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A Legislative and Management Plan for the Recreational and Commercial Striped Bass Fisheries of New York State

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Abstract

Available commercial and recreational fishery landings statistics and scientific evidence show that the Atlantic Coast striped bass resource has been increasing in abundance for forty years. There is no evidence that commercial fishing has been destructive or that the resource has been overfished. The controversy between recreational and commercial fishermen is based on misunderstanding and paradox. The distinction between management of the resource and who should get the catch has been almost totally ignored.

There is no comprehensive research or management plan for the entire Atlantic Coast striped bass fishery. A scientific basis for management does not yet exist. Minimum needs are accurate estimates of birth and recruitment rates, stock size, and natural and fishing mortality. Data must be derived from recreational as well as commercial fisheries. An empirical management scheme, if desired, might be developed from incomplete existing data, to be extended and revised as new information accumulates. New York State could best contribute to management by making a clear statement of policy and by assuming a position of leadership to get things done.

Recommendations

1. A select group of scientists familiar with striped bass biology and fisheries and experts in other fields related to fishery management should be brought together to develop a compendium of existing knowledge on striped bass and to develop a model research and management program. The meeting should be carefully planned and tightly controlled.

2. Effective management of the striped bass resource cannot be achieved by individual state management programs. If the State of New York wishes to preserve the resource for maximum benefit to its citizens it should take the lead in developing a comprehensive research and management program for the entire Atlantic Coast.

3. Assessment of the magnitude of the Hudson River striped bass resource and its contribution to the total Atlantic Coast striped bass fishery should be given high priority.

4. To aid in the collection of recreational catch and effort data, the New York State Legislature should establish a salt-water angling license. Funds collected from license fees should be allocated to research, development, and management programs for marine recreational fisheries.

5. Scientific management of the striped bass fishery should be applied equally to the commercial and recreational segments of the fishery. There is no scientific basis for eliminating the commercial fishery.

Introduction

Historically, striped bass has been important to commercial and sportfishing interests along the Atlantic coast, throughout its entire range, from as far north as the St. Lawrence River in Canada to the St. Johns River in Florida (Fig. 1). The Atlantic coast striped bass, an anadromous species, spawns principally in the larger Chesapeake - Delaware Bay tributaries and in the Hudson River and Albemarle Sound watersheds. The first two years of development are spent in estuarine nursery areas near the spawning grounds. At age two years and older striped bass undertake coastal migrations near to shore which take them northeastward in spring and summer. Southwestward coastal migrations, which begin in late fall, return the striped bass to southern waters in winter, from where they move into the rivers to spawn in spring. The migratory behavior of striped bass, through marine waters adjacent to fourteen Atlantic coastal states, presents a complex series of scientific and management problems and social-political controversies concerning management and allocation of the resource.

The basic objective of marine fishery conservation and management policy has been to maintain a resource in a condition that will produce the maximum sustainable yield. State or local governments have the responsibility for conservation and management of marine resources in waters within the territorial sea. To conserve and maintain a migratory resource such as striped bass uniform interstate regulations are desirable. These regulations should protect the resource from overharvesting and other detrimental environmental factors throughout its entire range and life cycle. Lack of sufficient

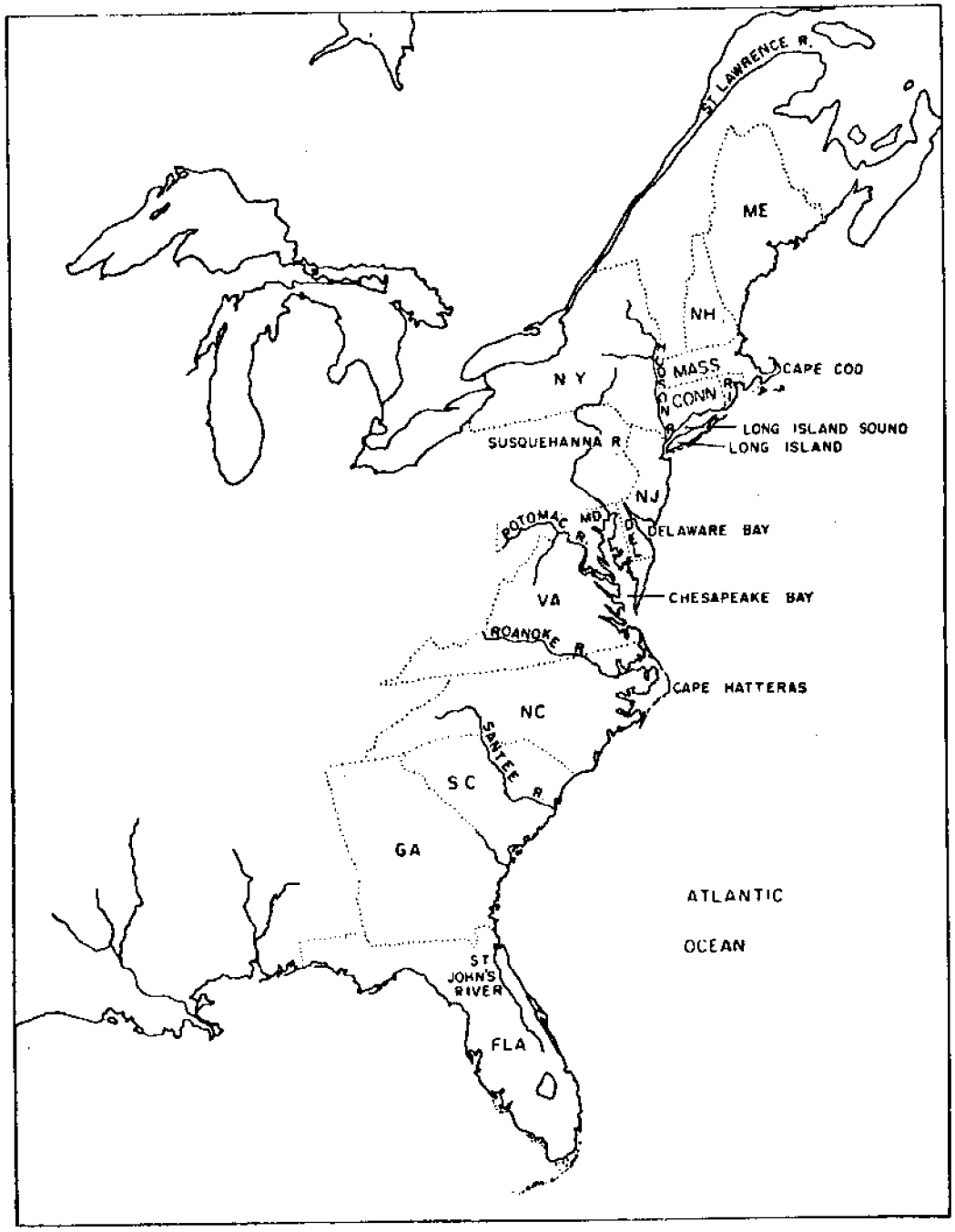


Figure 1.--Atlantic Coast of North America showing major place names mentioned in text.

knowledge on which to base sound management policies, and political pressure groups, have forced New York State legislators to enact inadequate and at times unsound legislation which affects only certain aspects of the recreational and commercial striped bass fisheries. The Atlantic coastal states have failed to develop the necessary cooperative measures for effective management of the striped bass fishery of the Atlantic Coast and the resource on which it depends.

A study of major historical trends in New York State commercial marine fisheries landings (McHugh, 1972) from 1880-1970 showed a shift from one species to another as landings for a particular species would rise to a peak and then rapidly decline, usually to very low levels. Figure 2 illustrates the successive rise and fall of commercial landings of several groups of New York State marine fisheries resources. The groups are arranged in chronological order of decades in which peak landings were reported. Rapid declines in landings probably resulted from overharvesting, due to insufficient control of the fisheries, complicated by the effects of natural fluctuations in abundance. Other biological, economic and social-political factors also have influenced the rate at which these commercial landings have declined.

Figure 3 shows New York State commercial striped bass landings. The trend has been upward for about 40 years. Striped bass landings may be nearing a maximum. However, adequate knowledge about the fishery and the resource, from which the level of maximum sustainable yield (MSY) could be determined, does not presently exist. It is obvious that the catch cannot increase

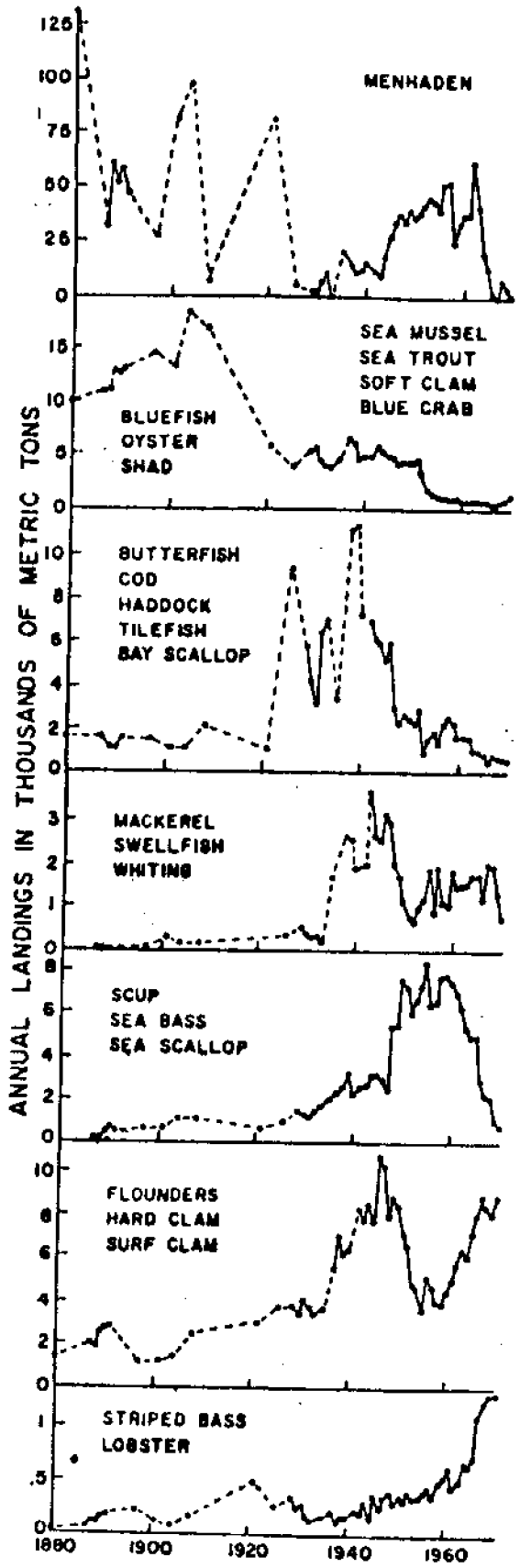


FIGURE 2 - Annual Commercial Landings of Fish and Shellfish in New York State 1880-1970. (McHugh, 1972)

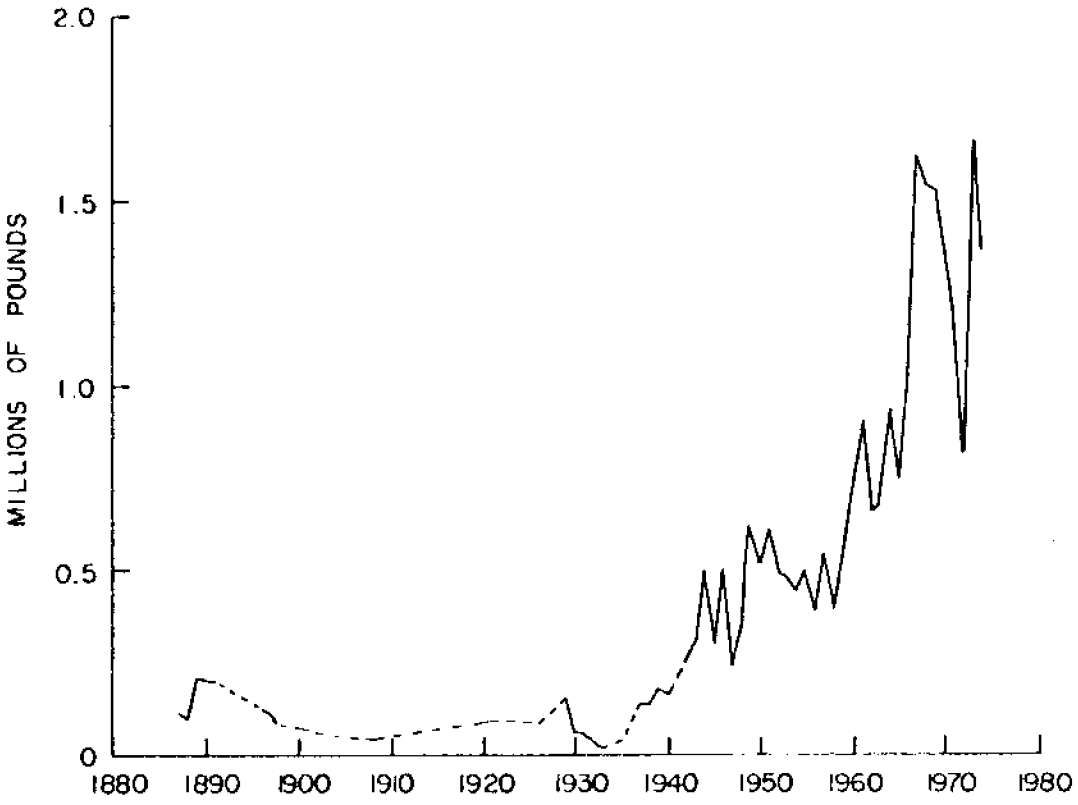


Figure 3.--New York State commercial striped bass landings 1887-1974.

indefinitely. If the history of other fisheries in the State is a reliable criterion, the striped bass catch will reach a maximum sooner or later, and then the trend will reverse. It should be the responsibility of government to make sure that this does not happen.

Since about 1930, each successive high in New York State commercial striped bass landings has been higher than the preceeding one and each low has also been successively higher (McHugh, 1974a). This trend in commercial landings cannot be entirely explained, as certain groups have attempted to do, as being the primary result of increased commercial fishing effort, since striped bass has long been an important commercial species. Commercial fishing effort as a whole has been declining over this period. The estimated catch of striped bass by sport fishermen along the Atlantic coast has increased from 1960 to 1970, the only period for which records of sport catches are available. In 1970 the recreational catch was six to seven times as great as the commercial catch. This was partly the result of an increase in sportfishing effort, but not entirely. All the evidence points to a substantial increase in abundance of striped bass since the 1930s.

Many recreational and commercial fishermen realize that living resources have a finite abundance. As a result of this realization, various assertions regarding allocation and abundance have been made by different groups of fishermen and concerned citizens. Three of the major assertions are that: a) "the striped bass resource is declining in abundance," b) "commercial fishing is destructive to the resource," and c)"striped bass should be made solely a sportfish."

This investigation examines these major assertions in light of existing scientific knowledge to determine the actual validity of such assertions. Commercial (Appendix B) and recreational (Appendix D) fishing methods and historical landings trends have been reviewed separately and compared to provide a better understanding of the conflicts between sport and commercial striped bass fishermen and their causes. Existing information has been analyzed to find out what is known and what still needs to be known about the resource. Present mangement arrangements have been reviewed and procedures to establish a comprehensive management plan are recommended, which should make maximum use of available knowledge. As further information and experience accumulates the management plans should be adjusted as necessary.

Assertion No. 1: Striped bass abundance is declining

Many individuals and groups involved in the striped bass controversy appear to be convinced that the resource is declining in abundance. Average citizens, many of whom are recreational fishermen and "armchair conservationists", have come in contact with a wide variety of literature that has dealt with many aspects of the striped bass controversy. Most of this literature seems to be written by individuals more sympathetic to emotional interests of recreational fishermen than eager to present accurate scientific information. These same individuals, usually writers of columns on sportfishing or conservation for newspapers, local fishing organizations, or the many sportfishing and outdoor magazines, appear to lack sufficient training or the desire to separate fact from unfounded emotional assertions. The result is that, to date, the public and the New York State Legislature have not been supplied with adequate scientific information from which they could determine the validity of the assertion that striped bass is declining in abundance.

Two fundamental questions which may arise in any discussion of marine fishery resources are - what causes fluctuations in the size of a particular fish population and what causes fluctuations in the catch from a particular fish population? Fluctuations in the size of a population of adult fish arise from differences between the number of fish which leave the population (die) during a given time period and the number of fish which enter the population (recruited) during the same period (Clark and Marr, 1955). The size of the population will be increased by larger than average recruitment of new individuals and continued growth of members already in

the population. Deaths may arise from two general sources: fishing or natural causes. An unfished resource remains in unsteady equilibrium, on the average neither increasing nor decreasing. A fished resource is on the average a smaller resource in numbers, but it also will be in dynamic equilibrium with the fishery and other environmental variables. The important thing is to make sure that removals of fish by fishing do not exceed the capacity of the resource to renew itself.

Fluctuations in the catch from a fish population are generally caused by fluctuations in the size of the population, in the degree of availability of the population to the fishery, and in the amount of fishing effort upon the population. Availability of a fish stock to fishermen may vary greatly at times, even if abundance does not change. This may come from changes in current patterns, water temperatures and other things, yet the exact causes of these fluctuations in availability are rarely understood. Fluctuations in fishing effort, however, are usually governed by economic factors, or sometimes by weather (Clark and Marr, 1955).

To estimate relative or absolute abundance or trends in abundance of a fishery resource investigators traditionally have used several methods. To study trends in abundance the most commonly used methods are commercial and, when available, recreational catch statistics, and studies of size and age distributions in commercial catches. To estimate relative or absolute abundance the methods most commonly employed use catch and effort data, age composition data, tag returns, and surveys of egg, larva, fingerling, and young-of-the-year abundance.

Because striped bass are anadromous and much of the fishing effort is concentrated in areas adjacent to the

major spawning grounds, it should be relatively easy to determine abundance. However, estimating relative and absolute abundance of a resource, especially a migratory anadromous resource which is harvested by commercial and recreational fishermen of many states, requires extensive, well coordinated and accurate data. Although striped bass research has been carried out for more than one hundred years such information still is largely lacking.

One of the most fundamental problems of determining the abundance of the striped bass resource is that investigators have not been able to agree upon the basic structure of the Atlantic Coast striped bass resource. It is widely accepted that striped bass along the entire coast do not belong to a single homogeneous stock (Merriman, 1941; Raney, 1952; Bigelow and Schroeder, 1953; Mansueti, 1961a; Talbot, 1966; Koo, 1970). This is characteristic of anadromous resources generally, for they tend to return to the same areas to spawn. Tagging results from several migration studies have been used to test the hypothesis that the Atlantic Coast striped bass population is composed of separate stocks originating from different tributaries of Chesapeake Bay, regions of North Carolina, and the Hudson River (Raney, 1952; Vladykov and Wallace, 1952; Raney et al., 1954; Chapoton and Sykes, 1961;Mansueti, 1961b; Alperin, 1966a; Clark, 1968). Investigators have broken the resource down into various sized units and have used the following terms to identify them: populations, subpopulations, races, subraces, stocks and coastal migratory stocks, contingents, and subspecies. Frequently, investigators have either failed to define these terms precisely or have used terms interchangeably. Also, the results of some investigations conflict with the conclusions of other investi-

gations. Apparently, sufficient evidence is not yet available to determine which segments of the Atlantic Coast striped bass population are truly separate and which may intermingle and interbreed, for, to date, neither standard definitions nor the number of separate units of the striped bass resource existing on the Atlantic Coast have been agreed upon.

Nevertheless, examination of commercial and recreational catch statistics and review of the evidence which supports or refutes the assertion that "the resource is declining in abundance" can still give some indication of trends in striped bass abundance. Before examining this evidence, however, definition of some terms used in this paper is necessary.

Population: All striped bass, regardless where spawned, along the entire Atlantic Coast.

Subpopulation: Two groups will be considered as separate subpopulations if they exhibit average differences in meristic characters, body proportions, or other features. If statistically significant differences exist it follows that the subpopulations from which the samples were drawn could not have intermingled completely.

Stock: A term commonly used interchangeably with subpopulation. However, stocks are usually separated by geographical location and rarely intermingle or interbreed. A subpopulation may be composed of one or more stocks.

Race: A genetically distinct stock.

Evidence which supports the assertion

Sport fishermen and their representatives involved in the striped bass controversy have often based their assertions upon incomplete or outdated information. Actually, no scientific evidence can be found that substantiates the assertion of declining striped bass abundance. Much unsubstantiated information has been disseminated to the public by "Save Our Stripers" (SOS), a Long Island based sport fishermen's organization. SOS representatives have supported and lobbied for proposed legislation which would declare striped bass a game fish. Members and bulletins (SOS, 1973; SOS, 1975) from SOS frequently have used outdated and inaccurate data (Raney, 1952; McHugh, 1974b; New York Times, 1975a) to support arguments that the resource is declining in abundance and that commercial fishermen are primarily responsible for this. When SOS representatives have been asked for the source of their information they often cite a paper written more than twenty (20) years ago by Raney (1952). In one part of this study, Raney (1952) concluded, partly from conclusions by Pearson (1938), that striped bass for the past 150 years had been on the decline with occasional periods of abundance from production and survival of dominant year-classes. In yet another part of the same paper Raney stated that striped bass abundance reached a low point in the early 1930s and that by the late 1940s considerable evidence existed that the downward trend in abundance had reversed. Members of SOS and other similar organizations tend to ignore this second piece of evidence.

Other evidence used by SOS to support the assertion of declining abundance is that New York State commercial striped bass landings have declined since 1967 and that this is mainly attributable to overfishing by commercial striped bass fishermen (SOS Bulletin, 1973). It is true that New York State commercial striped bass landings did decline between 1967 and 1972. There is no evidence, however, that the decline was caused by commercial overfishing. The large periodic variations in spawning success which in turn cause short-term variations in striped bass abundance could equally have been responsible. In the forty-one (41) year period 1933 to 1974, commercial striped bass landings in New York State reached 11 highs and 11 lows. In 24 of the 41 years landings were rising and in 17 years falling. For this reason many people are convinced at least 40 percent of the time that the resource is declining. Mr. Hodgson, president of SOS, was once quoted as saying "there are many more fishermen now. It takes me longer to catch a striper than it used to. I'm sure there aren't as many fish" (New York Times, 1975a). He apparently did not recognize that this would be inevitable if the numbers of fishermen were increasing more rapidly than the numbers of fish.

Evidence which refutes the assertion

Several methods have been employed to estimate abundance of the Atlantic Coast striped bass resource. The conclusion that striped bass abundance has been increasing since the mid-1930s is based on records of commercial landings and on the opinion of scientists and other trained observers. Commercial landings are a good indicator of trends in abundance if effort has remained rela-

tively constant throughout the period in question, if inconsistencies in keeping statistics can be taken into account, and if economic factors and weather conditions do not greatly influence fishing effort. Commercial striped bass landing statistics are available for most Atlantic Coast states from approximately 1890 to the present. Statistics are available prior to 1929 only for certain years and the accuracy of these is questionable (Knapp, 1974; McHugh, 1972). Beginning in 1929 the National Marine Fisheries Service (NMFS) and predecessor agencies began to compile monthly and annual landings summaries in cooperation with state conservation departments. In New York State, the Department of Environmental Conservation (NYDEC) compiles local commercial landings statistics for all commercially important species by directly interviewing fishermen and buyers (Knapp, 1974). NYDEC publishes monthly surveys and annual summaries which include information on the weight, ex-vessel value, and areas of capture of individual fishery species. In addition, a very small amount of information on fishing effort is included. Most statistics used in this study come from these sources.

Commercial catches

Since the early 1930s each major high, except one, in total commercial striped bass landings for the Atlantic Coast has been higher than the previous one, and most major lows have been successively higher (Fig. 4). If all highs and lows of New York State commercial striped bass landings from 1933 to 1974 are taken into consideration, of the 11 highs 8 were as high or higher than the last one, and 7 set a new record. Of 11 lows 7 were higher than the last one, and only one was a record low, the all-time low in 1933.

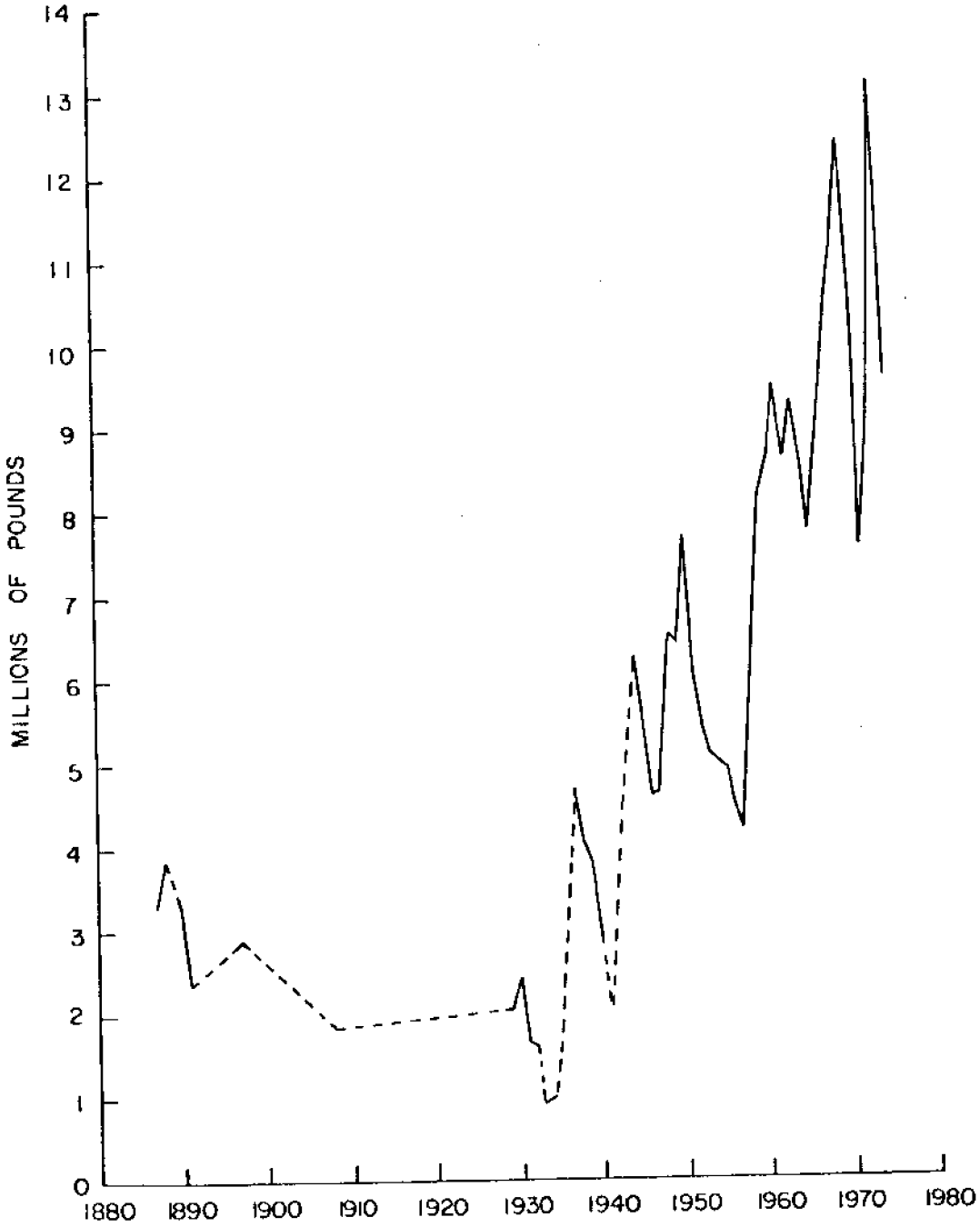


Figure 4.--Total Atlantic Coast Commercial striped bass landings 1887-1974.

