SURVEY OF THE TECHNICAL LITERATURE ON THE MARINE FINFISHERY RESOURCES OF THE PECONIC/GARDINERS BAY SYSTEM, NEW YORK, 1900-1984, WITH RECOMMENDATIONS FOR RESOURCE CONSERVATION AND STUDY

by

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April 1985

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J.R. Schubel, Director

CONTENTS

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LIST OF TABLES

LIST OF FIGURES

SUMMARY

This report is an inventory of the main sources of technical and scientific information published during this century (1900-1984) on the fishes (biology and life history) and finfisheries of the Peconic/Gardiners Bay system of eastern Long Island, New York. The general focus and important findings of more than 138 studies are summarized and annotated so that this body of knowledge can become a useable information source for natural resource managers, planners, and researchers. Recommendations for future study and resource conservation are addressed. A historical perspective on the scientific study of eastern Long Island fishes is presented.

The Bay system, in this report, is considered to include the marine and tidal waters within State jurisdiction that border the five eastern towns of Long Island, which have a direct exchange of water (tidal), biota, and people as resource users. These subunit areas are: southeastern Long Island Sound, southwestern Block Island Sound; Flanders, Peconic, Gardiners, Napeague Bays (i.e., those tidal waters between the North and South Forks); the Atlantic Ocean (and tidal ponds) adjacent to the South Fork; and Shinnecock Bay.

The body of technical literature presents a collective picture of the overall status of the Bay system's biota, environmental quality, coastal resources, and the public's concern with conservation. The Bay system's fish populations are described as diverse, abundant, and predictable in their seasonal migrations into and out of the area. The marine fish habitat is suggested to be of high quality based on: relative growth rates, sizes and ages attained by several species; the use of the bays as spawning and nursery

areas by many species, nearly year round; and abundance of prey and other food resources for important species; and low incidences of diseases, parasites, and abnormalities of resident species. Studies of the toxicity of chemicals to resident Bay system fishes and to fishes from other areas (with heavy pollution loads) provide evidence that the system is relatively unpolluted. There are a few areas with limited tidal flushing near centers of human activity, however, where sublethal pollution effects to fishes have been detected by biological testing. The human component of the fisheries is active and seeks a variety of species throughout the Bay system. Commercial fishermen harvest millions of pounds of fish annually by a variety of methods. Tens of thousands of anglers make millions of fishing trips annually and expend millions of dollars doing so. Anglers enjoy multiple experiences related to the total coastal environment, and consider the status or natural quality of the coastal area to be predominant factors in their use and enjoyment of the outdoor recreational experience. The status of the human component of the fisheries, therefore, can be indicative of the status or quality of the total aquatic/coastal environment. Conservation of coastal resources by local jurisdictions appears to be essential for continued integrity of the Bay system, its healthy biotic populations, and for continued use of the system by people. Local jurisdictions are able to assist the State to insure the continued viability of the fisheries by proper management of the surrounding natural resources.

Information and Study Needs Discussed in this Report Include the Following:

- Most of the study effort has been concentrated in the central bays, the sounds and the ocean. The inner bays and harbors that are the most used, have the most potential for impact from human activity, and that are significant spawning and nursery areas for resident fishes, have received the least study.

- Few studies have considered the Bay system as a whole. Most studies have been within individual subunit areas. The interrelationship of the subunits and the system as a whole needs to be considered.

- The significance of the Bay system as nursery and feeding grounds to the regional fisheries needs to be defined.

- A relatively few species have received most of the study effort. Other important and underutilized species need to be studied.

- The socioeconomics of recreational fishing has been studied more thoroughly than for commercial fishing, yet the commercial fishery has been the most regulated and legislated. More relevant studies are needed for resolution of conflicts among competing resource users.

- It has been 20 years since the State conducted in-depth studies on recreational fishing within the central bays, and nearly 50 years since the classic 1938 Salt Water Survey sampled the biota throughout Long Island and the eastern Bay system. More frequent coordinated study is necessary to provide information for resource conservation and management.

- Information surveys (similar to this report) on other aspects of the Bay system's marine and coastal resources are needed to develop a management overview by bringing together the historic and current information.

INTRODUCTION

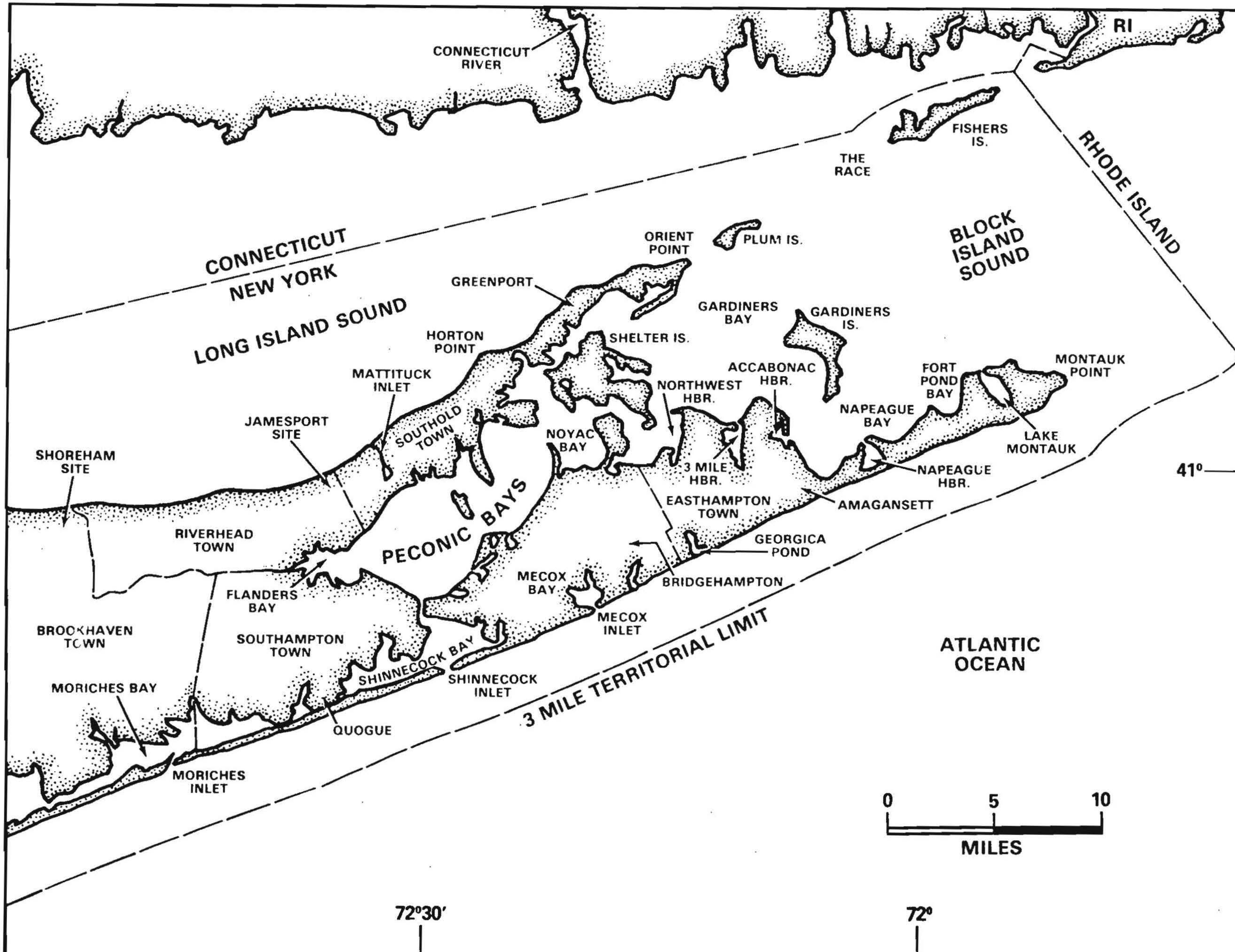
It has been said that we live in an "Age of Studies" that so overwhelm us by their frequency of occurrence that we need studies to tell us of their conclusions and impacts on public policy decisions. The purpose of this report is to bring together the main sources of technical and scientific information published during this century on the fishes (biology and life history) and finfisheries of the Peconic/Gardiners Bay system, and to summarize their results, so that this body of knowledge can become a useable information source for natural resource managers, planners, and researchers. The studies are annotated by subject in Tables 1 through 9 in the "Results" section that follows. Included in the tables are: the authors (or researchers) and the years of publication; the locations where the studies were conducted (or where sampling occurred) and the years in which the studies were done; and a general summary on the scope of the studies and their findings. Viewed collectively, the findings present a picture of the overall status or condition of the Bay system's biota, coastal resources, and environmental quality, and show a continuing interest by the public in coastal zone environmental conservation. This collective picture is reviewed in the "Discussion" section that follows. Knowledge of the existing studies aids in understanding what has been done, what has been left undone, and what needs to be done in the future. Recommendations for future studies and resource conservation are addressed in the "Results" and "Discussion" sections.

In his physical description of the Peconic Bay estuary, Hardy (1976) included the waters from Flanders Bay to Shelter Island Sound. I have taken a broader approach by reviewing the finfishery resources of the marine and tidal waters within State jurisdiction that border the five eastern towns of Long Island including: southeastern Long Island Sound; southwestern Block Island Sound; Flanders, Peconic, Gardiners, and Napeague Bays (i.e., those tidal waters between the North and South Forks); the Atlantic Ocean (and tidal ponds) within State waters adjacent to the South Fork; and Shinnecock Bay (Figure 1). Reasons for this broader and more inclusive approach are that: each of these areas essentially is a subunit of the larger integrated bay system in which tidal flushing results in direct exchange of water, biological products, and contaminants between and among those subunit areas; migrating fishes move freely throughout the areas; and people move freely throughout the areas while exploiting the fishery resources and using the coastal zone. It is arguable that other areas (or water bodies) could be included also. Since southeastern Long Island Sound is included, for example, then all of the Sound could be included due to the water flow and mixing within the Sound. For the purposes of this review, however, just those areas within State waters bordering the five eastern towns (that have direct exchange with Peconic Bay and Gardiners Bay) are included. The physical, biological and socioeconomic interconnections require that each subunit area be managed properly in order to conserve and manage the resources of the bay system as a whole. The use of the system as summer feeding and nursery grounds by fishes that migrate to it from other distant areas suggests that stewardship of the Bay system also has regional implications.

Economic growth and stability in the five-town area of eastern Long Island is important, but limited land area and the vulnerability of the adjacent marine environment to potential degradation are causes for concern. Several recent studies stated that little research has been conducted on the ecology or biology of the Peconic Bay system (Hardy, 1976); Bruno et al., 1980; Wilke and Dayal, 1982; Long Island Regional Planning Board, 1984), thereby limiting the basic information for resource management. Those studies also alluded to the importance of the Bay as spawning and nursery areas for fishes by citation to Perlmutter's (1939) study. Many studies have been published in recent years, but a full breadth of knowledge does not exist on the biology of the system or any of its subunits. While the information-resource of the Bay system is limited, studies and data available provide a working background on which to build and with which to draw some conclusions on the status of the system's aquatic resources. A general high quality of the coastal marine environment is suggested by the collective results of many studies examined in this report; however, some studies suggest there are areas where pollution effects to local resident fishes have been detected by biological testing. Significant among the findings of several recent studies are that marine anglers (as resource users) consider the status or natural quality of the coastal area to be predominant factors in their use and enjoyment of the outdoor recreational experience. Degradation of the marine environment in a region that depends heavily on quality aquatic resources for economic stability would be counterproductive.

Development, maintenance of economic stability, and environmental integrity can co-exist by the use of proper planning and foresight based upon past experiences, current knowledge, and future expectations. An inventory of aquatic resources is an essential step in the planning process. Also in need of inventory is the body of knowledge contained in the technical literature on the region. This report focuses on identifying the literature on the finfishery resources of the Bay system, summarizing the important findings, and providing recommendations for future study and resource conservation.

Figure 1. The Peconic/Gardiners Bay system and the major geographic areas and water body sub-units mentioned in the text.


CONNECTICUT RIVER
RI
FISHERS IS.
THE RACE
RHODE ISLAND
CONNECTICUT
NEW YORK
ORIENT POINT
PLUM IS.
BLOCK ISLAND SOUND
GREENPORT
GARDINERS BAY
GARDINERS IS.
LONG ISLAND SOUND
HORTON POINT
SHELTER IS.
ACCABONAC HBR.
MONTAUK POINT
FORT POND BAY
MATTITUCK INLET
NORTHWEST HBR.
NAPEAGUE BAY
JAMESPORT SITE
SOUTHOLD TOWN
NOYAC BAY
3 MILE HBR.
LAKE MONTAUK
SHOREHAM SITE
NAPEAGUE HBR.
41º
EASTHAMPTON TOWN
AMAGANSETT
RIVERHEAD TOWN
PECONIC BAYS
GEORGICA POND
MECOX BAY
BRIDGEHAMPTON
FLANDERS BAY
MECOX INLET
BROOKHAVEN TOWN
SOUTHAMPTON TOWN
ATLANTIC OCEAN
SHINNECOCK BAY
SHINNECOCK INLET
MORICHES BAY
3 MILE TERRITORIAL LIMIT
QUOGUE
MORICHES INLET
0
5
10
MILES
72º30′
72º

RESULTS

This review of the technical literature has identified 138 studies of marine fishes and finfisheries of the Peconic/Gardiners Bay System during the period 1900-1984. Most of the studies are published in scientific journals. Others are in the form of organization or institution technical reports (e.g., Austin, 1973b; or Subsara, 1971), annual reports (e.g., Young, 1981), or unpublished manuscripts (e.g., Hamilton and Young, 1974). These studies are cited in Tables 1 through 9 and listed alphabetically by author and year published in the Bibliography. Other studies that were not conducted specifically on the bay system, but which provide relevant information, are discussed and cited in the text of this report and included in the Bibliography. This report covers, to the extent possible, all of the readily available studies, but is not considered to be a complete listing or all-encompassing survey of the literature. Undoubtedly, there are other published studies and data available on the Bay system fishery resources that were not found and are not included here, as well as university theses and dissertations, unpublished data and manuscripts, and studies conducted by local government agencies. It is hoped that this report will encourage those with such information to make them available in some published form. Similar reviews of the scientific literature on other aspects of the Bay system's marine resources would be useful, also, such as: the plankton; benthic invertebrates; shellfisheries; marine plants (algae); and water quality. Such reviews would help to provide a broad picture of the resources by bringing together the historic and current information on a diversity of related subjects.

