Marine Recreational Boat Fishery of the New York Bight Apex in 1971

CHESTER C. BUCHANAN, RICHARD B. STONE, and FRANK W. STEIMLE

ABSTRACT—*The marine recreational boat fishery in the heavily populated New York City metropolitan area has not been well described. This paper describes the 1971 catch composition and the distribution of estimated effort over spatial and seasonal scales and between major vessel types (party, charter, and private boats) engaged in the fishery. Anglers spent an estimated 2.3 million hours fishing in the New York Bight apex in 1971, over half of this by party boat anglers, and caught almost 8 million game fish. Overall effort was about equal for pelagic and demersal species and was generally concentrated nearshore. There appeared to be a substantial change in the fishery since the late 1940's and early 1950's, possibly reflecting socioeconomic trends and population dynamics of the fish species.*

Introduction

Ocean waters adjacent to the densely populated and industrialized New York-New Jersey metropolitan area (the New York Bight apex) support one of the most concentrated marine recreational boat fisheries in the United States (Freeman and Walford, 1974). Despite the popularity and intensity of this fishery, little is known of its total catch and efforts. Information on this fishery is required because of multiple use issues in the New York Bight waters including fishery resources and habitat.

Although the area's fish resources have attracted recreational fishermen since colonial times (Pearson, 1972), this fishery was not specifically documented until the late 1930's (Westman, 1938). Butler and Spear (1950) were the first to document fishing success and catch composition for the party and charter boat fleets of the New York Bight in 1948. Redfield and Walford (1951) also estimated total catch, catch rates, catch composition, and effort rates for party and charter boats sailing from Bight ports between Jones Inlet, N.Y., and Manasquan Inlet, N.J., during 1949. The New Jersey party and charter fleet was also surveyed in 1952 by Younger and Hamer (1952) and in 1954 by Younger and Zamos (1955). These surveys yielded estimates of fishing success and catch composition. No estimates of total catch and effort were available, however, except later for two species: Bluefish, *Pomatomus saltatrix*; and summer flounder, *Paralichthys dentatus* (Christensen and Clifford, 1979 a,b). The private boat fleet had never been accurately surveyed because of the difficulties in adequately sampling the fishermen.

The purpose of our survey was to 1) document the 1971 recreational boat fishery in the New York Bight apex by estimating effort, catch (total and composition), and fishing success (catch rates), for that fishery and 2) to compare these estimates, where applicable, to estimates from past surveys. This survey was an expanded part of a 2-year study of angler use of New York Bight artificial habitats relative to other habitats. The initial 1970 survey data were focused exclusively on artificial reef use and were reported in Stone et al. (1974). This study suggests that there have been changes in the proportional composition of boat types engaged in the fishery since 1949, with an increase in private boat participation. It can also serve as a basis for comparison for more recent studies of the area's recreational fishery.

Chester C. Buchanan is with the U.S. Fish and Wildlife Service, Great Basin Complex, 4600 Kietzke Lane, Reno, NV 89502. Richard B. Stone is with the Recreational and Interjurisdictional Fisheries Division (F/CM3), National Marine Fisheries Service, NOAA, Washington, DC 20235. Frank W. Steimle is with the Sandy Hook Laboratory, National Marine Fisheries Service, NOAA, Highlands, NJ 07732.

Survey Area

The survey area, the New York Bight apex, extends from the New York coast southward to lat. 42°00′N and eastward from the New Jersey coast to long. 73°30′W (Fig. 1), and encompasses about 1,300 km^2. The ocean bottom is a gently sloping, sandy plain interrupted at the 30 m isobath by the northern terminus of the submerged Hudson Shelf Valley that has depths to 70 m in the apex. Soft substrate predominates the deeper half of the survey area. A natural horseshoe shaped rock formation begins a few kilometers off Manasquan Inlet and extends to a few kilometers off Jones Inlet, covering about 60 km^2 between the 9 and 27 m contours. Much of this formation is covered by sand; however, large patches of gravel, stones, and rocky outcroppings are exposed in some areas.

Over the last few centuries, man has increased the amount of rocky habitat in the survey area by nearly 8 km^2 with the disposal of debris and the sinkings of hundreds of ships. Regular dumping of building rubble, subway excavation tailings, and other solid wastes in the northern portion of the survey area has created expansive areas of irregular shaped hard bottom. Most of the ships sunk by military action or accident have decomposed to rubble piles

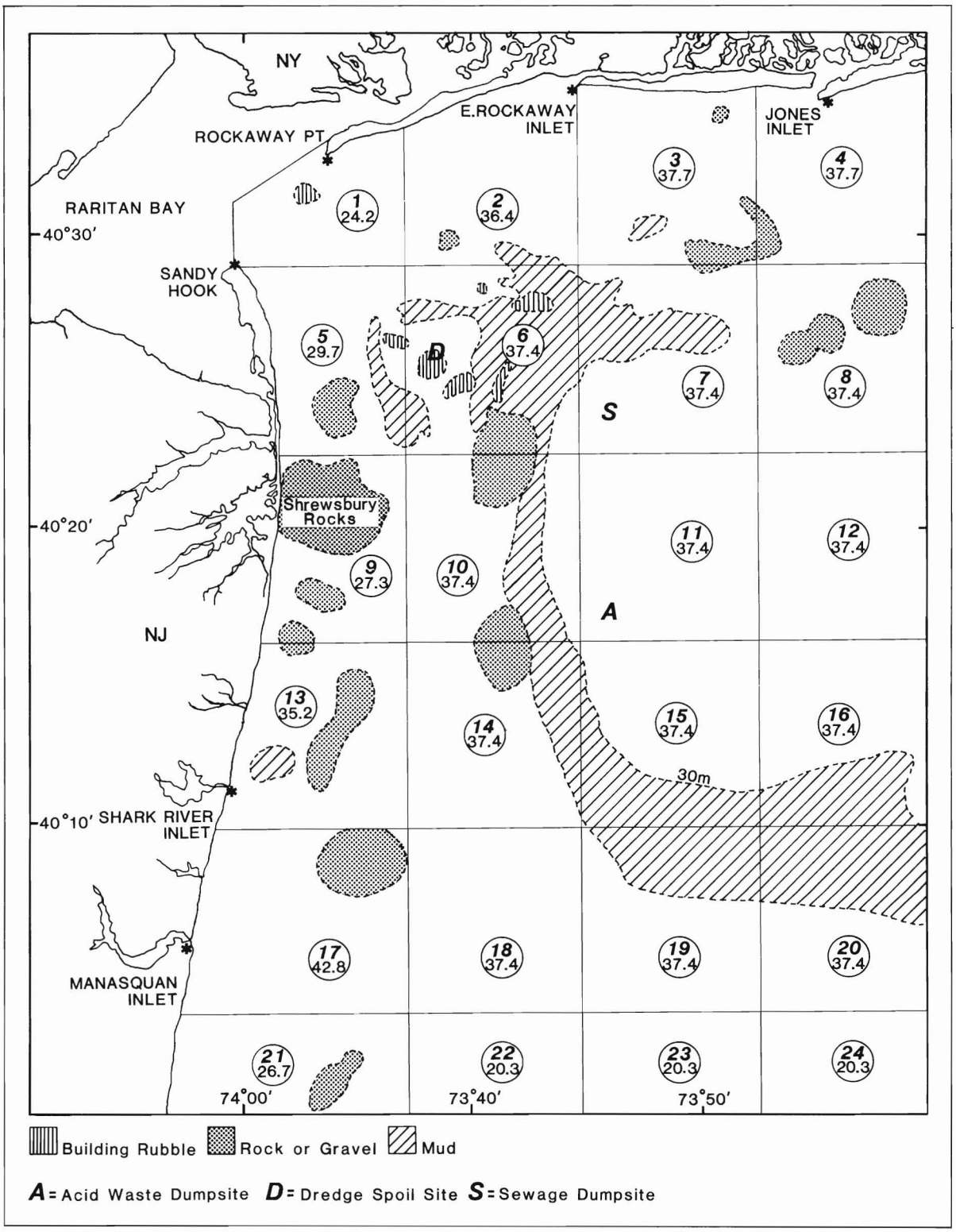


Figure 1.—Location of survey area and observation stations (*) in the apex of the New York Bight. Also shown are sectors with estimated square kilometers in parenthesis and approximate boundaries of predominate sediment components and locations of artificial reefs. Data compiled from: 1) NOAA charts; 2) Freeman and Walford (1974); 3) Personal commun., local party and charter boat captains; 4) Personal commun., A. Cok, Adelphi University, Garden City, Long Island, NY 11530; and 5) Hathway (1972).

that protrude only about 1 m above the bottom, while a few are still intact and protrude substantially off the bottom. Rocky habitat has been intentionally increased (about 0.03 km^2) since the 1920's in the Bight apex with the establishment of several artificial reefs in 10-20 m of water (Stone et al., 1974). They are composed of barges, tires, concrete culvert, and car bodies that protrude 1-5 m above the bottom.