An upward trend in commercial landings is evident in Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina (Figs. 5 - 8). Total commercial fishing effort for striped bass has remained relatively constant or increased only slightly during the past four decades, for striped bass has historically been a popular food fish (Koo, 1970; Wheeland, 1973; McHugh, 1974a; Knapp, 1974). Contrary to what many believe, or wish to believe, it appears that there has been an upward trend in abundance of the Atlantic Coast striped bass resource for approximately forty (40) years.

Recreational catches

Records of recreational catches are available only for 1960, 1965, and 1970, but these figures show the same upward trend in total weights caught (Table 1 and Figure 9). It has been demonstrated that increased landings by weight for recreational fishermen are due partly to an increase in the number of fishermen (Table 1) (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973). By weight, the sport catch has increased more rapidly than the numbers of fishermen, from about 78 pounds per fisherman in 1960, to 90 pounds in 1965, to 193 pounds in 1970. By numbers, however, the catch has dropped from 26 fish per fishermen to 18 per fishermen from 1965 to 1970. The total recreational catch in numbers of fish also declined moderately between 1965 and 1970. These changes in numbers and average weight of fish are related to changes in spawning success and to accumulations of large, older fish from earlier successful spawnings.

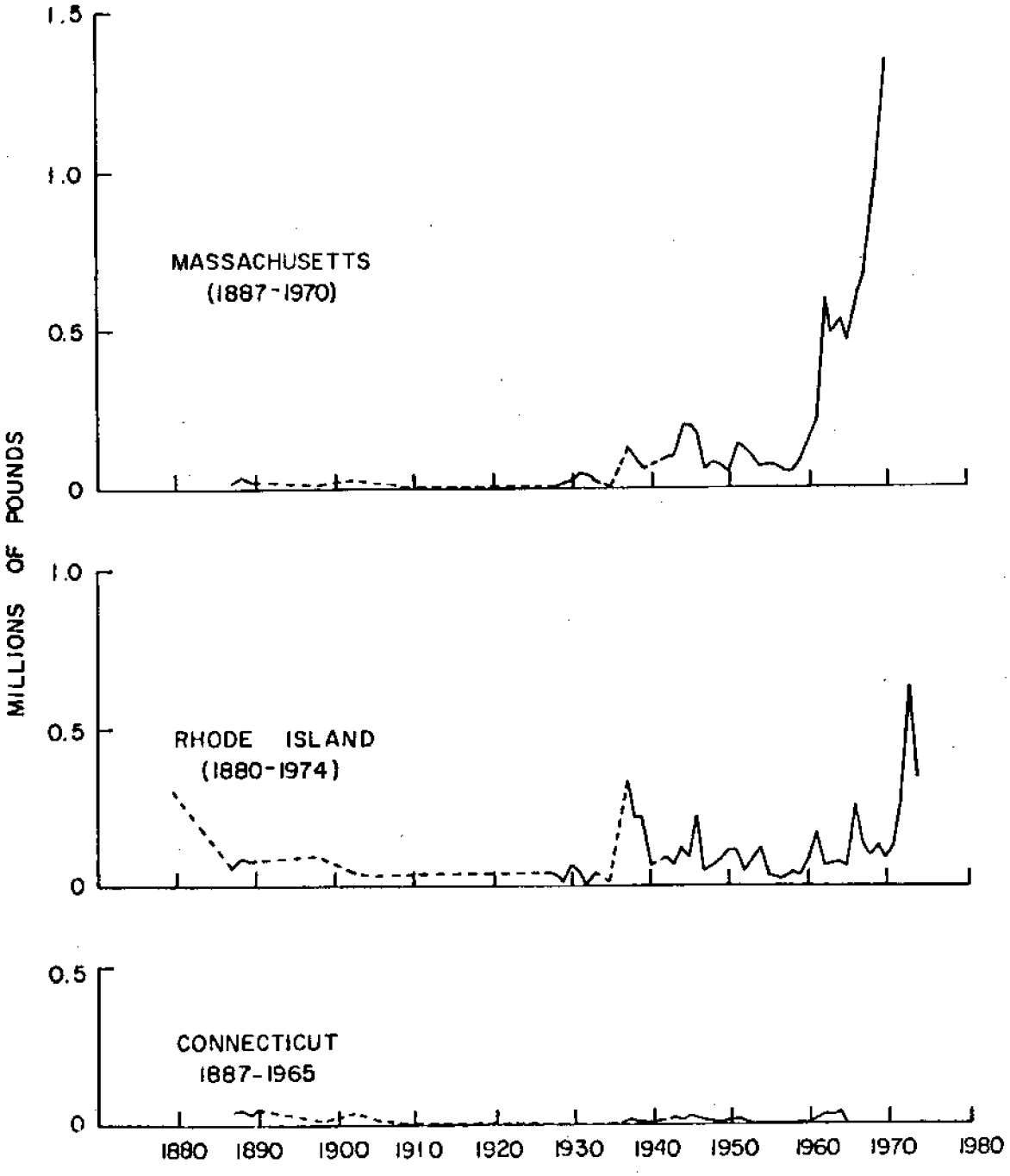


Figure 5.--Commercial striped bass landings - Massachusetts, Rhode Island, and Connecticut.

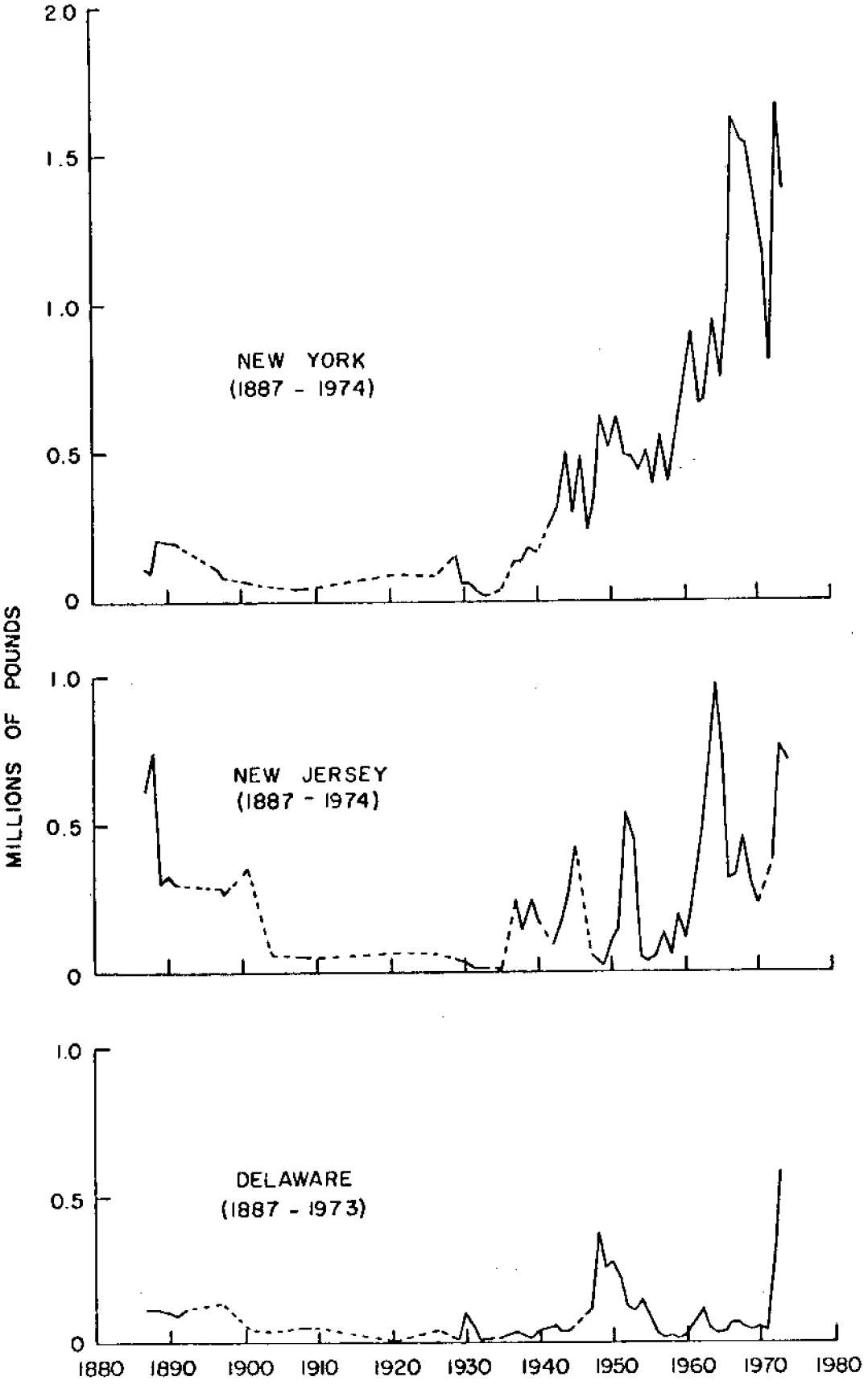


Figure 6.--Commercial striped bass landings - New York, New Jersey, and Delaware.

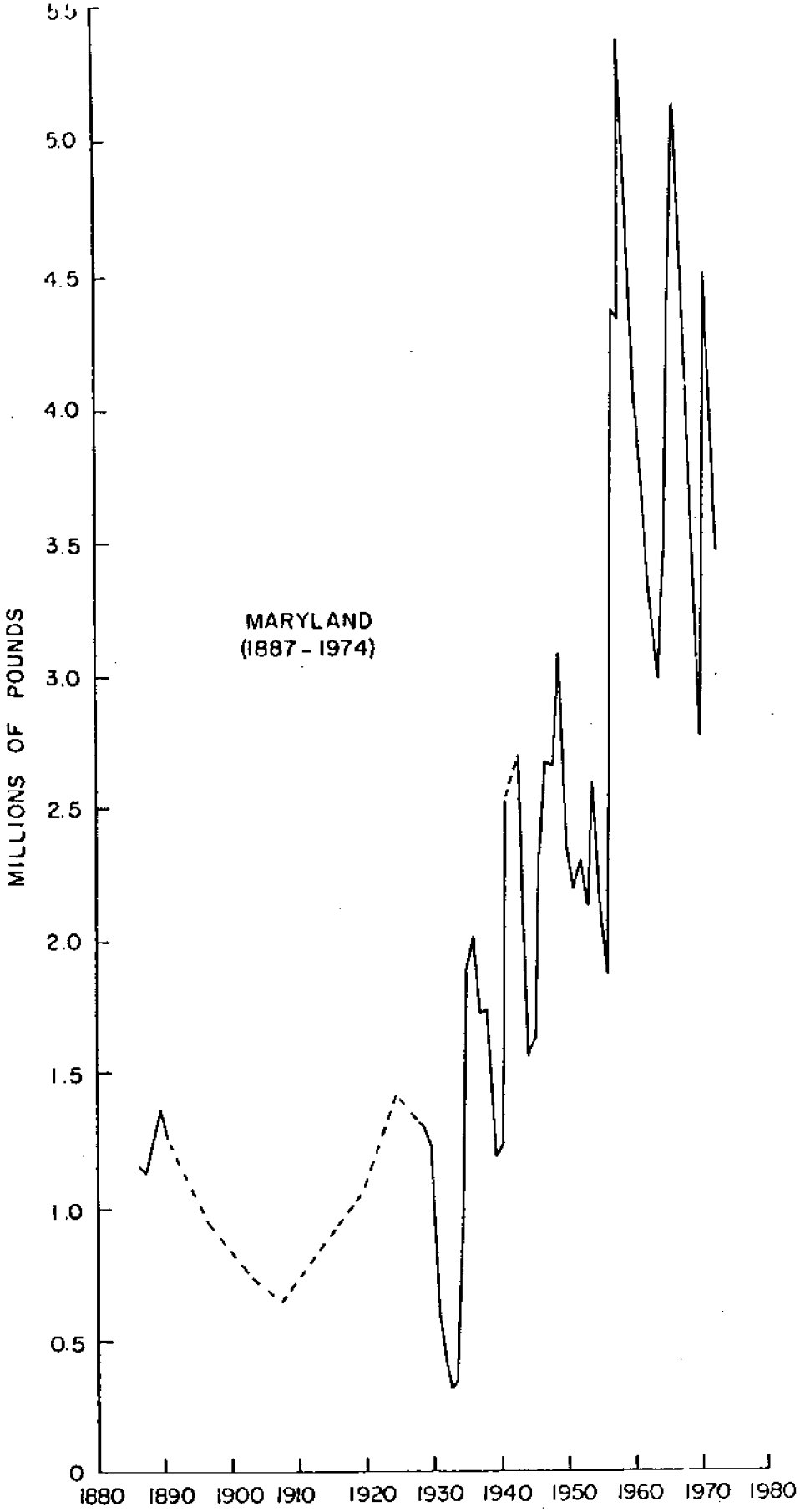


Figure 7.--Commercial striped bass landings - Maryland.

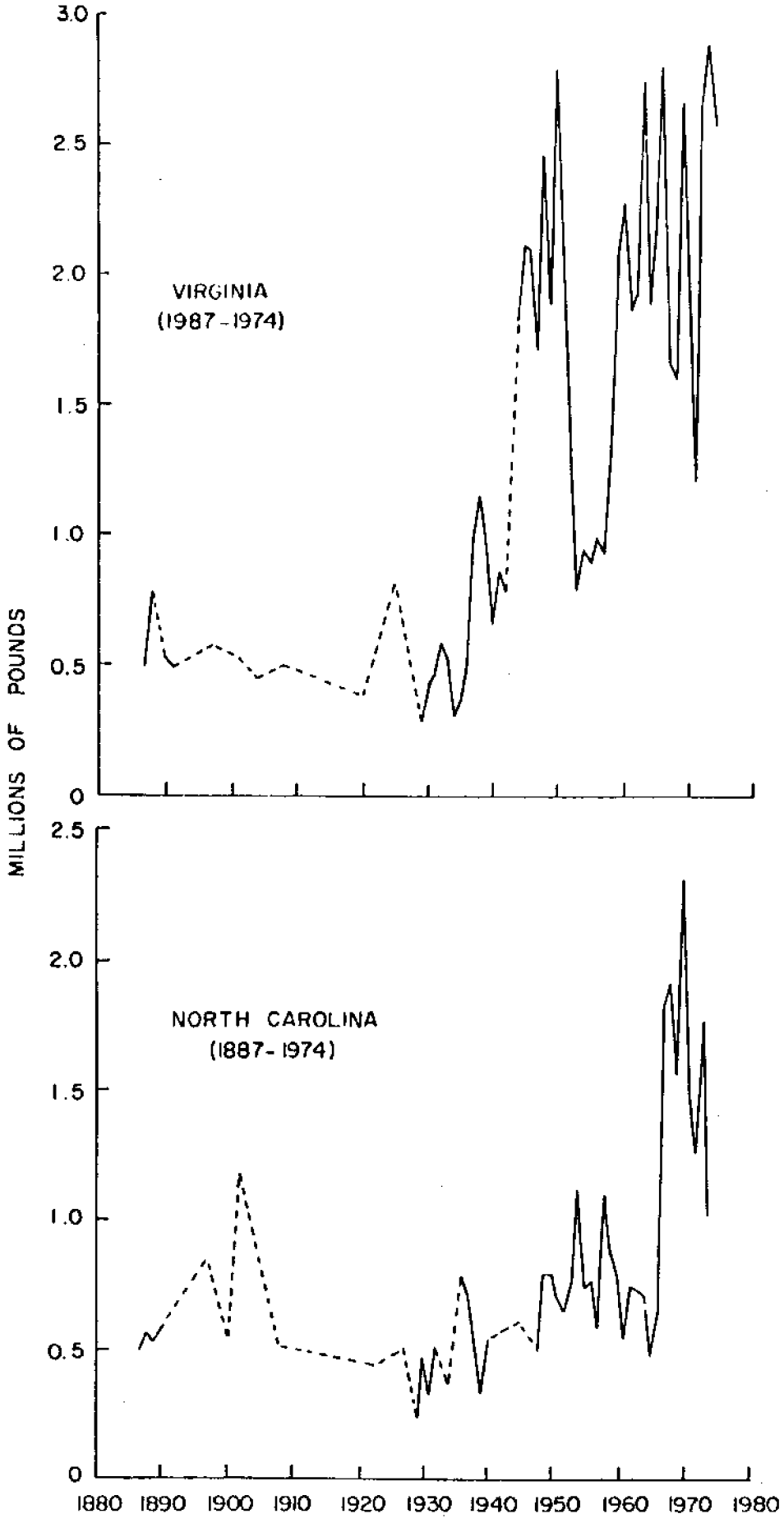


Figure 8.--Commercial striped bass landings - Virginia and North Carolina.

Table 1 Recreational and Commercial Catches of Striped Bass - Northern and Middle Atlantic Coast.

Year/ Region	Millions of pounds of fish caught	Millions of fish caught	Thousands of striped bass anglers	Numbers of fish per angler	Numbers of pounds per angler	Numbers of pounds per fish
1960						
N. Atl.	12.340	2.742	180	15.2	68.6	4.5
Mid-Atl.	24.810	6,530	298	21.9	83.3	3.8
Total (Rec.)	37.150	9.272	478	19.4	77.7	4.2
Total (Comm.)	8.551					
Total	45.701					
1965						
N. Atl.	47.999	13.199	318	41.5	150.9	3.6
Mid-Atl.	7.351	2.783	295	9.4	24.9	2.6
Total (Rec.)	55.350	15.982	613	26.1	90.3	3.1
Total (Comm.)	7.712					
Total	63.062					
1970						
N. Atl.	45.844	4.309	368	11.7	124.6	10.6
Mid-Atl.	27.262	9.857	415	23.8	65.7	2.8
Total (Rec.)	73.106	14.166	783	18.1	93.4	5.7
Total (Comm.)	11.136					
Total	84.242					

Source - Clark (1962), Deuel and Clark (1968), Deuel (1973), Wheeland (1973)

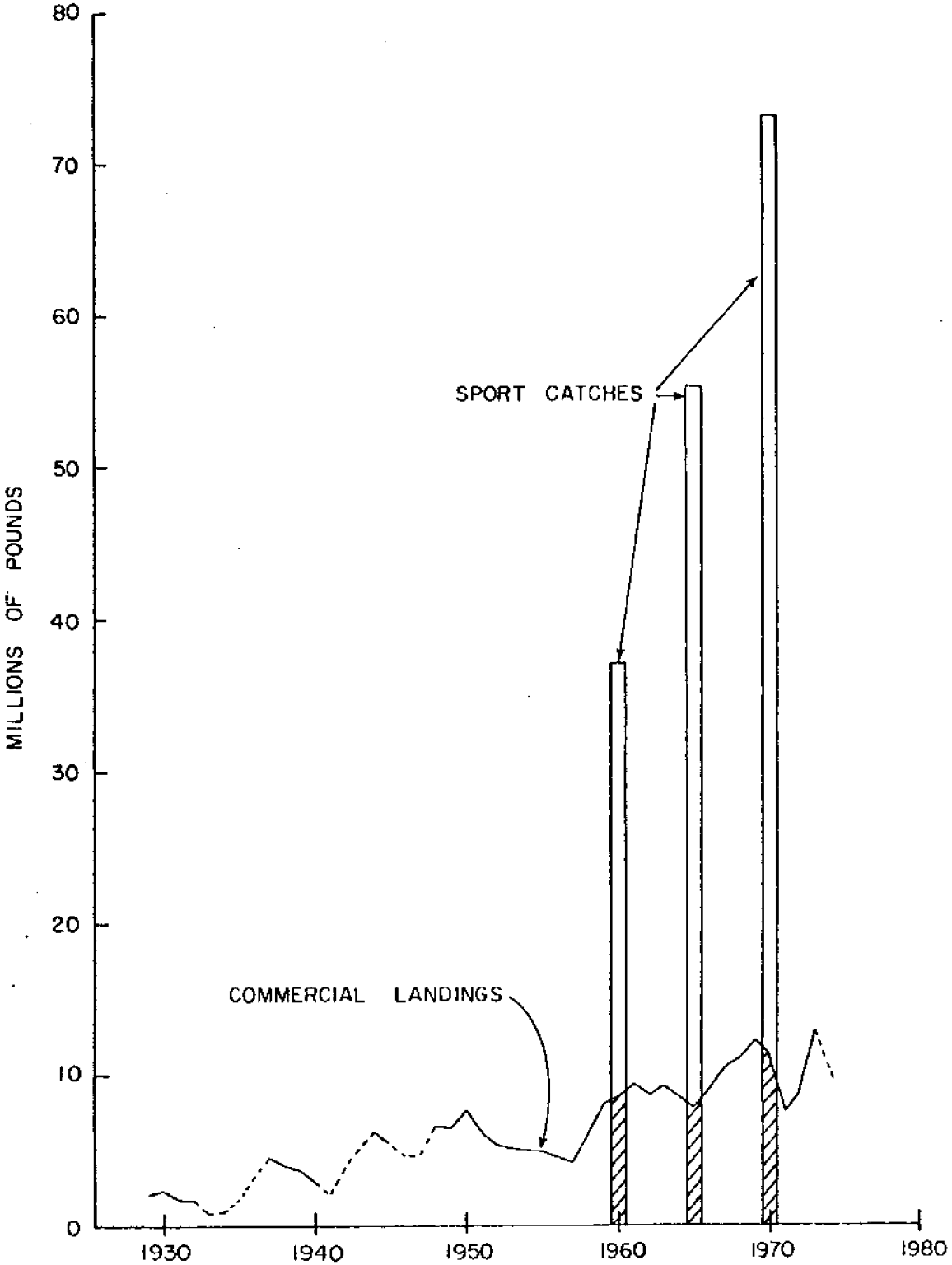


Figure 9.--Commercial landings of striped bass along the Atlantic Coast of the United States compared with sport catches for years in which estimates of sport catches are available.

Some estimates of numbers

These commercial and recreational landings statistics leave little room for doubt that an increase in abundance has occurred. Catches, unless they have been exaggerated, provide a minimum estimate of absolute abundance, because we know that not all fish in existence were caught. Therefore, it might be said with reasonable confidence that at least 14 million striped bass were in existence on January 1, 1970. It can be concluded also that the maximum sustainable yield of striped bass has an upper limit of at least 16 million fish, since somewhat more than that number were caught in 1965 without affecting future catches.

Catch per unit of effort

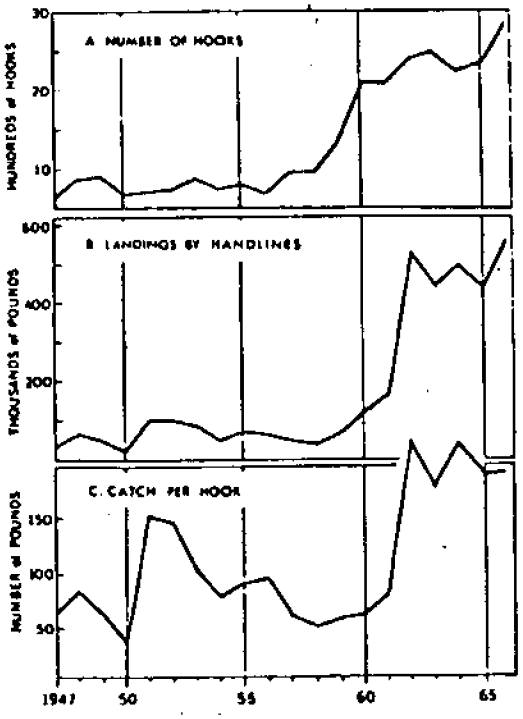
A more accurate method frequently used to derive indices of species abundance is based upon catch per unit of effort data. In addition, trends in success of fishing, usually in terms of catch per unit time by a standard unit of gear, may also accurately reflect changes in abundance and availability. These methods, which take varying amounts of fishing effort in different areas and in different years into account, provide more information than just trends in abundance. Using accurate catch and effort data one may, in some circumstances, estimate the level of maximum sustainable yield (MSY). The details and theory behind this method are discussed by Schaefer (1959) and Gulland (1968).

Koo (1970) performed what appears to be the only major catch and effort investigation of the striped bass

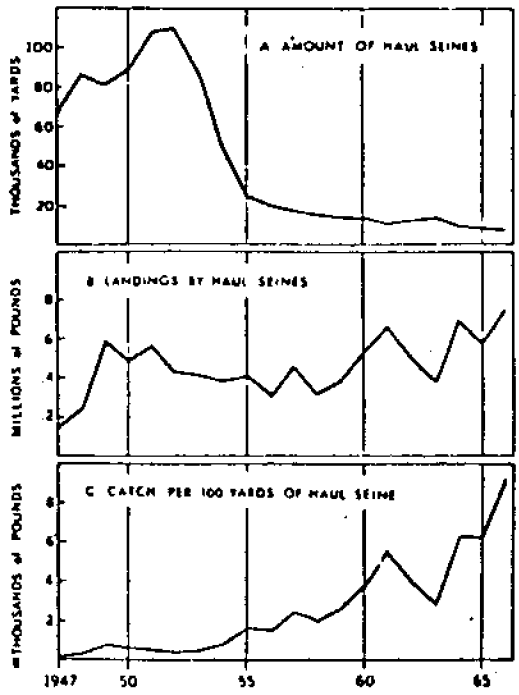
fisheries of New England, Mid-Atlantic, Chesapeake, and South Atlantic regions. Direct information on catch and effort from fishermen's log books or from interviews was not available. Therefore Koo (1970) used the catch per unit of licensed gear, information which is contained in statistics published by the federal government. Only the major striped bass fishing state, in each region, and the major gears were used in the calculations. To calculate catch per unit of gear, for states in which more than one gear was significant, it was necessary to convert all gears into a standard fishing unit. Koo used the pound net as the standard fishing unit, and all other gears were converted into equivalent pound net units by comparing the mean catch between the pound net and the gear in question (Koo, 1970).