Two marine resource bibliographies are available that provide annotated listings of sources of scientific information. The "Rhode Island Marine Bibliography" prepared by the University of Rhode Island (1972) contains references on all aspects of the marine sciences of Block Island Sound and Rhode Island Sound. The "Bibliography of the New York Bight" prepared by the MESA Program of the National Oceanic and Atmospheric Administration (1974) contains annotated references to information sources for the Atlantic Ocean, south shore bays (Mecox and Shinnecock), and waters of Block Island Sound between Gardiners Island and Point Judith. A similar bibliography on the marine resources of the Peconic/Gardiners Bay system (physical, chemical, biological, socioeconomic) does not now exist, but would be a useful reference source for future researchers and planners.

Fish Biology and Life History Studies

Species Occurrence, Distribution, and Seasonal Abundance

Literature sources that resulted directly from studies and observations of marine fish occurrences in the Bay system are annotated in Table 1. Included there are papers that primarily deal with species accounts and not those that report on life history, ecology, etc., that also contain much information on fish distribution and abundance. Those studies are included in the appropriate sections that follow. The names of the fishes used in the tables and throughout the test are those recommended by the American Fisheries Society (Robins, et al., 1980).

Table 1. Studies of occurrence, distribution and seasonal abundance of fishes conducted in the Peconic/Gardiners Bay system, 1900-1984.

Authors and Years Published	Locations Studied*	Scope and Findings
Bean (1901)	Peconic Bay, Mecox Bay, Shinnecock Bay	Occurrence of many species with notes on biology and life history during summer and fall of 1898 and 1901.
Murphy and Harper (1915)	Montauk at Fort Pond Bay and the Ocean	Observations of catches by pound net fishermen and anglers during Aug. 1915, 13 species recorded.
Latham (1916a, 1916b, 1917, 1918, 1919, 1920a, 1920b, 1921, 1922 1923)	Orient at LIS and Gardiners Bay	Records of many species captured in commercial pound nets during 1916-1923.
Latham (1964)	Orient, Gardiners Bay, Peconic Bay, Montauk	Additional records of 73 species not recorded in previous accounts, for the period 1910-1963.
Latham (1971a, 1971b)	Orient	Records of sea ravens captured by pound net in April 1971; and reviews occurrence of lumpfish caught during 1929 and 1934.
Nichols and Breder (1926)	Montauk, Orient, Southold, as part of a larger descriptive study of the fish fauna between Chatam, Mass. and northern New Jersey.	Distribution, abundance and life history of 261 species; with reference to eastern waters, primarily based on the observations of Roy Latham.
Dickinson (1939)	Orient Harbor, Gardiners Bay, LIS	List of 65 fish species caught by commercial fishermen during 1938.

Table 1 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Greeley (1939)	LIS, Peconic Bays, Montauk, Atlantic Ocean, part of a larger study of Long Island Marine waters	Record of 80 species captured by seine during July-August 1938; many taken in Bay system waters.
Perlmutter (1939)	Peconic Bay, Gardiners Bay, BIS, Montauk, Atlantic Ocean at Amagansett to Montauk	Records of fish eggs and larvae captured by plankton net during spring-summer 1938; 31 species from Bay system.
Nichols and Helmuth (1940)	Atlantic Ocean beach at Georgica	Record of one louvar captured in surf during August 1940.
Merriman and Warfel (1948)	BIS, eastern LIS near Fishers Island	Relative and seasonal abundance of 31 species captured by commercial trawl during 1943-1946.
Nichols (1949)	Shelter Island, BIS, Peconic Bay, Montauk, Shinnecock Bay, Ocean at Bridgehampton	Record of 6 species subsequent to publication of Nichols and Breder (1926)
Gordon (1951b)	Ocean at Montauk	Notes on the presence of a large school of mackerel offshore during February 1950.
Alperin (1955)	Peconic Bay	Records of pinfish captured by anglers during spring 1955.
Breder (1960)	Ocean at Quogue	Record of one flying halfbeak found dead on the beach; was a new species occurrence for the state.

Table 1 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Alperin and Schaefer (1965)	Shinnecock Bay, Peconic Bay	Records of 17 species new or rare to New York, captured during 1962-1963.
Alperin (1967a)	Noyak Bay, Peconic Bays	Records of blue runners captured by trawl during October 1964.
Alperin (1967b)	Shinnecock Bay	Record of one snakefish captured by seine during October 1964.
Subsara (1971)	Pond of Pines at Napeague	Record of 6 species observed or captured during February-May 1971.
Colton (1972)	BIS, Ocean near the South Fork	Spatial and seasonal distribution of bottom fish captured by trawl in relation to water temperature during 1956-1968.
Austin (1973a)	Northwest Creek	Record of one rhomboid mojarra captured by pound net during October 1971; was a new species for the continental U.S.
Austin (1973b)	Lake Montauk, BIS	Distribution and seasonal abundance of 19 species of fish eggs and larvae during 1971-1972.
Reisman and Nicol (1973)	Gardiners Island	Record of 28 species collected by seine from six ponds and creeks during July-September 1971.

Table 1 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Hamilton and Young (1974)	Accabonac Harbor	Distribution and abundance of 15 species captured by seine and trawl during March-April 1974.
Long Island Lighting Co. (1974)	LIS at Jamesport	Occurrence and abundance of 26 species of fish eggs and larvae captured by plankton net, and 58 species of juvenile and adult fishes captured by seine, trawl, and gill net during 1973-1974.
Hickey, Sosnow, and Lester (1975)	Fort Pond Bay, Lake Montauk, BIS	Occurrence and abundance of 24 species captured primarily by pound net during July-August 1973, with records for 1971 also.
Hickey and Lester (1975)	Fort Pond Bay	Records of two lumpfish captured by pound net during April 1974.
Hickey and Lester (1976)	Northwest Harbor	Record of one gizzard shad captured by pound net during May 1974; was the first marine record for New York.
Hickey and Loewen (1976)	Gardiners Bay	Record of one greater amberjack captured by pound net during October 1974; was the first conclusive record for New York.
Hickey, Young, and Lester (1976)	Montauk at Fort Pond Bay and the Ocean	Record of 2 tarpon captured by pound net and haul seine during July and August 1974; the largest recorded specimens for New York.

Table 1 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Young (1976a)	Atlantic Ocean at Montauk	Record of 75 species observed in commercial haul seine catches during 1973-1975.
Young (1978)	Fort Pond Bay	Record of one cubera snapper captured by pound net during August 1975.
Ferraro (1980)	Peconic Bay	Occurrence and abundance of 12 species of fish eggs captured by plankton net during spring-fall 1972-1974.
Hickey and Lester (1980)	Fort Pond Bay	Occurrence and seasonal abundance of 6 southern fish species captured by pound net during 1970-1974.
Grosslein and Azarovitz (1982)	BIS, LIS, central Bays, Atlantic Ocean along South Fork, as part of a study between Cape Hatteras and Nova Scotia	Describes distribution, abundance, and seasonality of many species of eggs, larvae, juveniles, adults for the period 1965-1977 based on field studies and literature reviews; cites other atlases and inventories through June 1980.
Penny (1982)	Mashomack Preserve on Shelter Island	Occurrence of 28 species captured by several methods from coastal ponds, tidal creeks, and inshore bay waters during summer and fall of 1980; part of a larger marine ecological survey.

Table 1 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Hanlon (1983)	Shinnecock Bay, as part of a study of the south shore estuaries between Fire Island Inlet and Montauk Point.	Occurrence and seasonal abundance of 51 species of juvenile and adult fishes captured by seine, trawl, and gill net during March-September 1981; comparison of catches and species among three estuaries - Shinnecock, Moriches, and Great South Bays.
Hickey and Lester (1983)	Fort Pond Bay	Occurrence and seasonal abundance of 102 species captured primarily by pound net during 1970-1978.
Briggs (1984)	Peconic Bay system as part of a review of New York's coastal fishes	Occurrence, abundance, and distribution of 311 species from N.Y. marine waters, with many citations to those of the Bay system.

*BIS = Block Island Sound
LIS = Long Island Sound

Description of the occurrence of marine fishes in eastern Long Island waters during this century began with the work of T. H. Bean who studied the waters of Peconic, Mecox, and Shinnecock Bays and the nearshore ocean waters between Great South Bay and Southampton, during the summer and fall months of 1898 and 1901 (Bean, 1901). During the period 1916 through 1923, naturalist and pound net fisherman Roy Latham published many accounts of fishes of the Orient area (including Long Island Sound and Gardiners Bay) for the years 1902 through 1922. Most of his information came from his own captures by pound net. The classic study by Nichols and Breder (1926) used Latham's data for their species account of fishes at Orient. Latham continued to produce records of fishes with his 1964 account that discussed data from his files for the years 1910 through 1963. He continued to publish through 1971, with two accounts of fishes at Orient - one from his records for 1929 and 1934 (Latham, 1971b), and the other of captures during 1971 (Latham, 1971a). Latham (1916a) stated in 1916 that he had been pound net fishing on eastern Long Island for over twenty years. His period of observing fishes in eastern waters thus spanned three quarters of a century (prior to 1896 through 1971) and is unequalled by any other naturalist or scientist. His published works are the most comprehensive long-term accounts of fishes for any area of the Bay system and continue to be used and cited by many other authors through the present time.

The State of New York studied and described the fishes in many areas of the Bay system during the classic 1938 saltwater survey (Dickinson, 1939; Greeley, 1939; Perlmutter, 1939). During the 1960's studies were conducted by the State in Shinnecock Bay and in Peconic Bay (Alperin 1967a, 1967b; Alperin and Schaefer, 1965).

The south fork areas from Gardiners Bay eastward to Montauk were not studied in earnest until the 1970's by researchers from Suffolk County Community College (Subsara, 1971), Southampton College (Reisman and Nicol, 1973; Hamilton and Young, 1974), New York State DEC (Young 1976b, 1978), the New York Ocean Science Laboratory, NYOSL, (several papers by Austin, and Hickey et al., Table 1), and the Nature Conservancy (Penny, 1982). The occurrence of fishes in Long Island Sound at Jamesport during 1973-1974 was studied by NYOSL for Long Island Lighting Company (1974).

Several general accounts exist of the marine fishes of New York, including those by Bean (1901, 1903), Nichols and Breder (1926), Breder (1938), Gordon (1951a) and Briggs (1984). The later paper by Briggs reviewed most of the studies of Long Island fishes and is the most complete and up-to-date species account of New York's marine fishes. Briggs (1984) recorded the known existence (historical and present) of 311 fishes species from the coastal and tidal waters surrounding New York. A review of Briggs (1984) and the references in Table 1 revealed that at least 200 species are known from the eastern Long Island bay, sound, and ocean waters. Those studies conducted since 1971 in the south fork area have documented the recent presence of about 130 fish species for those inshore waters.

The MESA New York Bight Project conducted by the New York Sea Grant Institute has published several Atlas Monographs related to fishes and fisheries. They are cited in the appropriate sections below. Atlas Monograph 15, authored by Grosslein and Azarovitz (1982), presents an excellent and detailed account on fish distributions, seasonality, abundance, spawning areas, and general population biology for many marine fishes between Cape Hatteras and

Nova Scotia. Environmental sensitivity of the species and an overview of human impacts also are discussed. These biological data are summarized and illustrated for the most abundant and important species on a series of coastal maps. The waters of eastern Long Island (ocean, bays, sounds) are included on the maps and are shown to be areas of fish spawning and abundance for many species.

The eastern Long Island marine fish fauna is a diverse mixture of resident and migratory north temperate and subtropical species. There are pelagic (open water and free swimming), benthic (bottom dwelling), plantonic (drifting eggs and larvae), and neustonic (floating, e.g., ocean sunfish, Mola Mola) fishes that occupy nearshore, offshore, and estuarine waters.

Movements and Migrations

Literature sources that resulted directly from studies conducted in (or concerned with) the Bay system are annotated in Table 2. Additionally, many studies have been conducted in other areas that have resulted in tagged fish being caught by the active recreational and commercial fisheries of eastern Long Island, such as several studies of striped bass in New York by Alperin (1966), Schaefer (1968), Austin and Custer (1974, 1977), and McLaren, et al. (1981). Westin and Rogers (1978) and Setzler, et al. (1980) summarized the migratory behavior of striped bass from studies conducted throughout the northeast and other areas. Schaefer (1966) reported on the capture at Amagansett of a kingfish tagged in Great South Bay in 1962. Dodson and Leggett (1974) reported on the movement of American shad from near the Connecticut River in Long Island Sound into eastern Long Island waters at Gardiners Island and Montauk.

Table 2. Studies of fish movements and migrations conducted in the Peconic/Gardiner Bay system, 1900-1984

Authors and Years Published	Locations Studied*	Scope and Findings
Striped Bass		
Austin and Hickey (1974, 1978)	Fort Pond Bay, Ocean at Amagansett to Montauk	Fish captured by commercial pound net and haul seine during 1972 and 1974; described movements into the Bay system, and from New York to New England and Chesapeake Bay.
Young (1976, 1977)	Atlantic Ocean at Bridgehampton to Montauk	Fish captured by commercial haul seine tagged and released during 1973-1975; returns from New York, New England, New Jersey, Delaware and Chesapeake Bay.
Kriete, Merriner, and Austin (1979)	Fort Pond Bay, Ocean at Amagansett to Montauk	Fish captured by commercial pound net and haul seine during 1972-1975;compares migration patterns of fish tagged in Chesapeake Bay and eastern Long Island.
Hickey (1981)	Eastern Long Island	Compares data and studies on patterns of seasonal fish migrations and water movement during 1969-1973.
Other Species		
Moore (1947)	Atlantic Ocean at Montauk, LIS, BIS.	Windowpane flounder captured by commercial trawl tagged and released during 1943-1944; returns from Montauk, BIS, and Moriches Inlet.