The survey area also currently encompasses the largest ocean waste disposal grounds in the United States (Mayer, 1982). For decades sewage sludge and dredging spoils have been regularly dumped at two sites in the survey area (Fig. 1). Sewage dumping in the survey area will be phased out by 1988. However, millions of cubic yards of dredging spoil from New York-New Jersey metropolitan area harbors may continue to be dumped annually. Up to 1982 and during the study period, industrial acid waste (8.5 percent H_2SO_4 and 10 percent F_3SO_4) were also disposed of daily in a general area 20 km east of New Jersey and 24 km south of New York (southwest corner of sector 11, Figure 1).

General Description of the Recreational Fishery

Recreational boat fishing in the New York Bight apex perhaps had its beginnings in the 1700's when professional fishermen occasionally hired out their boats, along with their services, to recreational fishermen (Pearson, 1972). The fishery appeared to grow slowly in popularity, however, until the second quarter of the 20th century when improved vessel design and safety coincided with economic and social changes. The 1950's saw further improvements including two-way radios, depth recorders, and improved fishing tackle. Party and charter boats are becoming larger, more comfortable, and faster than their predecessors. The number of private boats in the fishery has also increased due to small boat improvements since World War II. Recent improvements made it possible for many fishermen to buy larger, seaworthy boats capable of venturing offshore.

A substantial fleet of recreational boats, sailing out of ports from Manasquan Inlet to Jones Inlet, fishes primarily in the survey area. Few recreational boats from ports outside the boundaries of these inlets fish in the sampling area. The 1971 recreational fleet consisted of 122 party boats, 102 charter boats (both full- and part-time), and an unknown number of private boats. Party boats are larger vessels, up to about 30 m in length, publically available on a daily basis with a carrying capacity of up to 149 fishermen, while charter boats are medium sized (10-20 m) vessels available for hire by an individual or small group for their specific fishing interests; they typically carry 4-6 fishermen. Professional crews, usually with many years of experience, operate these boats; most use depth recorders and navigational equipment for locating fish schools and fishing sites. Private boats generally range in size from 5 to 15 m and usually carry up to 6 fishermen. These boats are usually not operated by professional crews and less than half were equipped with sensitive sonar, depth recorders, or navigational equipment at the time of the survey.

Although the fishery is pursued almost year round, most fishing activities are curtailed during winter (approximately late December to late February) because of adverse weather. Few party boats sail at this time of year and only an occasional charter or private boat. Most recreational boats operate only during the warmer months: May through October.

The majority of the recreational fleet fishes only during daylight. Party and charter boats usually maintain a regular schedule of leaving the dock at 0800 hours and returning at 1630 hours. During the summer a few party boats fish two half-day trips, while others fish at night, as well. Night fishing occurred mainly from June through October by party boats seeking bluefish. Few, if any, charter or private boats were active in this night fishery. Fish are attracted to the party boats at night by chumming with ground-up Atlantic menhaden, *Brevoortia tyrannus*, or other bait and illuminating the water around the boat with high intensity electric lights.

During warm months, the recreational boat fishery depends upon a mixture of boreal, oceanic, and temperate species. Diversity of the catch is made possible by cold bottom water (7°-10°C) in the deep extremeties of the survey area beneath the 20-25 m thermocline overlaid by warm water (20°-22°C). Boreal species (e.g., Atlantic cod, *Gadus morhua*, and pollock, *Pollachius virens*), inhabit the cold bottom water, while oceanic species (e.g., tunas and Atlantic bonito, *Sarda sarda*), and temperate pelagic and demersal species (e.g., Atlantic mackerel, *Scomber scombrus*; bluefish; summer flounder; black sea bass, *Centropristis striata*; scup, *Stenotomus chrysops*; and striped bass, *Morone saxatilis*) inhabit either warmer surface or the nearshore waters (Table 1).

Table 1.—Common and scientific names of game or nongame marine fishes reported caught during the 1971 recreational boat fishery survey.

Common and scientific name	Game	Non-game
American eel, *Anguilla rostrata*		X
Atlantic bonito, *Sarda sarda*	X	
Atlantic cod, *Gadus morhua*	X	
Atlantic herring, *Clupea harengus*	X	
Atlantic mackerel, *Scomber scombrus*	X	
Atlantic menhaden, *Brevoortia tyrannus*		X
American shad, *Alosa sapidissima*	X	
Black sea bass, *Centropristis striata*	X	
Bluefin tuna, *Thunnus thynnus*	X	
Bluefish, *Pomatomus saltatrix*	X	
Cunner, *Tautogolabrus adspersus*		X
Dolphin, *Coryphaena hippurus*	X	
Goosfish, *Lophius americanus*		X
Jacks, Carangidae		X
Little tunny, *Euthynnus aletteratus*	X	
Northern kingfish, *Menticirrhus saxatilis*	X	
Northern puffer, *Sphoeroides maculatus*		X
Northern searobin, *Prionotus carolinus*		X
Northern stargazer, *Astroscopus guttatus*		X
Ocean pout, *Macrozoarces americanus*		X
Oyster toadfish, *Opsanus tau*		X
Pollock, *Pollachius virens*	X	
Redfish, *Sebastes marinus*	X	
Red hake, *Urophycis chuss*	X	
Sculpins, Cottidae		X
Scup, *Stenotomus chrysops*	X	
Sharks, Squaliformes		X[1]
Silver hake, *Merluccius bilinearis*	X	
Skates and rays, Rajiformes		X
Skipjack tuna, *Euthynnus pelamis*	X	
Striped bass, *Morone saxatilis*	X	
Summer flounder, *Paralichthys dentatus*	X	
Tautog, *Tautoga onitis*	X	
Weakfish, *Cynoscion regalis*	X	
Windowpane, *Scophthalmus aquosus*		X
Winter flounder, *Pseudopleuronectes americanus*	X	
Yellowtail flounder, *Limanda ferruginea*		X

[1]Sport fishery for sharks was just starting to develop.

Methods

To determine fishing success, catch, catch composition, and fishing effort we used telephone interviews, mail questionnaires, and boat counting surveys from April through December, 1971. From the responses we calculated fishing effort (measured in angler-hours) from boat counts, the average number of fishermen per boat, and the average number of hours fished per fisherman. We assumed most anglers used only one fishing rod; however, this may be a source of some error in our data, as some do use two or more rods. The number of boat-days each month was estimated by expanding the number of party, charter, and private boats counted leaving Manasquan, Shark River, East Rockaway, and Jones Inlets or rounding Sandy Hook and Rockaway Point (Fig. 1) during randomly stratified periods. Sampling was stratified by observation station (port), month, day (weekend, holiday, and weekday), and hour (0600-1800 hours). The mean boat-days per unit were expanded by the number of units per strata for all strata and yielded a estimate of the boat-days per month per boat type (Table 2). The number of fishermen was estimated by multiplying the estimated number of boat-days by the average number of fishermen per boat. The number of angler-hours was estimated by multiplying the estimated number of fishermen by the average number of hours fished per fisherman, obtained from mail questionnaires (for private boats) and telephone interview (for party and charter boats).