In the New England region Massachusetts landed the most striped bass. Hand lines accounted for more than 90 percent of the total (Fig. 10). It is evident that the increase in Massachusetts landings in the early 1960s was correlated with an increase in the amount of licensed gear and in the catch per unit of such gear. There appeared to be a definite increase in abundance (Koo, 1970), assuming that all licensed gear was used with equal intensity, or if not, that there was no significant change in fishing intensity over the twenty (20) year period.

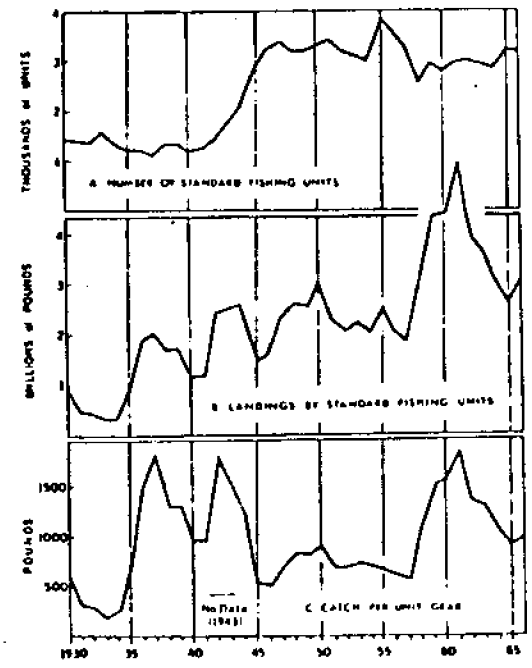
New York State had the largest striped bass landings for the Middle Atlantic region. Haul seines accounted for 76 percent of the total landings. From 1947 to 1966 the number of nets licensed was greatly reduced, while catch per unit of gear tended to increase, with some fluctuations (Fig. 10). This suggested a relatively



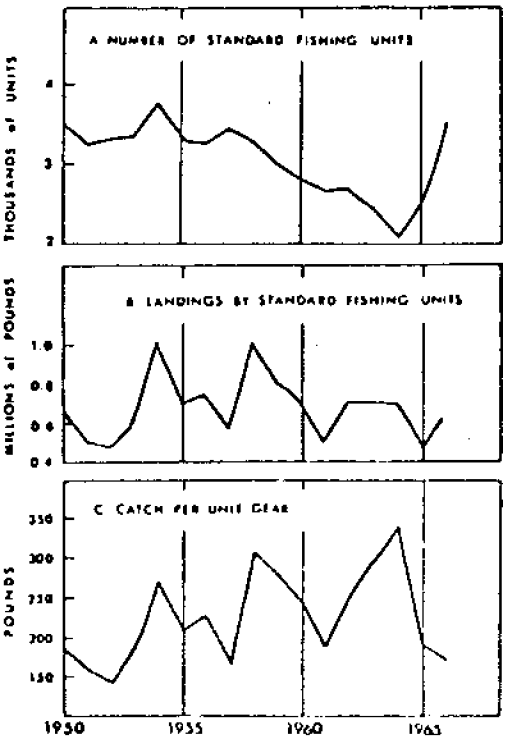
Massachusetts striped bass landing statistics.



New York striped bass landing statistics.



Maryland striped bass landing statistics.



North Carolina striped bass landing statistics.

FIGURE 10 - Striped bass landing statistics - Catch / Unit Gear (Koo, 1970)

large increase in abundance for this region (Koo, 1970).

In the Chesapeake region Maryland dominated landings. Pound nets, haul seines, and drift and fixed gillnets accounted for 98 percent of the total striped bass landings. Fluctuations in landings and catch per unit of gear were similar and appeared to reflect changes in abundance. The catch per unit of gear for the Chesapeake region appears to have stayed relatively constant, with some fluctuations (Fig. 10) (Koo, 1970).

North Carolina is the only state in the South Atlantic region which lands large quantities of commercially caught striped bass. Fixed gillnets, haul seines and pound nets accounted for almost 90 percent of the total landings (Fig. 10). Fluctuations in the landings were reflected fairly closely in the catch per unit licensed gear and were assumed to be due to direct changes in abundance of fish (Koo, 1970).

Koo (1970) concluded that the long-term rising trend in striped bass landings along the Atlantic Coast since the early 1930s, exclusive of North Carolina, was due mainly to a true increase in abundance of striped bass. Koo also concluded that at the present (1966) rate of exploitation in the New England, Mid-Atlantic, and Chesapeake regions the striped bass resource was in no danger of being commercially overharvested. He also concluded that the South Atlantic striped bass fishery fluctuates independently of northern stocks and there is no evidence to indicate a long-term rising or declining trend in abundance (Koo, 1970).

Relation between Chesapeake and northern catches

Another application of catch per unit of effort data

was used by Schaefer (1972) in an attempt to develop a method to forecast future relative abundance of striped bass in Long Island waters. Schaefer pointed out that many investigators have observed that increased commercial landings of striped bass occur along the northeastern Atlantic Coast several years after production of an exceptionally large or "dominant" year-class of striped bass, in Chesapeake Bay (Schaefer, 1972). Between 1954 and 1974, the Fish and Wildlife Administration of Maryland has monitored, by experimental haul seining, annual striped bass brood production by measuring the number of young-of-the-year per standarized unit of effort. These catch per unit of effort data were used as an indicator of year-class abundance in Chesapeake Bay. New York State commercial striped bass landing statistics were used as relative indicators of annual striped bass abundance in waters surrounding New York. Schaefer compared these two indicators by regression analysis.

Schaefer's work suggested that approximately seventy (70) percent of the variability in annual New York commercial striped bass landings could be explained by previous fluctuations in year-class production in Chesapeake Bay (Schaefer, 1972). Expanding upon this relationship he claimed to forecast the New York State commercial catch of striped bass for 1972 to 1974 (Table 2). Actual commercial landings in those years were well within the predicted range (Table 2).

Tag returns

Many investigators have conducted extensive striped bass tagging programs, usually to study migration habits of the striped bass. Tagging is yet another way of esti-

Table 2 Schaefer's Forecasted Commercial Landings of Striped Bass for New York State

Year	Forecasted Landings	Actual Landings (Pounds)
1972	908,000 ± 141,000	818,000
1973	1,455,000 ± 231,000	1,674,000
1974	1,607,000 ± 289,000	1,379,000

mating relative species abundance and of calculating rates of fishing. A known number of tagged fish are liberated into the population. Assuming that these fish distribute themselves randomly throughout the entire population, actual abundance can be calculated from the ratio of tagged to untagged fish in the catch. This gives an estimate of fishing mortality or the rate of exploitation upon the entire population available to the fishery. These same data can be used as a rough method of estimating species abundance. Some investigators believe that tagging data should not be used to estimate fishing mortality because of the effect of emigration and immigration throughout the area fished (Clark and Marr, 1955). Other investigators, however, believe that tagging data can be used to yield estimates of fishing mortality and abundance, the error of which is usually not known (Ricker, 1940; Clark and Marr, 1955). Several other problems are associated with this method: loss of tags from fish, possible increased susceptibility of tagged fish to capture or predation, failure of some fishermen to return tags, and possible higher mortality of tagged fish due to the tagging procedure and the type of tag employed.

Recently, tagging has been carried out by New York Ocean Science Laboratory (NYOSL). Investigators from NYOSL have been tagging and studying "short" striped bass, those below the 16 inch minimum size limit for New York State, caught in commercial gear. Tagging studies of these small striped bass, mostly two or three year old fish, enable the investigators to monitor and estimate annual year-class variations. Initial tag returns and the work of several other investigators (Merriman, 1941; Raney, 1952; Alperin, 1966a,b; Schaefer, 1968a; Koo, 1970)

seem to indicate that most of these small bass were on their first migration from Chesapeake Bay spawning and nursery grounds. One of the major results of this study concerns differences in size between the two year old striped bass tagged in 1972 (1970 year-class), which averaged 10.2 inches fork length (FL), and the two year old fish tagged in 1974 (1972 year-class), which averaged 12.5 inches FL. It appears that these differences are due to natural fluctuations in spawning success, fluctuations in young-of-the-year survival, and the effect of crowding on food supply and growth, before the striped bass commence their first migration out of Chesapeake Bay. During years of large commercial landings in New York State, the catches are composed primarily of "short" striped bass, while in other years when landings are low fish of the same age tend to be fewer but larger (Austin and Hickey, 1974). Using a formula similar to Schaefer's (1972), New York commercial striped bass landing statistics and information collected on annual size variations have been correlated into a mathematical relationship by NYOSL investigators. By monitoring the size of two year old striped bass, migrating into waters surrounding Long Island, and entering this information into the formula, it has been suggested that future commercial striped bass landings can be predicted (Austin and Hickey, 1974).

Status of knowledge

A fundamental problem with the methods of Koo (1970), Schaefer (1972), Austin and Hickey (1974) and others is that they can only estimate with a limited degree of accuracy and on a short-term basis the future of New York

State commercial striped bass landings. Until further well coordinated research has been carried out, especially in collecting detailed and accurate catch and effort data for the entire Atlantic Coast, examination of trends in commercial landings, catch per unit of gear data, and short-term forecasts will remain as the only means of estimating striped bass abundance. Commercial and recreational catch and effort data are needed to determine the effects of fishing upon abundance of the resource. To date, there is no evidence that striped bass is being overfished. This is evident from the continual increase in commercial landings without a proportional increase in commercial fishing effort. This does not mean, however, that this situation will continue indefinitely.

Assertion No. 2: Commercial fishing is destructive

The same people who are convinced that striped bass abundance is declining also claim that the commercial striped bass fishery is "destructive." Occasionally verbal and even physical confrontations have occurred between recreational and commercial striped bass fishermen. These conflicts appear to result from misunderstanding the magnitude of commercial versus recreational catches, confusion over the significance of short-term versus long-term trends, disagreement over who has the right to fish an area at a given time, and conflicting opinions over the relative value of recreational versus commercial striped bass fishing.

During the past 15 years over 90 legislative proposals to regulate striped bass fishing have been introduced into the New York State Assembly and Senate, most on behalf of sportfishing organizations and their members. Many of these bills seek to limit or prevent all commercial striped bass fishing within New York State waters (Ginter, 1974). Although such bills often are justified as conservation measures, they really deal only with the social question: who should get what share of the catch? The striped bass resource, like all other fishery resources, can produce only a finite yield. If that level of catch is exceeded, more fishing will produce a smaller total yield, no matter who takes the catch. The scientific question that must be answered is: what is the maximum allowable catch? Within that limit, allocation of the total catch between recreational and commercial fishermen, or a decision to declare striped bass a game fish, are purely social-political, not scientific decisions.

Evidence which supports the assertion

Prevailing views of recreational fishermen, reflected in most of the proposed New York State striped bass legislation, are based upon a paradox. Recreational fishermen take one fish at a time and possibly a few fish a day. For economic reasons commercial fishermen must take fish in large quantities. The paradox is that there are many recreational striped bass fishermen, estimated in 1970 as numbering 783,000 along the northern and middle Atlantic Coast (Deuel, 1973), but relatively few who fish the species commercially. Available statistics have shown that recreational fishermen, who make many small catches, took 6 to 7 times as much striped bass by weight in 1970 as did commercial fishermen, who make fewer but larger catches (Fig. 9). This is usually not evident, however, to the individual recreational fishermen.

When a surf caster sees a haul-seine crew on the beach near where he is fishing land tons of fish in a short time, rarely will anyone be able to convince that recreational fisherman that commercial fishing is not "destructive." In fact, at that instant of time the chances of that recreational fisherman catching a striped bass have been significantly reduced, because the numbers of fish available to him at that location have been reduced substantially. In that sense the paradox is not exactly a paradox. However, when one considers the thousands of other recreational fishermen who are fishing at the same time in other areas not utilized by haul seiners one begins to understand how it was possible that recreational fishermen took 6 to 7 times as much striped bass by weight as did commercial fishermen in 1970.

An additional source of evidence used to support the assertion of "destructive" commercial fishing are historical landings statistics. These old catch statistics, in conjunction with early records from sport fishing organizations and some scientific evidence, seem to indicate a definite decline in abundance or availability of striped bass from the late 1800s to the mid-1930s. Representatives of recreational fishing organizations often claim that this decline in landings was the result of overfishing by commercial striped bass fishermen. Scientific papers published in the 1930s and 1950s (Pearson, 1938; Raney, 1952) have been cited in support of this argument. Commercial overfishing is one of many possibilities, for in the late 1800s there was heavy market demand for large quantities of very small immature striped bass (Harris and Bean, 1905). In addition to overfishing, however, several other factors could have been just as significant in bringing about a decline in striped bass landings. Detrimental environmental factors resulting in decreased abundance, economic conditions resulting in a decrease in fishing effort, and changes in availability of striped bass to the fishery, all are possible explanations. The incompleteness of much of the available evidence makes it impossible to state exactly what caused this early decline in striped bass landings. It cannot be doubted seriously that the trend has been definitely upwards for the last forty (40) years (Koo, 1970; Wheeland, 1973; McHugh, 1974a; McHugh, 1975 (ms)).

Evidence which refutes the assertion

Commercial catches

The Atlantic Coast commercial striped bass fishery extends from Massachusetts to North Carolina inclusive. Occasionally small commercial landings of striped bass have been recorded for Maine and New Hampshire, but these are relatively insignificant in comparison to total Atlantic Coast landings. The Chesapeake Region (Maryland and Virginia) ranks first in total striped bass landings by weight for the Atlantic Coast (Fig. 11). The Middle Atlantic (New York to Delaware inclusive), South Atlantic (North Carolina to Florida inclusive), and New England (Maine to Connecticut inclusive) Regions rank second, third, and fourth, respectively, in total striped bass landings by weight (Fig. 12). Commercial striped bass fishing is legal only in Rhode Island, New York, Delaware, Maryland, Virginia, and North Carolina. All Atlantic Coast states, Maine to North Carolina inclusive, except for Connecticut, permit the sale of recreational catches of striped bass and also permit the sale of striped bass caught incidentally in nets set for other species or caught outside the jurisdictional waters of the states. This helps to explain why Massachusetts (Fig. 5) and New Jersey (Fig. 6), which supposedly do not have commercial striped bass fisheries annually record relatively large commercial landings of striped bass.

The low point of commercial striped bass landings for Atlantic Coast states, Massachusetts to North Carolina inclusive, occurred in the late 1920s or early 1930s. Prior to this period, statistics are available only for scattered years and their accuracy is questionable (McHugh, 1974a; Knapp, 1974). According to these statistics

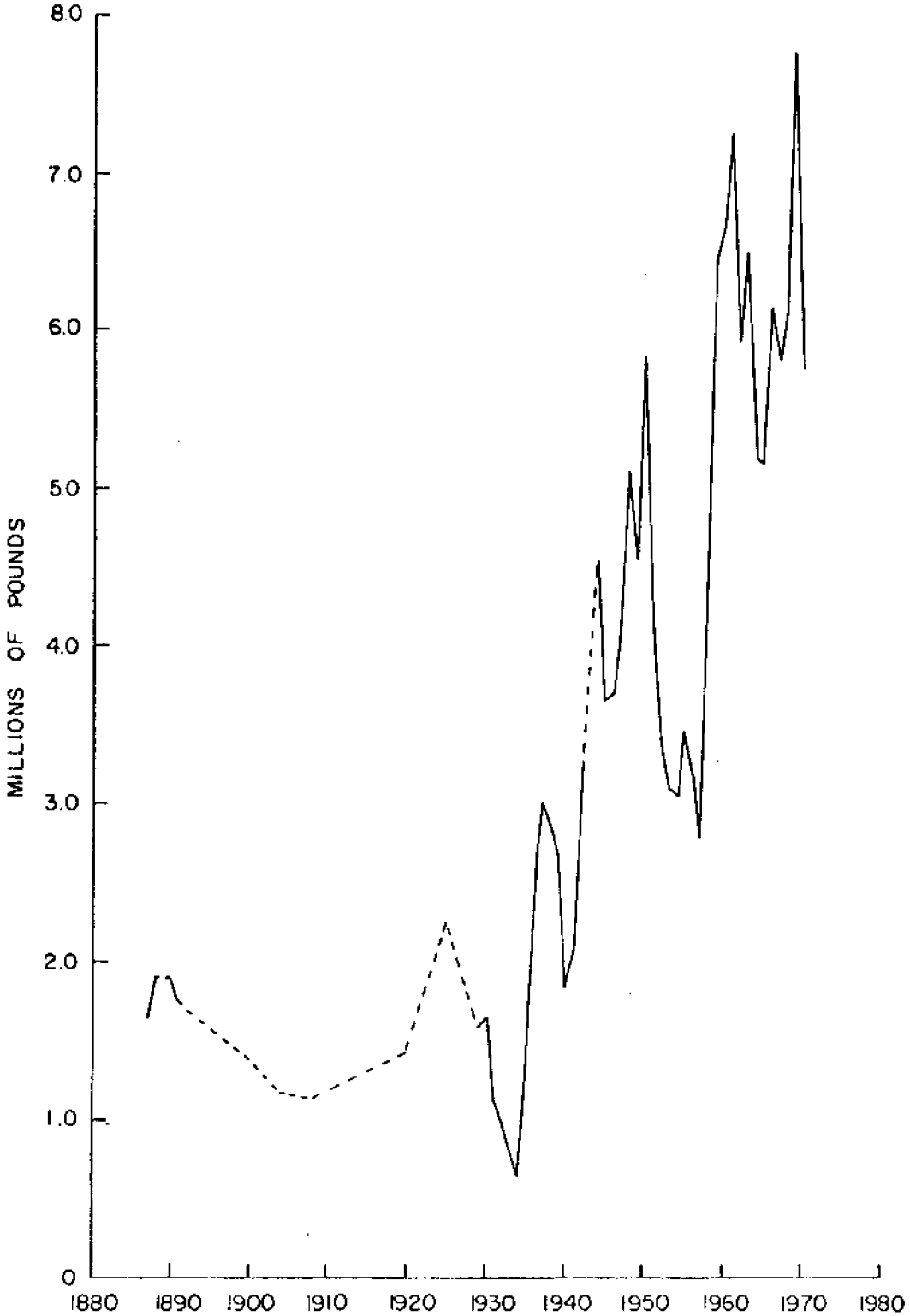


Figure 11.--Chesapeake Region commercial striped bass landings.

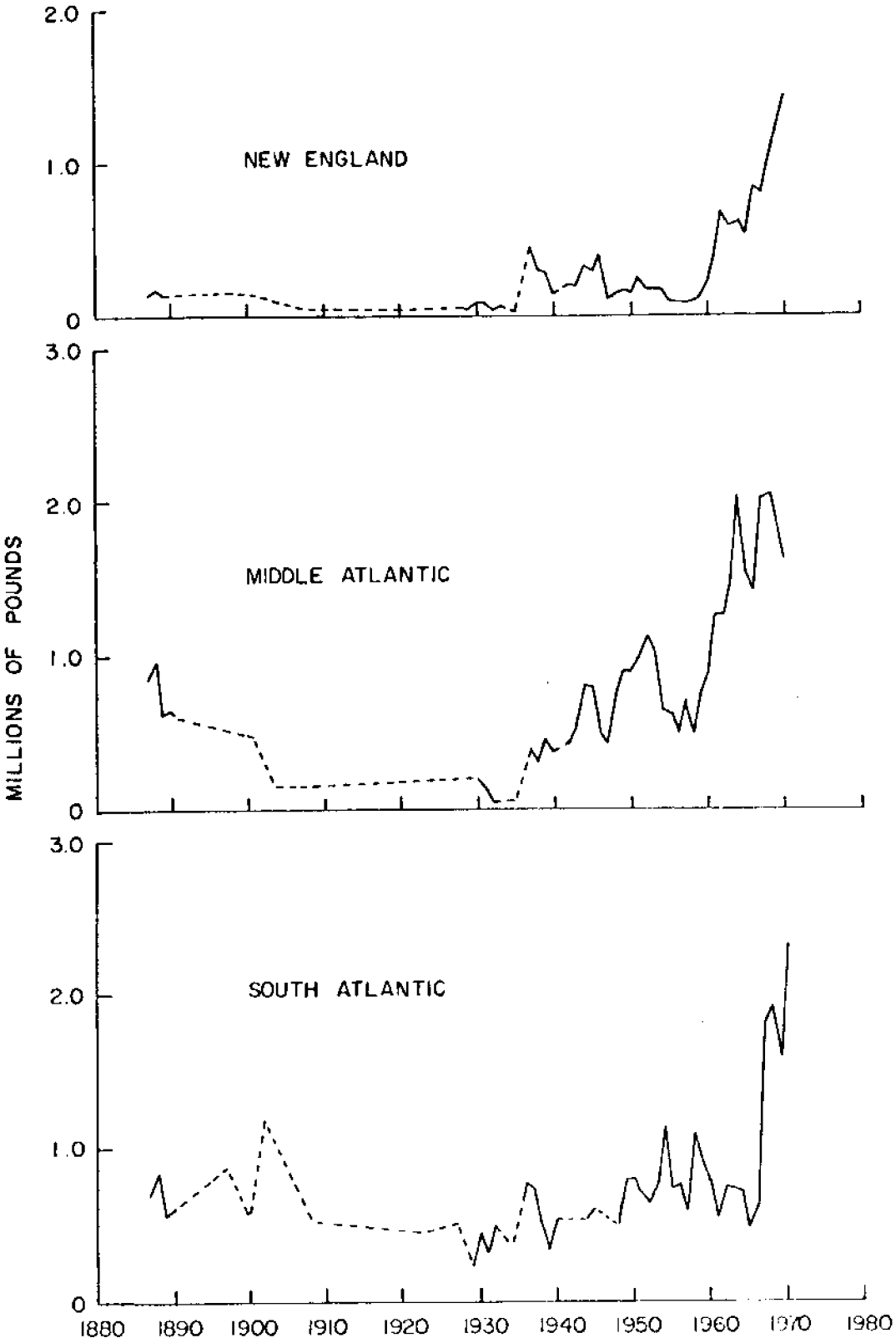


Figure 12.--Regional commercial striped bass landings - New England, Middle Atlantic, and South Atlantic.

and available scientific evidence, striped bass landings for all Atlantic Coast states north of Chesapeake Bay from the early 1900s to the early 1930s appear to have been at very low levels, usually less than one hundred thousand pounds per state per year. In 1934 the striped bass catch reached the lowest point in history when total commercial landings for the entire Atlantic Coast were barely over one million pounds (Koo, 1970). According to Taylor (1951) the landings of several major fisheries along the Atlantic Coast declined during the 1930s. He suggested that this was not entirely the result of a scarcity of fish or a large decline in abundance of most fishes, but rather, the pattern of behavior of United States fish production was typical of the United States business cycle (Taylor, 1951). Therefore, as business declined during the depression so did the landings of striped bass and many other fisheries. Taylor (1951) also suggested that as business began to improve, after the depression, better fishery technology, biological abundance, and favorable economic factors brought about an increase in total Atlantic and Gulf Coast fish production, an increase which generally keeps pace with the continual United States population growth (Taylor, 1951). An upward trend in commercial striped bass landings is evident since the mid-1930s for all Atlantic Coast states, Massachusetts to North Carolina inclusive, excluding Connecticut (Figs. 5 - 8).

High visibility as a factor in the striped bass controversy

Much of the 'evidence' which supports the assertion of "destructive" commercial fishing comes from emotional accounts by recreational fishermen who have viewed commer-

cial fishing activities in or near the same areas in which they pursue their favorite sport. One basic reason the striped bass controversy exists is simply because commercial haul-seine fishing activities are highly visible and viewed with concern by recreational fisherman and environmentalists, whether that concern is justifiable or not. Commercial and recreational fishermen want to be where the fish are. Consequently, they often will be fishing in the same places. The major problem, therefore, appears not to be so much a question of destructive commercial fishing but rather simply an issue of visibility. Evidence which supports this conclusion comes from historical records of three important fisheries, in the Middle Atlantic Bight (Cape Cod to Cape Hatteras), for striped bass, menhaden (Brevoortia tyrannus), and scup or porgy (Stenotomus chrysops).

Visibility of striped bass fishery

Striped bass has supported commercial fisheries since the early colonial period. One of the earliest indications that the resource was being harvested commercially is an early 1630s court order which prohibited use of readily abundant striped bass as farm fertilizer. In addition, partial financing of the first public schools in the new world was made possible by income generated from the colonial striped bass, mackerel, and herring fisheries of the New England region (Pearson, 1938). Early popularity of striped bass as a recreational species is evident in the records from many of the older striped bass angling clubs, such as the famous Cuttyhunk Club, established in 1865 at Cuttyhunk, Massachusetts (Harris and Bean, 1905).

Striped bass still supports major commercial and recreational fisheries in the Middle Atlantic Bight. In New York State the major commercial striped bass fishing method, since 1950, has been haul seining, usually on flat

open ocean beaches at the eastern end of Long Island. This is also a very popular recreational striped bass fishing area. In this area surf casting and trolling are the preferred sport fishing methods.

Total Atlantic Coast commercial striped bass landings by weight have increased from a record low of slightly more than one million pounds in 1934 to a high of almost 13 million pounds by 1973 (Fig. 4). From available evidence it appears that the upward trend in Atlantic Coast commercial striped bass landings, since the mid-1930s, resulted from a combination of environmental, biological, economic, and technical influences upon the Atlantic Coast striped bass population. It appears unlikely that this increase in landings could be solely the result of increased commercial fishing effort or "destructive" commercial fishing activities. A substantial increase in commercial fishing effort, if it had occurred, would have been documented in federal statistics. In addition, according to several investigators commercial fishing effort for striped bass has remained relatively constant or increased only slightly during the past forty years, while recreational fishing effort has shown a steady increase (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973; Koo, 1970; Wheeland, 1973; McHugh, 1974a; Knapp, 1974). As already mentioned, the total recreational catch of striped bass by weight was 6 to 7 times as large as the commercial catch along the Middle Atlantic and New England coast in 1970 (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973; Wheeland, 1973).