Table 2 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Poole (1962)	Atlantic Ocean east of Shinnecock Inlet	Summer flounder captured by trawl tagged and released during 1957; describes an eastward movement of fish into LIS, BIS, and northeast to Rhode Island and Massachusetts.
Finkelstein (1969a, 1971)	Great and Little Peconic Bays	Scup captured by trawl tagged and released during 1965-1966; returns from Georges Bank to North Carolina; inshore and offshore.
Lund and Maltezos (1970)	Peconic Bay, Gardiners Bay, Shinnecock Bay, LIS, BIS	Bluefish captured by gill net, seine, hook and line tagged and released during 1964-1968; describes seasonal migration of adult and juvenile fish.
Hamilton and Young (1974)	Accabonac Harbor	Winter flounder captured by seine and and trawl tagged and released during March-April 1974; describes relatively high rate of returns and no movement from the Harbor.
Hickey, Sosnow and Lester (1975)	Fort Pond Bay	Several species of jacks captured by commercial pound net tagged and released during summer-fall 1973; describes local movements.
National Marine Fisheries Service (1979, 1980); Carey et al. (1979); Casey et al. (1983).	Atlantic Ocean, BIS	Several species of sharks captured by recreational fishermen and others tagged and released over a period of several years prior to 1982.

Table 2 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Conover and Murawski (1982)	Atlantic Ocean, as part of a program extending from Gulf of Maine to Cape Hatteras	Atlantic silversides captured by trawl during 1972-1979; describes off-shore movement during winter north of Cape Hatteras; suggests that species has a high mortality and does not return to inshore waters.

*BIS = Block Island Sound
LIS = Long Island Sound

The studies of fish movements that have been conducted in eastern Long Island waters have been few and were done primarily during the period 1957 through 1975 (Table 2). Shark tagging still occurs by anglers who depart from Montauk Harbor and who participate in the summer shark fishing tournament at Montauk. Of the species studied in eastern Long Island waters, striped bass has received the most attention and primarily during the 1970's.

Although the tagging and migration studies conducted in eastern waters have been few, information on movements into and out of the area abound in the literature on seasonal abundance contained in many of the species accounts listed in Table 1 and discussed above. The seasonal abundance, occurrence, and species composition of the fishes in Fort Pond Bay were so distinct that Hickey and Lester (1983) used them to describe the seasons of the fishing year (spring, summer, fall). While the abundance of a given species may change from year to year, large annual migrations still occur into and through the eastern Long Island waters by many fishes, primarily coming from overwintering areas in estuaries to the south and from offshore continental shelf waters. John Cole in his book, Striper (Little, Brown and Company, 1978), described Montauk Point as the oceanic migratory crossroads for migrating striped bass. That concept contains some truth, since many striped bass of the northeast coastal migratory stock apparently pass Montauk Point on their way to and from Long Island Sound, New England, and southern Canadian waters.

In addition to the many migratory species that occur seasonally in eastern waters, many subtropical species from southern waters appear during the warm summer months. They often have been termed as wanderers or stragglers that drift north with the Gulf Stream during planktonic or juvenile life stages.

Large adults of several southern species also appear in summer and fall, and often are caught by fishermen. Notable among the subtropical species are tarpon, amberjack, blue runner, snapper (Lutjanus sp.), Spanish mackerel, and a few species of filefishes and triggerfishes.

Movements into the area are by adult fishes that are in transit to other areas (e.g., striped bass) and that are using the area for oversummering, feeding, and spawning. Juveniles of several species spawned elsewhere also arrive during late spring and summer to use the bays and harbors for nursery and feeding grounds (e.g., young bluefish).

The migrations of some species around eastern Long Island might be influenced by water movements and oceanographic conditions; species such as American shad (Dodson and Legett, 1973, 1974), striped bass (Hickey, 1981), and bluefish (Kendall and Walford, 1979). The seasonal migrations and appearance of several species in eastern waters are important for the active recreational and commercial fisheries of the region. Fluctuating oceanographic conditions are thought to influence the migratory behavior of some species and thus affect their times of arrival and departure, as well as their availability to the fisheries.

Spawning and Reproduction

Literature sources that resulted directly from studies in (or concerned with) the Bay system are annotated in Table 3. Included are studies on: the occurrence of ripe adult fishes in the spawning areas; use of many areas as nursery grounds by young-of-the-year and juvenile fish; occurrence and

Table 3. Studies of fish reproduction and the use of the Peconic/Gardiners Bay system as fish spawning and nursery areas, 1900-1984

Authors and Years Published	Locations Studied*	Scope and Findings
Perlmutter (1939)	Peconic Bay, Gardiners Bay, BIS, Montauk, Atlantic Ocean at Amagansett to Montauk	Records of fish eggs and larvae captured by plankton net during spring-summer 1938; 31 species; central bay area defined as important spawning/nursery area for summer fishes.
Moore (1947)	Atlantic Ocean at Montauk	Observations of mature and ripe windowpane flounder during May 1943.
Perlmutter (1947)	Gardiners Bay, Peconic Bay, Shinnecock Bay, Moriches Bay, LIS, BIS, Atlantic Ocean	Reviewed biology of winter flounder and conducted studies during 1928-1941; in any area, the fish are the product of local spawning; young fish remain in shallow water in the bays & estuaries during their first year of life.
Perlmutter, Miller, and Poole (1956)	Shinnecock Bay, Peconic Bay, Gardiners Bay	Collection of young-of-the-year weakfish during 1951-1953; determined that most of the fish were the product of local spawning.
Schaefer (1965, 1966)	Great Peconic Bay	Collected young-of-the-the-year northern king-fish by seine during July-September 1962 and 1963.
Poole (1966a)	Shinnecock Bay and Peconic Bay	Collected young-of-the-year winter flounder by seine during summer-fall 1961 and 1962.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Poole (1966b)	Shinnecock Bay and Peconic Bay	Evaluated nearshore areas and coves as nursery areas for young-of-the-year winter flounder; discussed natural areas prior to human alterations.
Finkelstein, (1969a, 1969b)	Peconic Bays	Collection of young-of-the-year scup by seine and adult scup by hook and line during 1965-1966; observed condition of gonads and determined spawning during May-July.
Smith (1973)	Atlantic Ocean at Montauk, as part of a study between North Carolina and Mass.	Collection of summer flounder eggs and larvae by plankton net during 1965-1966; determined spawning season to be September-December.
Richards and Kendall (1973)	Atlantic Ocean at Montauk, as part of a study between North Carolina and Mass.	Collection of sand lance larvae and juveniles by plankton net during 1965-1966; determined spawning season to be late November-mid-April.
Austin (1973b)	Lake Montauk and BIS	Collection of 19 species of eggs and larvae by plankton net during 1971-1972; discussed spawning seasons and areas, nursery grounds, transport of eggs into the area from Peconic Bay, LIS, Atlantic Ocean.
Colton and St. Onge (1974)	Atlantic Ocean along South Fork, as part of a study between Long Island and Nova Scotia	Collection of 12 species of eggs and 28 species of larvae during 1953-1971; discussed occurrence, seasonality and distribution.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Hamilton and Young (1974)	Accabonac Harbor	Collection of gravid winter flounder by seine and trawl during March-April 1974; discussed the area as spawning and nursery grounds for several species; absence of human alterations.
Long Island Lighting (1974)	LIS at Jamesport	Occurrence and abundance of 26 species of eggs and larvae captured by plankton net; occurrence and seasonality of young-of-the-year and juveniles of many species, maturity and spawning of adult fishes captured by seine, trawl, and gill net during 1973-1974.
Austin, Sosnow, and Hickey (1975)	Fort Pond Bay	Collection of ripe Atlantic silversides during June-July 1973; artificial fertilization of eggs and laboratory study of egg development and hatching success at various temperatures.
Hickey and Lester (1975)	Fort Pond Bay	Collection of ripe lumpfish by commercial pound net during April 1974; examination of ova and estimation of fecundity.
Kendall and Reintjes (1975)	Atlantic Ocean at Montauk, as part of a study between Cape Lookout and Martha's Vineyard	Collection of menhaden eggs and larvae by plankton net during 1965-1966; spawning season June-November; eggs collected at Montauk during October; larvae most abundant August-October.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Williams (1975)	Shinnecock Bay	Collection of mature winter flounder during February 1969-1973; artificial fertilization of eggs and laboratory study of egg development & hatching success at various temperatures.
Fuiman (1976)	Montauk Point	Collection of a cluster of sea raven eggs on the rocky shore during November 1973; laboratory observation of egg development, hatching, and larval development.
Valenti et al. (1977)	Georgia Pond	Collection of fish eggs and larvae by plankton net at three stations during February-September 1976; discussed seasonal abundance in relation to physical and chemical environmental changes; 12 species were captured; silversides, killifishes, and white perch dominated during April and June.
Colton et al. (1979)	BIS and Ocean at Montauk, as part of a study from Gulf of Maine to Cape Hatteras	Defined principal spawning areas and months for fishes in nearshore and offshore waters based on field surveys during 1950s and 1960s and a review of more recent literature sources.
Kendall and Walford (1979)	Atlantic Ocean at Montauk, as part of a study between Florida and Mass.	Collection of bluefish eggs, larvae, and juveniles by plankton net and midwater trawl during 1965-1968; defined spawning in the ocean during the summer.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Pratt (1979)	Montauk, as part of a study between Cape Hatteras and Georges Bank	Collection of blue sharks by longline and by anglers in fishing tournaments during 1969-1977; field & laboratory study of reproductive biology.
Ferraro (1980)	Peconic Bay	Collection of fish eggs by plankton net during spring-fall, 1972-1974; analysis of daily spawning times of 12 species.
Weis and Heber (1980)	Lake Montauk and Pile's Creek, N.J.	Compared the reproductive biology of mummichogs from the two locations; Montauk eggs were more salinity tolerant, more variable in viability, more adhesive, and had fewer oil droplets than N.J. eggs.
Grosslein and Azarovitz (1982)	BIS, LIS, central Bays, Atlantic Ocean along South Fork, as part of a study between Cape Hatteras & Nova Scotia	Distribution and abundance of 15 larval species based on field studies and literature review for the period 1965-1977; illustrates spawning areas.
Turner (1982) Turner et al. (1983)	Peconic Bay	Sampled eggs and larvae by plankton net as part of a study of phyto/zooplankton dynamics during 1978-1979; eggs taken in June-August; bay anchovy larvae collected in August, sand lance larvae in December-April.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Bush and Weis (1983)	Southampton and Pile's Creek, N. J.	Compared fertilization success and egg development of mummichogs from the two locations at varying salinity levels; Southampton eggs more tolerant of changing environment; N.J. fish may be a weakened population.
Casey, Pratt, and Stillwell (1983)	Montauk and BIS, as part of a study between New Jersey and Mass.	Determined age, growth, size at maturity and related reproductive biology of sandbar sharks captured by several methods during 1965-1982; females mature at 12 years of age, males at 13 years.
Hickey and Lester (1983)	Fort Pond Bay	Collection of juveniles of several species by commercial pound net during summer and fall, 1970-1975.
Pratt and Casey (1983)	Montauk, as part of a study between Cape Hatteras and Grand Banks	Determined age, growth, size at maturity and related reproductive biology of shortfin mako captured by several methods during 1965-1981; females mature at 7 years of age and a length of 258 cm. (8.5 ft), males at 2-3 years and 180 cm. (5.9 ft); the gestation period is about 1 year, pups born in late spring (May); there may be only 4-5 years of reproductive maturity for females and only 2-3 litters.

Table 3 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Suffolk County Dept. of Planning (1983)	Three Mile Harbor	Discusses the importance of the Harbor as a spawning and nursery area for several species; discusses the effects of development and land use on marine resources.

*BIS = Block Island
LIS = Long Island Sound

seasonality of fish eggs and larvae; and laboratory studies on reproductive biology and development of eggs and larvae.

The studies indicate that virtually all of the bay, sound, and ocean waters are used for spawning and that it occurs nearly year round. Spring and summer are the main spawning seasons for most of the fishes (Perlmutter, 1939; Austin, 1973b; Ferraro, 1980). Fall and early winter spawners include species such as summer flounder (Smith, 1973), sand lance (Richards and Kendall, 1973), and sea raven (Fuiman, 1976). Among winter and early spring spawners are haddock (Perlmutter, 1939), cod, fourbeard rockling, yellowtail, winter flounder, sculpins, and rock gunnel (Austin, 1973b). The more open waters of eastern Long Island Sound, Block Island Sound, and the Atlantic Ocean provide significant spawning grounds for species such as cod, pollock, haddock, fourbeard rockling, silver hake, black sea bass, mackerel, yellowtail flounder (Perlmutter, 1939; Austin, 1973b), and sand lance (Richards and Kendall, 1973). Bluefish spawning occurs in oceanic waters (Kendall and Walford, 1979). The inner bays and harbors provide significant spawning areas for many species including menhaden, bay anchovy, Atlantic silverside, mummichog, weakfish, scup, winter flounder, pipefish, snake blenny, and gobies. Several species spawn throughout the area; among them are sculpins, butterfish, searobins, windopane flounder, rock gunnel, sunner, and tautog. As a result of the 1938 survey, Perlmutter (1939) stated that the general area extending from Great Peconic Bay eastward to Montauk Point and vicinity were relatively more important as spawning and nursery areas for summer fishes than any other region of Long Island.

A study by Petzel, Reisman, and DeVries (1980) provided some insight into the ability of resident winter flounder to survive overwintering in the coal waters of Shinnecock Bay. They found that the flounder produced a peptide antifreeze compound that lowered the freezing point of its body fluids below that of the surrounding sea water. The compound appeared in the fish's blood during November, peaked in concentration during January, and began decreasing during March and April. Yearly low concentrations were maintained throughout summer and early fall. This pattern coincides approximately with the onset of gonad ripening during the fall, a peak in gonad size during winter, and spawning during March and April. This ability of winter flounder to adjust to the winter environment also may enable it to physically prepare for spawning during the same time period.

Several studies were concerned with the uniqueness of the bays for spawning and nursery activities, and with gathering information on those areas in relation to human-induced perturbations (present or future), including Shinnecock and Peconic Bays (Poole, 1966b), Lake Montauk (Austin, 1973b), Accabonac Harbor (Hamilton and Young, 1974), Fort Pond Bay (Hickey and Lester, 1983), and Three Mile Harbor (Suffolk Co. Dept. of Planning, 1983). Two studies compared the reproductive biology of mummichogs from the relatively unpolluted waters of Lake Montauk (eastern shore) and Southampton with fish from Pile's Creek, New Jersey, that is polluted by thermal effluents, heavy metals, and oil (Weis and Heber, 1980; Bush and Weis, 1983). By contrast, the developing ova of eastern Long Island fish were more tolerant to fluctuating environmental conditions (salinity) than were the ova of the New Jersey fish. The New Jersey fish appear to have adapted to a polluted environment, while the Long Island fish show reproductive biological characteristics of fish inhabiting a relatively unpolluted aquatic environment. The differences between New Jersey and Long Island fish also might be related to the geographic variation of the characters, that may be under genetic control (Morin and Able, 1983; Able, 1984) rather than strictly effects of the environment. Several studies described spawning activities and egg and larval abundances over protracted time periods and large areas, and compared eastern Long Island waters with other areas (Perlmutter, 1939; Perlmutter et al., 1956; Richards and Kendall, 1973; Smith, 1973; Austin, 1973b; Kendall and Walford, 1979).