Table 2.—Number of boats interviewed by month and boat type, 1971.

Month	Charter	Party	Private
April	4	138	37
May	36	247	140
June	147	184	529
July	67	155	448
Aug.	80	145	448
Sept.	61	134	189
Oct.	24	105	163
Nov.	20	66	114
Dec.	7	85	29
Total	446	1,259	2,097

We interviewed party and charter captains by telephone to determine the number of fishermen on board, fishing method, time fishing, and catch (by species) at each of their fishing sites per day. Using a systematic sampling design stratified by port, month, week, and day (weekend, weekday, and holidays), we selected 8 sampling days per month. We attempted to interview 25 party and 25 charter boat captains (selected on these days at random) for either that day's or previous day's fishing activities, or both. Our sample size was determined by the number of captains that could be interviewed in one night with available personnel.

We estimated fishing success and catch composition of private boat fishermen through mail questionnairs. During our boat counting surveys, we developed a list of registration numbers observed each day on boats that passed a survey point and appeared to be going out to fish (i.e., fishing rods and related gear evident). We then selected registration numbers at random from this list to determine who would be mailed questionnaires. Using these registration numbers, we obtained names and addresses of the boat owner from vessel registration lists maintained then by the New Jersey Marine Police and New York Department of Conservation on the same day or the day after the vessel was observed leaving the port. We then mailed each boat owner: 1) A questionnaire within a day or so requesting information about all the fishing activities for the day the boat was observed, 2) a letter explaining the purpose of the survey, 3) a pictorial key of the more common game fishes (to improve confidence in names fishermen supplied to their catch), 4) a map of the survey area with the popular fishing grounds marked (to help fishermen report where they fished accurately), and 5) a postpaid return envelope. We mailed a second request to boat owners who did not respond within 2 weeks of our initial inquiry.

Fishing methods were classified as either surface or bottom fishing. Surface fishing included trolling and jigging for pelagic species, whereas bottom fishing was usually conducted while anchored or drifting. When classification of method or segregation of catch and effort by method was not possible, we listed the method as "mixed." We considered game fishes in our survey (Table 1), as we assumed most fishermen did not report accurate numbers of nongame fishes caught. To better describe the fishery, we divided the survey area into 24 sectors which ranged in size from 39 to 68.5 km^2 (Fig. 1).

To test validity of the survey data, we surveyed party boats directly on 16 occasions to gauge the accuracy of information reported during the telephone survey of party boat captains. To do this, we chose at random party boats to be sampled from a group whose crew did not know the identity or affiliation of our sampler. Pretending to be an average fisherman, the sampler paid the fare and boarded the selected boat along with other fishermen. While at sea and intermittantly while fishing, the sampler watched and talked to the other fishermen, and kept track of the number of each species caught, number of fishermen, and hours fished. Later that evening, we telephone interviewed the same captain for the same information for comparison.

From this test, we found no significant difference between the number of hours ("t" test; $P = > 0.50$), number of fishermen (χ^2 test; $\chi^2 = 14.425$, $P > 0.25$), and the relative abundance of each species reported ("t" test: $P > 0.50$) between the telephone survey and those actually observed. We did find a significant difference in the number of game fish reported caught ($\chi^2 = 193.8$, $P < 0.005$). Party boat captains had a tendency to overestimate their catch of game fish by an average of 14 percent. We concluded that the catch of each species had been overestimated proportionately since we found no difference in the species composition. Overestimates did not seem to influence our estimate of catch rates since we found no significant difference between the two sets of catch rates (Wilcoxon paired test; $t = 28.5$, $P > 0.26$).

Catch rate of a species is calculated by dividing the number of that species caught by the number of angler-hours expended fishing specifically for the

species. It is usually not possible in a multiple species fishery to segregate effort specifically for each species or group of species. Butler and Spear (1950), Redfield and Walford (1951), and Younger and Hamer (1952) calculated species catch rates using the assumption that a fisherman was seeking a particular species if the species represented at least 75 percent of the fisherman's catch. Use of this assumption may bias species catch rates since undue emphasis is given to the successful fisherman. If the ratio of successful fishermen to unsuccessful fishermen varies significantly with time, the resulting species catch rate may only reflect changes in the species catchability and/or expertise of the fishermen (including the number of rods used), but not changes in the relative abundance of a species.

For historical comparison purposes, however, we had to assume that influence from the above potential bias to be slight. We calculated species catch rates from our data using the assumption criterion of Butler and Spear (1950). Our catch rate comparisons are only for party and charter boat anglers and species discussed in previous studies (Westman and Neville, 1942; Butler and Spear, 1950; Redfield and Walford, 1951; Younger and Hamer, 1952).

We did not test the accuracy of information reported through the mail questionnaire or by charter boats, because of the obvious problem of not being able to put an independent observer on board. The results of a similar survey (Buchanan et al., 1974) indicated that response and nonresponse errors had little effect on accuracy. Of nine response categories tested, only estimates of catch were significantly different from those counted at dockside (13 percent overestimated). These findings were similar for party and charter boat captain data.

Estimates derived from a sample are subject to sampling error. We did not measure the magnitude of this error in our data. Since our monthly samples were relatively small (Table 2), sampling error may have been large. We believe, however, that our sampling procedures and sample size were sufficient to give realistic estimates which are not extreme and are useful as preliminary indicators of the fishery.

Table 3.—Estimated number of angler-hours expended per boat type, fishing method, and month during 1971.

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Charter										
Surface	310	6,200	25,857	14,721	25,515	17,732	4,544	3,328	0	98,207
Bottom	1,421	5,543	17,566	569	1,050	2,392	1,141	1,596	555	31,833
Mix	0	420	1,170	0	255	504	0	0	915	3,264
Party										
Surface	11,760	187,550	88,862	74,375	73,125	53,340	25,160	6,160	10,450	530,782
Bottom	58,616	76,534	102,948	122,009	96,465	52,788	44,495	27,460	22,816	604,131
Mix	11,220	39,026	0	680	2,310	4,343	0	350	40,920	98,849
Private										
Surface	9,856	43,192	129,936	131,779	142,599	58,912	57,803	40,655	168	614,999
Bottom	749	5,971	90,347	85,801	60,590	20,227	14,565	12,548	7,617	298,415
Mix	602	3,235	9,132	6,633	7,553	6,896	2,580	86	8,391	45,105
Subtotal										
Surface	21,926	236,942	244,655	220,875	241,239	129,984	87,507	50,144	10,618	1,243,890
Bottom	60,786	88,048	210,861	208,379	158,105	75,407	60,201	41,604	30,988	934,385
Mix	11,822	42,681	10,302	7,313	10,118	11,743	2,580	436	50,226	147,221
Grand total	94,534	367,671	465,817	436,567	409,462	217,134	150,288	92,184	91,832	2,325,496

Results

Effort

We estimated that party and charter boat fishermen sailing from ports between Manasquan and Jones Inlets expended about 85 percent of their fishing effort in the survey area, while private boat fishermen expended about 94 percent of their effort in this area. This suggested that recreational boat fishermen expended over 2.3 million angler-hours fishing between April and December 1971 in the survey area (Table 3); 53 percent of this effort was by party boat anglers, 41 percent by private boat anglers, and 6 percent by charter boat anglers.