Visibility of menhaden fishery

Menhaden has long been an important industrial fish along the northeastern Atlantic Coast. Peak landings, from Rhode Island to Delaware inclusive, of over one

billion pounds were reached in 1956 and then dropped to a low of 22 million pounds by 1966 (McHugh, 1974a). In 1962, peak landings of menhaden were recorded in New York State. Since 1962, however, menhaden landings for New York have declined to insignificant levels. The early 1970s, however, have shown a slight increase in menhaden catches for the entire Atlantic coast, and substantial increases from New Jersey to New England.

Menhaden travel in dense schools at or near the surface and are usually captured by large encircling nets called purse seines. Recreational fishermen claim that menhaden is the principal food of striped bass and bluefish(Pomatomus saltatrix) in Long Island Sound. When large quantities of menhaden were removed by commercial fishing from near shore waters and bays of Long Island Sound recreational fishermen believed that striped bass and bluefish would be caught along with the menhaden or would leave the area to find menhaden elsewhere. Striped bass and bluefish are very voracious feeders. They will feed on whatever forage or "bait" fish, crabs or other invertebrates are most abundant in a particular area (Hildebrand and Schroeder, 1928; Hollis, 1952; Bigelow and Schroeder, 1953; Mansueti and Hollis, 1963; Talbot, 1966). Therefore, if menhaden are not available they will turn their attention towards some other available source of food in the area and will not necessarily travel to another area in search of menhaden. Neither scientific evidence, nor the increased menhaden landings along the Atlantic Coast during the early 1970s influenced the decisions of New York State legislators, for in July, 1974, a New York State law went into effect which prohibits commercial menhaden fishing from inshore areas and bays

along the north shore of Long Island and the south shore of Westchester County (New York State Environmental Conservation Law Bill #A-8562B). As a result of this regulation commercial menhaden purse seining may take place only in the central portions of Long Island Sound where previously fewer menhaden were caught. But more important, commercial menhaden fishing is now less visible to recreational fishermen on or near shore and this appears to be the main basis for this type of regulation.

Visibility of scup fishing

The scup fishery became increasingly important in New York during the 1940s and 1950s. New York State commercial landings of scup reached a maximum of almost 14 million pounds in 1958. Scup dominated New York landings of food fish by trawlers from 1948 to 1966 (Knapp, 1974). Between 1953 and 1961 inclusive scup ranked first by weight of all food fishes and shellfish landed in New York State (McHugh, 1972). The abrupt decline of New York scup landings began in 1959 and by 1970 the commercial catch had declined to just over one million pounds (Fig. 13).

Scup tend to concentrate in winter along the 200 meter contour from Cape Hatteras to the Hudson Canyon and to areas east of Long Island from November to March. Most landings made prior to the mid-1960s were made beyond the 3 mile limit in January to April inclusive. This suggests that the winter and early spring offshore trawl fishery was most important to total New York commercial scup landings (Knapp, 1974). Beginning in April schools of scup migrate north and west from their offshore overwintering areas into inshore waters around Long Island and southern New England (Bigelow and Schroeder, 1953). It is in these areas that a large summer recreational fishery for scup has developed. Briggs (1968) noted that

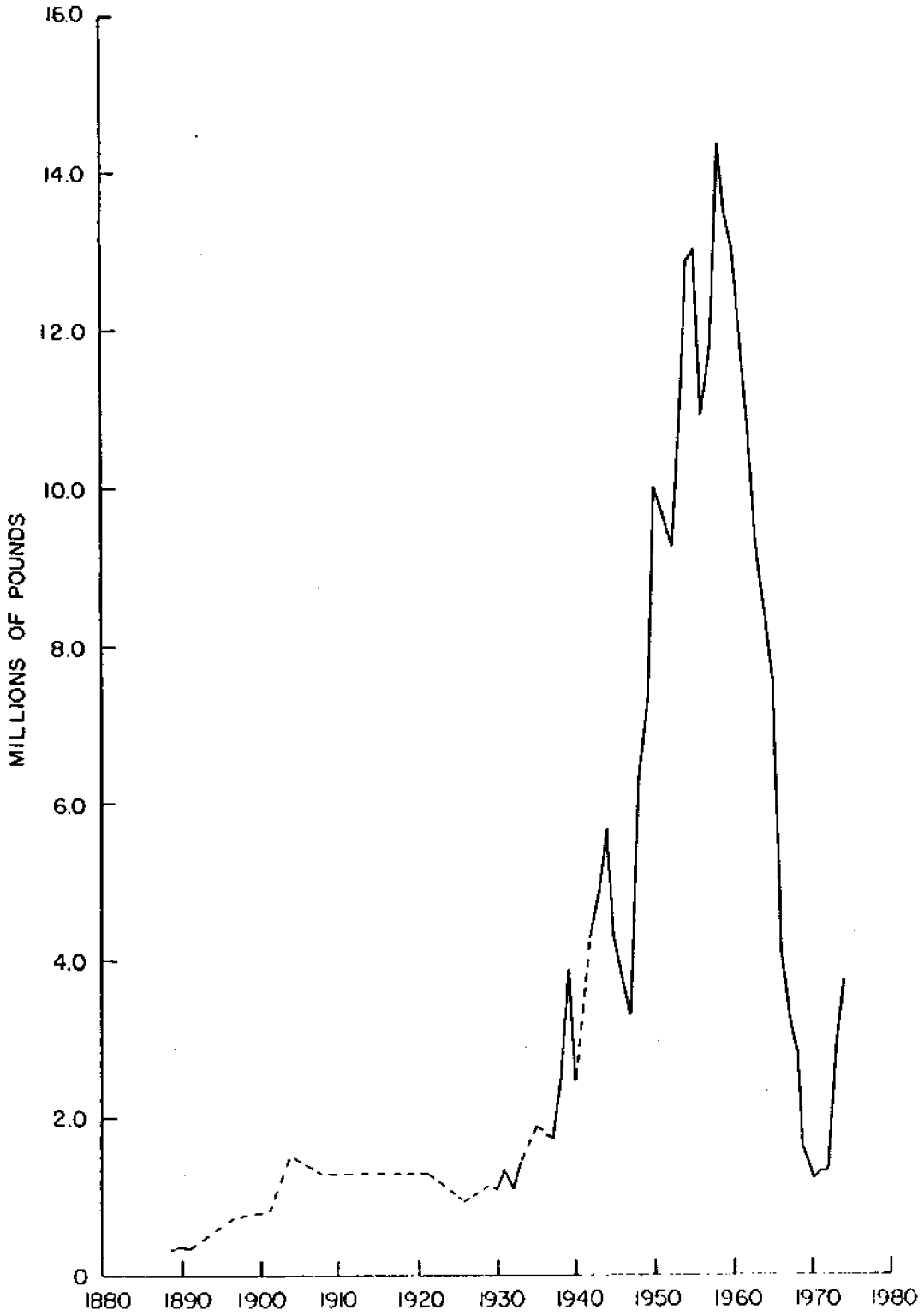


Figure 13.--New York State commercial scup landings 1889-1974.

scup were the most important species (by numbers) caught by recreational fishermen in the bays of eastern Long Island (Briggs, 1968).

Total recreational and commercial scup landings by weight for the entire Atlantic Coast have shown a decline from 1960 to 1970 (Table 3). Total commercial scup landings declined from 49 million pounds in 1960 to 10.4 million pounds in 1970. Recreational scup landings showed a similar, but not as drastic, decline from 36.7 million pounds in 1960 to 28.4 million pounds in 1970 (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973). The causes of this decline are not yet fully understood. However, scup have varied widely in abundance in the past from natural causes (Neville and Talbot, 1964), and the resource has increased somewhat in abundance in the last few years. If overfishing has been the main cause of this decline recreational fishing was as much responsible as commercial fishing. When a resource has declined to a low abundance level, for whatever reasons, it may be much more vulnerable to heavy fishing pressure (McHugh, 1972). It is not readily apparent that much concern has been shown by commercial or recreational fishermen over the decline of the scup resource. There has been no outcry by recreational anglers that the commercial scup fishery is "destructive" or pressure for restrictive legislation. During the past 15 years only four minor legislative proposals to regulate the scup fishery have been introduced in the New York State Assembly and Senate (Ginter, 1974).

Anomalous reasoning

How does one explain this apparent anomaly; in which the major harvesters (recreational fishermen) of a resource (striped bass) which has shown an increasing trend in abundance are vigorously trying to put the minor har-

Table 3 Recreational and Commercial Catches of Scup - Entire Atlantic Coast

Year/ Region	Millions of pounds of fish caught	Millions of fish caught	Thousands of scup anglers	Numbers of fish per angler	Numbers of pounds per angler	Numbers of pounds per fish
1960						
N. Atl.	13.420	14.909	256	58.2	52.4	0.9
Mid-Atl.	3.180	3.177	148	21.3	21.8	1.0
S. Atl.	20.050	10.553	262	40.3	76.5	1.9
Total (Rec.)	36.650	28.639	666	43.0	55.0	1.3
Total (Comm.)	49.159					
Total	85.809					
1965						
N. Atl.	10.150	10.819	280	38.6	36.3	0.9
Mid-Atl.	4.244	3.047	167	18.2	25.4	1.4
S. Atl.	23.213	13.337	231	57.7	100.5	1.7
Total (Rec.)	37.607	27.203	678	40.1	55.5	1.4
Total (Comm.)	35.823					
Total	73.430					
1970						
N. Atl.	2.296	2.850	202	14.1	11.4	0.8
Mid-Atl.	2.127	1.188	117	10.2	18.2	1.8
S. Atl.	24.059	16.230	488	33.3	49.3	1.5
Total (Rec.)	28.482	20.268	807	25.1	35.3	1.4
Total (Comm.)	10.432					
Total	38.914					

Source - Clark (1962), Deuel and Clark (1968), Deuel (1973), Wheeland (1973).

vesters (commercial fishermen) of the resource or some indirectly related resource (menhaden) out of business, whereas only a few government bureaucrats and scientists appear to have been worried about a fairly obvious example of unregulated exploitation of a major commercial and recreational resource (scup). The answer is lack of visibility. What the inshore menhaden fishery and the commercial striped bass haul-seine fishery have in common is that they are highly visible to recreational fishermen. The trawl fishery for scup, on the other hand, is not readily visible to recreational fishermen, for although scup are found in nearshore waters and bays in spring and summer, where they are caught in large numbers by recreational fishermen, most of the commercial catch occurs in winter and early spring off-shore.

Status of knowledge

Available information clearly suggests that the striped bass resource has increased in abundance for about the past forty (40) years. There is no evidence which suggests that levels of fishing effort up to the present time have harmed the striped bass resource. If in the future, however, evidence begins to accumulate that the resource is being overharvested, the major cause probably will be removals by recreational fishermen. Despite this evidence, much of it circumstantial, but convincing, recreational fishermen and their representative organizations are continuing to exert political pressure for legislation which would limit or prevent all commercial striped bass fishing in New York State waters.

From a conservationist's point of view, the scup situation should arouse more concern and is more deserving

of immediate attention, but one element is missing. There appears to be no constituency of recreational fishermen or environmentalists who identify with scup, the way a large number do with striped bass. Lacking public pressure for regulation, the scup resource, if not managed, may very well continue its decline. The commercial striped bass fishery may follow the course of the Long Island Sound menhaden fishery, simply because it is visible, and become restricted or prohibited. These conclusions seem inevitable if recreational fishermen and their representative organizations continue to exert political pressure to bring about their demands. Too often political decisions are dictated by pressure groups, and facts and logic play a minor role.

Assertion No. 3: Striped bass should be declared a game fish

The striped bass controversy revolves around two distinct issues, management of the resource for maximum (or optimum) sustainable yield, and allocation of the resource between recreational and commercial fishermen. To solve the controversy and develop an effective striped bass management program these issues must be dealt with separately. One is entirely a scientific question (how large can the catch be?) and the other is entirely a social-political question (who gets what portion of the catch?). As in most fishery controversies allocation of the catch is treated as if it were a resource conservation measure. Such assertions do nothing but confuse the real issues, further the controversies, and make the possibilities of effective management even more unlikely. In fact, in the striped bass controversy the question of who should get the catch has received more public attention and legislative action, thereby almost totally overshadowing the more important issue of management for maximum (or optimum) sustainable yield. Until the question of allocation has been answered it will be very difficult to enact a comprehensive management plan.

It is beyond the scope of this discussion to analyse the social-political implications of resource allocation, although the conservation question cannot be addressed without taking this conflict into account. The intention of the following discussion is to examine past, present, and future management possibilities for the Atlantic Coast striped bass fishery with special attention to the role of New York State in such a management scheme.

Management and legislation

A basic requirement for effective management of an anadromous migratory resource, such as striped bass, is uniform management policies and regulations throughout the entire range and life cycle of the species. Management of the Atlantic Coast (Maine to North Carolina inclusive) commercial and recreational striped bass fishery has mainly been by means of restrictive legislation, on an individual state by state basis. To date, there has been no comprehensive management plan for the entire Atlantic Coast striped bass fishery. Probably what is most evident about Atlantic Coast striped bass legislation is its non-uniformity. Examination of marine fisheries legislation by state indicates extreme variations in state philosophies and policies toward management of commercial and recreational striped bass fisheries (Appendix E).

Much of this legislation simply addresses the issue of allocation. This has been accomplished either by prohibiting all commercial striped bass fishing, as has been done in Maine, New Hampshire, Massachusetts, Connecticut, and New Jersey, or by enacting legislation which restricts or prohibits commercial striped bass fishing in certain waters under state jurisdiction. Restricting commercial striped bass fishing has usually been accomplished by closed areas, seasons, and fishing times, and by a wide variety of restrictions on gear and its method of operation. Some of these restrictions, if employed in the correct manner, could be effective management techniques; however, in this context they are not used as such.

Some states have enacted legislation which attempts, to a small degree, to regulate and manage their commercial striped bass fishery. Management techniques most

frequently employed are size limits, closed seasons and closed fishing areas (if enforced, closed seasons and closed areas may be useful in protecting spawning activities), fishing method and gear restrictions, licensing of some commercial fishermen, and pollution control and abatement programs. Some additional management techniques which may be instituted in the future, especially if a coastal management program is to ever be effective are, licensing of all commercial and recreational striped bass fishermen, commercial catch quotas, recreational bay limits, and limited entry.

Management of a fishery resource for maximum (or optimum) sustainable yield (MSY) requires basic information on species biology and the effect of fishing on the resource. Stocks of fishes tend to remain in dynamic equilibrium, neither falling to zero nor increasing without limit. Losses from the stock are balanced by inputs to the stock over a reasonably long period of time (Clark and Marr, 1955; Schaefer, 1957). To determine the MSY of a resource, stock size and at least four factors which increase or decrease stock size must be known (Fig. 14). Factors which tend to increase stock size are recruitment (entry into the stock of new catchable size fish) and growth (increase in weight of individual fish resulting in increased weight of the entire stock). Factors which decrease stock size are natural and fishing mortality.

Status of knowledge

Appendix F summarizes the status of knowledge for the striped bass resource. It is evident that although an extensive amount of research has been carried out on striped bass biology and its fisheries much of the information necessary to determine MSY is not available.

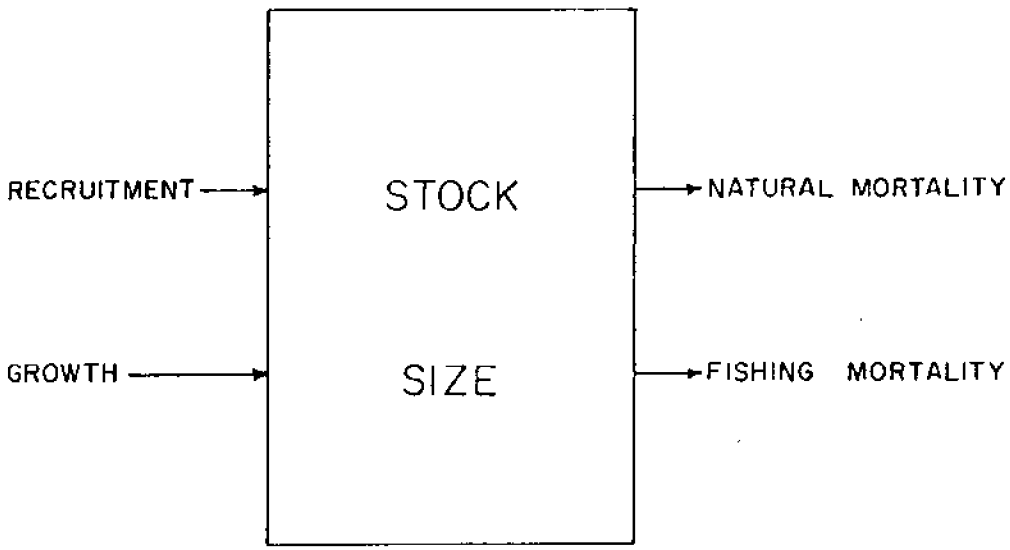


Figure 14.--Variables which affect stock size and yield.

Scientists investigating striped bass seem to have neglected research which would provide this information. It is impossible to determine the exact reasons why this research has been neglected but there appear to be several possible explanations.

A few investigators (Pearson, 1938; Raney, 1952; Koo, 1970) have attempted to examine the entire Atlantic Coast striped bass fishery. Lack of sufficient detailed and accurate catch and effort statistics, spawning ground surveys, and tagging studies have prevented examination of absolute abundance of the resource or the rate of fishing mortality. Some research has been done on recruitment, growth, and natural mortality rates of subpopulations of stocks of striped bass, but such research usually has not been expanded to encompass the entire Atlantic Coast striped bass population.

Research needs

One of the primary requirements for determining the MSY of the Atlantic Coast striped bass population is a well coordinated research program which would examine the Atlantic Coast striped bass fishery as a whole, not just on a state or local basis as has usually been done in the past. Presently, few interstate or federal organizations appear capable of funding or executing such a research program. It seems, however, to be beyond the physical and financial capabilities of an individual state or a private organization to obtain the necessary commercial and recreational catch and effort data.

In addition, much of the knowledge needed for management of the resource is lacking in certain areas. Since there has been no comprehensive striped bass research program along the entire Atlantic Coast scientists working on striped bass apparently have investigated

whatever they personally were interested in. This has left many gaps and lead to questionable conclusions.

Mechanisms for improved performance

Several things must be done if the Atlantic Coast striped bass fishery is ever to be effectively managed for MSY. To begin with, all Atlantic Coast states and the federal government must begin to cooperate adequately. A comprehensive research program must be designed and executed, a management plan for the entire Atlantic Coast striped bass fishery must be formulated, and uniform state striped bass regulations must be drawn up, enacted, and enforced by every Atlantic Coast state which has a striped bass fishery. This is a formidable task, but it appears to be the only means of preventing eventual overharvesting of the resource, which seems imminent if fishing effort continues to increase.

Before a comprehensive management plan can be developed the magnitude of the striped bass resource and the allowable catch must be estimated. As already mentioned, much of the information required to determine MSY is not available. Obtaining the necessary information may be accomplished in a variety of ways. One possibility would be to call together, for a workshop, scientists who have done research on striped bass and experts from the fields of fisheries management, biology and population dynamics, economics, social and political sciences, and law, who may not necessarily be familiar with striped bass. The agenda should be planned carefully to address the critical issues and to avoid trivia. A well planned and well conducted workshop could have two useful results: it would provide a thorough review of the status of knowledge and expert opinion on the status of knowledge of critical management issues, and would formulate a plan for action.

Once it has been determined what data are necessary for management of the striped bass fishery funds will be needed to carry out the necessary research. There are a few interstate or federal organizations, presently active, which could accept this responsibility.

The Atlantic States Marine Fisheries Commission (ASMFC), of which all Atlantic Coast states are members, was established "to make inquiry and ascertain from time to time such methods, practices, circumstances and conditions as may be disclosed for bringing about the conservation and prevention of the depletion and physical waste of the fisheries, marine, shell, and anadromous of the Atlantic seaboard." (Atlantic States Marine Fisheries Compact). ASMFC has the power to recommend to the governors and legislatures of the member states legislation dealing with conservation of anadromous fisheries of the Atlantic Coast.

The Fish and Wildlife Service of the U. S. Department of the Interior, in cooperation with state research agencies, acts as the primary research agency for the ASMFC. The ASMFC is a possible vehicle for coordinating the work and formulating a comprehensive striped bass management plan. The Commission, however, has no power to ensure that if a management plan was designed and uniform state regulations were formulated that the member states would ratify or enforce such regulations. The role of ASMFC is to review fishery problems along the Atlantic Coast and to recommend to state legislatures means by which these problems may be diminished or alleviated.

A more effective method to carry out the necessary research and formulate a comprehensive management plan might be the established State-Federal Fisheries Management

Program which works in cooperation with the National Marine Fisheries Service (NMFS). This program was formally established in 1971 as an evolving experiment in cooperative management of interjurisdictional fisheries. The program was designed to aid development and implementation of comprehensive management plans for fisheries so as to optimize social, recreational, and economic benefits on a sustainable basis (Schaefer,1975). The Program is an active part of the developing National Plan for Marine Fisheries and is funded by the federal government.

Presently, State-Federal Fisheries Management Councils have been established in each NMFS region. It is the function of these councils to act as joint State-Federal recommendatory and decision-making bodies at a policy operational level. "Currently it is the responsibility of these councils to identify appropriate fishery resource "targets" for joint State-Federal management; to jointly affectuate the development and implementation of comprehensive management plans for those "target" resources; to establish appropriate working committees of planners, biologists, economists, social scientists, and others to develop management plans under council guidance; and to adopt and implement such plans to the extent possible, including promulgation of appropriate regulations and their enforcement through the authorities of the individual states" (Schaefer, 1975).

To date, seven fishery resources have been designated as State-Federal "target" species. Striped bass has not been one of the "targets". If the Atlantic Coast striped bass fishery can be designated as a "target" species the NMFS State-Federal Fisheries Management

Program and the regional councils of the northern, middle and southern Atlantic Coast would assume the responsibility for carrying out the necessary research on the striped bass resource and then formulate a State-Federal management plan with uniform state regulations. Coordinated management regulations along the Atlantic Coast are a necessity if the striped bass resource is to be effectively managed throughout its entire geographical range for maximum benefit to the citizens of the Atlantic Coast states.

Yet another possibility would be to establish a new inter-state or federal organization to carry out the necessary research and management of the striped bass fisheries. This seems unnecessary in view of the existence of at least two organized mechanisms for doing the work.

Summary and Conclusions

1. No scientific evidence can be found to substantiate the assertion that the Atlantic Coast striped bass resource is decling in abundance. Contrary to what many people believe, it appears that the striped bass resource has been increasing in abundance for approximately forty years. Confusion over this issue results from the use of early publications and misunderstanding of the significance of short-term fluctuations versus long-term trends in abundance. Evidence that the resource has been increasing comes from the continual increase in commercial striped bass landings without a proportional increase in commercial fishing effort, a parallel increase in recreational catches, and scientific investigations.

Increased striped bass fishing pressure cannot continue indefinitely. One reason for concern is that in the early 1930s, when fishing effort undoubtedly was much less, and when water quality was better, commercial landings of striped bass were at the lowest point in history. It is probable that natural environmental conditions and adverse economic conditions were the causes. The same thing could happen again. If it is true that striped bass have been able to take advantage of man-induced nutrient enrichment of estuarine environments, then successful water pollution control and abatement programs might cause the resource to revert to lower levels of abundance. If the upward trend in abundance for the past forty years was the result of man-made changes, and if these changes are progressive, a point could be reached at which the changing environment will no longer be favorable. Historical evidence from other fishery resources

suggests that a sudden decline in abundance could then occur.

2. There is no evidence to suggest that New York State commercial striped bass fishing is destructive or that commercial and recreational fishing effort along the Atlantic Coast up to the present time have harmed the resource. Available statistics indicate that along the Atlantic Coast recreational anglers take six to seven times as much striped bass by weight as do commercial fishermen. Sport catch statistics are not available for New York State alone, from which commercial catches of striped bass could be compared to recreational catches. If evidence accumulates later to show that the striped bass resource is being overharvested, the major cause probably will have been removals by recreational anglers.

Despite this evidence, much of which is circumstantial, but convincing, recreational fishermen and their representative organizations continue to exert pressure for legislation which would declare striped bass a game fish in New York State waters. During the past 15 years over 90 legislative proposals to regulate striped bass fishing have been introduced into the New York State Assembly and Senate. Proponents of many of these bills have justified them as conservation measures, but in actuality they are attempts by recreational fishermen to secure exclusive rights to the resource. A major reason for the strong feelings of sport fishermen has been the high visibility of the commercial fishery, which lands most of its catch directly on the beach.

3. It is not commonly recognized that the striped bass controversy has two distinct aspects, management of the resource for maximum (or optimum) sustainable yield,

and allocation of the resource between recreational and commercial fishermen. To solve the controversy and develop and implement an effective comprehensive striped bass management plan these two issues should be dealt with separately.

The first issue is scientific: what is the maximum allowable catch? To date, this question remains unanswered. Much of the information required to determine maximum (or optimum) sustainable yield of the striped bass resource is not available. Few investigations of the entire Atlantic Coast striped bass resource have been attempted. Top priority should be given to studies of the effects of fishing on the resource. As a mimimum, the following pieces of information are needed: a) the numbers of striped bass in existence; b) the numbers that reach fishable size; c) the numbers caught; and d) the numbers that die from all other causes than fishing. If these quantities can be determined with reasonable accuracy, including their temporal and spatial variations, the need for management of the fishery will be known. Then it will be possible to design an appropriate management program.

The second issue, allocation of the resource among fishermen, is purely a social question. A decision to declare striped bass a game fish, or to divide the resource in some way between anglers and commercial fishermen, is a political decision. On this subject science can provide no useful guidelines. The only scientific advice that can be offered is that the decision should not be justified as a conservation measure. A purely recreational fishery for striped bass will be just as much in need of management as a commercial fishery, or a combination of the two.

4. Presently, neither a comprehensive research program, nor a comprehensive management plan exists for the entire Atlantic Coast striped bass population. To date, the only attempts at management of the resource have been restrictive legislation state by state, aimed mostly at commercial striped bass fishing activities. Little, if any, of this legislation has a scientific basis, and frequently regulations of one state are in conflict with those of other states.