The workshop proceedings of Pacheco (1973) presented graphic distributions of fish eggs, larvae, and juveniles along the U.S. Atlantic coast. Several species are depicted as present in eastern Long Island waters, indicating the presence of spawning and/or nursery activities. Folio Map 23 of the Serial Atlas of the Marine Environment (Colton and St. Onge, 1974) graphically displays the distribution and seasonality of fish eggs and larvae in continental shelf waters between Nova Scotia and Long Island. Species shown to occur in ocean waters near the South Fork and Block Island include cunner, red hake, squirrel hake, silver hake, pollock, fourbeard rockling, sand lance, butterfish, radiated shanny, windowpane, and Gulf Stream flounder. MESA New York Bight Atlas Monograph 15 (Grosslein and Azarovitz, 1982) depicts the waters of eastern Long Island, including the Bay System, as spawning areas for many fishes (based on historical records and/or the presence of eggs or larvae, such as menhaden, sand lance, mackerel, scup, cod, silver hake, herring, butterfish, searobins, silver anchovy, summer flounder, winter flounder, fourspot, and windowpane). Colton et al. (1979) summarized the principal spawning areas and seasonality of fishes for nearshore and offshore waters between the Gulf of Maine and Cape Hatteras. Block Island Sound and the ocean at Montauk are included. Their study was based on coastal surveys during the 1950's and 1960's and a literature review of more recent information.

Several general accounts of New York's marine fishes (discussed above and in Table 1) contain information on reproduction of local fishes, but they are not as specific to the waters of eastern Long Island as are the studies presented in Table 3. Ray et al. (1980) produced a data atlas of the coastal and oceanic regions of the Atlantic Coast that included a delineation of major spawning and nursery areas for important fish species. Eastern Long Island waters were depicted as major spawning and/or nursery areas for smooth dogfish, scup, menhaden, winter flounder, and black sea bass. The source of information cited in the atlas included only a few of the key studies presented here in Table 3. Beccasio, et al. (1980) produced an ecological inventory and a series of inventory maps of the Atlantic Coast that depicted the uses of coastal areas by important fishes. Inventory map numbers 40072 (New York), 41069 (Providence), and 41072 (Hartford) include the waters of eastern Long Island. Only seventeen fish species were shown for those waters, and only two were noted to use the area as spawning and nursery grounds -- winter flounder in Shinnecock Bay and Peconic Bay, and weakfish in Peconic Bay and in the ocean near Shinnecock Inlet and near Mecox Bay. None of the available information sources presented in Tables 1, 2 or 3 were cited in the inventory "User's Guide and Information Base." While the scope of the inventory was necessarily broad, the report and the maps were stated to "provide a comprehensive inventory of the natural resources of the Atlantic Coast" (page one of the User's Guide). The spawning and nursery ground resources of eastern Long Island's Marine waters are grossly underrated in their importance and in the magnitude of the activities, as depicted in the three inventory maps. Use of that resource inventory for interpretation of the value of eastern Long Island's spawning and nursery grounds or for their comparison with other Atlantic Coast areas would lead to inaccurate assessments or assumptions, and could lead a reader to suspect that few studies have been conducted in the eastern waters, or that the waters are not significant spawning or nursery areas.

Recent published studies of spawning activities conducted within 5-town waters (indicated by the occurrence and abundance of eggs and larvae) are those of: Austin (1973b) for Lake Montauk and adjacent waters; Long Island Lighting Company (1974) for the Sound area at Jamesport; Valenti et al. (1977) for Georgia Pond; and several studies of nearshore ocean waters by Richards and Kendall (1973), Smith (1973), Colton and St. Onge (1974), Kendall and Reintjes (1975), and Grosslein and Azarovitz (1982). The 1938 salt water survey (Perlmutter, 1939) compared and contrasted many of Long Island's Bay, harbor, and sound waters for the presence of ichthyoplankton. Since 1938, abundance shifts have occurred for several species, eastern Long Island has become more developed and populated, and its waters have become increasingly more important to recreational users of many types. A re-examination of the relative spawning contribution of the Bay system would be appropriate. In such a study, special efforts should be made to sample those areas that remain in a relatively natural state (i.e., Accabonac and Napeague Harbors) and those waters under stress from human activities (marinas and harbors; waters receiving domestic, industrial, or agriculture runoff).

Size, Age and Growth

Literature sources that resulted directly from studies conducted in the Bay system are annotated in Table 4. Additionally, data on the sizes and ages of several species are included in many of the studies on species occurrence, migrations, and reproduction that are discussed in previous sections.

Most of the studies examined age and growth during periods of one-to-three years. The studies of striped bass conducted by B. H. Young encompassed a period of several years and provided data on an annual basis that are useful for across-year comparisons of size and age composition of harvests and fish populations. Most studies in Table 4 were conducted to gather information relative to understanding the fish populations and the composition of the fishery harvests of eastern Long Island. Using size, age, and growth information, the studies evaluated: migratory behavior; differences in annual spawning success and abundance of young fish; evaluation of the usefulness of minimum size (length) limits for fishery harvests; size and age of fish in relation to maturity and spawning; impact of fishing on various species populations; comparison of growth differences between fish in eastern Long Island waters and in other areas of Long Island and the Atlantic Coast; and recruitment of young fish into the fishery.

Several studies demonstrated or suggested that fish in eastern Long Island waters grew faster, attained larger sizes, and lived longer than the same species in other areas. Moore (1947) found that windowpane flounder captured in Block Island Sound attained a larger maximum adult size than fish from within Long Island Sound. Poole (1966a) reported that older winter flounder

Table 4. Studies of fish size, age, and growth conducted in the Peconic/Gardiners Bay system, 1900-1984

Authors and Years Published	Locations Studied*	Scope and Findings
Striped Bass		
Austin and Hickey (1974, 1978)	Fort Pond Bay, Atlantic Ocean at Amagansett to Montauk	Captured fish by commercial pound net and haul seine; calculated growth rates; compared length differences of 2-year old fish in 1972 and 1974; correlated length differences with year class abundance in Chesapeake Bay.
Young (1976b, 1977, 1980, 1981)	Atlantic Ocean at Bridgehampton to Montauk, Napeague Bay, Fort Pond Bay, Orient, Gardiners Bay	Length, weight, age determined for fish captured by several methods during 1973-1980; age structure of the commercial harvest on an annual basis; ages 1-20 years observed.
Kriete, Merriner, and Austin (1979)	Fort Pond Bay, Atlantic Ocean at Amagansett to Montauk	Length, age and year classes of tagged fish determined and correlated with coastal migrations between New York and Cheaspeake Bay.
Scup		
Finkelstein (1969a, 1969b, 1971)	Great and Little Peconic Bays	Length, age, year classes, size and age at spawning determined for fish captured by several methods during 1964-1966; ages from young-of-the-year to 15 years observed.

Table 4 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Briggs (1968)	Peconic Bays, Gardiners Bay, Orient, Montauk	Length frequency and weight-length relationships determined for scup caught by anglers during 1964-1966; scup caught in the Montauk area were larger than those from Peconic Bays.
<u>Bluefish</u>		
Lund and Maltezos (1970)	Peconic Bay, Gardiners Bay, LIS, BIS, Shinnecock Bay	Estimation of year class composition based on size frequency of of fish captured during 1964-1968.
Richards (1976)	LIS at Horton Point	Length, weight, and age determined for fish captured by anglers during 1975; ages 1-7 observed.
<u>Winter Flounder</u>		
Briggs (1965b)	Shinnecock Bay, Moriches Bay, Peconic Bay, Gardiners Bay	Length frequency determined for fish captured by anglers during 1961-1963; catches from Gardiners and Peconic Bays had greater proportions of large fish than did catches from the south-shore bays (including Great South Bay) at all seasons.
Poole (1966a)	Shinnecock Bay, Moriches Bay, Peconic Bay, Great South Bay	Length and age determined for fish captured during 1961-1963; ages from young-of-the-year to 7 years observed; fish in the eastern bays were older, larger, and grew faster than those from the western bays.

Table 4 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Sharks		
Casey, Pratt, and Stillwell (1983)	Montauk and BIS, as part of a study between New Jersey and Mass.	Age, growth, size at maturity determined for sandbar sharks captured by research and commercial vessels and anglers during 1965-1982; oldest fish observed were 21 years (female) and 15 years (male).
Pratt and Casey (1983)	Montauk, as part of a study between Cape Hatteras and Grand Banks	Age, growth, size at maturity determined for shortfin mako captured by research and commercial vessels and anglers during 1965-1981; pups are 63-65 cm.(2.1 ft) long at birth; females mature at 7 years old, males at 2-3 years; maximum size (340 cm or 11 ft) attained in 11-12 years.
Other Species		
Moore (1947)	Atlantic Ocean at Montauk, during a study of LIS, BIS, and the Ocean	Length, weight, age determined for windowpane flounder captured during 1943-1944; largest fish taken at Montauk; fish outside of LIS grew faster and attained larger sizes than fish from within LIS; fish as old as 6-7 years observed.
Perlmutter, Miller and Poole (1956)	Shinnecock Bay, Peconic Bay, Gardiners Bay	Length and age determined for weakfish captured during 1952-1953; fish from New York waters grew faster and were larger than fish from Virginia waters; ages from young-of-the-year to 6-8 years observed.

Table 4 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Schaefer (1965)	Great Peconic Bay	Length and age determined for northern kingfish captured by seine and by anglers during 1961-1964; ages young-of-the-year to 4 years observed; growth rate of fish during their first summer apparently greater for Peconic Bay fish than reported for fish from other areas.
Briggs (1969)	New Suffolk, Southold, Orient Point	Length frequency and weight-length relationship determined for tautog captured by anglers during 1964-1966.
Long Island Lighting Co. (1974)	LIS at Jamesport	Length, length-frequency, weight, age determined for many juvenile and adult species captured by seine, trawl, and gill net during 1973-1974.
Hanlon (1983)	Shinnecock Bay, as part of a study of the south shore estuaries, including Moriches Bay and Great South Bay.	Compared mean lengths by month of capture for juveniles and adults of several species taken by seine, trawl, and gill net during March-September 1981; winter flounder from Great South Bay were substantially smaller in mean length than those taken in the other two bays; Atlantic silversides from Shinnecock Bay were consistently larger than those from the other two estuaries.

Table 4 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Shepherd and Grimes (1983)	Gardiners Bay, as part of a larger study between Cape Cod and Cape Fear	Compared length, weight, growth, and ages of weakfish among areas studied, including fish captured by commercial pound net during May 1980-June 1981; fish north of Ocean City, MD, were larger at each age and attained a greater maximum mean length (81 cm) and age (11 yrs) than fish captured in waters to the south; weakfish in NY Bight have shown an increase in length, weight, and age structure compared with data from studies conducted during 1929 and 1952.

*BIS = Block Island Sound
LIS = Long Island Sound

occurred more frequently in the eastern bays than in Great South Bay, and more frequently in Peconic Bay than in either Moriches or Shinnecock Bays. Further, Poole found that Great South Bay flounder grew at a slower rate and were at least one year behind (in length at a given age) compared with fish from the more eastern bays. Poole stated that the flounder populations of Great South Bay and Moriches Bay would always be composed primarily of smaller fish than in the more eastern bays. He suggested that several factors (alone or in conjunction) might be responsible for the growth differences of the flounder, including genetic differences, environmental differences affecting productivity, differences in competition caused by different population sizes, and differences in salinity that influence the growth of young fish. A study conducted during 1981 by Hanlon (1983) found that winter flounder in Great South Bay were substantially smaller in mean length than flounder from Moriches Bay and Shinnecock Bay, corroborating the findings of Poole's (1966a) study 20 years earlier (1961-1963). Schaefer (1965) found that the first summer's growth of young northern kingfish from Great South Bay and Peconic Bay was more rapid than reported in previous studies of kingfish from Woods Hole, Massachusetts, from Cape May, New Jersey, from Chesapeake Bay, and from Beaufort, North Carolina. Perlmutter et al. (1956) reported that weakfish spawned in New York waters (Great South Bay and the Gardiners-Peconic Bay system) were faster growing and larger at a given age than were weakfish spawned in Chesapeake Bay, Virginia. A recent study by Shepherd and Grimes (1983) confirmed this phenomenon that weakfish from waters north of Ocean City, Maryland, were larger at each age and attained greater sizes and ages than fish from waters to the south.

These studies demonstrated the importance or influence of spawning and nursery areas on the status of the fish populations--fish size, age, and growth being some indicators of general population status. Conversely, these indicators also may reflect the status of the aquatic environment in which the fishes live. Several of the species studied that utilize eastern Long Island waters for spawning and nursery activities (e.g., winter flounder, windowpane, weakfish, northern kingfish) provided indications that the eastern bays are especially good nursery and feeding areas.

Food Habits

Literature sources that resulted directly from studies conducted in the Bay system are annotated in Table 5. The most comprehensive studies have been of Long Island Sound and Block Island Sound fishes. Few studies were undertaken in the bays proper. Most of the studies examined the diets of single species, but the study of Long Island Sound fishes at Jamesport (LILCO, 1974) examined the stomach contents of many species and discussed seasonal, day/night, and size differences in food habits and diet. The general food habits of most of the important marine fishes in New York waters can be found in the review by Nichols and Breder (1926) and in the atlas monograph by Grosslein and Azarovitz (1982). Studies conducted in other Long Island areas probably are applicable to the same species in waters of the Bay system, such as the studies at Shoreham (Austin and Amish, 1974) and Northport (Austin, Dickinson, and Hickey, 1973), and for striped bass along Great South Beach (Schaefer, 1970).

Table 5. Studies of fish diet and food habits conducted in the Peconic/Gardiners Bay system, 1900-1984.

