would address difficult and controversial issues such as conserving adequate fishery habitat, allocating space and resources among recreational and commercial fishermen, limiting recreational and commercial harvests to assure long-term viability of the stocks of resource species.

Seafood Consumption

The past decade has produced a flood of new information documenting the health benefits of seafood consumption. Per capita consumption of seafood in the United States increased greatly during this period, reaching a peak of 15.9 lbs. in 1989[11]. However, the presence of natural and anthropogenic toxicants and pathogens in coastal marine waters and concerns about assuring the wholesomeness of seafood and seafood products from point of capture to point of sale have raised questions about the adequacy of current programs to guarantee the quality of seafoods available to the U. S. consumer.

The U. S. meat and poultry industries have long been subject to continuous, mandatory inspection programs. Active discussion is taking place among federal and State fishery and health agencies, with participation from the fishing and seafood industry, about the need and specifications for an inspection or surveillance program for fish and fishery products. It appears likely that national mandatory seafood inspection program will be instituted in the next several years. The proposed seafood inspection programs being developed are based on the HACCP (Hazard Analysis at Critical Control Points) principle. To implement this type of program, seafood businesses will have to evaluate their own operations to describe the processes that occur in their operation, to identify the critical control points, and to develop a monitoring and record-keeping system to manage these critical control points. Seafood businesses in all sectors of the seafood industry will need considerable educational and development support to implement this type of inspection program and remain competitive. The State will need to support the industry for it to make this transition and remain competitive. Although such a program may increase costs to the industry and prices of seafood to the consumer, it would probably have a net beneficial impact on the industry. This impact would be especially important to New York, where the public's general concern about the quality of the marine environment, and incidents such as those involving the extensive stranding of floatable materials on ocean beaches, often produce an understandable, but incorrect, belief that fish and seafood products from local waters are unsafe to eat.

Aquaculture

Commercial mariculture (marine aquaculture) in New York is stagnant. Aside from recent State-sponsored research and development programs, such as those of the Urban Development Corporation and the State Department of Agriculture and Markets, little has been done to encourage the expansion of marine aquaculture in New York. A comprehensive analysis of the potential for expansion of aquaculture in New York State and the obstacles to this expansion in the areas of technology, law, finance, and user group politics is contained in the document, "Aquaculture Development in New York State" produced by the NYSGI[3]. The volume contains specific recommendations for action at the town, county, and State level to enhance the climate for commercial aquaculture in New York. Suggestions to modify New York's existing aquaculture leasing programs are avaiable in Davies (1990)[4]. These recommendations should be acted upon if New York wishes to seriously enhance its aquaculture industry.

FINDINGS AND RECOMMENDATIONS

General Finding

The quantity and quality of virtually every fish stock in New York's marine waters have in some way been impacted by man. Virtually every major stock of marine fish and shellfish traditionally exploited by commercial and recreational fishermen in New York is harvested at or above sustainable levels. For some species, this situation is compounded by degradation and destruction of habitat, which presumably has reduced the biological carrying capacity of the aquatic ecosystem. Habitat degradation and the presence of toxic substances in some species have reduced the usability of a number of the more important inshore fish species. Marine aquaculture will hinge on decisions taken at State and local levels to make fuller use of existing bottom under private control for small-scale aquaculture operations. Opportunities for maintaining and increasing New York's investment in fishing industries are limited by economic factors such as waterfront development which produces loss of access, high labor and energy costs in the downstate region, limited availability of markets for fishery products beyond the Fulton Fish market, and the lack of alternatives to truck transportation in the Metropolitan area.

Improvement in these living marine resource industries will require the involvement of agencies from several levels of government, from international to local. Fisheries development requires coordination in the areas of economic development, resource management, and environmental management. It further requires an educated public, aware of the importance of fisheries to the regional economy.

Present knowledge of the impact of specific harvesting levels or habitat degradation on fish resources is extremely limited and must be expanded if fishery losses due to over harvesting, habitat loss, or contamination are to be restored and these fisheries expanded.

Specific Finding

New York State does not have an explicit set of goals and objectives governing the use and management of fishery resources, nor clearly defined policies that would translate these goals and objectives into specific management actions and decisions. The consequence is uncertainty, confusion, inconsistency, and inequity in the development and implementation of the management of the State's fisheries, particularly those in marine waters.

Recommendations

New York State Department of Environmental Conservation (NYSDEC) should promulgate a State marine fishery management policy that incorporates clearly-defined goals and objectives and provides guidance to resource managers and industrial leaders alike in resolving fishery management issues. The Marine Resources Advisory Council, created by State law, should continue to make recommendations on plans, policies, and programs to provide a mechanism for input into NYSDEC's programs from user groups and academia.