If the Atlantic Coast striped bass fishery is ever to be effectively managed a comprehensive research program must be designed and supported. The objectives should be to obtain the information necessary to understand the effects of fishing on the resource. As that information accumulates it will become possible to formulate a scientific management plan and put it into operation. If desired, an empirical management plan could be established immediately, to be redefined and extended as information accumulates.

Two mechanisms exist for developing the necessary research and management plans, putting them into operation, and coordinating and reviewing the work. The Atlantic States Marine Fisheries Commission (ASMFC) has generated successful comprehensive research programs in the past, using personnel and facilities provided by its official research agency, now the National Marine Fisheries Service. The commission has not succeeded in taking the final and most important step, to develop effective comprehensive management based on research findings. The new State-Federal Fisheries Management Program may succeed where ASMFC has failed. New York State should make use of this mechanism for striped bass management.

APPENDIX A

Striped Bass Life History

Taxonomy

Striped bass (Morone saxatilis) belongs to the taxonomic order Perciformes and is a member of the sea bass family Serranidae. North of Delaware Bay striped bass are commonly referred to as "stripers", while to the south they are more frequently referred to as rockfish or "rocks". White perch (Morone americana) and white bass (Morone chrysops) are two closely related species (Woolcott, 1957).

Description

The elongate body of a striped bass is stout, moderately compressed laterally, and has a deep keelless caudal peduncle (Fig. 15). The head is long with a moderately pointed snout. Color of the top and sides ranges from dark olive green to shades of blue, while the ventral side is usually silvery. Distinguishing characteristics of striped bass are, two well developed dorsal fins (the first spiny with usually 9 to 10 spines and the second soft rayed with usually 12 to 13 rays) of about equal length and separated by a distinct space, a moderately wide and slightly forked tail, and most of all, 7 to 8 narrow longitudinal stripes, which may be interrupted, along the sides of the body (Hildebrand and Schroeder, 1928; Bigelow and Schroeder, 1953).

Distribution

Striped bass is an anadromous fish which spends

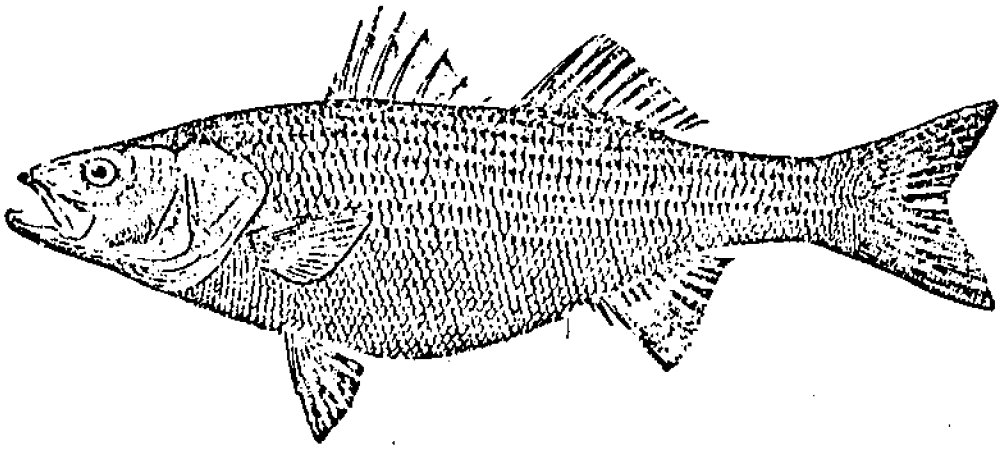


FIGURE 15 - Striped Bass (Morone saxatilis)
(Bigelow and Schroeder, 1953)

most of its life in salt water but migrates into fresh or slightly brackish waters to spawn. Juvenile striped bass, until approximately two years of age, remain in brackish water nursery areas, after which they may perform annual coastal migrations. Striped bass tend to remain inshore, usually within 4 to 5 miles of the shoreline (Bigelow and Schroeder, 1953).

Along the Atlantic Coast striped bass range from the St. Lawrence River to the St. John's River in Florida (Fig. 1). The center of abundance ranges between Cape Cod, Massachusetts, and Cape Hatteras, North Carolina, especially concentrating in Chesapeake Bay, the Hudson River, and Albemarle Sound watersheds. Along the northeastern shore of the Gulf of Mexico a separate population of striped bass ranges from northwestern Florida to the Tchefuncta River in Louisiana (Talbot, 1966; Barkuloo, 1970). Striped bass were first introduced on the Pacific Coast between 1879 and 1919 when approximately seven thousand were released in California waters. It is quite evident that this planting was very successful for striped bass are now reported to range from the Columbia River to about 25 miles south of the United States - Mexico border. The center of abundance on the Pacific Coast is in the Sacramento - San Joaquin River system in California (Scofield and Bryant, 1926; Talbot, 1966). Landlocked or freshwater self-perpetuating stocks of striped bass have been reported in the Santee - Cooper Reservoir, South Carolina, and the Kerr Reservoir in Virginia and North Carolina (Bigelow and Schroeder, 1953; Talbot, 1966).

Spawning and Reproduction

Striped bass spawn in freshwater or estuarine areas

with very low salinity along the middle and northern Atlantic Coast between April and June inclusive. The time of spawning depends mainly upon water temperature. Peak spawning occurs between 15.6 - 20.5°C, and 0 - 4 parts per thousand salinity(Albrecht, 1964; Talbot, 1966; Dovel and Edmunds, 1971).

A small proportion of female striped bass reach spawning maturity at 4 years of age. By 6 years of age greater than 95 percent of all female striped bass are capable of spawning. Nearly all male striped bass have reached spawning maturity by the time they are 3 years of age (Merriman, 1941; Bigelow and Schroeder, 1953). Lewis (1962) suggested that the age at which maturity is reached may vary between spawning regions.

The number of eggs produced by a mature female varies with size and appears to be directly proportional to body weight (Mansueti and Hollis, 1963). Several studies on fecundity of striped bass suggested that females produce between 62 to 112 thousand eggs per pound of body weight (Jackson and Tiller, 1952; Lewis and Bonner, 1966). It has also been suggested that although production of eggs increases with size and age, spawning may not take place every successive year once a female is 7 to 10 years of age (Merriman, 1941; Bigelow and Schroeder, 1953; Lewis, 1962).

Striped bass produce large semi-buoyant eggs which are suspended at or near the surface by currents. One of the chief requirements for successful spawning is a current strong enough to prevent the eggs from settling to the bottom where they may be silted upon and smothered. Eggs hatch within 1.5 to 3 days, depending upon water temperature, and larvae assimilate yolk sacs and oil

globules within 3 to 6 days(Albrecht, 1964; Talbot, 1966). By the time the eggs have hatched, the current has carried the eggs to a point in the estuary where increased salinity neutralizes and precipitates negatively charged suspended particles in the water. This results in reduced turbidity, increased light penetration, and production of phytoplankton blooms. Increased fertilization from domestic sewage and other artificial and natural sources, may provide nutrients for exceptionally large phytoplankton blooms and hence excellent grazing conditions for increased zooplankton populations (Mansueti, 1961a). This in turn might provide an increased supply of food for larval striped bass and enhance chances for survival. Since most striped bass apparently remain in estuarine nursery areas until age 2, the quality and quantity of food in this environment probably is vital to survival rates.

In late winter and early spring striped bass leave their overwintering areas and begin to migrate to the spawning grounds. Some evidence exists that striped bass tend to spawn in the same areas in which they were spawned. This is suggested by the recapture, on the spawning grounds, years later, of fish tagged on the same spawning ground during a previous spawning season (Tresselt, 1952; Massmann and Pacheco, 1961; Farley, 1966; Nichols and Miller, 1967). Male striped bass usually arrive on the spawning grounds first and may participate in several spawnings. Female striped bass arrive later and cast all their eggs over a relatively short period of time and then leave the area. On the spawning grounds males greatly outnumber females. During the act of spawning one female may be surrounded by as many as 50 males. Courtship behavior or "rock fights" consist

of vigorous movements and splashing on the surface, during which the female casts her eggs, which stimulates the males to release their milt (Merriman, 1941; Woodhull, 1947; Mansueti and Hollis, 1963).

Spawning areas may vary from year to year depending upon the amount of rainfall, salinity, temperature, and other environmental factors (Mansueti and Hollis, 1963). Historical records of juvenile striped bass from many coastal rivers led Merriman (1941) to suggest that at one time striped bass probably spawned in every river of any size along the Atlantic Coast where suitable conditions existed. Presently, it appears that the major spawning grounds of striped bass, along the Atlantic Coast, are areas of upper Chesapeake Bay, the Hudson River, and the Roanoke River and Albemarle Sound in North Carolina.

The major striped bass spawning area in the Hudson River is a relatively short section of the river between Bear Mountain and Kingston, New York. Spawning seems to be concentrated in the vicinity of the U. S. Military Academy at West Point. This area of the Hudson River is relatively narrow, ranges up to 200 feet in depth, has moderate to swift currents, and a maximum salinity of one part per thousand (Curran and Ries, 1937; Carlson and McCann, 1969; U.S. Nuclear Regulatory Commission, 1975).

For many years the lower Susquehanna River and secondarily the Potomac River were considered as together constituting 85 percent of the major striped bass spawning areas of upper Chesapeake Bay (Vladykov and Wallace, 1952). Historical data now indicate that many of the spawning grounds in the Chesapeake Bay watershed, especially in the upper Bay and Susquehanna River, have since

been destroyed. This is due in part to sedimentation, canal and dam construction, metropolitan expansion, mosquito control programs, wetlands alteration for agricultural, industrial and domestic uses, and disposal of waste materials. Construction of three important canals, the Chesapeake and Delaware (C and D), the Chesapeake and Ohio, and the Susquehanna Tidewater, appear to have had little detrimental effect upon the biota of the area, but have greatly increased spawning and nursery areas for certain species of fish, especially striped bass (Mansueti, 1961a). It now appears that over the past one hundred years the major locale of striped bass spawning in Chesapeake Bay has shifted from the Susquehanna River to the navigation channel of the C and D Canal. Recent investigations by Dovel and Edmunds (1971) and Johnson and Koo (1975) tend to corroborate these findings. The area of greatest egg density, the C and D Canal, is unique in that it represents an alteration of the natural environment, apparently providing an alternative, beneficial environment for striped bass egg incubation, nursery activities, and migratory activities (Dovel and Edmunds, 1971; Johnson and Koo, 1975; Koo and Wilson, 1972).

Age and Growth

Much work has been done by Mansueti (1961a) and others on the relationships between length, weight, age and sex of striped bass. Figure 16 summarizes these relationships. Growth rates of individual and year-classes of striped bass appear to vary from year to year, especially during the first few years of growth. After four years growth male striped bass tend to grow at a

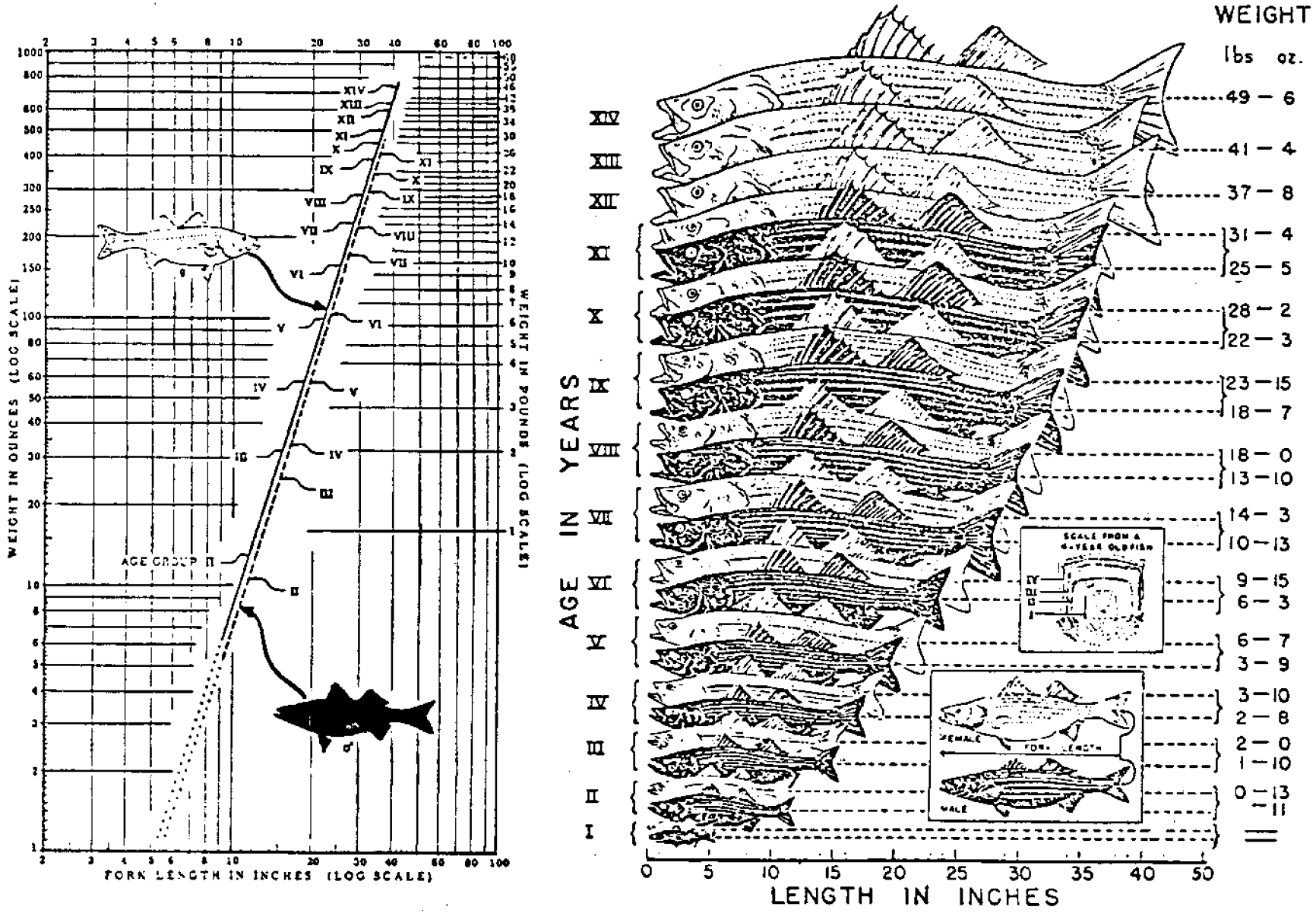


FIGURE 16 - Average length, weight, age and sex relationships of Striped Bass (Mansueti, 1961b

lower rate than female striped bass. Usually the growth rate of large year-classes of striped bass is lower than for smaller or average sized year-classes (Hildebrand and Schroeder, 1928; Mansueti and Hollis, 1963). Austin and Hickey (1974) have observed size differences between two year old striped bass tagged in 1972 and 1974. Two year old striped bass tagged in 1972, from the dominant 1970 year-class, averaged 10.2 inches fork length (FL). The same age striped bass tagged in 1974, from the poor 1972 year-class, averaged 12.5 inches FL. They suggest that these differences are due to natural fluctuations in spawning success, fluctuations in young-of-the-year survival, and the effect of crowding on food supply and growth, before the striped bass commence their first coastal migration (Austin and Hickey, 1974). It has also been suggested that there is a tendency for individual striped bass that grow less than the average one year to compensate by growing at a greater than average rate for the next few years (Tiller, 1943; Nicholson, 1964).

Year-Class Abundance and Possible Influencing Environmental Factors

Wide fluctuations in year-class abundance periodically and historically have taken place in the striped bass population. Some investigators have suggested that these fluctuations follow either three or six year cycles (Koo, 1970; Austin and Hickey, 1974). These fluctuations do appear to have some regularity, but they do not seem to exist as true cycles, unless one ignores certain time periods. As Cole (1951) has pointed out, "Until definite evidence to the contrary is forthcoming, the preferred

interpretation of population cycles should be that they are essentially random fluctuations with serial correlation between the populations of successive years." It has been observed that striped bass, especially those spawned in different tributary systems in Chesapeake Bay, sometimes produce strong (dominant) and sometimes poor year-classes. Dominant year-classes were produced in 1920, 1928, 1930, 1934, 1936, 1940, 1942, 1943, 1948, 1950, 1956, 1958, 1961, 1962, 1964, 1966, and 1970. Poor year-classes were produced in 1931, 1932, 1944 to 1947, 1957, 1959, 1963, 1965, 1972 and 1973 (Vladykov and Wallace, 1952; Bigelow and Schroeder, 1953; Mansueti, 1961a; Mansueti and Hollis, 1963; Alperin, 1966b; Schaefer, 1968a,1972; Austin and Hickey, 1974; Grant, 1974). Exceptionally good or poor year-classes have been underlined. The exact cause or causes of these dominant or poor year-classes have yet to be determined but several theories have been raised to explain their occurrance.

It is believed that environmental factors are the main causes of large variations in year-class abundance, affecting survival of eggs, larvae, and fingerling striped bass up to the time they are recruited into the fishery (Merriman, 1941; Mansueti, 1961a; Mansueti and Hollis, 1963; Talbot, 1966). Mansueti (1961a) suggested that civilization and striped bass populations are compatible, i.e., uncontrolled and unpredictable increased nutrification of inshore waters from artificial and natural sources may be responsible indirectly for the dramatic increase in abundance of striped bass since the mid-1800s. Eggs and larvae of striped bass, in the spawning and nursery areas of upper Chesapeake Bay and possibly in the Hudson River as well, may be uniquely suited to take advantage of this artificial nutrient

enrichment. The increase in numbers and magnitude of dominant year-classes of striped bass may be related to an increase in man-produced nutrients, especially from highly treated domestic sewage(Mansueti, 1961a). This is only a hypothesis, and additional investigation seems warranted.

Several other environmental factors may affect survival and cause fluctuations in abundance of eggs, larvae and young striped bass, which in turn may affect the strength of year-classes. Talbot (1966) and Albrecht (1964) and several other investigators (Hassler, 1958; Talbot, 1966; Hazel et al., 1971; Lauer, 1973; New York Times, 1975a) have suggested that the main factors are: current velocities and stream flow volumes, water temperature and salinity, egg diameter and specific gravity, turbidity and light penetration, available food supply, barriers to migration, power generating facilities, and industrial and agricultural pollutants. Industrial pollution, usually in the form of waste effluents, containing chemical toxins, may raise water temperatures above tolerable limits, tend to decrease oxygen content of the water, lead to increased biological oxygen demand, and render certain marine organisms unfit for human consumption (Hassler, 1958; Talbot, 1966; Alexander et al., 1973; New York Times, 1975b). Agricultural pollution from excessive fertilizing, soil erosion, and careless pesticide use may produce destructive effects on spawning and nursery areas.

Migrations and Movements

At age two years and older some striped bass undertake annual coastal migrations which take them north-

eastward, from their spawning areas, in the late winter, spring and early summer. Southwestward coastal migrations, which begin in late fall, return the striped bass to their southern overwintering areas (Merriman, 1941; Raney, 1952). The winter is spent in a less active state in the lower reaches of rivers and deep channels Mansueti and Murphy, 1961; Mansueti, 1961b; Mansueti and Hollis, 1963; Massmann and Pacheco, 1961). Upon arrival of spring and increased water temperatures most striped bass migrate into the spawning areas to spawn before beginning another northeastward coastal migration. Some evidence exists that large striped bass tend to migrate greater distances on the average than smaller striped bass (Chapoton and Sykes, 1961; Mansueti, 1961b; Schaefer, 1968a; Holland and Yelverton, 1973).

It has been suggested by several tagging studies that of the total number of striped bass in Chesapeake Bay (probably the source of most of the Atlantic Coast striped bass population) only a small percentage of striped bass, older than two years, leave the Bay to perform coastal migrations. Those striped bass that remain in Chesapeake Bay spend the summer and fall in open water areas of the Bay and surrounding tidewater tributaries. Even though the percentage of striped bass that perform annual coastal migrations is small it consists of a "large number of fish" (Raney, 1952; Vladykov and Wallace, 1952; Chapoton and Sykes, 1961; Mansueti, 1961b; Talbot, 1966; Nichols and Miller, 1967).

The migratory range of striped bass spawned in the Hudson River appears to be limited mainly to portions of western Long Island Sound and east along the south shore of Long Island as far as Jones Beach (Alperin, 1966a, b; Schaefer, 1968a). Only a small number of Hudson

River striped bass have been reported to migrate south along the coast of New Jersey or north along the coast of New England (Merriman, 1941; Raney et al., 1954; Clark, 1968; Stolte, 1973).

In the striped bass stocks which perform coastal migrations the percentage of males is quite low. It has been suggested that this is due to the fact that male striped bass mature earlier than the females, therefore many young mature males may remain behind to spawn while immature females of the same age group undertake coastal migrations (Schaefer, 1968b). Also it appears that female striped bass tend to live longer than the males (Mansueti, 1961b).

Food and Feeding Habits

Newly hatched striped bass larvae take 4 to 6 days to assimilate their yolk sac and oil globule during which time they disperse towards the bottom as they begin to feed. Early instars of copepods and cladocerans are the preferred food until the postlarvae are about 15 days old. The diet of juvenile striped bass, in nursery areas,consists mainly of adult copepods, cladocerans and insect larvae (Curran and Ries, 1937; Humphries and Cumming, 1973).

Considerable variations have been reported in the food habits of young-of-the-year striped bass (Pearson, 1938; Merriman, 1941; Raney, 1952). Young-of-the-year striped bass feed on or near the bottom and their ability to change to a fish diet with growth depends greatly on the availability of small benthic fishes (Shapovalov, 1936). As young striped bass approach one year of age their diet consists mainly of invertebrates, especially

amphipods, mysids, and crustaceans, and occasionally small forage fishes. Fishes do not significantly enter the diet of striped bass until they have reached approximately one year of age (Hollis, 1952; Stevens, 1966).

Adult striped bass are voracious and rather undiscriminating feeders. Members of a school of striped bass tend to feed periodically and simultaneously, with most active feeding occurring between sunset and sunrise. Striped bass feed mainly on smaller fish, crustaceans, and other invertebrates (Merriman, 1941; Hollis, 1952; Bigelow and Schroeder, 1953; Mansueti and Hollis, 1963; Alperin, 1966b; Talbot, 1966). Some of the most common foods of striped bass in New York waters are American eel (Anguilla rostrata), Atlantic menhaden (Brevoortia tyrannus), Atlantic silverside (Menidia menidia), bay anchovy (Anchoa mitchilli), northern kingfish (Menticirrhus saxatilis), and scup (Stenotomous chrysops) (Schaefer, 1970). Cannabalism, by large striped bass, has occasionally been reported (Mansueti and Hollis, 1963).

Much of the variations in food and feeding habits of striped bass, in published studies, may simply reflect differences in sampling gear used to collect striped bass for stomach content analysis and collection sites or regional differences (Stevens, 1966; Markle and Grant, 1970). Many investigators, however, have suggested that there is a direct correlation between the size of striped bass and the size of food organisms eaten (Hollis, 1952; Thomas, 1967; Schaefer, 1970). This is usual for most fishes, except filter feeders.

Feeding habits of striped bass are apparently influenced by several other factors, in addition to age and size. The diet of striped bass within different

regions varies seasonally in response to the migrations, availability and fluctuations in abundance of food organisms (Hollis, 1952; Mansueti and Hollis, 1963; Thomas, 1967). Another major seasonal influence occurs during the winter when striped bass feed only occasionally on organisms found on or near the bottom (Merriman, 1941; Johnson and Calhoun, 1952; Mansueti and Hollis, 1963).

Sexual maturity also tends to influence feeding habits. Striped bass feed during prespawning, as well as during spent stages of maturity. They do not feed, however, for a brief period just before and during the act of spawning (Woodhull, 1947; Stevens, 1966; Trent and Hassler, 1966).

APPENDIX B

Commercial Striped Bass Fishing Methods and Landings

Part 1. Atlantic Coast Commercial Striped Bass Fishery

The Atlantic Coast commercial striped bass fishery extends from Massachusetts to North Carolina inclusive. The Chesapeake Region (Maryland and Virginia) ranks first in total striped bass landings by weight for the Atlantic Coast. The Middle Atlantic (New York to Delaware inclusive), South Atlantic (North Carolina to Florida inclusive), and New England (Maine to Connecticut inclusive) Regions rank second, third, and fourth respectively in total striped bass landings by weight.

Most commercial striped bass landings from the New England Region come from Massachusetts and Rhode Island. Rhode Island is the only New England state which permits commercial striped bass fishing. However, Massachusetts permits the sale of recreational catches of striped bass and permits the sale of incidental catches of striped bass in nets set for other species. Floating fish traps and hand lines are the only methods permitted in Rhode Island's commercial striped bass fishery. Massachusetts 'commercial' striped bass fishery is mainly a hand line fishery. A license is required in Massachusetts to sell daily catches of greater than one hundred pounds. Connecticut prohibits all commercial striped bass fishing or the sale of recreational catches.

In the Middle Atlantic Region, New York lands the most striped bass by weight per year. The major commercial method for striped bass in New York is haul seining. Several other commercial fishing methods commonly employed in New York waters take striped bass as incidental catches or are used specifically to catch striped bass

(Part 2, Appendix B). New Jersey prohibits all commercial striped bass fishing by any gear within waters under New Jersey's jurisdiction. New Jersey, like all Atlantic Coast states north of South Carolina, excluding Connecticut, does, however, permit the sale of recreational and incidental catches, and deliberate catches of striped bass made outside the three-mile state jurisdictional limit. Most of New Jersey's striped bass landings are made by otter trawls, supposedly fishing outside the three-mile limit. In 1962, 1963 and 1965 otter trawls accounted for seventy percent or more of each year's total striped bass catch (LoVerde, 1962, 1963, 1965; Koo, 1970). Large landings of striped bass by otter trawls are not always due to increased abundance or increased availability but rather to variations in success of enforcement of New Jersey fishing regulations. Occasionally, trawlers fish close to shore (general trawling is prohibited within two nautical miles of New Jersey shores, while trawling specifically for striped bass is prohibited within three nautical miles of New Jersey shores) and catch large quantities of striped bass which sometimes overwinter in relatively shallow inshore waters (McHugh, 1975). The remainder of New Jersey striped bass landings, not taken by trawls, are taken by gill nets, fished more than three miles offshore or in Delaware Bay, and hand lines. By law commercial striped bass fishing in Delaware is by haul seines and gill nets only. Most Delaware commercial striped bass landings are by anchor and stake gill nets in Delaware Bay.