Authors and Years Published	Locations Studied*	Scope and Findings
Latham (1918, 1920a)	Orient	Examined stomach contents of spiny dogfish captured during 1917, silver hake and herring were eaten; observed pollock feeding on small squid during 1919.
Moore (1947)	BIS	Analyzed stomach contents of windowpane flounder captured by trawl during 1943-1944; mysid shrimp predominated in the diet.
Jensen (1966)	BIS	Analyzed stomach contents of spiny dogfish captured during 1963; fishes, rock crabs, and squid were the principal food items.
Newman et al. (1972)	LIS at The Race	Studied intestinal microorganisms of bluefish caught by hook and line during 1963; the presence of various yeasts and bacteria are a function of the type of food eaten.
Long Island Lighting Co. (1974)	LIS at Jamesport	Examined stomach contents of many species of juvenile and adult fishes captured by seine, trawl, gill net during 1973-1974; documented food habits and preferences seasonally and by size classes of fish.
Hickey and Lester (1975) Hickey and Loewen (1976) Hickey, Young and Lester (1976)	Fort Pond Bay, Gardiners Bay	Examined stomach contents of rare fishes captured by commercial pound net and haul seine during 1974.

Table 5 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Richards (1976)	LIS at Horton Point	Analyzed stomach contents of bluefish captured by anglers during 1975; squid and seven fish species were eaten; seasonal diets discussed.
National Marine Fisheries Serivce (1979), Stillwell and Kohler (1982).	Montauk area, as part of a study between Cape Hatteras and Grand Banks.	Analyzed diet, feeding habits and behavior of shortfin mako captured by several methods during 1972-1979; bluefish predominated in the diet during warmer months inshore; offshore mako predominantly ate squid and bony fishes.
Hickey and Lester (1983)	Fort Pond Bay	Discussion of food chain during the spring: amphipod shrimp eaten by small fishes (silverside, sand lance) that were eaten by predators (striped bass, bluefish, weakfish).
Turner et al. (1983)	Peconic Bay	Studied plankton dynamics during 1978-1979; fish larvae were abundant during seasons of phytoplankton and zooplankton abundance; young sand lance larvae fed on phytoplankton, older larvae fed on zooplankton; bay anchovy larvae were captured in summer coincident with peak abundance of large copepods.

*BIS = Block Island Sound
LIS = Long Island Sound

Several organisms appear to be the predominant items for many fish species. These food items include squid, sand shrimp, mysid shrimp, crabs, plankton, and fishes (especially silversides, anchovy, sand lance, herrings, and menhaden). Squid is a predominant prey species, especially during spring, for bluefish, pollock, spiny dogfish, weakfish and shortfin mako. Turner et al. (1983) studied the seasonal dynamics and interrelationships of phytoplankton, zooplankton, and ichthyoplankton in Peconic Bay and found that peak abundance of larval fishes (sand lance during winter) coincided with peak abundance of adult copepod plankters. They described a feeding relationship consisting of phytoplankton being grazed upon by zooplankton (i.e., copepods) and newly hatched sand lance larvae; and larger (older) sand lance larvae feeding upon adult copepod zooplankters. Examples of food chains derived from the studies in Table 5 might be: (1) squid preyed upon by bluefish (Richards, 1976), which is in turn preyed upon by shortfin mako (NMFS, 1979), which is caught and eaten by people; and (2) phytoplankton eaten by zooplankton (i.e., copepods) that are eaten by young (larval) sand lance (Turner et al., 1983); older sand lance then eat amphipod shrimp and are, in turn, eaten by predators (striped bass, bluefish, weakfish) that are caught and eaten by people (Hickey and Lester, 1983).

Many trophic levels and feeding types are represented among the resident and migratory fishes of eastern Long Island, including plankton feeders (e.g., fish larvae, herrings and menhaden), invertebrate eaters (e.g., windowpane, puffer), opportunistic feeders (e.g., scup, sea robins), and carnivores (e.g., bluefish, weakfish, sharks). Tautog and cunner are browsers upon organisms attached to rocks, pilings (and other structures in the water), and to bottom dwelling invertebrates. The cunner's habit of browsing upon attached and fouling organisms and the tautog's habitat of browsing or grazing on mussels are similar to tropical and subtropical species that browse on coral reef organisms.

The many species, life stages, and abundance of juvenile and young-of-the-year fishes in the eastern waters suggest that these areas are productive nursery and feeding grounds, abundant in food resources. Some food resources arrive during spring along with migratory predatory species - resources such as squid and silversides. Other prey species produced during winter and early spring (e.g., sand lance) are awaiting the arrival of the spring run of fishes. The distribution and abundance of food resources can affect the distribution and availability to the fisheries for important predator species (Hickey, 1981). The distribution of food resources can be affected by fluctuating local meteorological and oceanographic conditions, and perhaps by altered water quality or habitat alternation caused by human activities.

Fish Diseases, Pollution and Toxicity Studies

Literature sources that resulted directly from studies conducted in the Bay system are annotated in Tables 6 and 7. Included are studies on the occurrence and incidence of fish diseases, parasites and abnormalities, and on pollution and toxicology. Studies on the effects of temperature on eggs and larvae of locally spawned fishes are found in the papers by Williams (1975) and Austin et al. (1975), as presented in Table 3. Additional information on pollution effects to the New York marine environment in general are found in the papers by Jensen (1974a,b; 1976; 1977) and the book by Squires (1983).

Table 6. Studies of fish diseases, parasites, and abnormalities conducted in the Peconic/Gardiners Bay System, 1900-1984.

Authors and Years Published	Locations Studied*	Scope and Findings
Diseases and Parasites		
Murphy and Harper (1915)	Fort Pond Bay	Noted the occurrence of eye disease and exophthalmia in black sea bass during 1915.
Moore (1947)	BIS	Noted the occurrence of digestive system tape worms; determined the incidence of the external trematode parasite (Cryptocotyle lingua) infecting 23% of the windowpane flounder examined during 1944-1945; fish less than one year old were not infected.
Alperin (1967a)	Peconic Bay, Noyak Bay	Determined the incidence of the external copepod parasite (Lernaenicus longiventris) infecting 47% of the blue runners examined during 1964.
Hickey and Lester (1975)	Fort Pond Bay	Examined lumpfish for parasites during 1974; no parasites found.
Walker and Sherburne (1977)	Montauk	Determined the incidence of blood virus to be 3% for 32 tautog examined; none were found in any of 25 cunner examined.
MacLean (1980)	Montauk, as part of a study between Chincoteague, VA, and the Gulf of Maine.	Examined Atlantic mackerel for the presence of blood parasites; none of 14 young-of-the-year fish from Montauk were infected during 1975.

Table 6 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Abnormalities		
Briggs (1966)	Little Peconic Bay	Described one pugheaded tautog captured by an angler during 1965; the fish was a 9-year old mature female.
Kroger and Guthrie (1971)	Not specified, but appears to be in the Peconic-Gardiners Bay area, as part of a study between Florida and Mass.	Examined juvenile Atlantic menhaden for vertebral abnormalities during 1970; no abnormal fish were reported from the Bay system.
Austin and Hickey (1973)	Lake Montauk	Determined the incidence of spinal curvature in Atlantic silversides to be 0.45% (6 of 1,328 fish) and 100% for Atlantic menhaden (only one fish caught, and it was abnormal), captured by seine during 1971.
Hickey, Young, and Bishop (1977)	Reeves Bay, Three Mile Harbor, BIS at Montauk, Atlantic Ocean at Amagansett to Montauk, as part of a study of coastal N.Y.	Documented the occurrence of several types of skeletal abnormalities in 14 striped bass captured by anglers and commercial fishermen during 1973.
Hickey and Young (1984)	Atlantic Ocean at Amagansett to Montauk	Determined the incidence of skeletal abnormalities among striped bass captured by commercial haul seine during 1973 (0.60%), 1974 (0.67%), and 1975 (0.61%); and compared the incidence by year class with the incidence determined for young-of-the-year fish from the Hudson River.

Table 6 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Young, Mushacke, and Litwa (1984)	Atlantic Ocean at Amagansett, and Plum Gut	Documented the first known occurrence of the isopod parasite (Necrocila acuminata) on the fins of two striped bass captured during October 1981.

*BIS = Block Island Sound

Table 7. Studies of insecticide and heavy metal toxicity conducted on fishes of the Peconic/Gardiners Bay system, 1900-1984.

Authors and Years Published	Locations Studied	Scope and Findings
Insecticides		
P. Weis and J. Weis (1974a)	Montauk	Studied the effects of DDT, sevin, parathion, and malathion on the development and hatching of mummichog eggs during 1973; parathion was toxic to eggs at 1-10 ppm; sevin caused developmental arrest at 10 ppm, but when eggs were placed in clean sea water, eggs recovered to normal development.
P. Weis and J. Weis (1974b)	Lake Montauk, Napeague Harbor	Studied the effects of of a single application (100 ppb) of sevin on the schooling behavior of Atlantic silversides; sevin induced the school to spread out to twice its normal size; school placed in clean seawater returned to normal density and size after 3 days.
J. Weis and P. Weis (1975)	Lake Montauk	Studied the effects of DDT, sevin, malathion and parathion at 10 ppb on fin regeneration (healing) of mummichogs; DDT and malathion imposed high mortality on fish; sevin was less toxic than malathion and parathion in retarding fin regeneration after one week.

Table 7 (continued)

Authors and Years Published	Locations Studied	Scope and Findings
P. Weis and J. Weis (1976a)	Montauk	Studied the effects of DDT, carbaryl, and malathion on the development and hatching of sheepshead minnow eggs; at $\leq$ 10 ppm DDT and carbaryl had no effects; at 3-10 ppm malathion induced physiological changes and physical abnormalities.
J. Weis and P. Weis (1976)	Montauk	Studied the effects of sevin, DDT, and malathion on the development of Atlantic silverside eggs; survival was reduced by all three insecticides, and physical abnormalities were produced; effects were seen at dosages as low as 10 ppb and at levels found in natural areas.
<u>Heavy Metals</u>		
Alexander, Foehrenbach, Fisher and Sullivan (1973)	Montauk, Plum Gut, Gardiners Bay, Shinnecock	Analyzed the levels of mercury in edible flesh of bluefish and and striped bass caught by anglers during 1972; mercury content was directly related to weight of the fish.
P. Weis and J. Weis (1976b)	Lake Montauk	Studied the effects of inorganic mercury, lead, and cadmium on fin regeneration (healing) of mummichogs; mercury at $\geq$ 0.1 ppm was toxic and created high mortality; cadmium at $\geq$ 0.01 ppm slightly enhanced regeneration.

Table 7. (continued)

Authors and Years Published	Locations Studied	Scope and Findings
J. Weis and P. Weis (1977)	Montauk	Studied the effects of inorganic mercury, lead, and cadmium on the development of mummichog eggs during 1975; cadmium at $\geq$ 0.1 ppm caused only minor effects; lead at $\geq$ 0.1 ppm caused hatched larvae to be abnormal; mercury at $\geq$ 0.1 ppm was toxic to eggs and caused severe abnormalities, especially in early developmental stages.
P. Weis and J. Weis (1977)	Montauk	Studied the effects of organic mercury on the development of mummichog eggs; the incidence of abnormalities was directly related to dose and exposure time; the most sensitive period for causing eggs to develop abnormally is in the first 2 days after fertilization (or spawning).
P. Weis and J. Weis (1980)	Montauk	Studied the effects of zinc and methylmercury on fin regeneration of mummichogs; wounded fin regeneration was retarded by mercury; zinc exposure accelerated regeneration and counteracted the effects of mercury.

Table 7. (continued)

Authors and Years Published	Locations Studied	Scope and Findings
J. Weis, P. Weis and Ricci (1981)	Montauk	Studied the influence of cadmium, zinc, salinity and temperature on the ability of methylmercury to cause mummichog eggs to develop abnormally, during 1977 and 1978; mercury at 0.02-0.05 ppm induced abnormalities and delayed hatching time; the presence of zinc and cadmium ameliorated the effects of mercury.
J. Weis, P. Weis, Heber, and Vaidya (1981)	Tidal creek in Lake Montauk; and Pile's Creek, a tributary to the Arthur Kill in Linden, N.J.	Compared the effects of methylmercury on developing eggs of mummichog from polluted Pile's Creek and relatively unpolluted eastern Lake Montauk; Pile's Creek eggs were more resistant to exposure to mercury than Montauk eggs; Pile's Creek eggs had low hatching success in clean sea water, Montauk eggs had high success; Pile's Creek fish population more tolerant to pollution than Montauk fish.

Table 7. (continued)

Authors and Years Published	Locations Studied	Scope and Findings
P. Weis and J. Weis (1982b)	Bull Head Bay/Peconic Bay Southampton	Studied the tolerance of mummichog eggs and larvae to mercury and lead exposure during 1980; compared the results for Southampton fish with previous studies on fish from Lake Montauk and Pile's Creek, NJ and suggested that Southampton fish were the least pre-adapted to mercury pollution, Montauk fish were intermediate, and NJ fish the most pre-adapted and resistant to pollution.
J. Weis, P. Weis, and Heber (1982)	Lake Montauk	Studied the effects of organic mercury exposure on the development of mummichog eggs during 1979; described a within-population variability of tolerance to mercury toxicity, suggesting that the population is adaptable to the pollution.
P. Weis and J. Weis (1982a)	Southampton	Studied the effects of PCBs (Arachlor) on development of mummichog eggs and larvae; at $\leq$ 10 ppm PCBs had no effects, eggs were highly resistant; larvae were more sensitive than eggs to PCB exposure; larvae that had been pre-exposed to PCBs as eggs were more susceptable to toxic effects.

Table 7. (continued)

Authors and Years Published	Locations Studied	Scope and Findings
J. Weis and P. Weis (1983a, 1983b)	Bull Head Bay, and an adjacent pond in Southampton	Studied the changes in tolerance of mummichog eggs and larvae to mercury exposure, and altered reproductive success of adult female fish following a heavy rainfall during June 1982; chemicals flushed from a golf course into the pond contributed to altered pollution tolerance and biological characteristics of pond fish compared with normal Bay fish.

