Menhaden, Sport Fish, And Fishermen

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Marine Technical Report 60

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INTRODUCTION

During each summer millions of pounds of menhaden (Brevoortia tyrannus) and their predators, including bluefish, Pomatomus saltatrix (Linnaeus), and striped bass, Morone saxatilis (Walbaum), migrate into Narragansett Bay, Rhode Island. All are subject to intensive exploitation by fishermen. While numerous studies have been directed at the individual species and at the fishermen, few have sought to define the interaction between prey fish, predator fish and fishermen, and none of these studies have been done in the Northeast.

Background

During the 1960's the magnitude of menhaden stock size decreased sharply, some thought, because of increasing fishing pressure (Nicholoson 1971, Henry 1971). Henry (1971) calculated a stock recruitment relation for the poor year classes of the 1960's which indicated that the spawning stock in the mid-Atlantic fishery was below optimum size. As a consequence the commercial fishery declined in Rhode Island as well as other states (Figure 1). Another good year class must have occurred about 1966, since good catches have been taken after 1970, and because the North Atlantic fishery tends to yield older fish (average age 3.7 years) (Henry 1971). Modeling attempts, which include density dependent factors, environmental factors, and field checks on the abundance of junveniles in nursery areas, promise to be useful indicators of future menhaden stocks (Nelson, Ingham and Schaaf 1975, Pacheco 1966).

If predatory species are dependent on menhaden, menhaden abundance may be indicative of bluefish and striped bass abundance. However, the landings of these species, which have been on a more or less upward trend since 1958, do not correlate well with fluctuating menhaden landings (Figure 1). In this case too, the success of a year class is of prime importance. Striped bass dominant year classes occurred in 1958, 1964, 1965, 1969 and 1970 (Grand and Joseph 1969, Hassler and Hogarth 1970, Schaefer 1972). As with menhaden, usually larger fish, aged three years older, are caught in Rhode Island waters. Younger fish apparently do not migrate from the southern river systems (Chesapeake to the Hudson) in which they were spawned until they are at least two years old (Massmann and Pacheo 1961, Clark 1968). By contrast, bluefish within Massachusetts, Connecticut, Rhode Island and New York may constitute a geographically isolated racial grouping (Saila and Pratt 1973, Lund and Maltezos 1970). Other evidence from a National Marine Fisheries Service study indicates that the northern and southern stocks intermingle during the migration periods resulting in a bimodal size distrubution for an age class. While it is known that both species feed heavily on menhaden, it is not known how dependent they are upon them.

In the past several years, less than half a dozen menhaden fishermen have been taking 15 to 23 million pounds of menhaden from Narragansett Bay during the summer session. An unknown number of fishermen

(a 1973-74 telephone survey by the National Marine Fisheries Service (Ridgely and Deuel 1974) estimated a total of 584,000 persons fished in Rhode Island waters of which 269,000 were residents of Rhode Island) owning roughly 20,000 boats (Rorholm personal communication) take an unknown quantity of bluefish and striped bass during each summer season. Many times in the past, and recently with renewed vigor, local sport fishermen have claimed a close correlation between the exploitation of menhaden and a poor sport fishing season. They call for regulation of the menhaden fishery. Another opinion was expressed by McHugh (1972) who wrote: "When the sport catch has been demonstrated to greatly exceed the commercial catch, as is apparently true for species like bluefish and striped bass, the question arises whether sport fishing is not more in need of regulation than commercial fishing."

In this paper an attempt is made to sort out the interactions between prey and predators, including fishermen in Narragansett Bay. In order to do this the following questions must be answered: (1) What determines the seasonal pattern of abundance of menhaden in Narragansett Bay? (2) How efficiently are schools captured? (3) What percent of schools observed are actually finished? (4) What is the pattern of striped bass and bluefish abundance in the Bay? (5) Do these Bay fish have menhaden in their stomachs? (6) What is the abundance of predator fishes in the Bay and what are their food requirements? and (7) How heavy is the fishing pressure on striped bass and bluefish?

METHODS

During the past two summers data on fish and fishermen have been collected. In 1975, the Marine Fisheries Division of the Rhode Island Department of Natural Resources sampled the menhaden catch for size and age and for number of sport fish taken. They have also compared spotter pilot observations with actual catches (Ganz 1975). In 1976 spotter pilot observations of menhaden school sizes were made available by Ann and Edward Durbin (personal communication). The two sportfish species were sampled for size, age and sex weekly at buyer locations around Rhode Island - but primarily at two locations on the Bay and one on the South Shore - to establish a comparison between Bay-caught fish and offshore fish. At all sport fish tournaments fish were sampled for size, age, sex, stomach contents and location of catch. Occasionally in 1975 and weekly in 1976, bluefish were similarly sampled from fish traps located off Narragansett and Newport.

Information on individual fishermen was obtained through interviews and from buyers records. From one buyer located on the Bay, records were obtained back to 1972.

Individual measurements on fish included fork length to the half inch and weight to the nearest half pound. Sex was determined by studying the reproductive organs. Gut contents were identified on preserved material in 1975 and fresh material in 1976. Age was determined by

mounting scales on slides and counting the number of annuli under 120X magnification. In both years a number of scales were doubled checked by a second analyst to insure accuracy of the readings. Width of the scales was also measured on 1976 fish.