Specific Finding

Offshore fisheries are generally overcapitalized and are harvesting target stocks at or above optimum sustainable yields. While the aggregate regional fishery harvest has limited growth potential, some opportunity exists to increase the relative proportion of this catch that is landed in New York. Modest expansion in the harvests of short-finned squid, mackerel, and perhaps ocean quahog are possible.

Recommendations

1. Working through the Regional Fishery Management Councils and the Atlantic States Marine Fisheries Commission (ASFMC), New York State should advocate and support development of fishery management initiatives which

   * maintain harvesting capacity at levels consistent with stock abundance and availability;

   * regulate the harvest of interrelated species through coordinated multi-species management plans;

   * ensure that age and size of recruits to the spawning stock is appropriate to provide optimum yield per recruit and adequate stock reproductive capacity.

2. Provide support for research which will

   * establish an economic/behavioral model of trawl and longline fisheries in the southern New England and mid-Atlantic regions;

   * determine effects of mesh size, hook size, and other gear design factors on the quantity and species composition of the catch.

3. More effective interactions should be developed among those involved in fisheries manage ment and those involved in related activities, particularly public education programs dealing with the fisheries. The goal is to promote a broader awareness of the need to more effectively manage critical fisheries and the policy and scientific rationales for specific management measures.

Specific Finding

Stocks of many of the most important inshore fish and shellfish are declining because of a combination of over harvesting and habitat destruction. There are historic and bitter conflicts among various user groups as to the most acceptable allocation of these stocks. Commercial fishermen are pitted against recreational fisherman, baymen against aquaculturists, and trawl fisherman against pot fishermen. New York's inshore marine fisheries are seriously threatened and decisive action is necessary to turn the situation around.

Recommendations

1. NYSDEC should develop strategic plans for management and enhancement of major inshore fish stocks, initially including bay scallops, hard clams, lobsters, oysters, tautog, summer and winter flounder. Such plans should incorporate the habitat requirements of each species, the sustainable yield of the stock or stocks; and should provide specific mechanisms for maintain ing important habitat for each species and for controlling fishing mortality, recreational and commercial. The institutional structure to develop these plans should be patterned after the federal Fishery Management Councils but allow for flexibility for inherent variabilities in local waters (e. g. winter flounder growth rates in eastern and western Long Island Sound are different and therefore may require different size limit restrictions). Town shellfish manage ment plans and New York State goals and objectives would be required to be consistent with species management plans.

2. The Departments of State and NYSDEC should cooperate with city, town and county governments (and with each other) in formulating a resource/space allocation plan for the waters of New York's marine district. This plan should identify areas reserved for commercial fisheries, recreational fisheries, and aquaculture—among other uses of the inshore marine environment.

3. NYSDEC should expand the Shellfish Growing Water Certification Program to allow full use of shellfish resources through conditional openings, depuration, and carefully controlled relay

programs. Throughout the marine district, appropriate State and local governmental agencies should aggressively act to reduce non-point source loadings of pathogenic organisms, nutri ents, and toxic metals and organics. Specific reduction targets for these inputs must be developed. The State's goal should be to preserve existing shellfishing grounds and increase certified shellfishing areas.

4. To assure implementation of management plans, enforcement must be increased. This is essential not only for management of fish stocks but to eliminate harvesting of seafood from contaminated waters. Management plans, proposed and enacted, without proper enforcement, are not effective. Through enforcement, the health risks associated with consumption of seafood would be reduced and the industry would benefit.

Specific Finding

Dual problems of high real estate/operating costs and active opposition from resource harvesters are major limitations to the expansion of marine aquaculture in New York. As an alternative to public access, opportunities for further development of this industry are in the stimulation of small operations producing high-value crops from waters currently under private ownership or lease.

Recommendation

The recommendations for development of aquaculture which are contained in the document, Aquaculture Development in New York State[3], should be examined and, where appropriate, the necessary action taken by the responsible agencies for implementation. A State aquaculture policy should be developed.

Specific Finding

Opportunities exist for the development in New York of secondary fish processing facilities, but substantial obstacles to this development also exist in the form of high costs of labor, energy waste disposal, and transportation in the greater New York Metropolitan region.

Recommendations

1. Specific initiatives and studies should be undertaken (1) to evaluate what factors would bring about increased landings of groundfish, sea scallops, squid, mackerel, and ocean quahogs; and (2) to assess the feasibility of processing and marketing these species.