Most of the studies were conducted and published since 1970. Several papers studied disease conditions on a large regional basis, with eastern Long Island waters included as sampling areas (Walker and Sherburne, 1977; MacLean, 1980; Kroger and Guthrie, 1971). Many studies occurred in waters around Montauk -- Fort Pond Bay, Block Island Sound, Atlantic Ocean, Lake Montauk. Some species studied are immigrants from other areas that summer in Long Island waters or are transient in the area enroute elsewhere (e.g., striped bass, blue runner, bluefish). Other species studied were adults that immigrated into the area, perhaps to spawn (e.g., lumpfish). Several studies reported on juvenile and young-of-the-year fish that could have been spawned in the area (windowpane, mackerel, menhaden, silversides) or that were resident in the area (tautog, cunner). This group of studies on local spawners and residents are the most useful for assessing local marine environmental conditions and their relationship to disease, parasites, and abnormalities of fishes. Studies by Moore (1947), Kroger and Guthrie (1971), Austin and Hickey (1973), Walker and Sherburne (1977), and MacLean (1980) suggested that locally spawned fishes are relatively disease free, or are affected only minimally. This is contrasted with fin rot disease that reached epizootic proportions among at least 22 fish species during 1967 in lower New York Harbor. The disease conditions continued through the study period of 1971 and were suspected to have been related to domestic and industrial pollution of the area (Mahoney et al., 1973).

The studies by J. W. Weis, P. Weis, and Associates (Table 7) provided significant new information for understanding the potential effects of insecticide and agricultural pollutants on locally spawned fish species, and for assessing the health of local fishes in relation to degraded water quality. Three local species that reside and spawn within the inner bays and harbors were used to examine the effects of pollutants on their early egg and larval life stages -- mummichog, Atlantic silverside, and sheepshead minnow. All three species produce demersal adhesive eggs that would remain within an area receiving pollutants, as compared with planktonic eggs of other species that could be carried to or from such areas by tidal or wind-driven water currents. Of the three species, mummichog eggs were found to be most tolerant to several insecticides, while Atlantic silverside was most sensitive to insecticide toxicity. Developing silverside eggs were affected by the insecticide Sevin (carbaryl) at very low dosages and at levels that have been found in nature (J. Weis and P. Weis, 1976). Sevin also caused developmental arrest in mummichog eggs, but at much higher dosages. When placed in clean sea water after 3 days exposure to Sevin, however, mummichog eggs developed normally (P. Weiss and J. Weiss, 1974a). Sevin was less toxic than parathion to mummichog eggs and less toxic than malathion to sheepshead minnows eggs. Sevin also was shown to affect schooling behavior of juvenile silversides exposed for 24-72 hours. After placement in clean sea water for 3 days, schooling behavior returned to normal (P. Weis and J. Weis, 1974b). The effects of several insecticides on regeneration of wounded mummichog fins were tested by J. Weiss and P. Weiss (1975). Sevin was less inhibitive to fin regeneration or healing than malathion and parathion. DDT was least inhibitive, but along with malathion, was toxic to the fishes themselves and imposed high mortality. While Sevin did affect several life stages of the species tested, some effects were reduced or eliminated by placing fish into clean sea water, as might occur in nature during a tidal exchange, or by fish swimming into cleaner water.

Sevin is used for control of gypsy moths on eastern Long Island and has been sprayed after hatching of the caterpillar (during mid-late May). It is the period between hatching and early-to-mid summer that the caterpillar is most destructive to woodland vegetation. That period also corresponds to the main spawning season for many fish species in eastern waters, and is a period when sensitive early life stages are present in the inner bays and harbors. The relatively short half-life of as little as 3.5 days (P. Weis and J. Weis, 1974b) of Sevin, however, probably reduces the potential for the insecticide to travel to the bays via the groundwater route and still affect local fishes. Aerial spraying that results in direct application onto surface waters, however, could be of greater concern.

Comparative studies were conducted on mummichogs from the relatively unpolluted waters of Lake Montauk (near Little Reed Pond) and Southampton, with eggs from the heavily polluted area of coastal New Jersey (J. Weis, P. Weis, Heber, and Vaidya, 1981; P. Weis and J. Weis, 1982b). The New Jersey fish were found to be highly tolerant to mercury exposure, possibly having adapted to their polluted environment. The Southampton fish exhibited biological responses of mummichogs that were not significantly pre-exposed or pre-adapted to mercury in their natural habitat. The Montauk fish showed biological responses similar to those of Southampton, but did exhibit responses that suggested some degree of pre-exposure to mercury in their environment. These comparative studies provide evidence of the relative health of eastern Long Island waters. See, also, the studies on comparative reproductive biology by J. Weis and Heber (1980) and Bush and Weis (1983) in subsection A3 above. The primary effects on developing fish ova from exposure to pesticides and heavy metals were induction of abnormalities, as seen in the embryos and hatched larvae. Studies of fishes in bay waters, however, have found few abnormal fish, again suggesting that eastern waters are relatively pollution free.

Semi-enclosed areas with limited tidal circulation that receive heavy use (such as Lake Montauk), however, are at risk and should be monitored closely.

An example of short-term pollution of an enclosed water body and its effects to local fishes was demonstrated by J. Weis and P. Weis (1983a, 1983b) for a pond that receives runoff from a golf course in Southampton. The pond is connected by a culvert to Bull Head Bay which eventually empties into Peconic Bay. During June 1982, the area received exceptionally heavy rainfall that is suspected to have resulted in flushing of pesticide chemicals from the golf course into the pond. Mummichogs were collected from the pond and from Bull Head Bay during June through August of that year and studied for pollution-related effects. The authors found the following: (1) the tissues of pond fish had residues of several pesticides, while bay fishes had no detectable levels; (2) tissues of pond fishes had twice the level of mercury as did bay fish tissues; (3) bottom sediments from the pond had detectable levels of several heavy metals, bay sediments had few; (4) ova and larvae of pond fish showed increased tolerance to mercury exposure (under laboratory conditions), bay fish ova and larvae did not; and (5) adult female fish from the pond showed striking changes in reproductive success (a great increase in the production of non-viable eggs) compared with normal bay fish. The authors hypothesized that golf course runoff was responsible for the changes they noted. They, further, suggested that studies of pollution tolerance in fish populations (such as theirs for eastern Long Island, and New Jersey) may be used to monitor changes in environmental quality that might not be readily apparent otherwise.

The approaches taken by Weis and Weis in studies of pesticide and heavy metal toxicity are especially applicable to eastern Long Island. They also provided predictive and monitoring tools for assessing effects to biota, and for recognizing when waters were degrading. Several compounds have been used for various purposes in recent years, either for pest control (i.e., gypsy moth) or for agricultrual purposes. Some fungicides contain mercury compounds which can be converted to methylmercury forms under anaerobic conditions, if they enter the sediments of the marine environment. Oil has been shown to be a concentrator of toxic compounds such as heavy metals and pesticides, in bottom sediments and oil slicks. If oil or other petroleum compounds accumulate in sediments of harbor areas, the possibility exists for accumulation of other compounds also. The more heavily used harbors in areas of restricted water flow or tidal exchange might be the most vulnerable, such as Montauk Harbor and Coonfoot Cove. Future development in such areas should include considerations for pollution control of petrochemical wastes or discharges. Testing of harbor bottom sediments for presence of toxic compounds prior to dredging might provide forewarning against possible release of resuspension of such materials.

The three fishes used in the toxicity studies are species that reside and spawn within the inner bay or harbor areas. They deposit adhesive eggs on or near the bottom where they could be in constant contact with harmful substances, if present. Mummichog eggs also are deposited up on the Spartina mats of marshes and thus are exposed during part of the tidal cycle. The potential exists, therefore, for toxicants to become concentrated on or near the eggs during evaporation and air exposure. The species also are important locally as food for larger predator fishes. Atlantic silverside is fished commercially and is a source of bait for recreational fishermen. Mummichog is a standard experimental animal for which much scientific information is available. Future studies of pollution problems or eastern Long Island could use these same important species. Studies comparing the biological responses to pollutants of eastern Long Island mummichogs with those of fish from other areas, however, should consider the influence that geographic variation, as suggested by Morin and Able (1983) and Able (1984), may have on experimental results. Other important species that spawn within the influence of human activities that might be used for laboratory studies include winter flounder, sand lance, bay anchovy, cunner, tautog, and other cited in Table 3.

Several studies cited in Table 6 provide information on the normal occurrence of fish disease, parasite, and abnormality conditions in eastern Long Island waters. Degradation of the marine environment, especially within inner bays and harbors, could result in the appearance of, or an increase in the incidence of, disease conditions. Knowledge of present normal baseline conditions will be important for understanding pollutant-disease relationships in future, and will provide a yardstick against which to measure future conditions.

Fisheries Studies

Literature sources that resulted directly from studies conducted in (or concerned with) the Bay system are annotated in Tables 8 and 9. Included are studies of: fishery catch and harvest, and their variability; recreational fishery creel surveys; human impact on fishery resources; and surveys of motivations, characteristics, preferences and behavior of fishermen. Additional information related to the fisheries of eastern Long Island can be found in many studies cited in previous sections, especially those on movements and migrations, reproduction, and size, age, and growth. Other literature sources

Table 8. Studies of Commercial and Recreational Fishery Catch and Harvest Conducted in the Peconic/Gardiners Bay System, 1900-1984.

Authors and Years Published	Locations Studied*	Scope and Findings
Perlmutter (1947)	Peconic Bay, Gardiners Bay, Shinnecock Bay, Moriches Bay, BIS, LIS, Atlantic Ocean	Reviewed winter flounder catches and fishery value and changes in abundance between 1887-1941; conducted biological studies; suggested that resident local stocks might be managed similar to local shellfish resources.
Perlmutter, Miller and Poole (1956)	Shinnecock Bay, Peconic Bay, Gardiners Bay	Sampled weakfish populations during 1952-1953; determined that 50-54% of the total commercial catch of weakfish in Long Island waters came from the Peconic-Gardiners area.
Poole (1962)	Atlantic Ocean near Shinnecock Inlet.	Studied summer flounder captured by trawl, tagged and released during 1956-1959; defined the susceptibility of the fish to capture by hook and line; fishing pressure was heavy in the south shore bays, with the population possibly overfished; management by season, size, or catch limitations would not affect the sport fishery.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Briggs (1965a)	Atlantic Ocean from Shinnecock west to Jones Inlet.	Conducted interview/creel survey of surf anglers during 1961-1963; in the area between Shinnecock and Moriches Inlets; anglers sought striped bass during spring and fall, and bluefish during summer; despite poor catches, many anglers sought striped bass during summer; fishing areas and access were limited; catches ranged between 2500-4200 striped bass and bluefish annually.
Briggs (1965b)	Shinnecock Bay, Moriches Bay, Gardiners Bay Peconic Bays	Conducted interview/creel survey of winter flounder sport fishery during 1961-1963; determined fishing pressure, catch, seasonality; number of anglers and catch increased significantly during 1938-1963; peak catches were in April, mostly by rowboat anglers; harvests ranged between 801,000-1,201,000 fish annually; fishery could withstand increased pressure.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Wilkins (1967)	Waters of Southold Town	Studied the recreational and commercial fisheries during 1964 and 1965; estimated the average level of summer recreational participation to be 18,000 shore anglers and 27,000 boat anglers; predicted a 93% increase in fishing pressure by 1985; estimated the commercial value of finfish landed in the Town to exceed $500,000 per year during 1961-1965, scup and flounders were the most important fishes; total poundage landed ranged between about 8-11 million pounds annually.
Briggs (1968)	Peconic Bays, Shinnecock Canal, Gardiners Bay, Orient, Montauk, BIS	Conducted interview/creel survey of scup sport fishery during 1964-1966; determined fishing pressure, catch, seasonality; number of rowboat and open boat anglers increased significantly during 1938-1966; bank and pier access was limited; scup changed from a secondary to a preferred species; harvests ranged between 587,000-1,016,000 fish annually.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Briggs (1969)	Peconic Bays, Gardiners Bay, Orient, Montauk, LIS, BIS	Conducted interview/creel survey of tautog sport fishery during 1964-1966; determined fishing pressure, catch, seasonality; angling most successful from open boats; heaviest fishing pressure was in LIS near Orient; best harvests were during fall; bank and pier access was limited; harvests ranged between 146,000-307,000 fish annually; tautog could sustain heavier fishing effort.
Hamilton and Young (1974)	Accabonac Harbor	Discussed bank and boat fishing by anglers for winter flounder during 1974.
Jensen (1974a, 1976, 1977)	Montauk vicinity	General discussions of New York's marine fisheries in relation to changing fishing pressure and environment; estimated the recreational harvest of cod at Montauk to be 5,000-10,000 pounds per day on a typical party boat, and about 6 million pounds annually.
Young (1976b)	Montauk: east jetty of Lake Montauk around the Point to Ditch Plains on the Ocean.	Conducted a creel survey of the recreational striped bass fishery during 1973-1975; estimated catch per-effort on a monthly basis; estimated harvests ranged between 254,000-443,000 pounds annually; documented the harvests of several other species by boat and surf anglers.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Austin and Hickey (1978)	Fort Pond Bay, Atlantic Ocean at Amagansett to Montauk	Discussed Suffolk County striped bass harvest in relation to total NY harvest; derived a method to forecast the commercial harvest based on the length of 2-year old fish during 1972 and 1974; suggested that the NY commercial fisheries collect representative biological samples of the Chesapeake Bay coastal migratory stock.
Thorsen (1979)	Waters of East Hampton Town	Survey during 1977-1979 of marinas, boat owners, commercial fishermen, and marketing conditions; recommendations for improving local fishing industry.
Christensen and Clifford (1980)	Inlets at Shinnecock, Montauk, Greenport, and Mattituck, as part of a study between Delaware and LIS.	Conducted interview/creel survey of the Atlantic mackerel recreational boat fishery during 1978; the NY harvest accounted for 66% of the total catch for Delaware, New Jersey and New York; fish caught were older age groups predominantly (ages 5 through 11 + years).
Hickey and Lester (1980)	Fort Pond Bay	Documented the marketed catch of southern migrant fishes in pound net harvests during 1970-1974; southern fishes comprised about 1% of the total 5-year harvest and about 11.5% during September 1973.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Atlantic States Marine Fisheries Comm. (1981)	Coastal NY, including eastern Long Island, as part of a fishery management plan for coastal waters between Maine and NC	Reviewed coastal striped bass stock and fisheries; described NY fishery harvests and historical perspectives; recommends management measures.
Hickey (1981)	Eastern Long Island - bays, sounds, ocean.	Discussed effects of water movement and local weather on availability of striped bass to fishermen and their inshore gear types; discussed methods of fishing during spring and fall.
Penny (1982)	Mashomack Preserve on Shelter Island	Described the recreational and commercial fisheries of the Bay system historically, and estimated harvests and number of fishermen during 1977-1980; there may have been as many as 100,000 anglers who harvested as much as 3.5 million pounds from Peconic and Gardiners Bays during 1979; at least 1200 baymen derived at least half of their income from fin- and shellfishing in the eastern towns; commercial landings from Peconic and Gardiners Bays during 1980 were about 2.6 million pounds of fish valued at about 1 million dollars.