RESULTS AND DISCUSSION

Menhaden Patterns Of Abundance

In most years adult menhaden (3 years and older) move into Narragansett Bay to spawn in April (Mattiessen 1975, Nelson, Ingham and Schaaf 1975). They are not visible and do not form surface schools and are therefore not fished. Schools are visible from May to November as the migrating fish from offshore move in and out of the Bay. In June largest catches are taken in the Upper Bay. By July the population becomes dispersed in the Lower Bay and during August most of the fish leave the Bay. In September menhaden return to the Bay, and it is speculated that these fish are part of fall southern migration (Durbin 1976).

There is good evidence from Durbin (1976) that this general pattern of abundance in the Bay is regulated by the availability of food. She indicates that at no time during the summer would menhaden be able to obtain more than 30 percent of their daily food requirements from phytoplankton. The phytoplankton food supply would be largest during late spring and early summer when phytoplankton of sizes the menhaden can filter predominate in the water column. This phytoplankton would be most abundant in the eutrophic regions of the Upper Bay. Menhaden may help promote phytoplankton species succession to the small flagellates which predominate during summer. Menhaden also feed heavily on zooplankton and in fact may require a large portion of zooplankton production during their stay in the Bay. (Durbin 1976). In August, when zooplankton biomass is low, menhaden leave the Bay.

While the patterns of menhaden abundance may be determined by food supply, sport fishermen feel that the absolute abundance is determined by menhaden fishermen. Their view is that such a large portion of the biomass of menhaden is taken that there is insufficient food for predator species. It is well established that when a purse seine is set on a school of menhaden most of the fish in the school are captured (Reintjes 1969). In Narragansett Bay in July and August of 1975, 22 observations by the spotter pilot and of the actual catch on local boats indicated that from 20 percent to 100 percent (mean = 80 percent) of the fish in a school were captured (Ganz 1975). The spotter pilots average daily estimate of the total abundance of available schools on nine days for Narragansett Bay was 670,000 pounds, and ranged from 160,000 to 1,760,000 pounds. During this period the average daily catch of menhaden was only 15 percent of the observed total biomass, and ranged from six to 76 percent (Ganz 1975). At least during this period, menhaden fishermen did not severely reduce the size of the menhaden population in the Bay. Nevertheless, considering the efficiency with which schools can be captured, it is possible that

that a greater fishing effort on the part of menhaden fishermen might well severely lower the menhaden population (see Henry 1971, Schaaf and Huntsman 1972).

Evidence that fishing pressure may increase is illustrated by the 1976 catches. A state law which prevented large out-of-state boats from coming into Narragansett Bay was found unconstitutional (Civil Action No. 75-210). Contrary to the usual pattern of abundances, in August 1976 large schools of menhaden from offshore moved into Narragansett Bay. The abundance of menhaden was estimated by spotter pilots to be as high as 50 million pounds (A. Durbin and E. Durbin, personal communication). Out-of-state boats which followed the fish into the Bay caught an estimated 40 million pounds by September, or roughly double the usual in-state catch and 80 percent of the overall estimated supply.

Besides food limitations and fishing pressure, other factors which affect recruitment (locally and in southern estuaries) regulate the number of menhaden in Narragansett Bay. During 1976, the expected menhaden population was not present, according to spotter pilot estimates. Very few menhaden appeared in the Bay until the first of August. The fish which did appear during the early summer were extremely small, immature, three-year-old fish (A. Durbin and E. Durbin, personal communication). Despite extensive sampling around the Bay we found no juveniles during the summer, which suggests a complete failure of a new year class in Narragansett Bay.

In addition to factors including food, cannibalism, currents, temperature, stock density which affect egg and larval survival (Cushing 1969, Nelson, Ingham and Schaaf 1975), the condition of the adult fish affects the number of eggs produced (Schaaf and Huntsman 1972). Apparently the early 1976 fish were immature and unable to spawn.

Patterns of Abundance of Predator Fish

The general pattern of striped bass abundance in Narragansett Bay is similar to the general pattern of menhaden abundance. Striped bass arrive in May, become most abundant in the Bay in June, and leave the Bay in mid-summer when bluefish become most abundant, as our samples indicate (Table 1). An equal sample effort was maintained through October, and these numbers should be reliable estimates of relative population. These findings show 52 percent Bay bass versus 47 percent offshore bass in 1975, and 81 percent Bay bass versus 19 percent offshore bass in 1976. Corresponding percentages for bluefish are 26 percent versus 73 percent and 55 percent versus 45 percent. A high percentage of the striped bass were females, as previous studies have also indicated (Massmann and Pacheo 1961). In the fall, southward moving migrants return to the area. Bluefish were fairly evenly divided between males and females early in the summer although later in the summer and fall the percent of males appears to decrease (Table 1). Bluefish were most abundant in the Bay in July and August. Buyers records in 1976 indicated greatest landings for striped bass within the Bay in June and July, and for bluefish from July through October.