Overall, recreational boat fishermen expended 53 percent of their total fishing effort seeking pelagic species. They concentrated most of their surface fishing activities along the coastline and in the central portion of the survey area (Fig. 2). Party boat fishermen concentrated their surface fishing effort over the Shrewsbury Rocks, Mud Hole, (the deeper parts of sectors 6 and 10), the sewage sludge disposal area, and just outside Manasquan Inlet (Figure 2, sectors 7-10, 15, 17, and 21). Charter boat

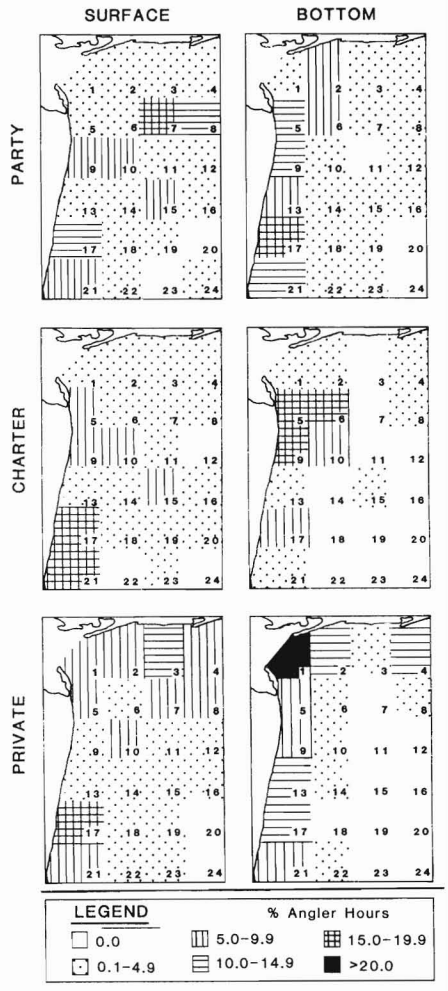


Figure 2.—Percent angler-hours expended per boat type and fishing method per sector (see Fig. 1).

Table 4.—Estimated proportion of angler-hours (%) expended per boat type and fishing method while over artificial reefs (AR), wrecks (WK), natural habitat (NH), and unknown (UNK) from April through December, 1971.

	Boat type		
Item	Charter	Party	Private
Surface			
AR	0.9	0.0	4.9
WK	0.0	0.0	0.2
NH	99.1	99.9	93.4
UNK	0.0	0.1	1.5
Bottom			
AR	5.0	4.7	2.2
WK	3.1	15.6	2.7
NH	91.2	78.3	93.9
UNK	0.7	1.4	1.2

Table 5.—Estimated number (in thousands) and percent of total catch of major species caught per boat type, April through December 1971, in the New York Bight apex.

	Boat type							
	Party		Charter		Private		Season	
Species	Number	%	Number	%	Number	%	Number	%
Atlantic mackerel	4,383.2	66.1	6.8	4.2	157.4	19.2	4,547.4	59.7
Bluefish	433.4	6.5	91.6	56.0	290.0	35.4	815.0	10.7
Red hake	614.0	9.3	20.2	12.4	15.3	1.9	649.5	8.5
Silver hake	469.6	7.1	25.0	15.3	39.4	4.8	534.0	7.0
Scup	350.3	5.3	1.6	1.0	18.8	2.3	370.7	4.9
Summer flounder	119.1	1.8	3.0	2.0	144.0	17.6	266.1	3.5
Tautog	137.2	2.1	1.6	1.0	26.1	3.2	164.9	2.2
Black sea bass	66.5	1.0	2.2	1.0	6.0	0.7	74.7	1.0
Striped bass	0.4	0.0	3.7	2.3	62.1	7.6	66.2	0.9
Atlantic cod	28.2	0.4	0.4	0.2	7.4	0.9	36.0	0.5
Little tunny	3.7	0.0	4.1	2.5	8.0	1.0	15.8	0.2
Bluefin tuna	0.2	0.0	1.4	0.9	7.3	0.9	8.9	0.1
Others	23.6	0.4	2.0	1.2	37.8	4.6	63.4	0.8
Total	6,629.4		163.5		819.5		7,612.4	

anglers also concentrated their surface fishing effort off Manasquan Inlet, Shrewsbury Rocks, and Mud Hole, but along the Sandy Hook coastline, as well (Figure 2, sectors 5, 9, 10, 15, 17, and 21). They did not expend many angler-hours (less than 5 percent) surface fishing in sectors containing the dump sites. Surface fishing effort by private boat anglers was concentrated in the northern third of the survey area and off Manasquan Inlet (Fig. 2).

Bottom fishing, which accounted for 39 percent of total fishing effort, was concentrated mainly between the 10 and 30 m contours off the New Jersey coast (Fig. 2). Party boat captains concentrated their effort in the areas of Sandy Hook, Shrewsbury Rocks, and Manasquan Inlet (Figure 2, sectors 2, 5, 6, 9, 13, 17, and 21). Charter boat anglers also limited most of their fishing effort to areas off Sandy Hook and Shrewsbury Rocks, but also fished in the vicinity of the dredge spoil disposal and Mud Hole Areas (Figure 2, sectors 5, 6, 9, and 10) and off Manasquan Inlet (sector 17), whereas most of the private boat anglers remained within a short distance of the inlets or Sandy Hook and Rockaway Points (Fig. 2).

Party boat anglers expended over 1.2 million angler hours in the survey area: 43 percent surface fishing, 49 percent bottom fishing, and 8 percent using a combination of the two methods (Table 3). They fished for pelagic and demersal species during the entire season. Most of their effort for pelagic species was from May through October with a large peak in May for Atlantic mackerel. They distributed their effort for demersal species more evenly through the season than for pelagic species. There was a slight increase in effort from the beginning of the season to July; afterwards, their effort gradually decreased.

Charter boat anglers expended over 133,000 angler-hours for pelagic and demersal species from April through December: 74 percent surface fishing, 24 percent bottom fishing, and 2 percent mixed methods. Most of their effort for pelagic species was from June through September and mostly for bluefish (Tables 3 and 6), with peaks in June (26 percent) and August (26 percent). They scattered their effort for demersal species irregularly through the season with a peak in June (55 percent) and low in July (2 percent).

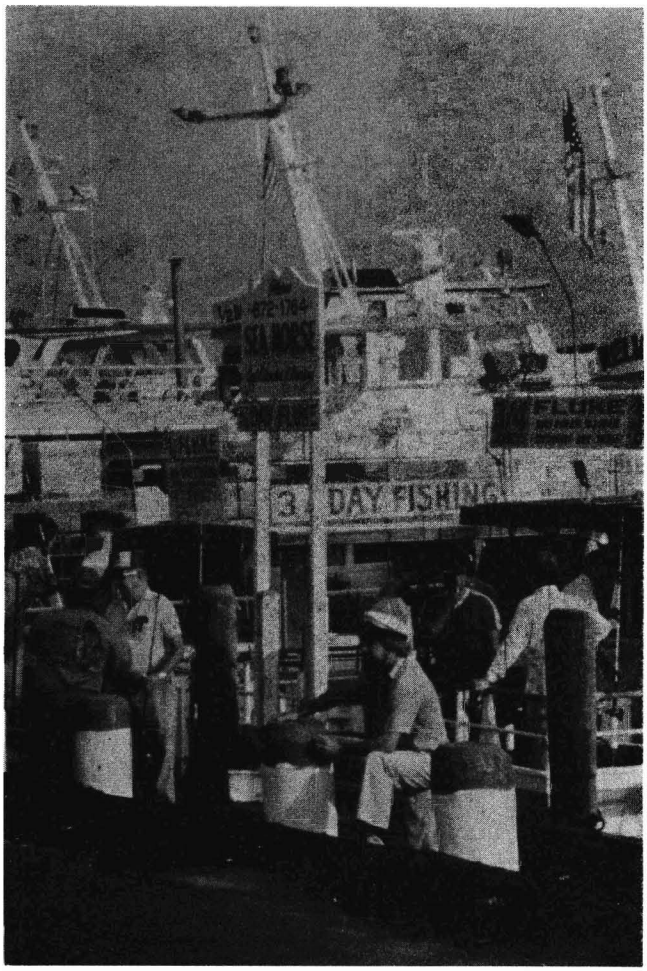
Private boat anglers spent nearly 1 million angler-hours fishing for pelagic and demersal species during the season: 64 percent surface fishing, 31 percent bottom fishing, and 5 percent mixed methods (Table 3). Peak effort for pelagic species occurred in August (23 percent) for bluefish and in June (30 percent) for demersal species, mostly summer flounder.