2. The Department of State has conducted a comprehensive study of the potential to further enhance New York's marine commercial fishing industry through infrastructure development, including investments in major seafood processing facilities. Additional recommendations on opportunities in this area await further analysis of this information.

Specific Finding

Considerable areas of fish habitat have been lost by dredging, filling, sea level rise and pollution. Spawning and nursery grounds for many commercially, recreationally and trophically important fish have been significantly reduced.

Recommendations

A net gain policy should be adopted to increase available wetland habitats. This can be done by utilizing "clean" dredged materials to nourish and create salt marshes and may be an effective means to enhance the overall productivity of New York's estuaries. Standards for this procedure need to be developed along with a definition for "clean". Other habitats for fishes could be improved or created through construction of artificial reefs or altering bottom types.

Specific Finding

The anadromous fishery resources that New York shares with other states (striped bass, shad, river herring, and sturgeons) have particular management needs.

Recommendations

Maintain and enhance the interstate management program of the ASMFC for these species. These plans should contain specific provisions for resource monitoring, research, habitat protection, and harvest regulation to ensure the maintenance of optimum yields of these historically important fisheries.

Specific Finding

The institution of a marine recreational fishing license in New York is appropriate and would substantially expand funds available for fishery management and enhancement programs. The license would be obtained at a relatively small cost to the State's marine anglers.

Recommendation

NYSDEC should work with the Legislators, the Governor's Office, and marine sportfishing groups to develop and institute a marine recreational fishing license. The funds from such a license should be specifically dedicated to research, development, management and enforcement of New York's fisheries.

Specific Finding

Contaminant levels of food fish are adequately monitored.

Recommendation

Coordinated, consistent information on contaminant levels in seafood (such as levels of PCBs in striped bass and bluefish) should be disseminated to appropriate audiences without causing undue alarm. There should be nationally consistent risk assessment for all foods.

Public education programs are necessary. Appropriate State agencies such as the Department of Health, NYSDEC, and New York Sea Grant Extension (NYSGE) should work together to develop programs that target recreational fishermen.

Only commercial fishermen should be permitted to sell their catch. The commercial fishing license should also include an apprenticeship and not just a simple fee requirement. This will serve to reduce the tendency for recreational fishermen to exploit the fisheries only to sell their unwanted and uninspected catch dockside.

Specific Finding

Programs to develop fishery markets are not well supported. These programs are necessary to ensure seafood is of high quality and safe and will also serve to increase public confidence in industry and specific local markets.

Recommendation

Resources must be allocated for coordinated market development programs and public education efforts. Marketing programs may be supported by the Department of Agriculture and Markets or Department of Economic Development in cooperation with industry groups like the Marine Resources and Products Council and public education programs like the Sea Grant Extension Program and Cornell Cooperative Extension. The fishing industry can be marketed and promoted by celebrities through New York State Department of Economic Development's Division of Tourism.

Increase access to waterfront land. Plans prepared to increase access to New York City's waterfront should be implemented. Acquisition of waterfront land for fisheries purposes on Long Island may be prohibitive because of the high value, but should be explored. Publicly owned sites could be utilized for fishing facilities.

Specific Finding

Recreational fishing in New York's waters, unlike Chesapeake Bay, is of greater importance than commercial fishing and the public's understanding of the fragility of the marine environment and fisheries is poor.

Recommendations

An educational program to promote conservation in conjunction with the licensing of recreational fishermen is essential. A catch and release ethic should be emphasized in this program so people will understand that the fish they catch in the near coastal waters will not be replenished by unlimited oceanic populations.

Specific Finding

Population trends indicate that though the growth rate is slowing there remains a population redistribution favoring the coastal areas. Anthropogenic impact on the coastal environment can only be detrimental. Current strategies to manage coastal development are not effective in controlling human impacts on the environment.

Recommendations

New management strategies must be developed to allow moderate development without harm to the coastal environment. Inputs of pathogens, nutrients, and floatables to waterways must be controlled. This problem must be dealt with on a regional and not on a site-specific basis. New York can not afford to lose any more existing fisheries.

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LIST OF ACRONYMS

ASMFC	Atlantic States Marine Fishery Commission
EEZ	Exclusive Economic Zone
FCZ	Fishery Conservation Zone
FMP	Fishery Management Plan
HACCP	Hazard Analysis at Critical Control Points
ISFMP	Interstate Fishery Management Plan
MFCMA	Magnuson Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NYSDEC	New York State Department of Environmental Conservation
NYSGE	New York Sea Grant Extension
NYSGI	New York Sea Grant Institute

Todg