Table 1. Sample Abundance and Sex of Striped Bass (A) and Bluefish (B)

A. Striped Bass

Month	Number of Fish Sampled		% m		% F		% Unknown	
	1975	1976	1975	1976	1975	1976	1975	1976
May	14	11	7	--	93	--	0	--
June	111	235	5	9	91	85	4	6
July	32	183	3	8	94	84	3	8
August	28	45	7	4	93	67	0	30
October		64		4		40		56

B. Bluefish

Month	Number of Fish Sampled		% m		% F		% Unknown	
	1975	1976	1975	1976	1975	1976	1975	1976
June	27	78	48	67	52	33	0	0
July	84	578	38	47	57	53	5	0
August	372	468	35	34	56	61	8	5
September	15	76	20	38	67	48	13	14
October		69		21		77		2

The records of a buyer of mainly offshore fish indicated greatest landings for striped bass and bluefish from July through September.

Feeding Patterns of Predator Fish

Three trends are indicated by the analysis of stomach contents (Table 2). When in Narragansett Bay, both striped bass and bluefish feed mainly on menhaden. Percentage occurrence of menhaden for both species was remarkably consistent and ranged between 41 percent and 46 percent over the two-year study period. When offshore, both species fed mainly on sand launce. Percentage occurrence was consistent for bluefish (range 41 percent to 45 percent) and more variable for striped bass (range 54 percent to 17 percent). During 1976 striped bass contained a greater percentage of crabs, which was indicative of the third trend. While striped bass and bluefish contained about the same percentage of fish (55 percent to 88 percent), striped bass contained more crabs, and bluefish contained more squid. Perhaps this difference inidcates a greater tendency for striped bass to feed on the bottom and for bluefish to feed on pelagic species.

Data presented in Table 2 includes only fish with stomachs containing food and indicates items which occurred more than five times during the two-year period for Bay and offshore fish. A total of 15 fish species and ten invertebrate species occurred in striped bass stomachs. In bluefish, 16 fish species and eight invertebrate species occurred. One additional fish species, Atlantic mackerel, had a 15 percent occurrence in bluefish samples from fish traps located outside the Bay.

The stomach contents of bay fish, offshore and trap fish indicate that both striped bass and bluefish are generalized feeders, feeding on the most abundant prey in their locality. The findings of other studies are in agreement (Raney 1952, Table 3). Only in the surf waters of Long Island were invertebrates dominant in the stomachs of striped bass, and it was speculated that the many amphipods were a more available food source in the turbid waters than less visible prey fish (Shaefer 1970). The most vivid evidence in our study was the amount and variety (often more than three species) in the stomachs of bluefish recovered from fish traps. Combined data of Bay offshore and trap fish for the two study years shown in Figures 2 and 3 may be most indicative of changing abundance of prey species and location of sample collection.

Both predator species feed on the same prey, indicating a high degree of dietary overlap. Abundance patterns suggest that striped bass move out of Narragansett Bay when more aggressive bluefish become abundant and thus avoid competition with them. When both species are feeding mainly on menhaden in the Bay, striped bass will be abundant in early summer and bluefish will be abundant in mid and late summer. In fall, bluefish numbers decline as they begin their southward migration when water temperatures reach 12 to 15 degrees C (Lund and Maltezos 1970). Striped bass, which do not begin their southward migration until water temperatures are colder, then return to the Bay.

Table 2. Stomach Contents of Predator Fish A. Striped Bass, B. Bluefish

A. Striped Bass — Percent Occurrence

Item*	1975 bay	1975 offshore	1976 bay	1976 offshore
Fish	75	88	71	55
Northern Sand launce (Ammodytes americanus)	7	54	9	17
Atlantic Menhaden (Brevoortia tyrannus)	42	6	44	9
Alewife (Alosa pseudoharengus)	15	6	--	2
Atlantic Silverside (Menidia menidia)	--	1	7	12
American eel (Anguilla rostrata)	2	4	--	9
Invertebrates	25	12	29	45
Crab (Cancer sp. Ovalipes sp.)	8	7	--	26
Squid (Loligo pealii)	3	1	18	7
Polychaete	5	--	7	3
Number of Fish Analyzed	48	55	35	54

*5 or less occurrences in two year period omitted.

B. Bluefish — Percent Occurrence

Item*	1975 bay	1975 offshore	1976 bay	1976 offshore	1976 fish trap
Fish	81	69	77	82	81
Northern Sand launce (Ammodytes americanus)	3	41	3	45	2
Atlantic Menhaden (Brevoortia tyrannus)	41	7	46	21	26
Butterfish (Peprilus triacanthus)	2	3	9	6	33
Atlantic mackerel (Scomber scombrus)	--	--	--	--	15
American eel (Anguilla rostrata)	20	5	3	2	--
Atlantic Silverside (Menidia menidia)	--	5	6	3	T
Silverhake (Merluccius bilinearis)	6	3	--	3	3
Cunner (Tautogolabrus adspersus)	5	3	--	--	T
Invertebrates	19	31	23	18	19
Squid (Loligo pealii)	6	24	17	18	11
Crab (Cancer sp)	6	--	3	1	--
Number of Fish Analyzed	46	53	35	124	210

*5 or less occurrences in two year period in bay and offshore omitted.