The Chesapeake Region is the major producer of striped bass along the Atlantic Coast. Maryland permits commercial striped bass fishing by any gear, except

purse seines and otter trawls. Gill nets take more than eighty percent of Maryland's commercial striped bass landings by weight. Most landings by gill nets are made just before the striped bass spawning season, during upriver spawning migrations (Koo, 1970). Three gears are about equally important in Virginia's commercial striped bass fishery: pound nets, haul seines, and gill nets (Reid, 1955; Koo, 1970). In addition to these three major gears, fyke nets, once an important gear for taking striped bass farther up rivers, and otter trawls take small portions of Virginia striped bass landings. Otter trawls are limited to offshore fishing by law. Most landings by otter trawls in Virginia are made in winter and early spring. Landings by otter trawls tend to increase in severe winters when striped bass migrate to warmer offshore coastal waters (Grant et al., 1970).

North Carolina is the only state in the South Atlantic Region with a large commercial striped bass fishery. Most North Carolina landings are made by anchor and stake gill nets and pound nets (Koo, 1970). Recently catches of large or "jumbo" striped bass in haul seines have increased in late fall and winter, on Outer Banks beaches between Kitty Hawk and Cape Hatteras. This winter haul-seine fishery, especially along North Carolina beaches of the Cape Hatteras National Seashore, has generated numerous conflicts between commercial haul seiners and recreational surf casters (Stroud, 1973; Linton, 1975). A recent study by Holland and Yelverton (1973) of the winter haul-seine fishery and the offshore winter purse-seine and otter trawl fisheries off the Outer Banks, suggested that these fisheries have had little effect upon the overwintering striped bass stocks

and may actually be underharvesting the resource.

Part 2. New York State Commercial Striped Bass Fishery

The major commercial fishing method for striped bass in New York State is haul seining. Haul seines are very effective in capturing coastal migratory species which concentrate in schools in shallow inshore waters. A haul seine is an encircling net, usually 150 to 450 meters long, which uses a beach as a stationary boundary (Knapp, 1974). New York State law prohibits the use of haul seines greater than 275 meters in length (Ginter, 1974). The net is composed of two wings or "bunts" and a bag or "cod-end". To keep the net vertical in the water, the top of the net is rigged with floats and the bottom with weights. Attached to each end of the net are lines or "warps" used in hauling in the net (Knapp, 1974).

Haul seining is usually conducted when the weather is favorable, along flat open ocean beaches or occasionally in bays and estuaries. High winds, rain and heavy surf prevent spotting of schools of fish and make it extremely difficult and often hazardous to set and haul the seine. Commercial haul seines are normally set from a two-man surf dory. The surf dory is rowed 100 to 200 meters offshore and then parallel to the shore in the direction of the prevailing longshore current, until the first warp and most of the seine have been payed out over the stern, and then rowed directly in towards shore as the remainder of the seine and the second warp are payed out (Schaefer, 1967). The seine is then hauled into shallow water or onto a beach by pulling, either

by hand or with the aid of a powered winch, on the two warps (Knapp, 1974).

Landings of striped bass by haul seines in New York State have increased, with some fluctuations, since the mid-1930s (Fig. 17). The low points in New York striped bass landings by haul seines seem to have occurred for several years in the early 1930s, when average landings were only about 6,000 pounds per year. This was the same period in which striped bass abundance is believed to have been very low all along the Atlantic Coast. Highest recorded landings of striped bass in New York by haul seines were in 1967 when over one million pounds were reported.

Several other gears commonly employed in New York State waters take striped bass as incidental catch or are used specifically to catch striped bass. The most common of these gears are inshore otter trawls, gill nets, pound nets, and hand lines.

An otter trawl is essentially a large conical shaped bag of mesh netting, open at the forward end or "mouth" and closed at the opposite end or "cod-end". The mouth is held open vertically by floats rigged along the top of the mouth and weights rigged along the bottom edge of the mouth. To keep the mouth open horizontally, otter boards are attached to the sides of the mouth and set obliquely to the direction of tow. The net is towed behind a vessel by two steel cables or "warps". The trawl is towed at various speeds and depths depending upon target species, bottom contours, hydrographic conditions, and characteristics of the otter trawl and fishing vessel (Knapp, 1974).

After World War II and prior to the early 1960s

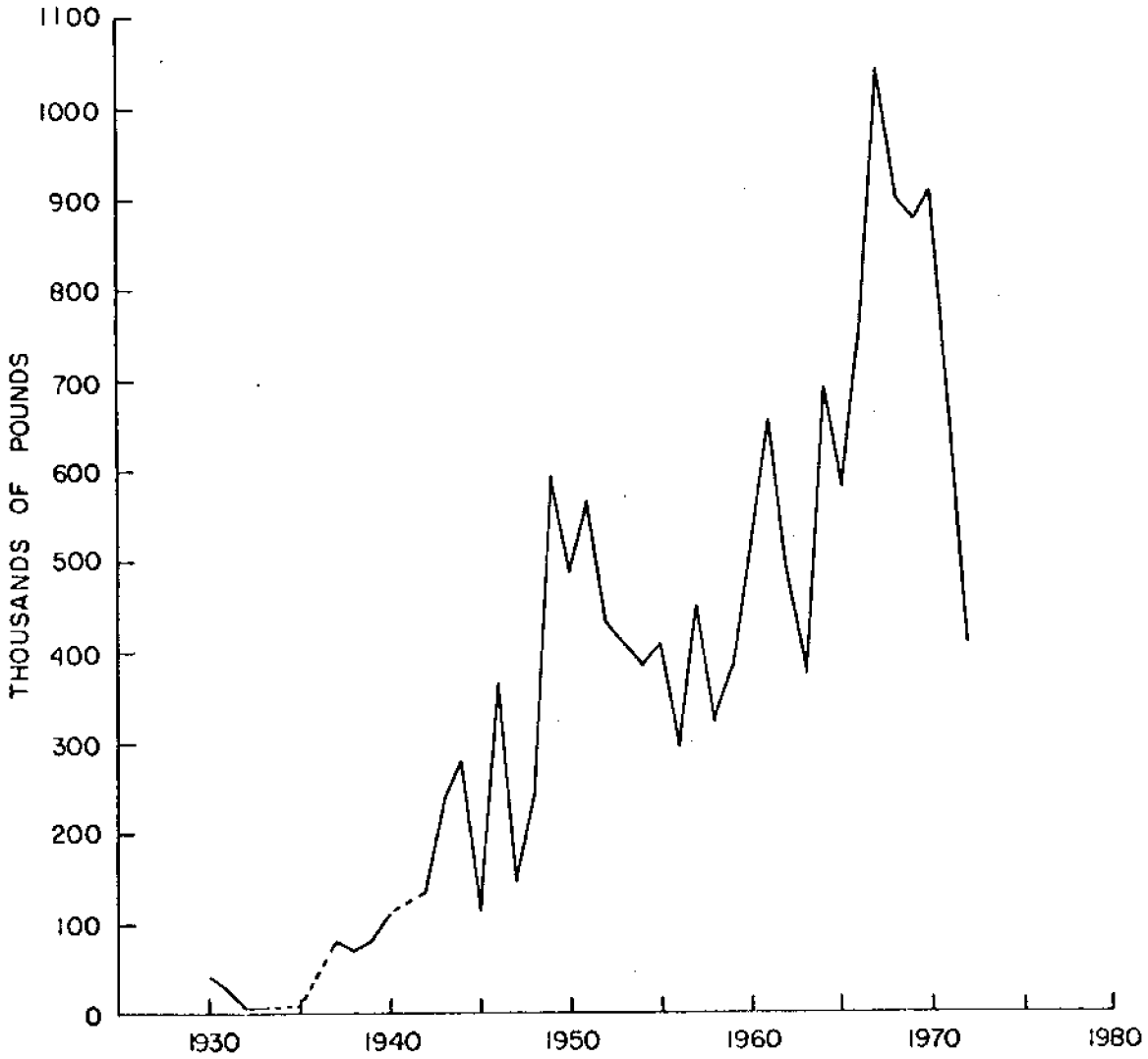


Figure 17.--New York State striped bass landings by haul seines.

New York otter trawlers usually fished offshore in the Middle Atlantic Bight and concentrated mostly on scup and winter flounder. Prior to 1950 only occasional large catches of striped bass by otter trawls were recorded. During the 1950s, when New York trawlers were concentrating their efforts on the abundant scup resource, striped bass landings by otter trawls declined to very low levels, only about 3,000 pounds per year. In the early 1960s, as landings of scup declined and competition from Delaware Bay based trawlers for the diminishing supply of scup increased, New York trawlers shifted their fishing inshore, closer to their home ports (Knapp, 1974). It was at this time, the early 1960s, that New York inshore trawlers began taking striped bass incidental to their normal catches of flounders, industrial and unclassified mixed species. New York landings of striped bass by otter trawls began to increase, resulting in peak landings in 1961, 1964, 1967, and 1969 (Fig. 18). The largest landing of striped bass by otter trawls, over 223,000 pounds, was recorded in 1969.

Three basic types of gill net are used in New York commercial striped bass fishing: drift, anchor and stake, and runaround gill nets. They all work on the same principle, that the greatest girth of a fish is at the middle of the body behind the head. Attempting to swim through the meshes, a fish, if large enough, can get only part of the way through. When the fish attempts to back out it becomes entangled by its gill covers or operculi (Knapp, 1974). Drift, anchor and stake gill nets are usually fished perpendicular to a current. Anchor and stake gill nets are held in a stationary position, while drift gill nets move with the current.

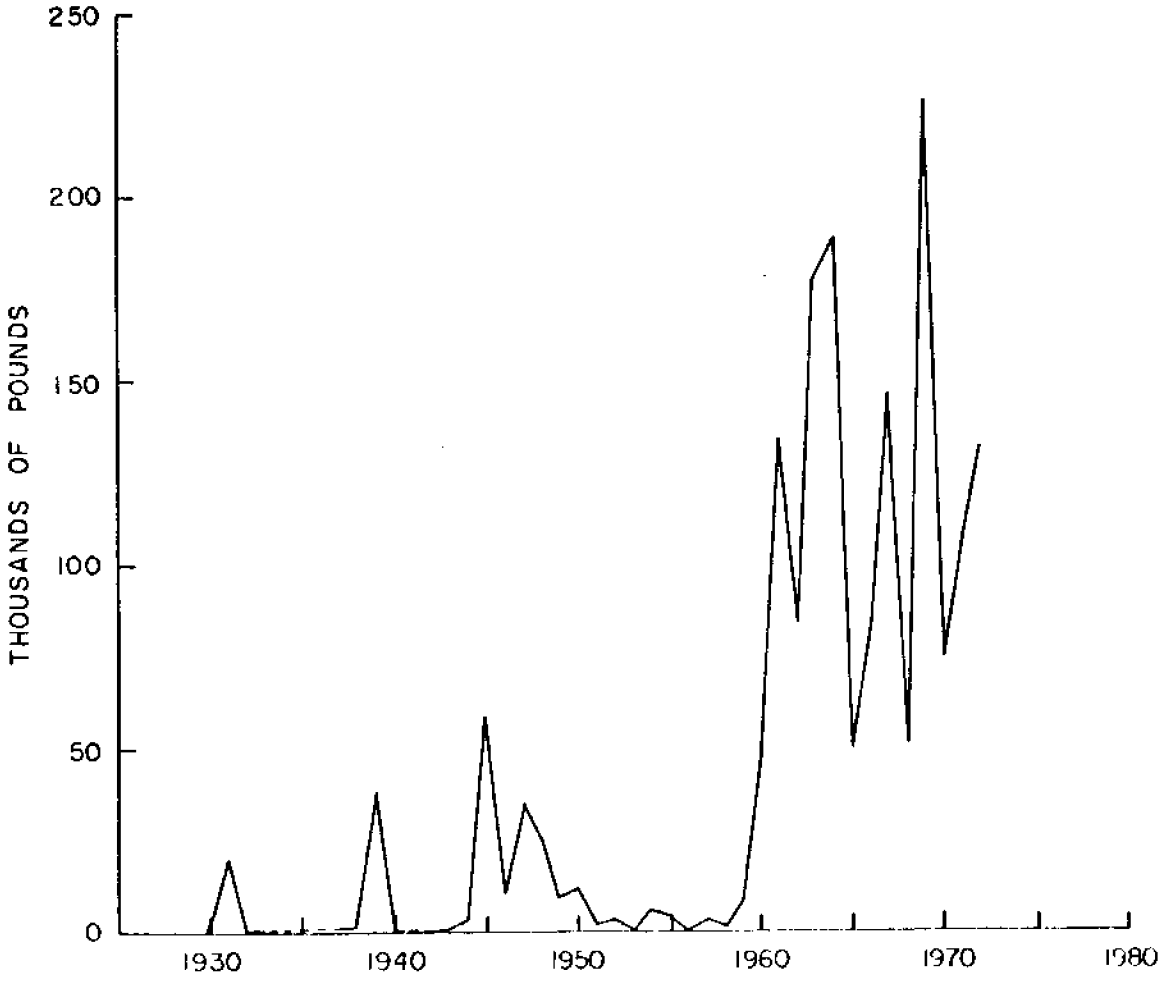


Figure 18.--New York State striped bass landings by otter trawl.

Runaround gill nets usually are set around a school of fish.

New York State landings of striped bass by all types of gill net combined began to increase in 1950 (Fig. 19). Medeiros (1974) attributed much of the increase in striped bass landings by gill nets to a decline in the numbers of drift gill nets employed and an increase in numbers of anchor, stake and runaround gill nets. He suggested that many fishermen who formerly fished drift gill nets, usually in the upper reaches of the Hudson River, converted their nets to anchor and stake gill nets. Most anchor and stake gill nets were fished in the lower reaches of the Hudson River, usually below Bear Mountain Bridge, where increased catches of striped bass, which do not go as far upstream as shad (Alosa sapidissima) were possible (Medeiros, 1974). Landings of striped bass by drift gill nets in New York never exceeded 20,000 pounds per year, the average being a few thousand pounds per year (Fig. 20). No landings of striped bass by anchor and stake gill nets were recorded in 1949. Throughout the 1950s, however, landings of striped bass by anchor and stake gill nets began to increase. A temporary decline occurred during the early and mid-1960s. Landings by anchor and stake gill nets once again began to increase in 1967 and reached a peak of 156,000 pounds by 1968, afterwhich they again started to decline (Fig. 20).

New York landings of striped bass by runaround gill nets became increasingly important in the early 1960s (Fig. 20). Usually the runaround gill net fishery concentrates its effort on striped bass, bluefish and weakfish (Cynoscion regalis) migrating along the south shore of Long Island. The large increase in landings of striped bass by runaround gill nets in 1967 and 1968, however,

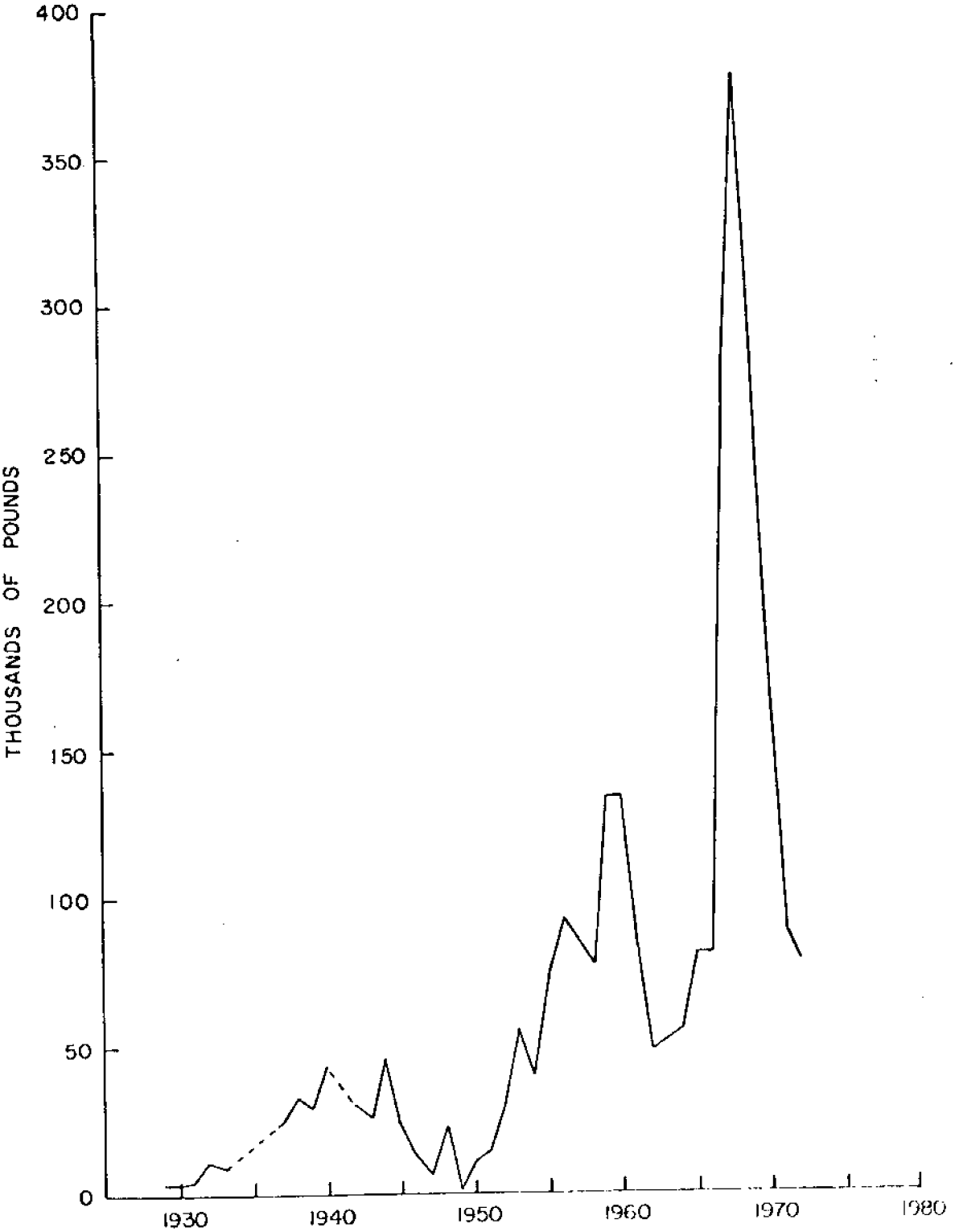


Figure 19.--New York State striped bass landings by all types of gill nets.

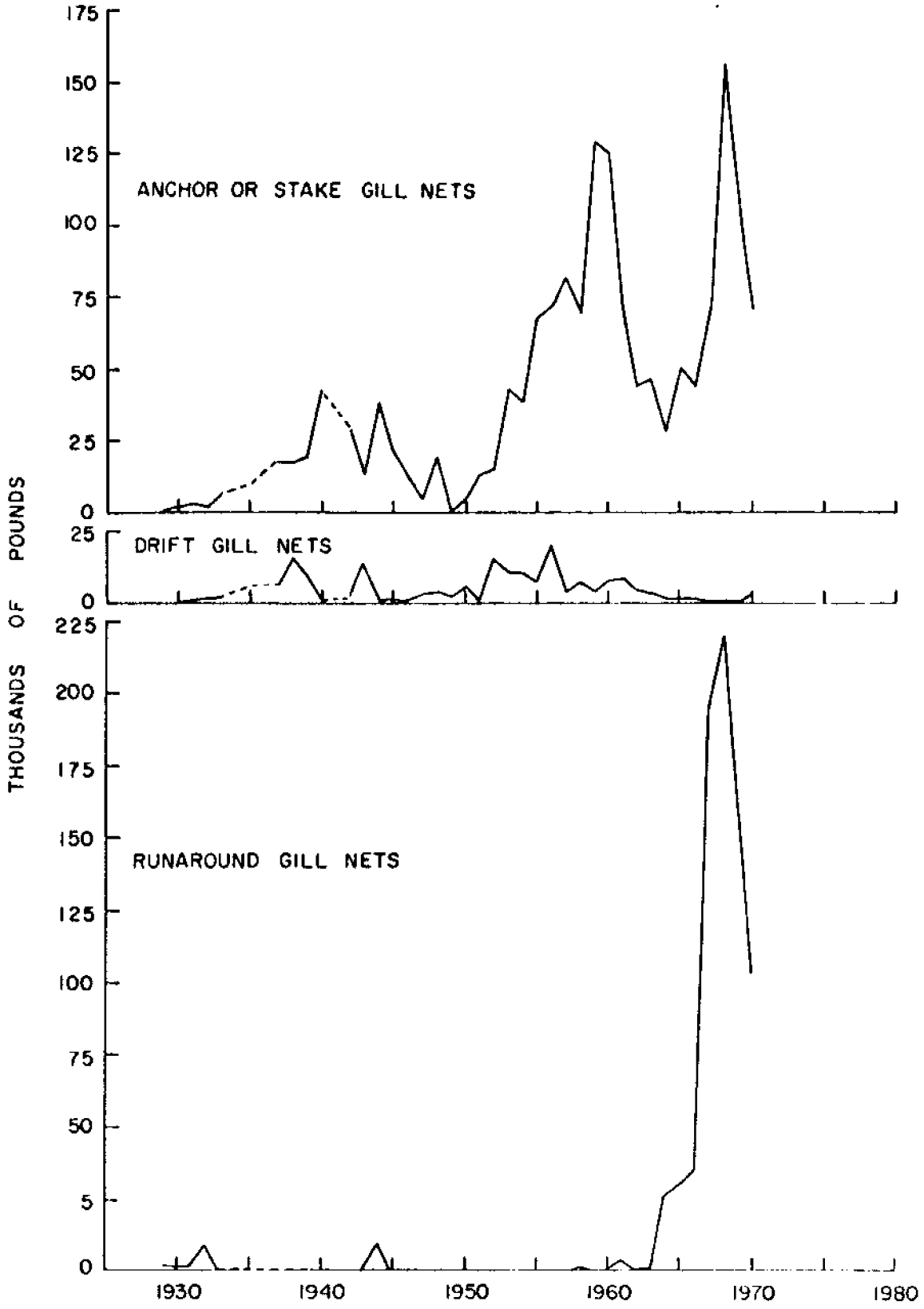


Figure 20.--New York State striped bass landings by anchor and stake, drift, and runaround gill nets.

was a result of increasing numbers of runaround gill net fishermen in Long Island Sound making exceptionally large catches of striped bass and bluefish. The sudden decline in New York landings of striped bass by all types of gill net, especially runaround gill nets is probably due, in part, to a law adopted in 1969 which prohibits gill netting in most New York waters of Long Island Sound (Ginter 1974).

Pound nets or "fish traps" are designed to direct fish into an impounding structure in which they become trapped. A pound net consists of a rectangular bowl or "head" open only above water, which is the entrapping structure. One or more heart-shaped "bays" concentrate and direct fish towards the head, and a leader or "hedging" intercepts and directs the fish towards the bays (Reid, 1955). Pound nets are usually placed perpendicular to the shore with the leader leading out from shore to deeper water where the bays and head are located.

New York landings of striped bass by pound nets began to increase in the late 1950s, but it was not until 1966 that the increase became significant. Landings of striped bass by pound nets have increased from a low of 800 pounds in 1957 to a peak of 148,000 pounds in 1972 (Fig. 21). As a result of scarcity of some species of fish, declining production, increased pollution, and rising costs of materials, vessels, and labor the number of pound nets fished in New York State has generally declined since 1948 (Smith, 1968, 1969). Smith (1968) reported that increased landings of striped bass by pound nets in 1967 were from nets being fished in the bays of eastern Long Island. In 1973 only one ocean pound net was reported operating off Long Island (Knapp,

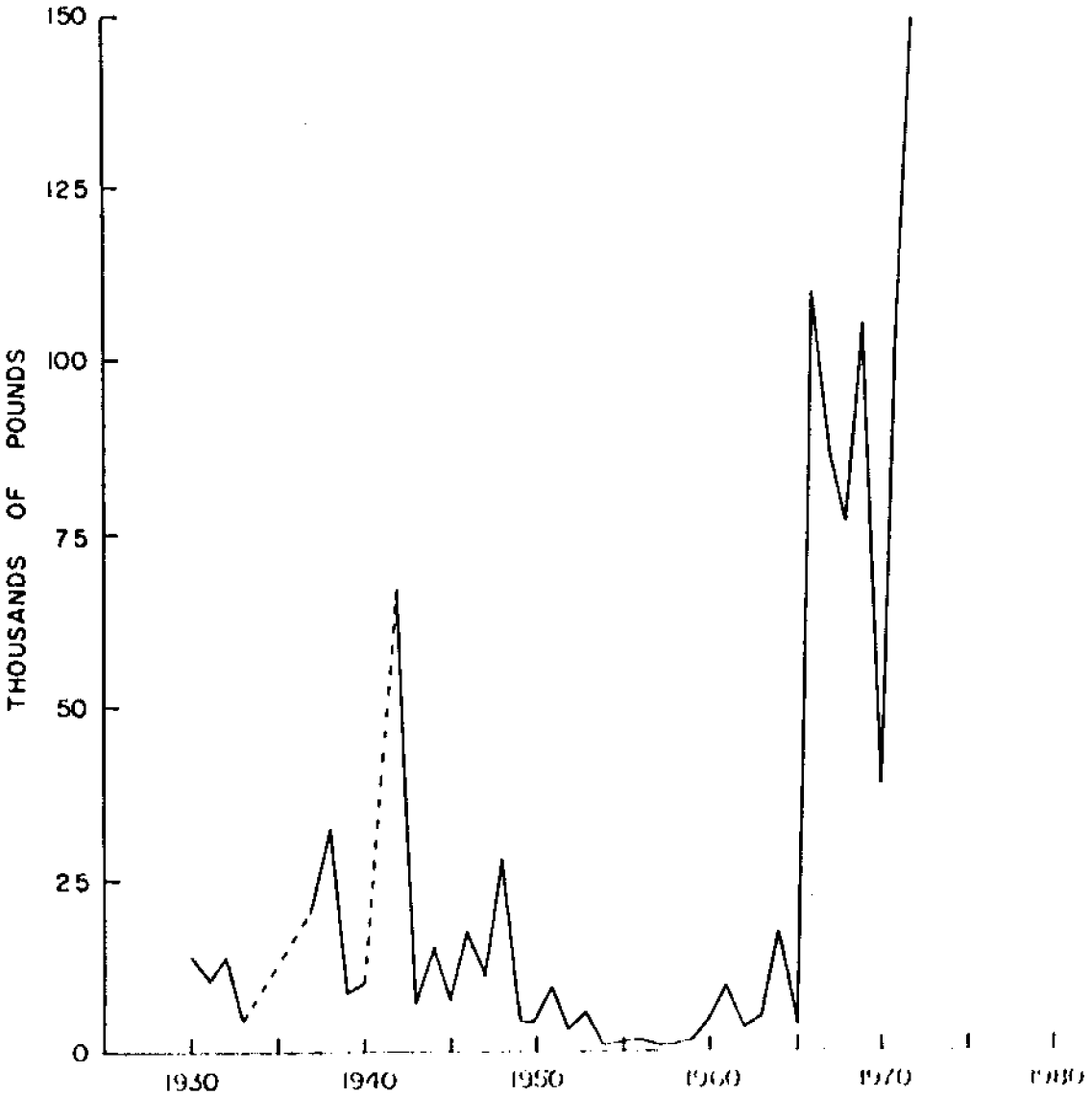


Figure 21.--New York State striped bass landings by pound nets.