Table 8 (continued)

Authors and Years Published	Locations Studied*	Scope and Findings
Norton, Smith, and Strand (1983)	New York and Suffolk County, as part of a study from Maine to North Carolina	Described the economics of the striped bass fishing industry during 1979 and 1980; the 1980 commercial harvest for NY was 572,043 pounds, 97% occurred in Suffolk County, most of that between Shinnecock and Montauk Point; discussed haul seine share-system for wages; NY was second to MD in number of striped bass caught by anglers in 1979; NY anglers made 408,000 trips to catch 276,000 fish and expended 31.6 million dollars doing so; the average expenditure per trip was $77.42; the mean catch rate was 0.68 fish per trip, or 1 fish in every 1.47 trips.
Suffolk Co. Dept. of Planning (1983)	Three Mile Harbor	Discussed the recreational and commercial fisheries of the Harbor; compared the fisheries and number of fishermen using the area in 1879 (about 130 commercial) and in 1983 (about 500 commercial and 2,200 recreational shellfish permit holders in East Hampton Town).

*BIS = Block Island Sound
LIS = Long Island Sound

Table 9. Studies of motivations and characteristics of eastern Long Island fishermen.

Authors and Years Published	Locations Studied	Scope and Findings
Wilkins (1967)	Waters of Southold Town	Conducted interviews of fishermen, boaters, clammers as part of a larger study of outdoor recreation during 1964 and 1965; many visiting anglers spent more than seven days a year in the town, and most were residents of New York City and Nassau County; the rustic aura of the town and good fishing were the primary attractants for most anglers; recommendations were made for enhancing recreation in the town, including improved fishermen access; the effects of people on the resources and habitats were discussed, along with recommendations for conservation.
Carls (1978)	Montauk Harbor, as part of a study that included the harbors at Captree State Park and Sheepshead Bay.	Conducted a questionnaire survey of party and charter boat anglers during September-November 1975; boat angling was growing in popularity, a social activity, a day-use and local/regional phenomenon; the catch rate was not high, but most fish caught were eaten; success of the angling experience depended on character and quality of the environment, as well as costs and fish caught; most respondents were opposed to a saltwater fishing license.

Table 9. Studies of motivations and characteristics of eastern Long Island fishermen.

Authors and Years Published	Locations Studied	Scope and Findings
Carls and Bresnen (1979)	Montauk State Park, as part of a study that included the surf fishing areas of Jones Beach, Robert Moses State Park, and Smith County Park.	Conducted a questionnaire survey of surf anglers during July-October 1975; surf fishing was growing in popularity and a local/regional phenomenon; anglers fished 1-2 days per week, many fishing almost every day; striped bass and bluefish were most sought; most anglers ate their catch; clean water and naturalness of the area were more important than number and size of fish caught as factors contributing to enjoyment of the fishing experience; the catch rate was not high; access to shore fishing sites was important.
Carls (1980)	Montauk Harbor and Montauk State Park, as parts of a study that included several Long Island areas (see Carls, 1978; Carls and Bresnen, 1979).	Conducted questionnaire surveys of party boat, charter boat, and surf anglers during 1975; compared and contrasted the characteristics of boat and surf anglers; both angler groups considered clean fishing waters as environmental prerequisites for enjoyment of the fishing experience; shoreline access, productive waters, and a reasonable chance of catching a fish were important to anglers.

Table 9 (continued)

Authors and Years Published	Locations Studied	Scope and Findings
Panek and Lamson (1980)	Five Towns of eastern Long Island	Conducted a random mail questionnaire of 2,098 residents in the area during 1977; respondents expressed concern about environmental quality (water, wetlands, dunes); having an unpolluted natural area readily accessible was the primary prerequisite to an enjoyable fishing trip; respondents favored R & D for aquaculture, favored a saltwater sport fishing license, and regulations fixing minimum size and limiting daily recreational catches; commercial fishermen respondents would support legislation on recreational shellfishing and commercial fishing licenses if revenues went to reseeding shellfish beds.
Dawson and Wilkins (1981)	NY coastal region including eastern Long Island	Conducted an angler preference survey during May-October 1980; anglers considered their fishing trips as opportunities to have multiple experiences in addition to catching fish; anglers did not have to catch large numbers of fish to be satisfied; a minimum legal size limit was the most acceptable constraint to fishing.

on New York's marine fisheries in general are applicable to the East End, such as the papers by Koo (1970), Schaefer (1972), McHugh (1972, 1977), Saila and Pratt (1973), Ginter (1974), Retzsch and McHugh (1975), Jensen (1975), and McHugh and Ginter (1978).

Fishing occurs throughout the eastern Long Island area, in bays and harbors, in Long Island and Block Island Sounds, and in Atlantic ocean waters. Recreational fishing occurs from bank and pier, in the surf, by private boat, and by commercial charter and party boat fleets at Montauk and Greenport. Commercial fishing is done by pound net, gill net, fyke, spearing through winter ice, haul seine, trawl, handline, and purse seine. Many species are harvested including resident, north temperate migratory, and southern subtropical fishes. The three main ports of landing for Suffolk County are located at Montauk, Greenport, and Shinnecock; all within the eastern five-town area (Thorsen, 1979).

The average number of marine shore and boat anglers fishing the waters of Southold Town during the summers of 1964 and 1965 were estimated at 45,000 (Wilkins, 1967). Ninety percent of the patrons of Southold's rowboat rental stations, open boats, and charter boats were visitor fishermen (versus seasonal residents). During 1977, an estimated 50,750 resident marine anglers in the five towns of eastern Long Island made 1,116,508 fishing trips at an expense of $12,281,600 (Panek and Lamson, 1980). Other estimates of the number of anglers fishing in eastern Long Island waters are shown below.

The National Marine Fisheries Service (and its predecessor the Bureau of Commercial Fisheries) complies annual estimates of the commercial landings of

Fishery and Years Studied	Range of Estimated Number of Anglers Annually	Source
Surf (Moriches Inlet to Shinnecock Inlet) 1961-63	2,340 - 3,150	Briggs (1965a)
Winter Flounder (Shinnecock, Gardiners, Peconic Bays) 1961-63	61,251 - 92,301	Briggs (1965b)
Scup (Eastern Long Island) 1964-66	52,473 - 57,642	Briggs (1968)
Tautog (Eastern Long Island) 1964-66	26,076 - 50,436	Briggs (1969)
Surf and Boat (Montauk) 1973-75	62,312 - 67,065	Young (1976b)

finfishes and shellfishes in New York. Prior to 1970, landings were reported by subarea within the Marine District in the "Current Fisheries Statistics Annual Summary" series. Eastern Long Island subareas included: Moriches and Shinnecock Bays; the ocean from Moriches Inlet to Shinnecock Inlet; the ocean from Shinnecock Inlet to Montauk, including Block Island Sound; and the Gardiners Bay-Peconic Bay system. During the period 1961-1969, annual commercial finfish landings ranged from about 8-9 million pounds and comprised between 7-37% of the total annual Marine District finfish landings. It has been estimated that approximately 50% of all finfish landed in Suffolk County occurs at Montauk (Thorsen, 1979). The value of finfish landed at Montauk during 1977, therefore, was estimated at 7.5 million pounds worth $2.4 million. To estimate the net worth of the fishery, a multiplier of about 4 may be used (Thorsen, 1979). This would value the Montauk segment of the industry at about $10 million per year. The number of commercial fishermen operating out of Montauk was estimated to have been about 412 (Thorsen, 1979). A questionnaire survey conducted in the five eastern Long Island towns during 1977 found that 5% of the respondents claimed commercial fishing status (Panek and Lamson, 1980). The number of baymen residing in the five eastern towns who derived at least half of their annual income from commercial fishing was estimated to have been at least 1200 during 1980 (Penny, 1982).

Most studies on recreational catch and harvest were conducted during the early 1960's through the mid-1970's and focused on several important species -- winter flounder, scup, tautog, striped bass, mackerel, and weakfish. Recreational creel surveys and angler interview surveys show that the principal species sought or harvested by surf and boat fishermen have been bluefish, striped bass, winter flounder, scup, summer flounder, weakfish, tautog, and others. The preference for some species has changed over the years (i.e., scup, puffer) dependent on their population size, availability, and changing availability of other species. A preference for bluefish and striped bass by anglers has persisted over the years, even during times of fluctuating or decreasing fish abundance and increasing numbers of anglers and fishing pressure. Studies conducted during the 1960's documented large increases in the number of surf anglers, and anglers seeking winter flounder and scup (Briggs, 1965a, 1965b, 1968). With the increase in angling popularity came a shortage of adequate access sites and bank/pier fishing sites. Angler interview surveys conducted during 1975 reaffirmed the surf anglers' concern with access to shore as an important factor in making fishing trips (Carls and Bresnan, 1979; Carls, 1980).

Studies conducted during the 1960's determined that recreational fisheries for winter flounder in the Gardiners-Peconic area (Briggs, 1965b) and for tautog in eastern waters could sustain heavier fishing effort and support larger fisheries. Follow-up studies have not been undertaken to re-examine the harvests or fishing pressure, but a recent questionnaire survey of anglers in the 5-town area showed that winter flounder and tautog still were among the most popular species sought (Panek and Lamsen, 1980).

Most fishery studies conducted during the 1950's through the 1970's were concerned with the fish, the amount of harvest, and the fishing pressure (number of anglers, fishing effort, catch per effort, etc.). Significant new information on the human aspect of the fisheries has been contributed by studies cited in Table 9. Knowledge of the motivations and characteristics of fishermen is important for development of fishery management strategies and for resolving conflicts among fishery resource user groups. Fishermens' needs, problems (real or perceived), economics, and availability of markets, dockage and other services provide information essential to understanding the status of the commercial fishery and for making necessary improvements.

Significant among the findings of studies in Table 9 are that recreational fishermen considered clean fishing waters and natural areas as environmental prerequisites for enjoyable fishing experiences. Number and size of fish caught and fighting qualities of the fish were important, but not predominant factors. This suggests that for continued viability of the recreational fishing industry, Long Island jurisdictions and resource managers need to be concerned with overall environmental qualities of the natural areas used by fishermen, as well as the status of fish stocks exploited.

Marine recreational fishing was found to be a local/regional phenomenon, that is, most anglers are residents of New York City and the Long Island Counties of Nassau and Suffolk (Carls, 1980). It was estimated that 50,750 marine anglers resided in the five eastern Long Island towns, a number equal to about 60% of the resident population (Panek and Lamson, 1980). Concern for environmental quality, therefore, may be related to the waters near an angler's residence, as well as those in which an angler fishes for sport or food.

Fishery studies in Tables 8 and 9 also reveal some insight into the continuing striped bass resource allocation conflict between recreational and commercial fishermen on Long Island. Most commercial fishing for striped bass occurs in Suffolk County (primarily in the eastern five towns) by residents many of whom have been commercial fishermen most of their lives or come from multi-generational fishing families. As such, they have experienced (or heard of) the fluctuating abundance of desirable fish species over the years. Surveys of recreational fishermen, however, revealed that only slightly more than half had lived on eastern Long Island for over 10 years (Panek and Lamson, 1980) and that the largest proportion of surf fishermen (40.7%) and boat fishermen (57.9%) had participated in marine angling for five years or less (Carls, 1980). Most surf anglers (60.5%) and boat anglers (81.6%) had fished ten years or less. Long Island marine anglers were found to have substantially fewer years of experience than reported for anglers in other northeastern areas (Carls, 1980). During the 5-10 year period preceding those surveys, abundance of striped bass was increasing significantly. Large year classes of Chesapeake Bay fish during the latter 1950's, and especially during 1964 and 1970 (Schaefer, 1972; Austin and Hickey, 1978) contributed to the abundance, availability, and increasing harvests of striped bass through the mid-1970's. It seems likely, therefore, that many anglers involved in the conflict with commercial interests knew only an abundant and available resource, until more recently when Chesapeake production, and thus coastal stock abundance have declined.

The striped bass conflict appears to have been centered primarily around the shore zone commercial harvest and the recreational harvest in or near the surf fishery. The offshore recreational boat fishery (charter and party) appears to have been less involved. Angler survey studies suggest that catch rates for boat and surf fisheries were not high (Carls, 1978; Carls and Bresnan, 1979). Creel surveys found that boat anglers had higher catch success rates than surf anglers (Young, 1976b), and that many surf anglers fish for striped bass during times of the day (daylight) and seasons (summer) when the fish are least available (Briggs, 1965a), thus lowering their chances of success. Additionally, studies have shown that marine angling generally is an activity of short-term duration. Fifty-six percent of surf anglers and 87% of boat anglers interviewed during 1975 reported day trips only (Carls, 1980). However, more than one third (37%) of surf anglers interviewed (chiefly those who fished near Montauk) said they took overnight or weekend trips. It is not unusual for surf anglers to fish all night or sleep on the beach and in parking areas in their cars or recreational vehicles in the Montauk vicinity. It therefore appears that surf anglers might expend more effort with less success than boat anglers in pursuit of striped bass. In doing so, they often are in the same area or on the same beach as commercial fishermen who might be seen to make a reasonable catch. Most conflicts between the two groups arise when visual contacts are made (Thorsen, 1979). All of this coupled with limited access probably adds to the frustration of the surf anglers.

Studies in coastal areas of Rhode Island and Texas have shown that non-resident anglers were more successful and had higher retention rates than resident anglers, perhaps due to differing fishing goals and angler preferences (Matlock, 1983). It has been shown, also, that in deciding to return to a fishing site, anglers responded more to past total success at a site rather than to past success per unit of effort expended at a site (Steinnes and Raab, 1983). If non-resident (i.e., not resident within the eastern Long Island five-town area) anglers who remember successful days of striped bass fishing in eastern waters during the latter 1960's or early 1970's now feel frustrated by poor catches at their traditionally successful sites, they might tend to resent other resource user groups they observe making larger catches by other gear types. How (or if) these factors influence the participation or behavior of anglers who fish the Bay system is unknown. Future fishery studies could address these matters.