Table 3. Most Frequent Items in Stomachs of A. Adult Striped Bass and B. Bluefish

A. Striped Bass

Location of Study	Items	Percent Occurrence	Reference
Surf Water of Long Island	Invertebrates (esp. amphipods)	50-80	Shaefer 1970
Albemarle Sound, North Carolina	Fish Menhaden	92 75	Manooch 1973
Connecticut	Silverside		Merriman 1941
Sacramento-San Joaquin Delta, California	Thread fin shad juvenile striped bass	22 38	Stevens 1966
This study, Rhode Island	Fish Sand launce Menhaden Crab	66-84 24-32 16-22 10-17	

B. Bluefish

Location of Study	Items	Percent Occurrence	Reference
Indian River, Delaware	Silverside Menhaden Mummichogs	22 19 14	Grant 1962
Long Island Sound	Bay Anchovy Menhaden Butterfish	48 9 9	Richards 1976*
Lower Hudson	Bay Anchovy Atlantic tomcod	43 12	Texas Instruments, Inc. 1976
This study, Rhode Island	Sand launce Menhaden Mackerel Squid	8-32 10-22 0-26 13-14	

*Percent of fish containing particular food items.

Age Distribution and Mortality

An analysis of age structure of striped bass and bluefish gives an estimate of total mortality for the two species (Ricker 1958). With a series of assumptions, this estimate can be used to roughly calculate the abundance of these fish in Narragansett Bay.

Age distribution of striped bass in 1975 ranged from four to 14 years with age classes six and nine present in maximum abundances (Figure 4). In 1976 age classes ranged from three to 16 years, with maximum abundances of ages seven, nine, and ten. On the basis of this evidence, that the same contingents of fish are returning to the area in successive years, it was assumed that the decrease in successive age classes could be used to estimate mortality. Clark (1968) has noted that young fish (less than four years old) form contingents which engage in distinct patterns of seasonal migration. These patterns may well persist over several years. This assumption does not work so well for bluefish because the same age classes (three, four and five) were dominant in both years (Figure 5). However, recent tagging studies have indicated that adult bluefish return to the same general area in successive years (Lund and Maltezos 1970; Deuel, N.M.F.S. personal communication).

Perhaps a greater mortality of bluefish than striped bass explains the lack of dominant year classes in successive years. A regression of age versus abundance gave an estimated mortality of 23 percent ($r = -0.85$) for 1975 striped bass and 29 percent ($r = -0.88$) for 1976 striped bass six years and older. By contrast, estimated mortality for 1975 bluefish was 65 percent ($r = -0.99$) and for 1976 fish it was 64 percent ($r = 0.91$) for fish four years and older. Most of this mortality is assumed to be due to local fishing. This assumption is very broad considering that the fish are present locally for only three to four months. However, striped bass, which over-winter locally or in the Hudson, are not now fished during the winter months (Clark 1968). Occasional winter kills in shallow waters which have gone anerobic under ice and power plant effluent kills in the Hudson have been reported (Clark 1968). It is not known to what extent more sourthward-moving fish are caught during the winter months, but that mortality is thought to be slight. While some adult bluefish are taken by the winter trawl fishery along the outer margins of the continental shelf, these quantities are small and most of the fish are probably able to avoid the nets (Hamer 1959). Although some observations indicate that sharks and swordfish feed on adult bluefish, natural predation on adults of either species is probably small. Despite some uncertainty it seems likely that local fishing accounts for a large proportion of total mortality. On this basis the recorded commercial landings (R.I. Landings 1977) and estimates of the recreational fishery (Deuel personal communication) provide an indication of the total amount caught and an estimate of total weight of older fish in Rhode Island waters can be calculated.

Since the primary interest is with Narragansett Bay, however, it is more desirable to estimate abundance for the Bay alone. In order to do this it was assumed that the largest buyer on the Bay and the largest buyer on the South Shore were obtaining fish in proportion to the total commercial landings. The proportion bought by the Bay buyer to the offshore buyer then provided an estimate of fish caught in the Bay. While this calculation gave the only available estimate, it was not strictly correct because fishermen will travel to sell to the buyer paying the most. However, examination of names of fishermen indicated very little overlap between the two buyers.

With these assumptions a calculation of the weight of striped bass and bluefish in Narragansett Bay in 1976 can be made (Table 4). These estimates of roughly 600,000 and 1,800,000 pounds for these species are conservative, as they do not include younger age classes (striped bass less than six years old and bluefish less than four years old) which are not well represented in the catches. The combined total for both species may be much higher.

The claims of fishermen seeking striped bass and bluefish, that Bay fish are feeding largely on menhaden, appears correct. The question of whether menhaden abundance may be so reduced by the commercial fishery that there is not enough for prey species may now be examined. If we assume that the food requirements of striped bass and bluefish are 3 percent of their body weight per day (Rogers 1977), then their individual demand for menhaden, which accounts for 43 percent of their diet, should be close to 24,000 pounds per day for striped bass and 8,000 pounds per day for bluefish. Since these species do not occur in abundance in the Bay at the same time, it is doubtful if their combined demand ever exceeds 24,000 pounds per day. When there is less than one million pounds of menhaden present in Narragansett Bay the commercial fishery is unprofitable and ceases, as it did during July of 1976 (Ganz 1977 personal communication). Under these conditions there were still enough menhaden to satisfy the daily demands of predator species. Nothing in our sampling (Table 5) or in buyers' records indicated significantly fewer predator fish in July 1976 than in July 1975.