Artificial habitats (wrecks and artificial reefs) in the survey area were important to the recreational boat fishery. They received between 2.7 and 15.6 percent of the bottom fishing effort (Table 4). They were not as important to surface fishermen. This effort varied between the two types of artificial habitat (wrecks or reefs), as well. No seasonal trends in effort on artificial habitats were evident.

Catch

We estimate that, in 1971, New York Bight recreational boat fishermen caught about 7.6 million fish of 24 game species (Table 5). Party boat anglers accounted for 6.63 million of the catch, charter boats for 0.16 million, and private boats for 0.82 million (Table 5). Of the 24 game species reported (Table 1), only 12 were caught consistently enough to be used in comparisons with previous surveys. The rest were included together as "others" in Tables 5, 6, 7, and 8. Atlantic mackerel comprised 60 percent of the total catch (Table 5) and were the most numerous species taken in spring and early winter when silver hake, *Merluccius bilinearis*, were also abundant. Bluefish, summer flounder, and red hake, *Urophycis chuss*, were abundantly caught in the summer, and scup in the fall (Tables 6, 7, and 8). It appears that an Atlantic mackerel recreational fishery did not exist prior to 1940 (Westman, 1958).

[1]Westman, J. R. 1958. A study of the newly created "Acid Grounds" and certain other fishery areas of the New York Bight. Unpubl. rep., 50 p.



Party boats: A typical scene at major New York and New Jersey ports.

Table 6.—Estimated number (thousands) of each species caught per month by party boat fishermen while surface, bottom, or mixed method fishing during 1971 (T = <100 caught).

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Atlantic cod										
Surface	0.3								T	0.3
Bottom	6.0	8.7	0.1	3.7	0.2	0.5	T	1.9	1.1	22.2
Mix	T	0.1						T	6.1	6.2
Atlantic mackerel										
Surface	162.2	2,845.4	31.6					11.1	218.8	3,269.1
Bottom		0.3					T	T	2.7	3.0
Mix	133.0	714.5						0.1	263.4	1,111.0
Black sea bass										
Surface					T	0.4				0.4
Bottom	0.4	3.4	20.1	8.0	4.5	14.5	10.8	3.7	0.6	66.0
Mix						0.1				0.1
Bluefin tuna										
Surface				T	0.1	T				0.1
Bottom										0.0
Mix				T						T
Bluefish										
Surface		0.6	125.7	146.5	82.3	30.5	32.3	5.7		423.6
Bottom		T		2.4	T	T	5.2	0.1		7.7
Mix					1.0	0.9				1.9
Red hake										
Surface										0.0
Bottom	66.7	199.0	83.8	88.6	53.9	4.9		3.1	54.0	553.9
Mix	0.8	0.9		3.0					55.4	60.1
Little tunny										
Surface					0.1	2.4	1.2			3.7
Bottom										0.0
Mix										0.0
Scup										
Surface						T	T			T
Bottom			0.4	0.4	5.1	73.3	121.9	149.1		350.2
Mix						T				T
Silver hake										
Surface	0.1	15.7							0.3	16.1
Bottom	31.9	143.6	44.3	0.1	0.1	0.1		0.9	95.9	316.9
Mix	16.6	61.1							59.1	136.8
Striped bass										
Surface					T		T	0.1		0.1
Bottom		T	0.1				T	T		0.1
Mix										0.0
Summer flounder										
Surface				T	T	0.4				0.4
Bottom			50.7	52.1	10.3	4.5	T			117.6
Mix					1.0	0.1				1.1
Tautog										
Surface										0.0
Bottom	3.1	17.1	24.3	8.6	1.7	8.6	43.2	27.4	2.9	136.9
Mix									0.4	0.4
Others										
Surface	0.3	0.3		T	2.3	0.3	0.6	1.0	3.7	8.5
Bottom	3.6	0.6	0.1	0.1	0.2	0.1	0.7	0.2	T	5.6
Mix	2.5					0.2			6.7	9.4
Total										
Surface	162.9	2,862.0	157.4	146.6	84.8	34.1	34.2	17.9	222.8	3,722.7
Bottom	111.6	372.8	224.0	164.0	75.9	105.9	181.9	186.4	157.1	1,579.6
Mix	152.9	776.6		3.0	2.1	1.3		0.1	391.2	1,327.2
									Grand Total	6,629.5

Party boats caught 56 percent of their catch surface fishing (Table 6). Atlantic mackerel constituted 88 percent of the surface fishing catch, while bluefish, the second most numerous species caught, constituted 11 percent or almost all of the remaining catch. Seasonally, Atlantic mackerel also dominated the party boat catch in the spring and winter, with bluefish dominant in the summer and fall. Six species (red hake, silver hake, scup, tautog, *Tautoga onitis*; summer flounder, and black sea bass) constituted 98 percent of the bottom catch by party boats (Table 6). Red hake, tautog, and black sea bass were caught throughout the season, with the exception of October when no red hake were reported caught. Silver hake, summer flounder, and scup were caught seasonally; party boats caught silver hake during the winter and spring, summer flounder during the summer months, and scup during the fall.

Charter boat anglers caught 64 per-

Table 7.—Estimated number (thousands) of each species caught per month by charter boat fishermen while surface, bottom, or mixed method fishing during 1971 (T = <100 caught).

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Atlantic cod										
Surface										0.0
Bottom	0.1							T	0.1	0.2
Mix										0.0
Atlantic mackerel										
Surface	2.2	0.4								2.6
Bottom		T						T	0.1	0.1
Mix		T							4.1	4.1
Black sea bass										
Surface				T	0.2	0.2		T		0.5
Bottom			1.0			T	0.3			1.3
Mix			0.3			T				0.4
Bluefin tuna										
Surface				0.2	1.1	T				1.4
Bottom										0.0
Mix			T							T
Bluefish										
Surface		4.7	38.8	27.3	10.1	4.6	4.6	1.3		91.4
Bottom			0.1			0.1	T	0.1		0.1
Mix					T	T				T
Red hake										
Surface		0.2			0.6	T				0.8
Bottom		1.2	3.6	0.8	1.3	0.8	0.1	1.8	1.6	11.1
Mix	0.2	1.4			0.3	0.2			1.3	3.4
Little tunny										
Surface					0.2	3.7	0.2			4.1
Bottom										0.0
Mix						T				T
Scup										
Surface										0.0
Bottom						T	1.5			1.6
Mix										0.0
Silver hake										
Surface		T					0.1			0.1
Bottom		5.0	8.7						0.1	13.8
Mix		T				T				0.1
Striped bass										
Surface		0.1	0.3	2.0	0.1	T	T	0.6		3.0
Bottom		T	0.6	T						0.6
Mix		0.1								0.1
Summer flounder										
Surface					T	0.1				0.1
Bottom			1.0	0.3	1.3	0.4				2.9
Mix						T				T
Tautog										
Surface				0.1			0.1	T		0.3
Bottom		0.2	0.3				0.6	T	0.2	1.3
Mix			T							T
Others										
Surface		T		0.1	1.5	0.2	0.1	0.0	0.0	1.9
Bottom		T	T			T	T	T		T
Mix										0.0
Total										
Surface	2.2	5.2	39.1	29.7	13.3	8.9	5.1	1.9		105.3
Bottom	0.1	9.1	25.8	0.4	1.3	0.4	2.5	0.1	0.5	40.3
Mix		T	2.0		0.1	0.1			15.6	17.8
									Grand Total	163.4

Table 8.—Estimated number (thousands) of each species caught per month by private boat fishermen while surface, bottom, or mixed method fishing during 1971 (T = <100 caught).