Studies of recreational fishermen, therefore, suggest that, overall, Long Island striped bass surf anglers: increased in large numbers during recent years; knew mostly an abundant resource until recently; were relatively new and inexperienced; were relatively less successful than their boat-angling counterparts; had limited access to areas of their choice; and often shared space with other resource users (commercial fishermen). The ASMFC (1981) interstate management plan for Atlantic coastal striped bass did not examine the social aspects of the striped bass controversy (between recreational and commercial fishermen), and did not consider the behavioral aspects of fishermen (as suggested by example in this section). The ASMFC plan referenced none of the studies shown in Table 9 and did not attempt to factor into the plan the human behavioral and motivational aspects of striped bass fishing. The plan, however, emphasized "...the need for a good understanding of the socioeconomic characteristics of the striped bass fisheries." It states further that "The desires of user groups cannot be met if they are not known..." Social and motivational information are necessary to fully comprehend the nature of conflicts between or among users of common resources. In this case, however, there appears to be much more information on the recreational fishery and far less on the commercial fishery. It seems ironic that the recreational fishery has been the most thoroughly studied, yet the commercial fishery has been the most regulated and legislated. Comparable studies on the characteristics and motivations of Long Island commercial fishermen would be extremely useful for conflict resolution and fishery management in general. Management of the fisheries (and the environment or natural resources) ultimately is management of people and the way they exploit the resources.

Mariculture of finfish, shellfish, and marine plants had been cited as having potential for development on Long Island, including the waters of Gardiners and Peconic Bays (Davies, 1982). Growth and success of mariculture will depend, in part, on reducing or avoiding spatial arrangement incompatibilities and conflicts among coastal resource users. Some of the reasons why Long Island waters are conducive to development of coastal zone mariculture are that: local waters are high in nutrients and exceptionally disease free; water quality is favorable for the reproduction, growth, and survival of target species; concentrations of toxic pollutants are very low; and toxic red tide blooms have not occurred in Marine District waters (Davies, 1982). Studies of local fishes cited in Tables 3, 4, 6 and 7 support the statements related to low disease incidence and pollutant levels, reproduction, growth and survival. Questionnaire survey respondents living in the five-town area of eastern Long Island during 1977 favored research and development on aquaculture as a means of supplementing natural production and enhancement of marine life, and on the commercial aspects of aquaculture (Panek and Lamson, 1980).

Viable fisheries and successful aquaculture endeavors on Long Island will depend on maintaining (or enhancing) the quality of the marine and coastal environment so that it will provide the habitat necessary for healthy resources, and so that it will be conducive and attractive to resource users.

DISCUSSION AND CONCLUSIONS

Published studies on the fishes and fisheries of the Peconic/Gardiners Bay system are contained in many journals, some international in scope and others of regional or local interest. Copeia figured prominently as an outlet for information on species accounts early in this century. Publications by New York State and the New York Fish and Game Journal have been the primary sources for dissemination of marine fisheries information from the later 1930's through the present time. During the 1940's through the mid-1960's, the Bingham Oceanographic Laboratory of Yale University conducted many marine resource studies (principally in Long Island and Block Island Sounds) and published them in the Bulletin of the Bingham Oceanographic Collection. The 1960's and 1970's saw a greater interest and necessity to study the marine environment in relation to human needs (recreation; food source) and human impacts (habitat and water quality alterations; effects of fishing). As a result, many new journals appeared and others expanded their scope to adjust to new and changing interests. This has provided a variety of outlets for the studies conducted in the Bay system, but has made it increasingly difficult to keep abreast of the current literature and developments.

During the first half of this century, studies were conducted primarily on the occurrence, distribution, and abundance of fishes by T. H. Bean, by Roy Latham in the Orient area of the North Fork, and by the State's 1938 Salt Water Survey of Long Island, as reported by Perlmutter, Greeley, and Dickinson (Table 1). The mid-1950's through the 1960's saw an expansion of study by the State of New York in Shinnecock, Peconic, and Gardiners Bay on a variety of biological and fisheries subjects. The findings from that era of study still form the basic foundation for much of the background and descriptive information on the Bay system's biotic resources. During the 1970's, new interest in studying the easternmost areas of the South Fork occurred with the founding of the New York Ocean Science Laboratory at Montauk and by renewed socioeconomic interest in the coastal striped bass fishery. Prior to about the mid-1970's, management of the marine fisheries was conducted primarily on a biological basis, and the study programs were concerned with collecting the appropriate information on fish population biology and fishery harvests (Table 3, 4, 8).

The latter 1970's saw a shift in interest toward socioeconomic considerations in fisheries management, with emphasis on recreational aspects (Table 9). These same studies also emphasized the public's continuing awareness and interest in environmental conservation of the coastal zone in which they live, work, and recreate. During the 1970's and continuing through the present, studies related to fish diseases, pollution, and toxicity have become important new sources of information on the status of the fishes and the environmental quality of the Bay system (Tables 6 and 7). Even in light of all this information, the number of studies (138) found and cited in Tables 1-9 are relatively few in proportion to the time period considered (1900-1984) and to the importance and use of the Bay system by people. Of studies annotated in tables, 115 (or about 83%) have been published since 1960, and 96 (or about 70%) since 1970. This is reflective of recent concern for environmental impact and coastal resource management related to human activities.

Those areas of the Bay system in which most published fisheries studies have been conducted are Great/Little Peconic Bays, Shinnecock Bay, Gardiners

Bay/Orient, Montauk/Block Island Sound, and the Atlantic Ocean. Relatively few studies were published on the numerous and smaller water bodies, inner bays, and harbors such as Flanders Bay, Three Mile Harbor, Napeague Harbor, Accabonac Harbor, Northwest Harbor, Mecox Bay, Georgica Pond, etc. These areas receive much commercial and recreational use and have limited tidal circulation. As such, they are more susceptible to impact from human activities than the larger, more open areas of the Bay system. These areas will need to be studied (separately and as parts of the larger system) as future uses increase in number and intensity.

In 1965, the Town of East Hampton recognized that its wetlands were vital to its fishing, shellfisheries, and tourist industries. The Town therefore requested that the State Conservation Department survey its wetlands as an initial step toward preservation of those resources. The State's survey report by Wallace, Taormina, and Renkavinsky (1965) described 19 wetland areas, their animal life (mostly birds and mammals), man's impact, and recommended some management and preservation measures. Three Mile Harbor is the only area for which any detailed finfish information was presented, and that was summarized from the 1938 Salt Water Survey by Perlmutter (1939). During the nearly 50 years since that study and in the 20 years since the Town wetland survey, the only inner bay-wetland areas of East Hampton Town for which any detailed information on fishes has been compiled are Pond of Pines at Napeague (Subsara, 1971), the Gardiners Island coastal ponds (Reisman and Nicol, 1973), Accabonac Harbor (Hamilton and Young, 1974), Lake Montauk (Austin, 1973b; and several studies by Judith and Peddrick Weis, Table 3 and 7), Georgia Pond (Valenti et al., 1977), and The Nature Conservancy's Mashomack Preserve (Penny, 1982).

One of the most comprehensive studies on any area within the Bay system during recent years is the one-year biological survey of fishes and ichthyoplankton in Long Island Sound at the former Jamesport power plant site on the North Fork (located about two miles west of Mattituck Inlet). The survey was conducted by the former New York Ocean Science Laboratory (NYOSL) for the Long Island Lighting Company during 1973-1974. Several gear types were used to sample fishes of all species and life stages on a frequency ranging from weekly-to-monthly. Detailed biological and life history data were recorded for species captured during the year. NYOSL also conducted concurrent studies of marine benthic invertebrates, phytoplankton and zooplankton, sea water chemistry and physics, and water current movements. The survey was designed by NYOSL to provide baseline or background information on the biota and the area that could be used for both impact prediction and as a base for comparison, if the proposed power plant were to be constructed and then to operate (which it has not). Studies such as that are labor intensive and costly to conduct, but similar studies (perhaps on a reduced scale) could provide useful information on the resource status for areas of the Bay system that are heavily used or for which there is high public interest.

Another intensive study was that by Penny (1982), who used volunteer help during 1980 and 1981 to study the marine ecosystem of the Nature Conservancy's Mashomack Preserve on Shelter Island. The physical, chemical, and biological characteristics of the preserve's tidal creeks, coastal ponds, and inshore waters were studied in detail. The results were compared with other studies conducted in the Bay system, and recommendations were made for future study, fishery management, and resource stewardship. This report is a fine example of the type of study that is possible with help from concerned citizens, and the kind of information that is necessary for resource conservation of sensitive and important areas within the Bay system.

The fishes that have received the most study over the years are those that are important to the commercial and recreational fisheries (i.e., striped bass, flounders, scup, weakfish, etc.). Important species that have received little study in eastern Long Island waters are bluefish, menhaden, and butterfish. Species considered to be "trash fish" that are seasonally abundant and which hold promise as future sources of protein also have not been studied to any degree in eastern waters. These include dogfish sharks, searobins, and windowpane flounder. Data gathered now on these species could be important if they should become desirable as food resources in the future. Shortfin mako, bluesharks, and sandbar sharks captured during summer shark fishing tournament at Montauk have been studied for several years. Recent publications have begun to describe the growth and reproductive biology and migratory habits of these important and little-understood species in northeastern waters. Species that have been used recently for laboratory studies of the biological effects of pollutant toxicity (Table 7) are mummichog, Atlantic silverside, and sheepshead minnow. These species reside and spawn within the inner bay and harbor areas most susceptible to effects from human activities. Continuation of these types of studies can provide advice on potential effects of commercial chemicals and to interpret the relative health or integrity of the aquatic system. Future studies could use the same species and life stages for evaluation of the potential effects of: oil and other petro-chemicals in harbor areas; releases of toxic substances from harbor bottoms during dredging or placement of marina structures; agricultural and woodland pesticides (i.e., Temik or Sevin); and non-point source pollution from domestic cesspools and septic systems.

A fishery consists of three essential components: (1) the fish (the biotic populations); (2) their habitat or environment (as influencing, governing, or limiting factors); and (3) the people who exploit or depend on the biota (anglers, commercial fishermen, markets, restaurants, consumers, bait shops, marinas, etc.). Therefore, a fishery is dependent on all three components and if any one is altered, the quality of the fishery also can be altered, resulting in socioeconomic impacts. Significant among the findings of recent recreational fishery surveys (Table 9) are that Long Island anglers considered clean fishing waters and natural areas as environmental prerequisites for enjoyable fishing experiences. Most anglers surveyed considered their fishing trips as opportunities to have multiple experiences or satisfactions in addition to catching fish (e.g., enjoy the ocean and coastal scenery, and observe nature). Marine anglers or angling might serve as one indicator of the status or quality of the coastal resources in general. This suggests that component (3) of the fishery - the people - can be affected by the condition of natural surroundings of desirable fishing areas. Management of the inshore marine fisheries in New York is done primarily by the State via regulation of minimum legal size limits, designation of fishing areas by gear type, etc. Local jurisdictions (county and town), however, are much more involved in managing, planning and zoning of the natural resources bordering the Bay system. Conservation (or perhaps preservation) of these resources by local jurisdictions appears to be essential for continued integrity of the system, its healthy biotic populations, and for continued use of the system by people. In this respect, local jurisdictions are able to assist the State to insure the continued viability of the fisheries by proper management of the surrounding natural resources.

Studies cited in this review describe the Bay system fish populations as diverse, abundant, and predictable in their seasonal migrations into and out of the area. The marine fish habitat is suggested to be of high quality based on: relative growth rates, sizes and ages attained by several species; use of the bays as spawning and nursery areas by many species, nearly year round; an abundance of prey food resources for important predator species; and low incidences of diseases, parasites and abnormalities of resident species. Comparative studies of chemical toxicity to resident fishes suggest that eastern Long Island waters are relatively unpolluted. The human component of the fisheries is active and seeks a variety of species throughout the Bay system. Commercial fishermen harvest millions of pounds of fish annually by a variety of methods. Tens of thousands of anglers make millions of fishing trips annually and expend millions of dollars doing so. Anglers enjoy multiple experiences related to the total coastal environment. The status or condition of the fishes and fisheries can be indicative of the health or quality of the total aquatic environment. The scientific literature cited in this review supports a conclusion that the aquatic environment of the Peconic/Gardiners Bay system generally is of high quality. These conclusions are based on the literature reviewed and are valid as of the dates that the studies were published. It appears that these conditions of the marine fisheries still are valid. However, it has been nearly 20 years since Briggs' in-depth studies (Table 8) on recreational fishing have been conducted in the Bay system. It is nearly 50 years since the classic 1938 salt water survey sampled the marine biota throughout Long Island, including the eastern Bay system. Periodic studies to monitor the status of important aspects of the marine fisheries (including all three components) are essential to provide a working knowledge useable for resource assessment, management, and planning. Subunits of the Bay system need to be monitored for selected or specific problems (i.e., harbor areas). A baywide monitoring program (as part of a Bay system marine and coastal resources management plan) might be necessary to aid in decisions on allocation of specific areas for competing future uses, possibly including fisheries, marine businesses, recreation, aquaculture, industry, and housing. A Bay system management plan could include a coordinated effort to systematically study or monitor the system as a whole and the interrelationships of its subunits (biologically, physically, socioeconomically). Also in need of definition is the significance of the system to the regional fisheries -- its multistate or interstate importance due to the use of it or dependence on it by fishes from other areas (i.e., striped bass from Chesapeake Bay; bluefish spawned in the ocean that feed within the system as juveniles; etc.).

The U.S. Department of Commerce Office of Coastal Zone Management and the New York Department of State published (in August 1982) the "State of New York Coastal Management Program and Final Environmental Impact Statement." The Program strongly supported and encouraged local governmental efforts to initiate and/or continue activities that result in the wise use and protection of natural resources. Special studies that address one or more coastal issues affecting two or more adjacent coastal communities will be eligible for funding under the State Program. Cooperative programs conducted by the eastern Long Island towns to study, preserve, or protect the resources of the Peconic/Gardiners Bay system might be eligible for funding under the State Coastal Management Program.

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