Fishermen, Striped Bass and Bluefish

Just as menhaden stocks may be limited by fishing pressure, so may predator fish stocks be potentially limited. Landings of predator fish have been high and fairly stable, indicating no cause for alarm (Figure 1). As previously indicated, increasing commercial catches have occurred over the past 20 years. This suggests that, even with the increased effort of catch for menhaden, commercial landings, if they are indicative of menhaden populations, have not seriously affected striped bass or bluefish. Nevertheless, "old timers" assure us there used to be more fish. If more substantial evidence in the future indicates the fishery is facing a decline, management will need accurate information on catch per unit of effort, the number of recreational fishermen, and other factors needed to estimate stock

Table 4. Population estimations of striped bass and bluefish in Narragansett Bay in 1976.

	Striped Bass	Bluefish
(1) Narragansett Bay Buyer[1]	12,000 pounds	18,800 pounds
(2) South Shore Buyer[1]	39,400 pounds	43,300 pounds
(3) Percent from Bay Buyer	23%	37%
(4) Total Commercial Catch in Rhode Island [2]	154,000 pounds	242,000 pounds
(5) Recreational Catch[3]	1,958,000 pounds	894,000 pounds
(6) Minus known recreational fish sold, (1)+(2)	51,000 pounds	62,000 pounds
(7)	1,907,000 pounds	832,000 pounds
(8) Total Catch in Rhode Island, (4)+(7)	2,061,000 pounds	1,074,000 pounds
(9) Total Bay Catch, (3)x(8)	474,000 pounds	397,000 pounds
(10) Mean Fishing Mortality	26%	65%
(11) Population Estimate for the Bay	1,823,000 pounds	611,000 pounds

[1]Hook and Line caught fish

[2]Leslie Robinson, personal communication

[3]Extrapolated from David Deuel, N.M.F.S. unpublished manuscript, estimated recreational catch for Rhode Island in 1974 assuming the recreational landings followed the same pattern as the commercial landings from 1974 through 1976.

Table 5. A comparison of Bay versus offshore fish sampled in July 1975 and July 1976.

	Percent (number)			
	Striped Bass		Bluefish	
	Bay	Offshore	Bay	Offshore
1975	81 (26)	19 (6)	53 (45)	47 (39)
1976	87 (166)	13 (25)	70 (350)	30 (150)

strength. It is a well known fact that a small percentage of the fishermen catch a large percent of the fish, and this is certainly the case for striped bass and bluefish (Table 6). Interviews with 38 striped bass fishermen indicated that 30 of them caught less than four pounds per hour fishing (mean = 2.3). However, two spectacular individuals caught nearly 30 pounds per hour (Figure 6). One individual who kept accurate records demonstrated how much he increased his skills over a seven-year period (Figure 6). Nevertheless, these skilled fishermen have little impact on predator fish abundance, when compared to the total number of fishermen who catch these species. In 1976 the recreational catch of striped bass and bluefish was 13 and 3 3/4 times greater than the commercial catch of the two species respectively. With such a large part of the public spending a substantial amount of money (our interviews indicated $1,100 for striped bass fishermen and $400 for bluefish fishermen per year), it is clearly time to acquire as much information about these recreational fish as has been acquired for commercial species such as menhaden. Programs carried out annually over the total range of the fisheries would provide accurate information on relative abundances and year class strengths and eliminate the necessity for the long series of assumptions and "ball park" estimates presented in this study.

SUMMARY

Narragansett Bay is located in the northern range of migratory menhaden, striped bass, and bluefish, and contributes an insignificant amount to the total fishery on any of the three species. Yet on a local scale conflicts have developed between menhaden fishermen and striped bass / bluefish fishermen. The claim was made that menhaden fishermen were taking such a high percentage of the prey fish that there remained an insufficient food supply for predator fish.

An analysis of the conflict indicated that menhaden move in and out of the Bay according to the food supply available. When only small local boats were fishing in the Bay in 1975, observations indicated they caught only 15 percent of the total menhaden population. When fishing effort was increased in 1976, 80 percent of the total menhaden population in the Bay was caught. Analysis of stomach contents indicates that while both striped bass and bluefish are generalized feeders, they feed primarily on menhaden in Narragansett Bay, as fishermen have long claimed. However, preliminary calculations suggest that even when menhaden abundances are so low that it is not commercially feasible to catch them, they are still sufficiently abundant to be a primary food source for predator fish.

Total annual mortality estimates were 26 percent for striped bass and 65 percent for bluefish, assumed to be largely the result of local fishing pressure. At present, stocks of predator fish - according to catch records - appear high. If stocks decline, the public outcry

Table 6. Combined sales record of 1976 fishermen selling to a buyer located on Narragansett Bay and a buyer located on the south shore.

A. Striped Bass Sales of 169 Fishermen

% Fishermen	lbs/man/season	% Total Catch
52	20-100	7
32	101-500	15
5	501-1,000	8
12	1,001-10,000	69

B. Bluefish Sales of 101 Fishermen

% Fishermen	lbs/man/season	% Total Catch
45	20-100	7
46	101-500	30
4	501-1,000	8
7	1,001-10,000	55

would be substantial, indicating the need for more accurate information on catch per unit of effort, number of fishermen, year class success, and other data well estimated for commercial species.

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Figure 1. Rhode Island Landings of menhaden, bluefish and striped bass from 1945 to October 1976. Final estimates of landings for 1976 are 154,000 pounds for striped bass and 242,000 pounds for bluefish (from Leslie Robinson N.M.F.S. Personal Communication).