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Atlantic cod										
Surface	T	T	T					0.8		0.8
Bottom	0.5	0.1						1.3	2.3	4.2
Mix	T	0.2							2.2	2.4
Atlantic mackerel										
Surface	32.2	108.6	0.9					1.6	1.4	144.7
Bottom					0.1				1.6	1.7
Mix	0.2	4.6	1.5	0.2					4.6	11.1
Black sea bass										
Surface										0.0
Bottom		0.1	1.3	0.6	1.1	0.4	1.7	0.5		5.8
Mix					T	0.2				0.2
Bluefin tuna										
Surface			0.6	3.1	2.9	0.3	0.1			7.0
Bottom										0.0
Mix					0.2	0.1				0.3
Bluefish										
Surface		14.5	72.7	88.0	55.3	14.6	24.6	7.7		277.4
Bottom		T	0.5	1.3	0.8	1.2	0.4	0.3		4.6
Mix		0.4	3.7	1.0	1.2	1.1	0.6			8.0
Red hake										
Surface										0.0
Bottom	T	3.9	14.1	0.1				0.1	0.1	18.3
Mix		T	1.5		T				5.1	6.7
Little tunny										
Surface				0.1	0.8	6.9	0.1			7.9
Bottom										0.0
Mix						0.1				0.1
Scup										
Surface				T		0.2				0.2
Bottom		T	T	0.3	6.1	7.5	3.8	0.3		18.0
Mix						0.6				0.6
Silver hake										
Surface	0.3	6.7			0.2					7.2
Bottom	0.4	12.9	4.0	1.9	0.2	1.0		2.0	1.5	24.0
Mix	1.3	4.3	0.3		T	0.5			1.8	8.2
Striped bass										
Surface		0.7	6.2	13.5	4.3	2.5	5.3	9.0		41.5
Bottom		0.1	1.9	1.3	0.6	14.0	1.1	0.1		19.2
Mix		0.1	0.3	0.3	0.1		0.6			1.4
Summer flounder										
Surface			0.6	0.8	0.8	0.2				2.4
Bottom		0.3	44.7	56.1	29.5	6.3	0.9			137.8
Mix		T	0.5	1.2	1.8	0.2	0.1			3.8
Tautog										
Surface			0.1	0.1		T				0.2
Bottom		1.0	3.9	1.0	1.1	1.1	12.3	5.2		25.6
Mix						0.3				0.3
Others										
Surface	0.2	0.2	T	0.9	8.7	3.5	3.7			17.2
Bottom		1.9	5.1	0.9	0.9	2.4	2.4	3.4		17.0
Mix		0.2		T	0.2	T	0.5		2.6	3.6
Total										
Surface	32.7	130.9	81.1	106.5	73.6	28.2	33.8	19.1	1.4	507.3
Bottom	0.9	17.8	65.0	64.3	41.7	34.7	22.7	14.9	6.9	268.9
Mix	1.7	11.2	6.3	2.7	3.8	3.3	1.8		12.5	43.3
									Grand Total	819.5

cent of their fish while surface fishing, mainly bluefish (87 percent), while little tunny, *Euthynnus aletteratus*; striped bass, Atlantic mackerel, bluefin tuna, *Thunnus thynnus*; and a small percentage of "others" completed the list (Table 7). Silver and red hakes constituted 80 percent of the bottom fishing catch by charter boats, most of which were

caught during May and June.

In contrast to the seasonal success pattern of party boat anglers, the charter boat fishing season was slow until late May and early June when bluefish began to appear. Charter boat catches, however, declined again when bluefish emigrated in the fall. Catches picked up for a short while in December when Atlantic mackerel and silver and red hakes began showing up in the landings. The relatively poor season for the charter boat fleet was reflected in their catch statistics (Table 7); they caught only 2 percent of the total catch by New York Bight boat fishermen in 1971.

Private boat anglers caught 62 percent of their catch while surface fishing. As with party and charter boats, bluefish (55 percent) or Atlantic mackerel (28 percent) dominated the catch by private boat anglers, however, their catch of other species was more numerous (Table 8). Most of the oceanic species, such as little tunny, bluefin tuna, skipjack tuna, *Euthynnus pelamis*; and Atlantic bonito were caught by private boat anglers, as were 94 percent of all striped bass. Summer flounder constituted 51 percent of their catch while bottom fishing. Silver hake were the next most numerous species taken, with peak landings during May. Tautog landings peaked during October. Scup, red hake, black sea bass, and Atlantic cod were caught sporadically throughout the year while bottom fishing.

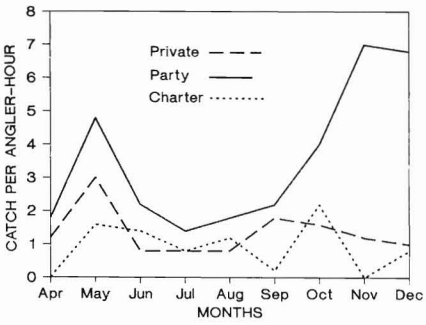


Figure 3.—Catch per angler-hour by charter, party, and private boat fishermen while surface fishing, April through December 1971.

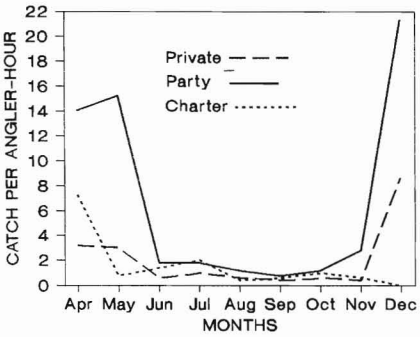


Figure 4.—Catch per angler-hour by charter, party, and private boat fishermen while bottom fishing, April through December 1971.

Catch Rates

Catch per angler-hour fluctuated considerably during the season and among the three fishing groups (Figs. 3, 4). In general, the highest monthly catch rates occurred during the spring, late fall, and early winter when Atlantic mackerel dominated the catch. The lowest monthly catch rates occurred in the summer and early fall.

Party boats had consistently higher monthly catch rates for pelagic species than either private or charter boats, except during July when their monthly catch rate was slightly lower than that of charter boats (Fig. 3). Their catch rates were high during spring when the fishery was harvesting large numbers of Atlantic mackerel from the northernly migrating schools until they passed beyond the daily range of most boats in June. They were replaced in early summer by schools of bluefish entering the area from the south and offshore. This resulted in a sharp drop in the monthly catch rate from 15.3 fish per angler-hour in May to less than 2.0 fish per angler-hour in June. Between June and October, bluefish dominated the surface fishery and the monthly catch rates remained below 2.0 fish angler-hour. After the bluefish departed in November, the monthly catch rate increased again in December when Atlantic mackerel returned during their fall migration south. We found the party boat captains we interviewed had spent 6,243 angler-hours night fishing during which 13,058 fish were caught (Table 9). Bluefish represented over 95 percent of that catch.

Table 9.—Night fishing statistics for party boat fishermen interviewed from June through October, 1971.

Item	June	July	Aug.	Sept.	Oct.
Angler-hours	2,322	1,980	904	637	400
Catch (no. of fish caught)	5,620	4,656	1,006	1,036	740
Catch per angler-hour	2.4	2.4	1.1	1.6	1.8

We were not able to estimate total night fishing angler-hours or total catch; we did, however, estimate monthly catch rates which varied between 1.1 and 2.4 fish per angler-hour. The average number of fish caught per angler-hour while night fishing tended to be slightly higher than the number caught during daylight hours. As expected, the night fishing catch rates basically followed the same trend as established by daytime surface fishing from party boats, except during September when the night fishing, monthly catch rate indicated a slight increase.

Party boat anglers had consistently higher bottom fishing monthly catch rates than private or charter boat anglers (Fig. 4). Their highest catch rates occurred during May and December when red and silver hake dominated the landings, and during October and November when scup entered the landings in large numbers. Their lowest catch rates occurred during the summer when summer flounder and red hake dominated the landings.