1974). Recently, increased landings of striped bass, bluefish, and weakfish by pound nets appears to be directly related to increases in abundance of these species (McHugh, 1974a).

Hand line fishing refers to any fishing done with hook and line whether the line is simply hand held or if a rod and reel are also used. New York State commercial landings of striped bass by hand lines average less than 40,000 pounds per year, except for two periods of increased landings. During the mid-1940s and more recently, the late 1960s and early 1970s, landings by commercial hand liners increased to a point where peak landings were in excess of 50,000 pounds per year (Fig. 22). Increased New York landings of striped bass, during the 1940s, appears to be directly related to increased numbers of commercial hand liners. Commercial fishing activities were forced closer to shore and increased demand for protein occurred during World War II. Increased landings of striped bass in the late 1960s and early 1970s appears to be the result of an increase in numbers of hand liners and an actual increase in abundance of striped bass. Part of this increase in commercial landings of striped bass by hand liners may in fact result from the sale of recreational catches of striped bass.

Part 3. Commercial Striped Bass Fishing Effort

Detailed and accurate statistics on Atlantic Coast commercial fishing effort for striped bass are not available. Available information on fishing effort is published annually in federal Fishery Statistics of the United States. Most of this information is rarely broken down by effort devoted to individual species. Fishing

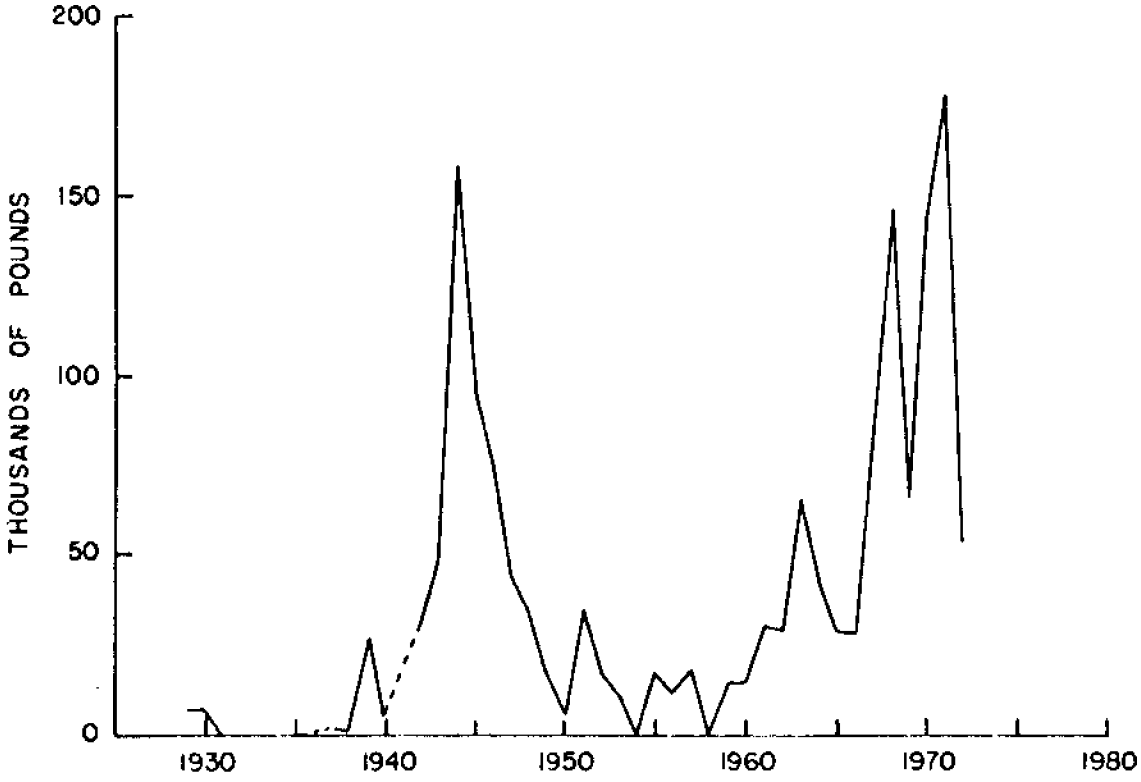


Figure 22.--New York State striped bass landings by hand lines.

effort statistics are separated for individual Atlantic Coast states into three categories: fishermen, vessels and boats, and gear. Information on the number of fishermen is separated into numbers of commercial fishermen on vessels and numbers of regular or casual commercial fishermen. Regular fishermen earn more than fifty percent of their annual income from commercial fishing (Knapp, 1974). The numbers of commercial fishermen by states are not analysed by the type of gear or the species fished. Numbers and gross tonnage of vessels (net capacity of greater than five tons) and boats (net capacity of less than five tons) is the only available information in this category of fishing effort.

Statistics on the amount of gear employed in commercial fisheries is slightly more detailed than the information on numbers of fishermen and vessels, but is still of little value when attempting to analyse a specific fishery. Statistics separated by states are available only on the number and approximate size (length or square yards of netting) of different gears. Since striped bass are commercially harvested by several gears it is impossible to determine from the available statistics how much effort is devoted specifically to striped bass. The opposite is also true, for even though one gear, haul seines in the case of New York State's commercial striped bass fishery, lands more of a species than any other gear, the same gear may also be used for several other species. Until more detailed information is available on fishing effort for individual species the available statistics are useful only in determining general trends of commercial fishing effort, and not trends by species.

APPENDIX C

Seasonal Variations in Commercial Striped Bass Landings

Part 1. Atlantic Coast Commercial Striped Bass Fishery

Striped bass landings by weight fluctuate seasonally in all Atlantic Coast states with major striped bass fisheries. Data on monthly striped bass landings by weight are available for Massachusetts, Rhode Island, New York (Part 2, Appendix C), New Jersey, Maryland, Virginia, and North Carolina (Wheeland, 1973). The most recent year for which monthly striped bass landings statistics, for all of these states, are available and complete is 1973 (Fig. 23). By weight, monthly striped bass landings for these states, excluding North Carolina, are bimodal, with peaks in spring and fall. The greatest weight of striped bass landings in 1973 for Rhode Island and New York occurred in September, October, and November. Although it is not evident in the 1973 New Jersey monthly landings of striped bass, usually the main seasonal peak occurs slightly later than for more northern states. Monthly striped bass landings in New Jersey usually peak in November and remain high until January. Occasionally, such as in 1965, the period of peak landings in New Jersey occurred from January to March (LoVerde, 1966). Maryland and Virginia also have periods of peak landings in spring and fall, but most 1973 landings were made in February to April. North Carolina's striped bass fishery is predominantly a winter fishery. Most landings are made from November to March.

No definitive explanation has been offered to explain why seasonal patterns of striped bass landings vary so markedly from north to south. It appears that the seasonal

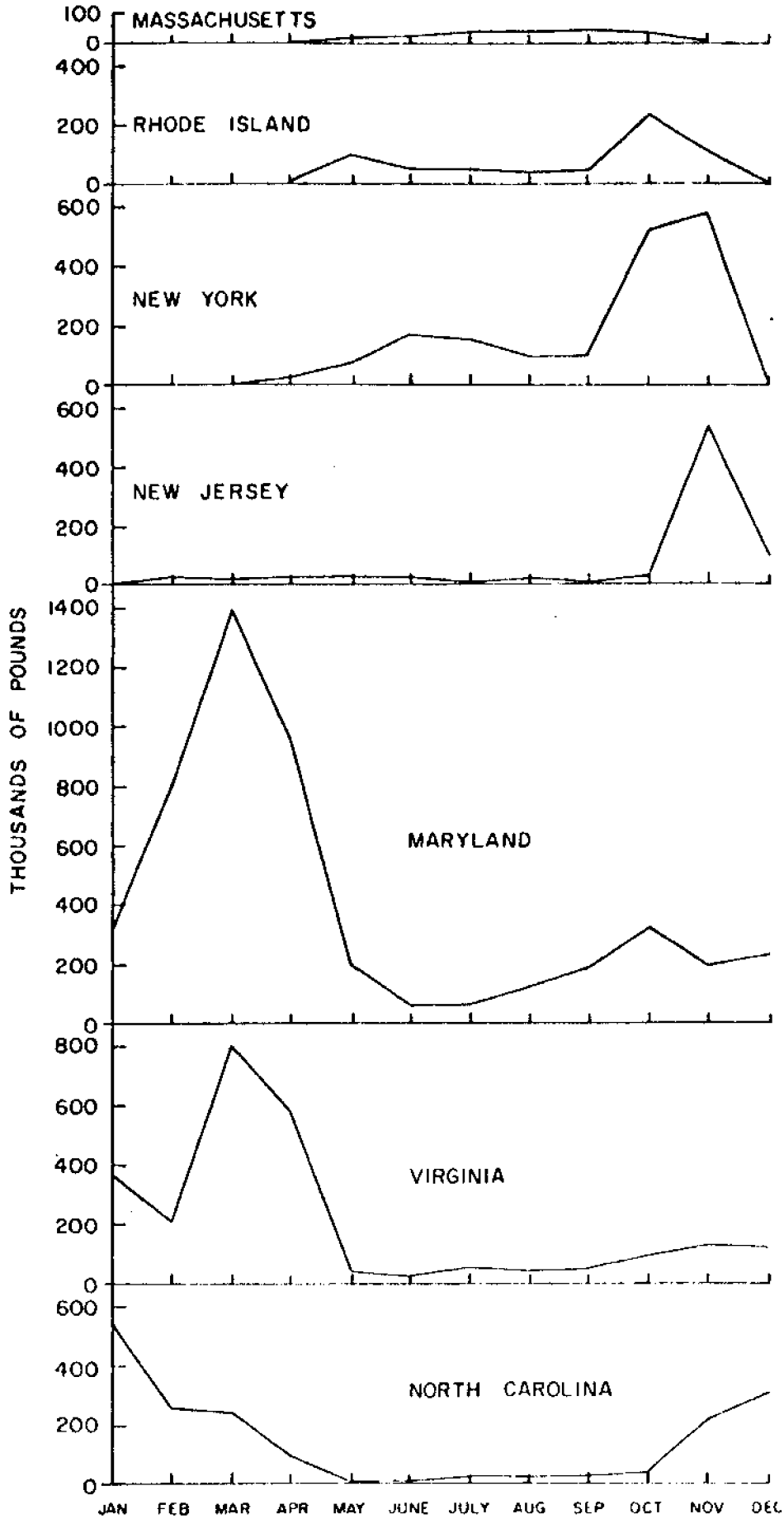


Figure 23.--1973 state commercial striped bass landings by month.

variations in state commercial striped bass landings (Fig. 23) are directly related to seasonal migratory patterns (Appendix A) of the Atlantic Coast striped bass population. Beginning in the South, North Carolina's commercial striped bass fishery is predominatly a winter fishery. Peak landings for Virginia and Maryland correspond to their main fishing effort during and just after the spawning season in Chesapeake Bay. After spawning a portion of the Chesapeake Bay striped bass resource perform coastal migrations. These migrations proceed northeastward during the spring and summer to the coast of New England. North of New Jersey no significant catches are made in the period December to March inclusive, and the Massachusetts fishery is entirely a summer fishery, from May to November. Southwestward coastal migrations begin in the fall and return migrating striped bass to southern overwintering areas. This probably explains why peak landings in Rhode Island, New York, and New Jersey are in fall and early winter.

Part 2. New York State Commercial Striped Bass Fishery

New York State's commercial striped bass fishery is a seasonal fishery. Most landings are made in spring and fall. Average monthly commercial landings of striped bass, between 1955 and 1974, show a distinct bimodal distribution (Fig. 24). Examination of four five-year averages during this period show the same bimodal distributions, with differences only in intensity of the two peaks (Figs. 25, 26). New York State landings in fall tend to be much larger than in the spring. A possible explanation for this annual distribution in New York landings of striped bass has been suggested by Schaefer (1967, 1968a). Spring landings of striped bass appear to be mostly of fish on their northward migrations from Chesapeake

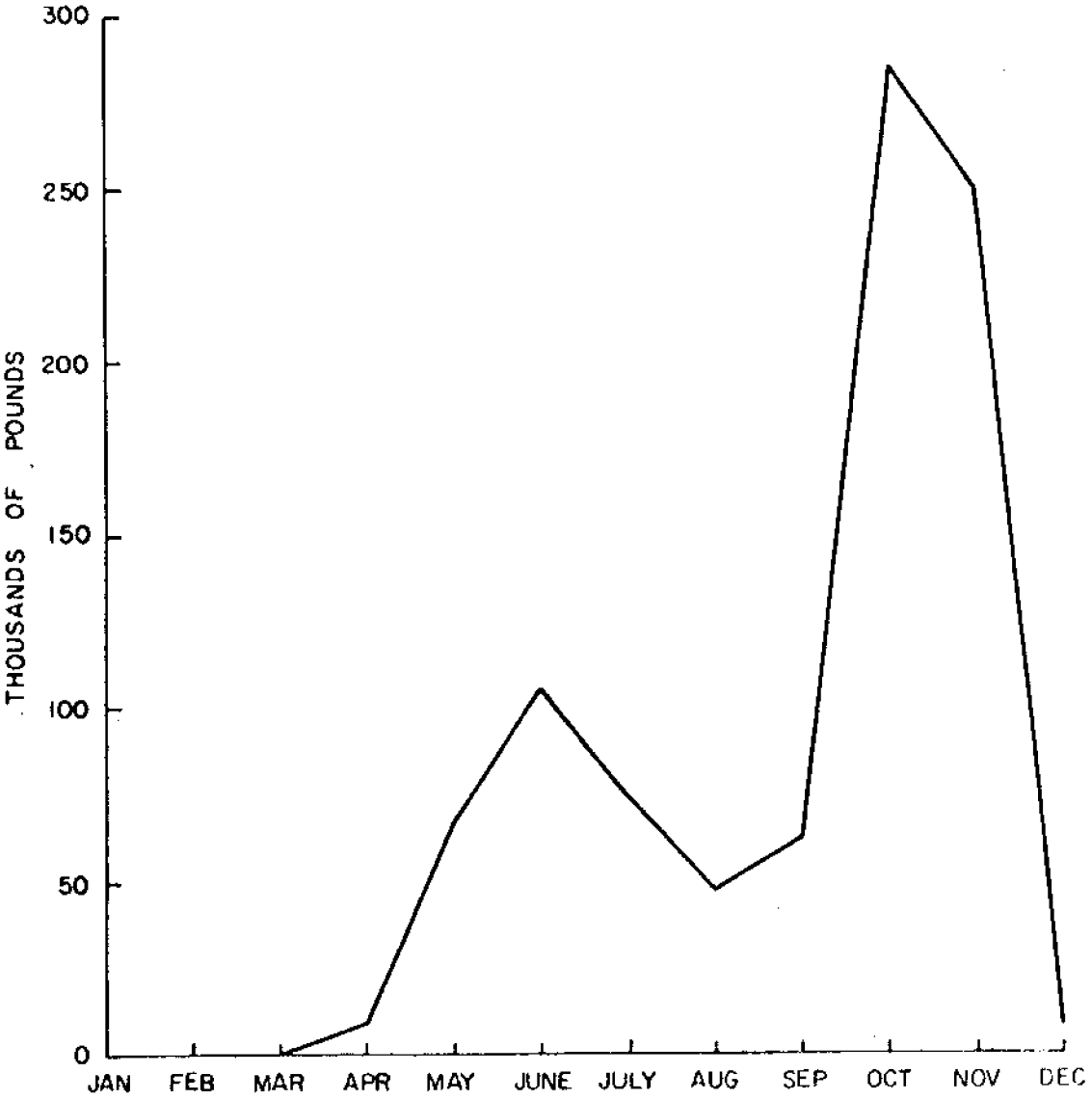


Figure 24.--1955-1974 average monthly New York State commercial striped bass landings.

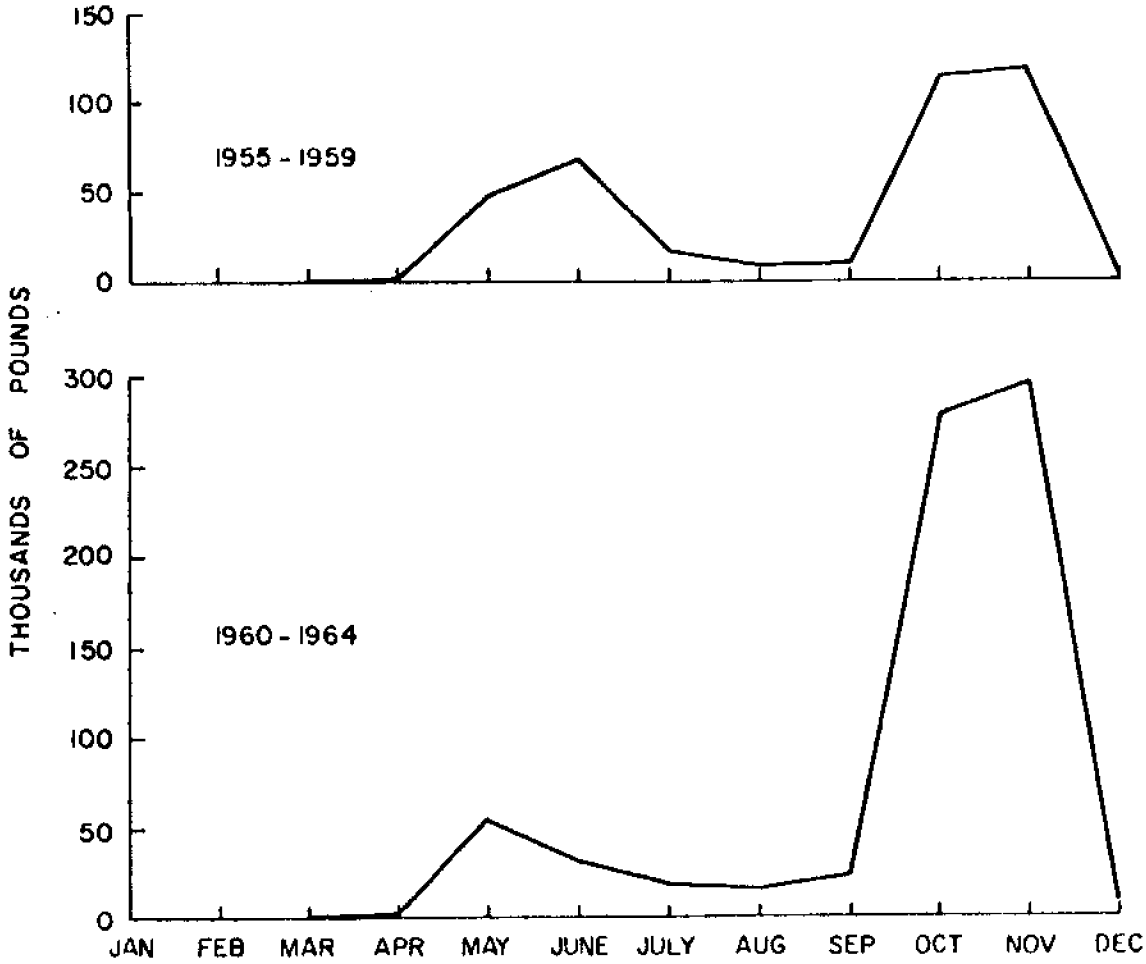


Figure 25.--Five-year average monthly New York State commercial striped bass landings 1955-1959, 1960-1964.

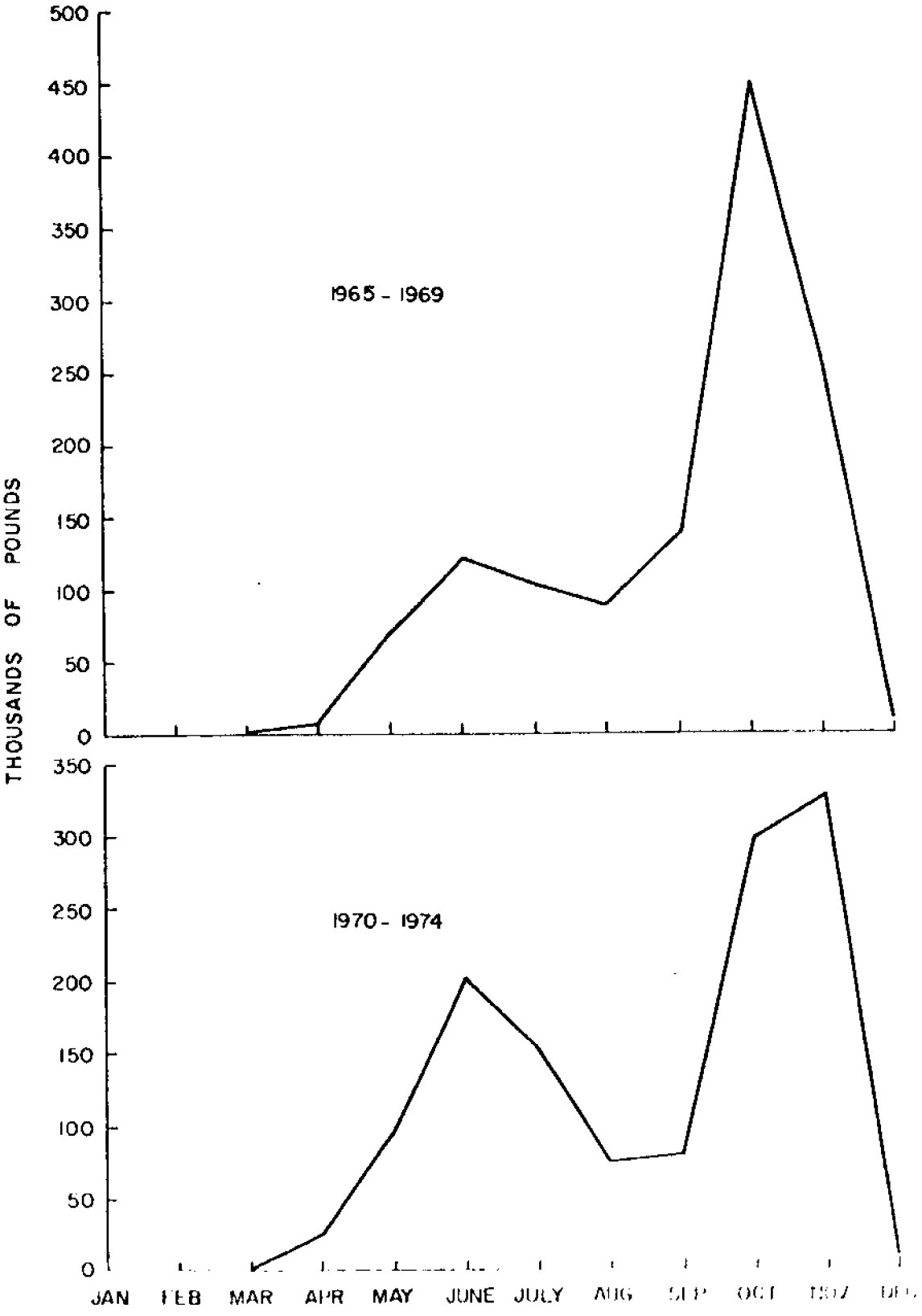


Figure 26.--Five-year average monthly New York State commercial striped bass landings 1965-1969, 1970-1974.

Bay and possibly the Hudson River. In fall, as striped bass return to southern overwintering areas, they again become susceptible to capture by New York fishermen. Having spent the summer feeding in northern waters they will undoubtedly be larger than when they passed Long Island beaches the previous spring. Growth may partially explain the increased fall landings of striped bass in comparison to spring landings. Year-class abundance, the contribution of Chesapeake Bay versus Hudson River spawned striped bass, the seasonal availability of striped bass to New York haul seiners (Appendix C, Part 1), economic factors, and variability of fishing effort all are additional factors which may contribute to this bimodal distribution of monthly landings (Chapoton and Sykes, 1961; Schaefer, 1967, 1968a, 1972; Koo, 1970; Austin and Hickey, 1974; Knapp, 1974).

APPENDIX D

Recreational Striped Bass Fishing Methods and Landings

Part 1. Atlantic Coast Recreational Striped Bass Fishery

Recreational striped bass catch statistics for the entire Atlantic Coast are available only for general geographical regions and are not separated into landings by individual states. Surveys of salt-water sport fishing were conducted in 1960, 1965, and 1970 by the federal government (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973). Regions in which most striped bass are taken are the North Atlantic Region, from Maine to New York inclusive, and the Middle Atlantic Region, from New Jersey to Cape Hatteras. Available information consists of estimated weight and estimated numbers of striped bass caught in each region. By region, the information available on recreational fishing 'effort' consists of total numbers of salt-water anglers, numbers of salt-water anglers, by species caught, and numbers of fish caught by principal area of fishing and method of fishing. The principal areas of fishing are separated into two categories, oceans and sounds, rivers and bays. Principal method of fishing is separated into four categories, private or rented boats, party or charter boats, bridge, pier, or jetty, and beach or bank.

Striped bass landings statistics and recreational fishing 'effort' information have been summarized in Table 4. This information can be used to estimate general trends and order of magnitude changes in the Atlantic Coast recreational striped bass catch. Because the Atlantic Coast striped bass population fluctuates widely in abundance these statistics must be interpreted with caution. More detailed statistics on recreational catch and effort

Table 4 Recreational Striped Bass Catches and 'Effort' Information - Northern and Middle Atlantic Regions.