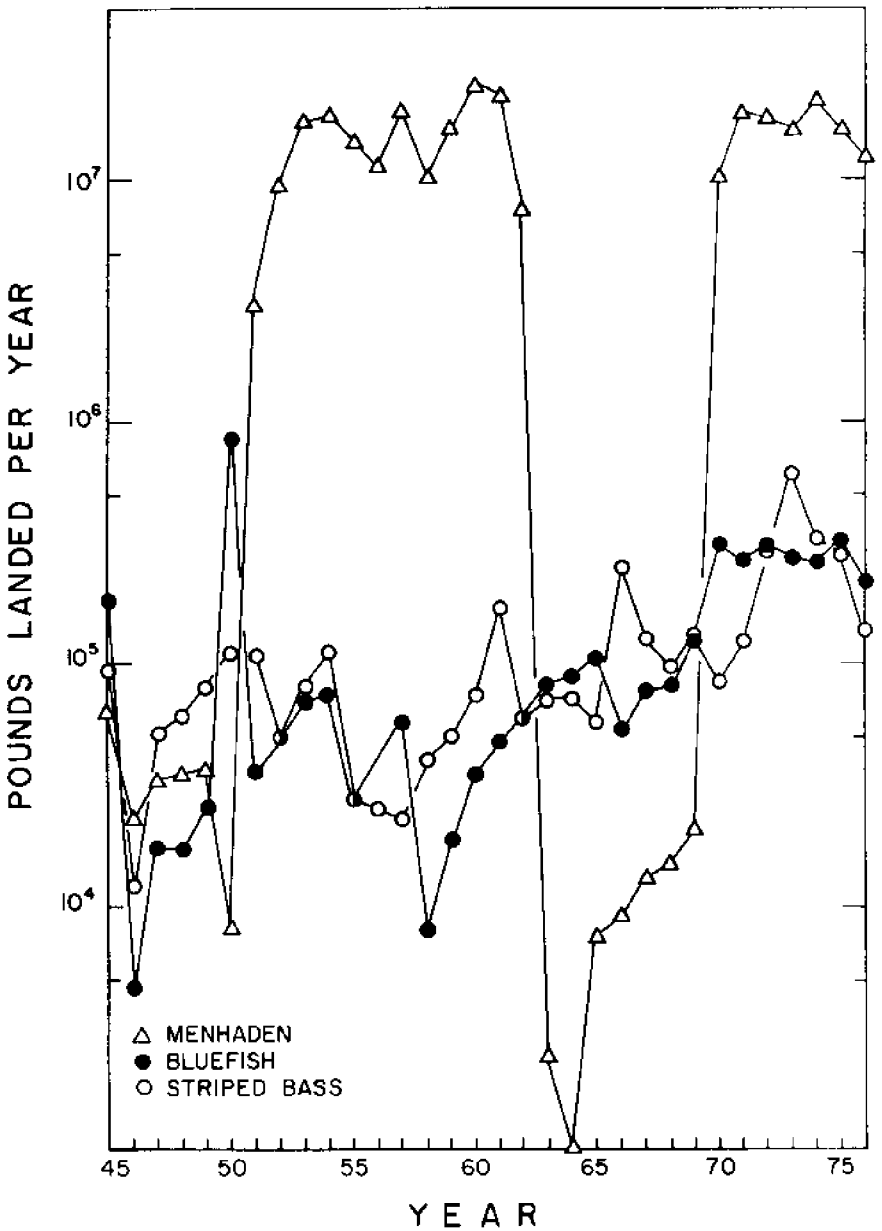

Figure 2. Percent occurence of food items found in the stomachs of striped bass and bluefish caught in Rhode Island waters in 1975.