Charter boat fishermen seeking pelagic species had their highest monthly catch rates during April and July (Fig. 3). Only during April, when Atlantic mackerel dominated the landings, did the monthly catch rate exceed 2.0 fish per angler-hour. During May, when bluefish began to replace Atlantic mackerel as the most prevalent species, the monthly catch rate dropped below 2.0 fish per angler-hour from a seasonal high of 7.2 fish per angler-hour during April. For the remainder of the season, bluefish represented most of the pelagic catch. Charter boat anglers had low monthly catch rates while seeking

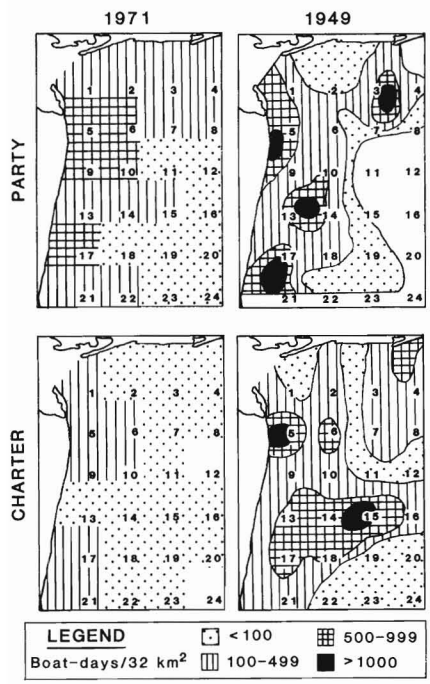


Figure 5.—Boat-days per 32 km² (20 mi.²) for party and charter boats during 1949 and 1971. Original data from 1949 presented only as contours. Effort data from 1971 presented by sectors (see Fig. 1).

demersal species, only once exceeding 2.0 fish per angler-hour (Fig. 4). Their highest catch rates occurred during May and June when red hake made up most of the catch, and during October when scup was the predominant species.

The highest monthly catch rates for the private boat surface fishery occurred during spring and winter when Atlantic mackerel dominated the catch and their lowest catch rates occurred during summer when bluefish were sought (Fig. 3). In general, they had lower monthly catch rates than either charter or party boat anglers. Only during May was their catch rate higher than that by charter boat anglers. The difference in these catch rates may be due to private boat anglers fishing primarily for Atlantic mackerel during May which normally yielded high catch rates, while charter boat anglers sought bluefish which normally yielded comparatively low catch rates. The highest monthly catch rate (3.0 fish per angler-hour) for private boats bottom fishing occurred during May, the other monthly catch rates fluctuated between 0.7 fish per angler-hour and 1.7 per angler-hour (Fig. 4).

Table 10.—Estimated number (in thousands) and percent total of each species caught by party and charter boat fishermen in the New York Bight apex, April through December 1949 (Redfield and Walford, 1951).

Species	Boat type: Party No.	Party %	Charter No.	Charter %	Total for 1949 season
Scup	3,161	45.5	126	8.1	3,287
Atlantic mackerel	1,985	28.6	1,047	67.0	3,032
Black sea bass	1,032	13.0	73	4.7	1,105
Red hake	208	3.0	4	0.3	212
Summer flounder	186	2.7	24	1.5	210
Tautog	146	2.1	6	0.4	152
Bluefish	4	<0.1	136	8.7	140
Weakfish	78	1.1	15	1.0	93
Atlantic cod	66	0.9	12	0.8	78
Little tunny	1	<0.1	46	2.9	47
Bluefin tuna	0	0.0	24	1.5	24
Dolphin	2	<0.1	12	0.8	14
Skipjack tuna	0	0.0	6	0.4	6
Atlantic bonito	0	0.0	3	0.2	3
Striped bass	0	0.0	1	0.1	1
Others	74	1.0	27	1.7	101

Discussion

Historical Comparisons of Effort and Catch Rates

Although several previous surveys have been conducted of the New York Bight recreational fishery, only Redfield and Walford (1951) estimated total effort and catch by party and charter boat anglers. They presented their effort data in contours of boat-days per 32 km² (20 square miles) per year. For comparison purposes, we converted our effort estimates to the same units, but could only present them for sectors as our sampling and summarizing methods prevented us from drawing contours (Fig. 5) similar to those of Redfield and Walford (1951).

Although the number of party boats fishing the survey area decreased from 157 (in 1949) to 122 (in 1971), the distribution of effort changed very little (Fig. 5). Party boat anglers in 1949 concentrated much of their effort, 1,000+ boat-days per 32 km², in sectors 7, 9, 14, and 21 (Fig. 5). The remaining effort was distributed within 24 km of the coast. Party boats still concentrated much of their effort nearshore in 1971, but extended the remainder further offshore than in 1949, possibly a partial reflection of an increase in the size and speed of party boats or greater competition for resources. They decreased their fishing intensity in sectors 7 (the sewage sludge area) and 14 (Fig. 5), while maintaining their 1949 intensity in coastal sectors 5, 9, 17, and 21 and increasing it to 1,000+ boat-days per 32 km² in sectors 6 and 10 (the Christiensen Basin and Mud Hole).

In 1949, charter boat anglers concentrated much of their effort in sectors 5 and 15 and scattered the remainder throughout the survey area (Fig. 5). In 1971, their fishing intensity decreased in nearly two-thirds of the sectors, but not in sectors 6, 9-11, 21, and 23 (Fig. 5). Most of the fishing effort in 1949 seemed to be directed further offshore than in 1971, possibly more effort for large pelagics, e.g. tunas.

Our estimate of catch is not directly comparable to that of Redfield and Walford (1951) because of differences in our survey boundaries. We estimated catch only within our survey area by the party and charter boat fleet sailing from ports between Manasquan Inlet and Jones Inlet, whereas Redfield and Walford (1951) estimated the entire catch by the fleet, overlooking boundaries. Overall catch composition, however, should be comparable since the majority of the effort by the fleet in 1949, as in 1971, was within our survey boundaries.

The catch composition by fishermen aboard party boats in 1971 differed from that reported in 1949. Scup, Atlantic mackerel, and black sea bass were the most numerous species taken in 1949, representing 87.1 percent of the catch (Table 10). In 1971, proportional to 1949, the percentage of scup in the catch was lower by 40.2 percent while Atlantic mackerel was higher by 37.5 percent to become the largest component of the total catch. Red and silver hake were the second and third most numerous species caught in 1971, representing 9.3 and 7.1 percent, respectively, of the catch. In 1949, red hake constituted 3.0 percent of the catch, while silver hake were not mentioned.

The charter boat catch composition in 1971 differed from that in 1949. Com-

Table 11.—Estimated catch per man-day for major species during selected years for party and charter boats.

Species	Party boats			
	1948[1]	1949[1]	1952[1]	1971[1]
Atlantic mackerel	30.0	26.0	33.6	69.2
Scup	19.8	32.2	31.1	31.8
Black sea bass	12.9	17.0	14.9	2.4
Summer flounder	11.6	7.6	7.3	3.0
Weakfish	19.1	18.5		4.3

	Charter boats				
	1938[2]	1941[2]	1948[1]	1949[1]	1971[1]
Atlantic mackerel			25.1	33.0	20.3
Bluefish			5.7	6.0	7.5
Little tunny			2.3	3.6	2.8
Bluefin tuna	1.6	1.2	1.1	4.2	1.4
Striped bass			0.9		2.2

[1]Catch rate calculated from trips in which a species represented 75 percent or more of total catch. The 1948 estimates are from Butler and Spear (1950), 1949 estimates are from Redfield and Walford (1951), and 1952 estimates are from Younger and Hamer (1952).
[2]Catch rates calculated from trips in which the fisherman stated that he was fishing specifically for a given species and original data presented as fish per boat-day trip. We assumed an average of six fishermen per boat. The 1938 estimates are from Westman (1938) and 1941 estimates are from Westman and Neville (1942).

pared to 1949, the relative abundance of Atlantic mackerel, scup and black sea bass in 1971 were lower, while bluefish, red hake, summer flounder, tautog, and striped bass were higher. The catch of bluefish (dominant species in 1971) was higher by 47.3 percent and Atlantic mackerel (dominant species in 1949) was lower by 58.6 percent.