Year/ Region	Millions of pounds of fish caught	Millions of fish caught	Thousands of anglers	Millions of striped bass caught by principal area of fishing		Millions of striped bass caught by principal methods of fishing			
						Boats		Shore	
				Ocean	Sounds Bays Rivers	Private Rented	Party Charter	Bridge Pier Jetty	Beach and Bank
1960									
N. Atl.	12.340	2.742	180			1.098		1.644	
Mid-Atl.	24.810	6.530	298			6.251		0.279	
Total	37.150	9.272	478			7.349		1.923	
1965									
N. Atl.	47.999	13.199	318	11.627	1.572	1.410	0.269	11.133	0.387
Mid-Atl.	7.351	2.783	295	0.547	2.236	1.998	0.538	0.046	0.201
Total	55.350	15.982	613	12.174	3.808	3.408	0.807	11.179	0.588
1970									
N. Atl.	45.844	4.309	368	0.496	3.813	3.154	0.575	0.162	0.418
Mid. Atl.	27.262	9.857	415	0.961	8.896	7.784	1.164	0.177	0.732
Total	73.106	14.166	783	1.457	12.709	10.938	1.739	0.339	1.150

Source - Clark (1962), Deuel and Clark (1968), Deuel (1973), Wheeland (1973).

are necessary before these surveys accurately represent the true landings and fishing effort involved in the Atlantic Coast recreational striped bass fishery.

Much has been written about recreational striped bass fishing. Most sport fishermen in New York and along the Atlantic Coast catch striped bass by surf casting, trolling, and live-bait fishing. Infinite variations in gear, bait and daily fishing times are used. Detailed descriptions of the numerous techniques, gears, baits, and other aspects of the sport fishery can be found in several books devoted entirely to recreational striped bass fishing (Lyman and Woolner, 1954; Rosko, 1966; Karas, 1974; Moss, 1974). A basic knowledge of surf casting is necessary, however, to understand why the striped bass controversy between recreational fishermen and commercial haul seiners exists. For those readers unfamiliar with surf casting, a brief description is included in Part 2 of this appendix.

Historically, major fishing grounds for striped bass existed off the coast of Rhode Island in the vicinity of Newport, in Massachusetts around Cuttyhunk Island and Martha's Vineyard, in several areas around New York and Long Island, along the New Jersey coast from Sandy Hook to Barnegat Bay, in extensive areas of Chespeake Bay, and around Cape Hatteras in North Carolina (Endicott, 1892; Harris and Bean, 1905). Some of the most productive recreational striped bass fishing areas in New York were once in the immediate vicinity of New York City. Endicott (1892) claimed that one of the favorite places to fish for striped bass near New York City was at Hell Gate, where the Harlem River joins the East River. In 1905, Harris and Bean noted that pollution around New York City was becoming a

problem, especially for recreational fishermen, saying that "notwithstanding the deterioration of the waters by oil, trolling, at Hell Gate, sometimes furnishes good sport" (Harris and Bean, 1905).

Recently the major recreational striped bass fisheries of the Northern Atlantic Region are concentrated in Massachusetts, Rhode Island, and New York. The most productive angling areas in Massachusetts are around Cuttyhunk, Nantucket, and Cape Cod Canal from May to October (Evanoff, 1958; Chapoton and Sykes, 1961). Rhode Island's best recreational fishing locations are now in and around Block Island Sound, Narragansett Bay, and Newport from May to November, with September and October the two peak months (Evanoff, 1958). New York's recreational striped bass fishing is centered around Montauk Point. The best months appear to be May, June, September, October, and November (Evanoff, 1958; Chapoton and Sykes, 1961; Briggs, 1962; Briggs, 1965; Karas, 1974).

Major recreational striped bass fishing areas of the Middle Atlantic Region range all the way from Sandy Hook, New Jersey, to Cape Hatteras National Seashore in North Carolina. Striped bass are caught in New Jersey waters from April to November. The best areas are Sandy Hook, Barnegat Bay, and many of the inlets and beaches from Atlantic City down to Cape May (Evanoff, 1958; Chapoton and Sykes, 1961). Most recreational striped bass fishing in Delaware is done from June to December in Delaware Bay (Evanoff, 1958). Recreational striped bass fishing in Maryland and Virginia is carried out in many areas of Chesapeake Bay and its tidewater tributaries usually from early spring to late fall. In North Carolina some year round recreational striped bass fishing occurs in Albemarle Sound and its tributaries. A winter recreational

striped bass fishery occurs along the Outer Banks beaches of the Cape Hatteras National Seashore (Chapoton and Sykes, 1961).

Part 2 - New York State Recreational Striped Bass Fishery

New York's recreational striped bass fishery is centered around Montauk Point, one of the best striped bass fishing locations along the entire Atlantic Coast. In addition, areas such as the 'Race' and 'Plum Gut' off the northern fork of eastern Long Island, portions of western and eastern Long Island Sound, segments of the Hudson River, Long Island's south shore beaches and inlets, Great South Bay, and countless other bays and estuaries around Long Island all may be productive striped bass angling areas at different times of the Year (Evanoff, 1958; Chapoton and Sykes, 1962; Briggs, 1962; Briggs, 1965; Karas, 1974).

Recreational striped bass fishing in New York may start late in March and may last until early December. Peak recreational catches of striped bass by numbers in New York usually are made during the same period as peak commercial landings (Briggs, 1965). The best months appear to be May, June, September, October, and November.

Specific scientific information on New York State recreational striped bass fishing has been published mainly by Briggs (1962, 1965). Briggs (1962) concluded that of six major sport fisheries in Great South Bay and nearby vicinity, the least important in terms of numbers of participants and numbers of fish caught, was the surf fishery, which concentrates almost solely on striped bass and kingfish (Menticirrhus saxatilis). From 1956 to 1960 the catch (in numbers of fish) of striped bass by surf anglers fishing in an area from Jones Inlet to Fire Island

Inlet increased from 388 to 3,290. Briggs (1962) suggested that this was the result of a steady increase from 1956 to 1960 in numbers of surf anglers fishing this area. If recreational landings of striped bass for the entire Great South Bay area and the ocean surf fishery are combined the increase in numbers of striped bass landed is even more impressive, from 388 in 1956 to 28,261 in 1960 (Briggs, 1962).

Briggs (1965) later expanded his study of the Long Island surf fishery to include the area from Jones Inlet east to Shinnecock Inlet. He reported that from 1961 to 1963 the number of surf anglers fishing this area increased from 18,811 to 25,177. Numbers of striped bass landed increased from 5,420 to 6,881 (Briggs, 1965). The catch per angler for 1961 to 1963 declined only slightly, from 0.29 to 0.27 fish per angler. Briggs suggested that the increase in numbers of surf anglers was a result of human population growth, rising salaries, increased leisure time, and wide publicity by columnists of outstanding surf catches of striped bass. He also suggested that the increase in recreational striped bass landings was a result of a real increase in striped bass abundance and use of new and improved fishing tackle (Briggs, 1965).

In addition to studies by Briggs (1962, 1965) several other investigators (Alperin, 1966a; Schaefer, 1967; Schaefer, 1968a) have given scattered statistics on New York State recreational striped bass fishing. It is difficult to correlate these statistics with the work of Briggs or the national Salt-Water Angling Surveys, for often the accuracy or the method used by the author to determine their statistics was not described.

Most sport fishermen in New York catch striped bass by surf casting, trolling, and live-bait fishing. The

striped bass controversy between New York recreational and commercial striped bass fishermen exists mainly between recreational surf casters and commercial haul seiners. New York recreational fishermen, especially surf casters, are attempting to get legislation passed which would prohibit all commercial haul seining for striped bass.

Surf casting for angling in the surf is a highly specialized and challenging form of striped bass fishing around which has developed an extremely devoted "cult" of striped bass fishermen. To this group, surf casting is as much a form of art as it is a method of catching fish. Some investigators believe it is the least efficient of the many techniques commonly used to catch striped bass (Briggs, 1962). But, to the striped bass surf casters this information is no deterrent.

The minimum gear required to surf cast is a surf rod or "stick", a reel and line, and some natural bait or artificial lure or "plug". Accessory equipment may include waders, a storm suit or parka, a lantern for night fishing, and a shoulder bag filled with an assortment of lures, line, a gaff and other miscellaneous gear. Some very devoted surf casters may invest in a beach buggy to get them quickly back and forth to the best fishing spots. The investment in gear and accessory equipment made by surf casters is proportional to their interest in the sport and may range from less than a hundred dollars to thousands of dollars. A commercial haul seiner, on the other hand, must make a much larger investment. One haul seiner from eastern Long Island claims to have invested $14,000 in nets, trucks, and dories used in his commercial business (New York Times, 1975a).

Surf casting may be done at any time, but surf casters make the greatest catch per effort at night, especially at

dusk and dawn (Briggs, 1962; Briggs, 1965). Surf casting usually is done along flat sandy ocean beaches, rocky shorelines and jetties, or anywhere that fishermen believe striped bass may be feeding. Flat sandy ocean beaches of eastern Long Island are the places where most New York State commercial haul seining takes place. Surf casters and commercial haul seiners tend to fish when and where most striped bass are available. This becomes an area of conflict, for during the period it takes commercial fishermen to set and haul their seines they are competing with surf casters, at that specific location, for available striped bass.

APPENDIX E

Striped Bass Legislation by State

State: Maine
Size limit: None
Creel limit/day: None
Recreational fishing season: No closed season
Commercial fishing season: None
Rec. gear permitted: Hand lines and spearfishing
Comm. gear permitted: None
Areas closed to rec. fishing: None
Areas closed to comm. fishing: Since 1968, all state tidal waters.
Sale of rec. catch: No restrictions
Sale of comm. catch: Sale of incidental striped bass catches permitted.

State: New Hampshire
Size limit: 16 inches FL (min)
Creel limit/day: None
Rec. fishing season: No closed season
Comm. fishing season: None
Rec. gear permitted: Hand lines
Comm. gear permitted: None
Areas closed to rec. fishing: None
Areas closed to comm. fishing: All state waters.
Sale of rec. catch: No restrictions
Sale of comm. catch: Sale of incidental striped bass catches permitted.

State: Massachusetts
Size limit: 16 inches FL (min)
Creel limit/day: None
Rec. fishing season: No closed season
Comm. fishing season: None
Rec. gear permitted: Hand lines
Comm. gear permitted: Hand lines and fish traps if not specifically to capture striped bass.

Massachusetts cont.

Areas closed to rec. fishing: None

Areas closed to comm. fishing: All state waters

Sale of rec. catch: No restrictions

Sale of commercial catch: Rod and reel license required to sell daily catch of more than 100 pounds. Sale of incidental catches permitted.

State: Rhode Island

Size limit: 16 inches FL (min)

Creel limit/day: None

Rec. fishing season: No closed season

Comm. fishing season: March 1 to December 31

Rec. gear permitted: Hand lines

Comm. gear permitted: Fish traps or pound nets

Areas closed to rec. fishing: None

Areas closed to comm. fishing: Numerous closed areas

Sale of rec. catch: No restrictions

Sale of commercial catch: Some restrictions on the sale of incidental catches.

Addl. comments: Many restrictions on size, shape and placement of fish traps.

State: Connecticut

Size limit: 16 inches FL (min)

Creel limit/day: None

Rec. fishing season: April 20 to February 28

Comm. fishing season: None

Rec. gear permitted: Hand lines

Comm. gear permitted: None

Areas closed to rec. fishing: None

Areas closed to comm. fishing: All state waters

Sale of rec. catch: Not permitted

Sale of comm. catch: Sale of incidental catches of striped bass not permitted.

State: New York

Size limit: 16 inches FL (min)

Creel limit/ day: None

Rec. fishing season: No closed season except in Hudson River and Delaware River between Dec. 1 - Mar. 15

Comm. fishing season: Same closed season as above and certain other areas are closed all year.

Rec. gear permitted: Hand lines and spear fishing

Comm. gear permitted: No restrictions except certain areas closed to certain gears.

Areas closed to rec. fishing: Hudson and Delaware Rivers between December 1 to March 15

Areas closed to comm. fishing: Same as above and many other areas are closed all year

Sale of rec. catch: No restrictions

Sale of comm. catch: No restrictions

Addl. comments: For further information refer to Ginter (1974) and McKinney's Consolidated Laws of New York Annot. (1972).

State: New Jersey

Size limit: Atlantic Coast - 18 inches TL (min)
Delaware Bay and tributaries - 10 inches TL (min)
20 pound (max)

Creel limit/day: 10

Rec. fishing season: All areas except Delaware Bay March 1 to December 31, No closed season in Delaware Bay and fresh waters.

Comm. fishing season: None within state waters

Rec. gear permitted: Hand lines and spear fishing

Comm. gear permitted: None within state waters

Areas closed to rec. fishing: None

Areas closed to comm. fishing: All state waters

Sale of rec. catch: No restrictions

Sale of comm. catch: Sale of incidental striped bass catches is permitted.

State: Delaware

Size limit: 12 inches FL (min) and 20 pounds (max)

Creel limit/day: None

Delaware cont.

Rec. fishing season: No closed season

Comm. fishing season: November 1 to April 30

Rec. gear permitted: Hand lines and spear fishing

Comm. gear permitted: Haul seines and gill nets only

Areas closed to rec. fishing: None

Areas closed to comm. fishing: Certain areas of Delaware Bay and tributaries are closed to non-residents.

Sale of rec. catch: No restrictions

Sale of comm. catch: No restrictions

State: Maryland

Size limit: Tidal waters - 12 inches TL (min) and 15 pounds(max)
Non-tidal waters-14 inches TL (min) and no max

Creel limit/day: None, however, only one fish/day over 15 pounds may be kept between March 1 - June 15.

Rec. fishing season: No closed season

Comm. fishing season: Some areas have closed seasons for some gears.

Rec. gear permitted: Hand lines and spear fishing

Comm. gear permitted: Gill nets, pound nets, haul seines, fyke and hoop nets.

Areas closed to rec. fishing: None

Areas closed to comm. fishing: Many areas may be closed to certain gears during certain seasons and days

Sale of rec. catch: Some restrictions

Sale of comm. catch: Only by licensed comm. fishermen.

Addl. comments: Commercial fishing license is required,
Many restrictions have been placed on gear size and fishing locations,
Incidental catches of striped bass may be sold.

State: Virginia

Size limit: 14 inches TL (min) and 40 inch (max) - tidal waters
Must be greater than 20 inches TL - inland waters

Creel limit: Tidal waters - None other than no more than 2 striped bass over 40 inches may be kept per day.
Inland waters - creel limit of 4 per day

Virginia cont.

Rec. fishing season: No closed season

Comm. fishing season: No closed season

Rec. gear permitted: Hand lines

Comm. gear permitted: No restrictions on type of gear, but many restrictions exist on the size and operation of the different gears.

Areas closed to rec. fishing: None

Areas closed to comm. fishing: Many areas are closed to certain gears.

Sale of rec. catch: No restrictions

Sale of comm. catch: No restrictions

State: North Carolina

Size limit: 12 inches TL (min)

Creel limit/day: Tidal waters - None
Inland waters - Reservoirs and trib. 8/day
All other areas 25/day

Rec. fishing season: No closed season

Comm. fishing season: No closed season

Rec. gear permitted: Hand lines

Comm. gear permitted: Many restrictions on the size, operation, and types of gear permitted.

Areas closed to rec. fishing: Within 50 feet of the fish ladder at Quaker Neck Dam on the Neuse River.

Areas closed to comm. fishing: Same as above and many other areas are closed to certain gears.

Sale of rec. catch: From tidal waters - no restrictions
From inland waters - sale is prohibited

Sale of comm. catch: No restrictions

APPENDIX F

Summary of the state of knowledge on striped bass

Part 1 - Striped Bass Biology

Part 2 - Commercial Striped Bass Fishery

Part 3 - Recreational Striped Bass Fishery

Part 4 - Effect of Industrialization on New York State Striped Bass Fisheries

Key to Parts 1 to 4

Quantity of information available on a subject

1. A substantial amount of information is available.
2. A moderate amount of information is available.
3. Very little or no information is available.

Quality of information available on a subject

1. Sufficient information, from which sound scientific conclusions can be drawn.
2. Insufficient or unsubstantiated information, from which only general conclusions or no scientific conclusions can be drawn.

Status of knowledge about the subject

1. An adequate amount of information is available.
2. Some information is available.
3. Very little or no information is available.

Additional research or further analysis of available information is necessary.

Part 1 - Striped Bass Biology	Quantity	Quality	Status
I Taxonomy	1	1	1
II Distribution			
Atlantic Coast	1	1	1
Pacific Coast	2	1	2
Gulf of Mexico	2	1	2
III Spawning and Reproduction			
Maturity			
Methods of determining	2	1	1
Size and Age at maturity	2	1	1
Spawning Migrations			
Location	3	2	2
Time	3	2	2
Water characteristics	1	1	2
Spawning Behavior			
Homing tendency	3	2	2
Frequency of spawning	2	1	1
Sex ratios during spawning	1	1	1
Behavior on spawning grounds	1	1	1
Embryology and Development			
Fecundity - # eggs/female vs age and size	2	1	1
Eggs and their behavior	2	1	1
Larvae and postlarvae and their behavior	3	2	2
Juveniles and fingerlings and their behavior	3	2	2
Nursery Areas			
Time spent in nursery areas	2	1	1
Location of nursery areas	3	1	2
Water characteristics of areas	2	1	1
IV Age and Growth			
Methods of age determination	1	1	1
Size relationships			
Length vs age / sex	1	1	1
Weight vs age / sex	1	1	1
Growth rate vs age / sex	3	2	2
Compensatory growth	2	1	1
V Food and Feeding Habits			
Methods of determination	1	1	1
Effect of size on food eaten	3	2	2
Effect of seasons on feeding	3	2	2
Effect of location on feeding			
Atlantic Coast	3	2	2
New York			
Long Island Sound	3	2	2
Hudson River	3	2	2
South shore of Long Island	2	1	1

Part 1 cont.	Quantity	Quality	Status	Addl. Res.
Food of larvae and postlarvae				
Atlantic Coast	3	2	2	+
New York	3	2	2	+
Food of juveniles and fingerlings				
Atlantic Coast	3	2	2	+
New York	3	2	2	+
Food of adult striped bass				
Atlantic Coast	2	2	2	+
New York	2	2	2	+
VI Migratory Behavior				
Methods of study				
Tagging methods	1	1	1	
Efficiency of different tagging methods	2	1	1	
Problems associated with tagging as a means of studying migration	1	1	1	
General migratory behavior				
Feeding migration patterns	1	2	2	+
Spawning migration patterns	1	2	2	+
Composition of migrating stocks				
Age and size	2	1	1	
Sex	2	1	1	
Effect of size on migratory patterns	2	2	2	+
Sources of migrating stocks				
Number and location of separate stocks				
Chesapeake and Delaware Bay regions	1	2	3	+
Hudson River region	1	2	3	+
North Carolina region	2	2	3	+
Factors affecting feeding migrations				
Year-class abundance	1	2	2	+
Water characteristics				
Physical	3	2	2	+
Chemical	3	2	2	+
Biological factors				
Abundance of food	3	2	3	+
Distribution of food	3	2	3	+
VII Abundance				
Methods used to determine abundance	1	1	1	
Causes of fluctuations	3	2	2	+
Contribution of Chesapeake Bay versus Hudson River to:				
Atlantic Coast striped bass fishery	1	2	3	+
New York State striped bass fishery	1	2	3	+
Recruitment rates of different stocks to:				
Atlantic Coast striped bass fishery	3	2	3	+
New York State striped bass fishery	3	2	3	+
Natural mortality rates				
Eggs and larvae	3	2	2	+
Juveniles and fingerlings	3	2	2	+
Adult striped bass	3	2	2	+
Standing crop	3	2	2	+

Part 2 - Commercial Striped Bass Fishery	Quantity	Quality	Status	Addl. Res.
I Commercial Landings				
State landings by species	2	1	1	
Amount caught by fishing locations	3	2	3	+
Amount landed in fishing ports	3	2	2	
Time of landings				
Annual landings	2	1	1	
Monthly landings	2	1	1	
Landings by Gear (See below)				
II Commercial Fishing Gears				
Size of gear - length, depth, mesh-size	2	2	2	+
Amount or units of gear actively fished				
Annual and monthly guantities	3	2	3	+
Amount of time gear was in use:				
Monthly - number of days	3	2	3	+
Daily - number of hours	3	2	3	+
Landings by gears				
Total weight of fish caught per gear	2	1	1	
Weight of individual species caught	2	1	1	
III Commercial Fishermen				
Number of regular fishermen by gears fished / species landed	3	2	3	+
Number of casual fishermen by gears fished / species landed	3	2	3	+
IV Commercial Fishing Boats or Vessels				
Number of boats or vessels	2	1	2	
Size or capacity of boats or vessels	2	1	2	
Number of fishermen / boat or vessel	3	2	3	
Number of days boats or vessels were used:				
By gear fished	3	2	3	+
By species caught	3	2	3	+
V Commercial Fishing Economics				
Costs of:				
Boats or vessel - variable and fixed	3	2	3	
Gear - initial cost and repairs	3	2	3	
Labor to operate boat and gear	3	2	3	
Income from landings:				
Ex-vessel value of catch per pound and landings per vessel	2	1	1	
Wholesale value	3	2	3	
Seasonal fluctuations of values:				
Ex-vessel value	2	1	1	
Wholesale value	3	2	3	

Part 2 cont.

		Quantity	Quality	Status	Addl. Res.
VI	Commercial Fishing Locations				
	Weight of species caught / location	3	2	3	+
	Amount of gear fished / location	3	2	3	+
	Amount of time gear was fished / location	3	2	3	+
	Number of vessels fishing / location	3	2	3	+
	Amount of time vessels fished / location	3	2	3	+
	Characteristics of fishing locations	2	2	3	+
VII	Biological and Management Information About Commercial Landings				
	Sources of fish	3	2	2	+
	Magnitude of standing crop available to commercial fishermen	3	2	3	+
	Commercial fishing mortality rates	3	2	3	+
	Recruitment rates to available stocks	3	2	3	+
	Distributions of catch by gear and species				
	Size	3	2	2	+
	Age	3	2	2	+
	Weight	3	2	2	+
	Stomach contents	3	2	3	+

Part 3 - Recreational Striped Bass Fishery	Quantity	Quality	Status	Addl. Res.
I Recreational Landings				
Landings by weight				
By regions				
1960, 1965, 1970	1	2	2	+
All other years	3	2	3	+
By states	3	2	3	+
By fishing areas within states	3	2	3	+
Landings by numbers of fish				
By regions				
1960, 1965, 1970	1	2	2	+
All other years	3	2	3	+
By states	3	2	3	+
By fishing areas within states	3	2	3	+
Period of landings				
Annual				
1960, 1965, 1970	1	2	2	+
All other years	3	2	3	+
Monthly	3	2	2	+
Time of day	3	2	2	+
Landings by fishing method (See below)				
II Recreational Fishermen				
Numbers of anglers				
By regions				
1960, 1965, 1970	1	2	2	+
All other years	3	2	2	+
By states	3	2	3	+
By fishing areas within states	3	2	2	+
III Recreational Fishing Methods				
Surf casting for striped bass				
Number of anglers / year	3	2	2	+
Number of anglers / month	3	2	3	+
Number of days fishing / month / angler	3	2	3	+
Number of days fishing / month / fishing area	3	2	3	+
Landings				
By weight / month / fishing area	3	2	2	+
By number / month / fishing area	3	2	2	+
Trolling for striped bass				
Number of boats used for trolling				
Annually	3	2	3	+
Monthly	3	2	3	+
Number of days trolling / month / boat	3	2	3	+
Number of days trolling / month / fishing area	3	2	3	+
Number of anglers / boat	3	2	3	+
Landings				
By weight / month / fishing area	3	2	3	+
By number / month / fishing area	3	2	3	+

Part 3 cont.	Quantity	Quality	Status	Addl. Res.
Live-bait fishing for striped bass				
From Shore				
Number of anglers / year	3	2	2	+
Number of anglers / month	3	2	3	+
Number of days fishing / month / angler / fishing area	3	2	3	+
Landings				
By weight / month / fishing area	3	2	3	+
By number / month / fishing area	3	2	3	+
From Boats				
Number of boats used for live-bait fishing / annually and monthly	3	2	3	+
Number of days fishing / month / boat	3	2	3	+
Number of anglers / boat	3	2	2	+
Number of days fishing / month / angler / fishing area	3	2	3	+
Landings				
By weight / month / fishing area	3	2	3	+
By number / month / fishing area	3	2	3	+
IV Recreational Fishing Economics				
Costs / year				
Boats - variable and fixed	2	2	2	+
Gear	2	2	2	+
Bait	2	2	2	+
Travel	2	2	2	+
Miscellaneous	2	2	2	+
Income / year from sale of catches				
Weight of fish sold / angler	3	2	3	+
Amount of money received for sale of fish	3	2	3	+
Numbers of anglers who regularly sell their catches or a portion thereof	3	2	3	+
V Biological and Management Information About Recreational Catches				
Sources of fish	3	2	2	+
Magnitude of standing crop available to recreational fishermen	3	2	3	+
Recreational fishing mortality rates	3	2	3	+
Recruitment rates to available stocks	3	2	3	+
Distributions of catch				
Size (length)	3	2	2	+
Age	3	2	2	+
Weight	3	2	2	+
Stomach contents	3	2	2	+
Bait used to catch fish	3	2	2	+

Part 4 - Effect of Industrialization on New York State Striped Bass Fishery	Quantity	Quality	Status	Addl. Res.
I Pollution				
Industrial pollution				
New York State marine district	2	2	2	+
Atlantic Coast				
Chesapeake Bay	2	2	2	+
Delaware Bay	2	2	2	+
Other areas	3	2	2	+
Domestic pollution				
New York State marine district	2	2	2	+
Atlantic Coast				
Chesapeake Bay	2	2	2	+
Other areas	3	2	2	+
Power generating facilities				
New York State				
Hudson River	1	2	1	+
Long Island Sound	2	2	2	+
Atlantic Coast				
Chesapeake Bay	3	2	2	+
Other areas	3	2	2	+
Alterations of topography, hydrology, and circulatory patterns in spawning, nursery, and other estuarine areas				
New York State marine district	2	2	2	+
Atlantic Coast				
Chesapeake and Delaware Bays	2	1	1	+
Other areas	3	2	2	+

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