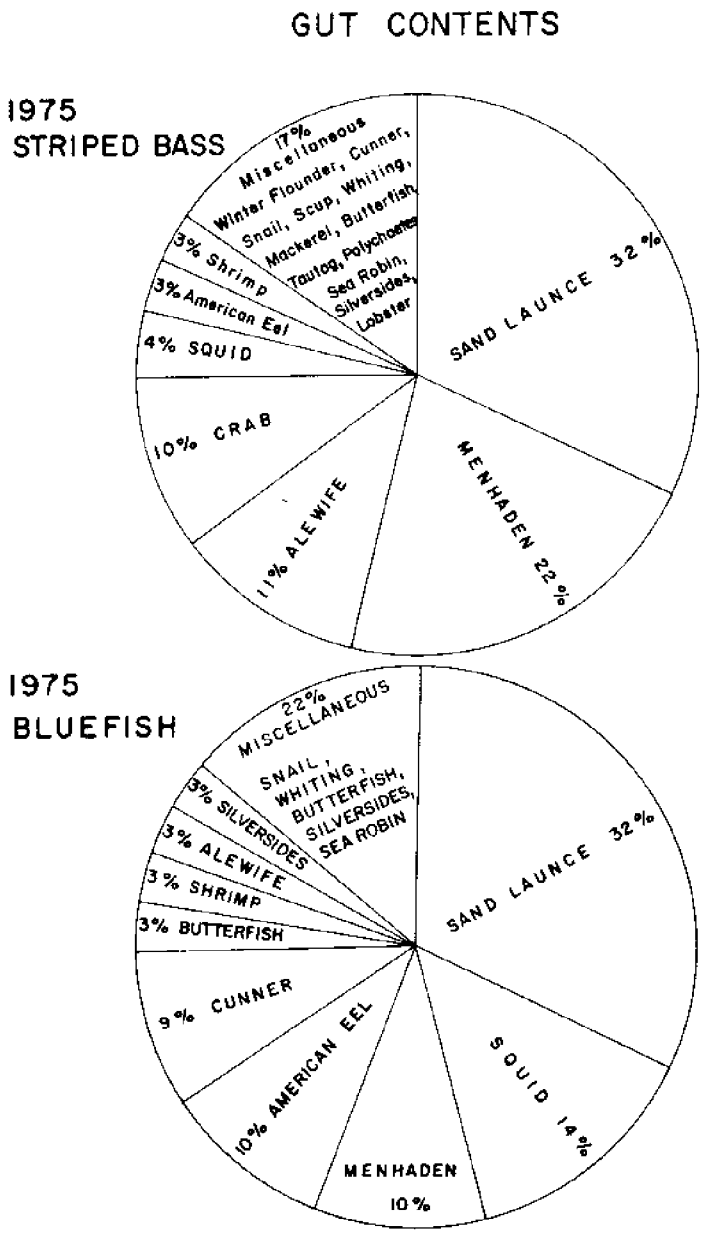

Figure 3. Percent occurence of food items found in the stomachs of striped bass and bluefish caught in Rhode Island waters in 1976. Data on bluefish includes 69 October Trap fish which fed mainly on mackerel which are not included in Table 28.

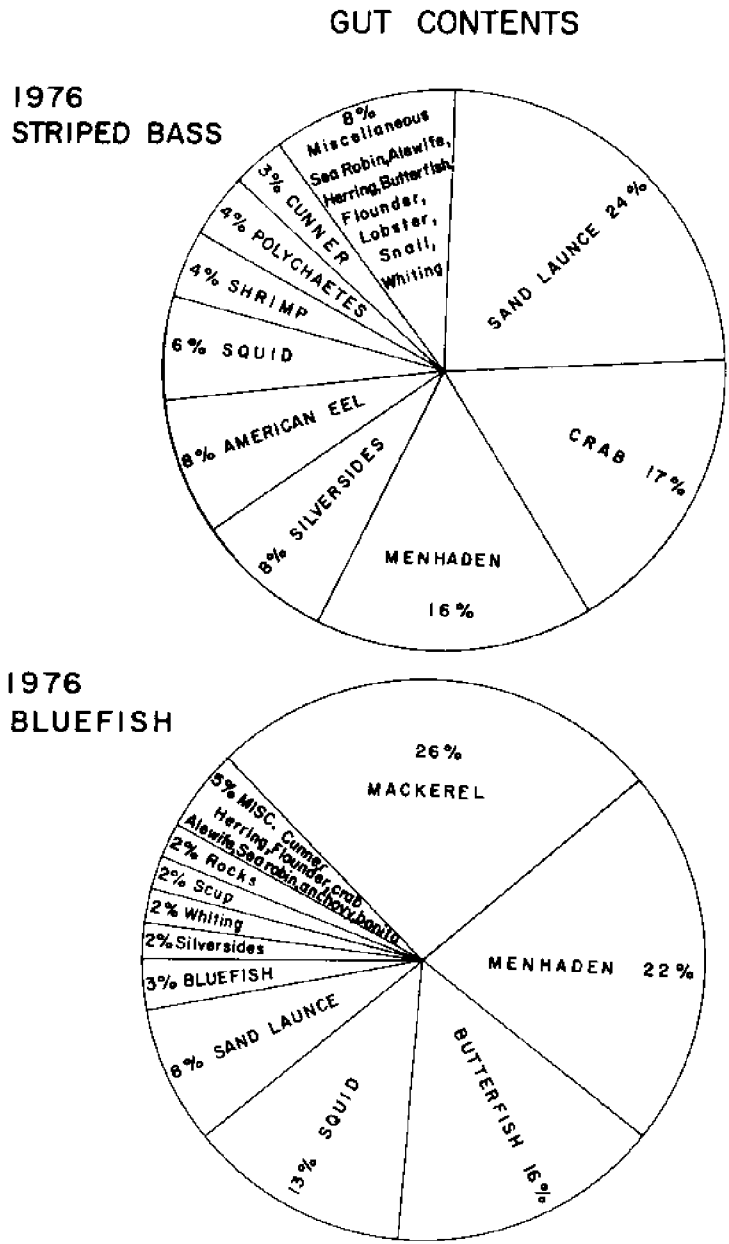

Figure 4. Age class distributions of striped bass caught in Rhode Island waters in 1975 and 1976. In 1975 the number of fish analyzed was 182 and in 1976 the number was 148.

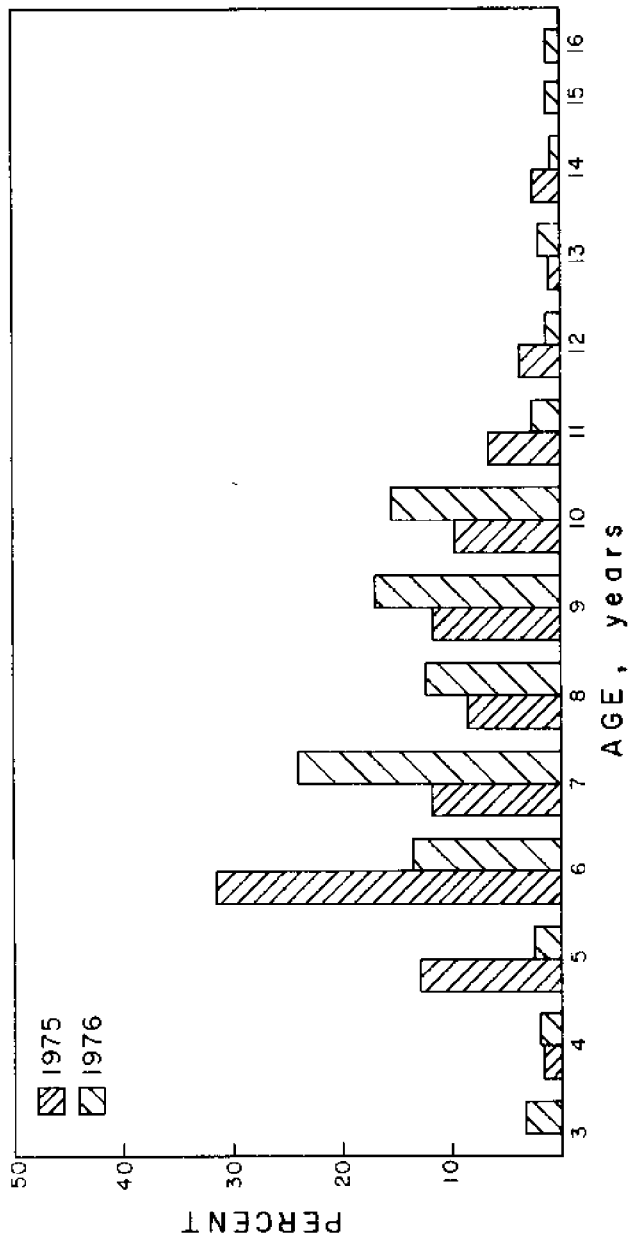

Figure 5. Age class distribution of bluefish caught in Rhode Island waters in 1975 and 1976. In 1975 the number of fish analyzed was 237 and in 1976 the number was 219.

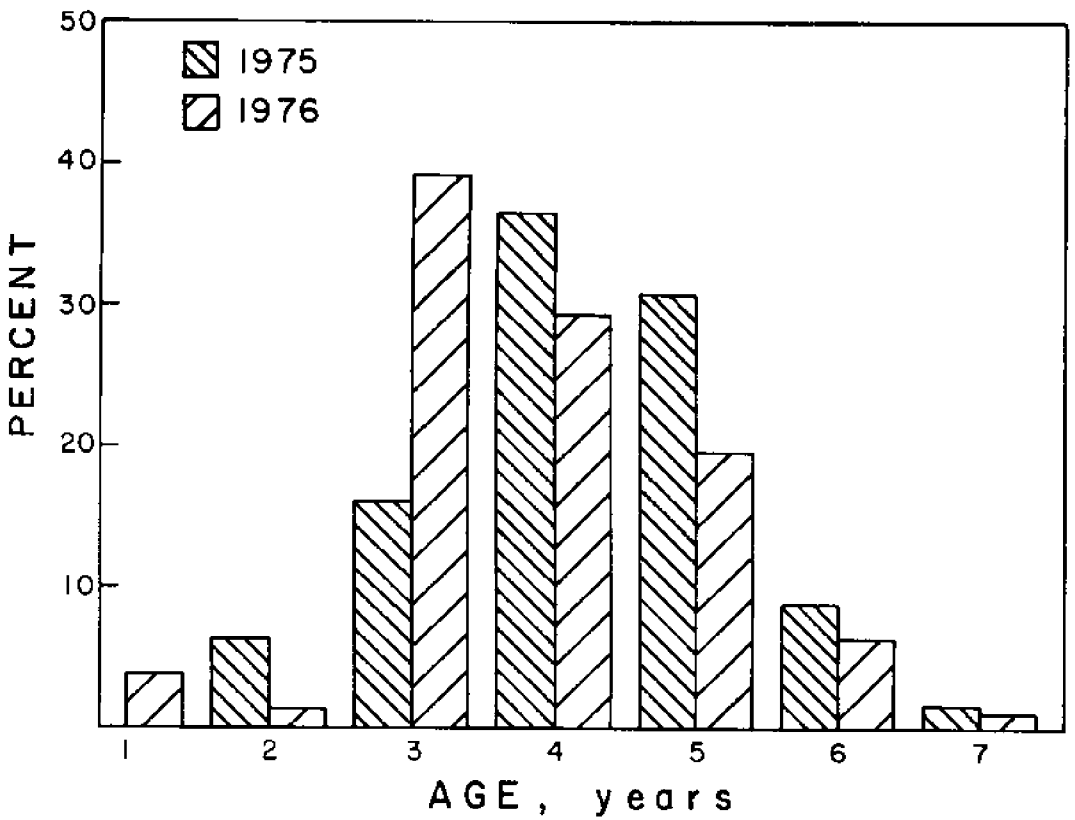

Figure 6. Catch per unit effort of 38 interviewed fishermen fishing for striped bass indicated that most fishermen catch less than 4 pounds per hour fishing. The line connects efforts of one fishermen who kept records for seven years. His 1973 catch effort and one other individual indicate that very skilled individuals may catch nearly 30 pounds per hour fishing.