Between 1948-52 and 1971, party boat anglers have experienced higher catch per angler-day for Atlantic mackerel and lower catch rates for black sea bass, summer flounder, and weakfish (Table 11). For summer flounder, this lowered catch rate appears to have stabilized as Christensen and Clifford (1979a) report a catch rate of 3.2 fish per angler-day for 1978 party boat data in the same general area. Between 1948 and 1952, Atlantic mackerel catch rates fluctuated by only 8 fish per angler-day, but were doubled in 1971. Scup catch rates showed a sharp increase from 1948 to 1949, but thereafter the rate was similar in 1952 and 1971. Black sea bass catch rates also showed a slight increase between 1948 and 1949, but was lower in 1952 and only 2.4 fish per angler-day in 1971.

Charter boat anglers did not experience wide fluctuations in catch per angler-day as did party boatmen. Catch rates in 1971 for Atlantic mackerel, little tunny, and bluefin tuna were about the same as those in 1948, but lower than those in 1949. Bluefin tuna and striped bass catch rates are higher in 1971 than in 1948.

The proportional participation of charter, party, and private boats in the New York Bight apex recreational fishery seems to have changed between 1949 and 1971. Charter boats no longer share the position, with party boats, in 1971 of being the primary type of boat used by recreational fishermen, but may have relinquished their position to private boats. This must be inferred, in the absence of prior specific effort data, by an overall decrease in the carrying capacity of the charter boat fleet and an increase in the carrying capacity of the party boat fleet. Between 1949 and 1971, the charter boat fleet decreased by about 190 boats, while the average boat capacity remained the same. The number of party boats available to fishermen also decreased (slightly), but the carrying capacity of the fleet (size of vessels) increased from 30 to 50 fishermen per average boat, thereby increasing the overall party boat fleet's daily carrying capacity by nearly 2,000 fishermen in 1971. In discussing this possible trend we are making the reasonable assumption that the number of boats in the fishery is a relatively conservative variable and does not have major year-to-year fluctuations.

We were not able to estimate changes in private boat useage because of the lack of prior effort data. An increase in effort, however, does seem likely because of technological advances in small boats (5-10 m). Improvements in relatively inexpensive small boat production techniques, designs, and materials, and general standard of living made it possible for more fishermen to buy and operate their own boats and to fish many areas previously fished exclusively by charter and party boats.

The importance of the party boat fleet to the recreational fishery is reflected in our effort statistics. During 1971, party boat fishermen expended more angler-hours than private or charter boat fishermen. They were responsible for over half of the total effort, two-thirds of the total bottom fishing effort, and two-fifths of the total surface fishing effort. Charter boats accounted for less than 10 percent of the total effort. Private and charter boat fishermen spent nearly 65 percent of their effort seeking pelagic species while party boat fishermen divided their time about equally between pelagic and demersal species.

Distribution of effort by party boat fishermen has changed little between 1949 and 1971 surveys. Most of their angler-hours were expended within 16 km (10 miles) of the New York and New Jersey coasts. There was, however, a suggested slight decrease in effort in the northeastern sectors of the survey area and a corresponding increase in effort in the western sectors. The distribution of effort by charter boat fishermen between 1949 and 1971 changed more noticeably than that by party boat anglers. In 1949, charter boats scattered their effort throughout the survey area, whereas in 1971 they concentrated most of it within 16 km (10 miles) of the New Jersey coast.

Magnitude of the 1971 Apex Recreational Fishery

Our data suggest that the New York Bight apex supports a major, concentrated recreational fishery that harvested about 7.6 million game fish in 1971 (Table 5). This may be >10 percent of the mean combined total New York/New Jersey marine recreational catch based on a 71.7 million fish average for the period 1979 through 1984 (USDOC, 1984, 1985a,b). The 10 percent estimate is minimal as the Commerce Department data include nonboat data and estuarine data and we did not include nongame fish in our estimates. Marine recreation fish catches in the New York/New Jersey waters vary annually. For example, the Commerce Department's Marine Recreational Fishery Statistics Survey data for 1979 through 1984 (USDOC, 1984, 1985a,b) estimates the total annual, combined New Jersey and New York recreational catch ranged from a low of about 40 million fish (1982) to a high of about 100 million fish (1980).

Our 1971 catch estimate is not direct-

ly comparable to commercial landings records because of the lack of weight data. McHugh (1977) concluded from an analysis of New Jersey and New York commercial landing records and recreational surveys, however, that the recreational catch (by weight) of several commercially important species during the 1960-70 decade was larger than the domestic commercial catch. This could be due to an extremely complex situation stemming from sociopolitical and economic factors along with an increase in the number of recreational fishermen.

Surface fishing in 1971 was mostly dependent on two migratory pelagic species: Atlantic mackerel during spring and early winter and bluefish during summer. The popularity of bluefish and Atlantic mackerel varied among the vessel types which is probably a reflection of seasonal availability of the two species and seasonal distribution of fishing effort by the different vessels. Party boat anglers expended nearly one-third of their 1971 surface fishing effort in pursuit of Atlantic mackerel; charter and private boat anglers directed less than 10 percent of their surface fishing effort toward Atlantic mackerel. This resulted in Atlantic mackerel composing nearly 60 percent of the total 1971 catch. Deuel (1973) also found Atlantic mackerel to be the single most numerous fish caught by party-charter boats off the northeastern U.S. in 1960's.

Bluefish was the most highly sought pelagic species in the New York Bight apex in 1971, based on the Butler and Spear (1950) assumption discussed previously. More angler-hours were spent seeking bluefish than any other species including a specific party-boat night fishery. Even though the total number of bluefish caught in 1971 was less than the catch of Atlantic mackerel, we believe the total pounds to be much larger because of the larger average size of bluefish. Deuel (1973) found this to be generally true of the overall recreational catch between Maine and Cape Hatteras, N.C. In terms of pounds landed, the recreational fishery for bluefish was much larger than the commercial fishery in the Bight (McHugh, 1972, 1977). The popularity of bluefish to fishermen stems to a large degree from bluefish being abundant in the Bight during favorable weather conditions when all types and sizes of vessels can participate in the fishery, as well as, the species' larger size and fighting nature.

Historical Comparison of Catch Composition

The importance of Atlantic mackerel and bluefish to party and charter boat anglers seems to have changed, in most cases, between 1949 and 1971. Between these two survey periods, the percent composition of Atlantic mackerel in the party boat catch increased by 37 percent and bluefish by 6 percent (probably not significant). Whereas the two species seem to have exchanged relative position with charter boats, e.g., the relative number of Atlantic mackerel decreased by 63 percent while bluefish increased by 47 percent. Catch figures from the National Saltwater Angling Surveys for 1960, 1965, and 1970 (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973) also indicate changes in the relative numbers of these species. The total recreational catch of bluefish from Maine to Cape Hatteras between 1960 and 1970 increased only slightly (0.3 percent), while Atlantic mackerel increased by 13.1 percent. McHugh (1972, 1977) also reported a resurgence in the commercial fishery for bluefish, although there was much year to year variability, in the Bight. Atlantic mackerel commercial landings were strong in 1949 but less in the 1960's, increasing again in the 1970's. Effort and abundance is involved, however, in these trends (Long and Figley, 1982) and is probably reflected in the overall increase of Atlantic mackerel landings in the recreational and commercial fisheries, despite a decrease in the charter boat fishery. The change in the relative number of Atlantic mackerel and bluefish in the charter boat catch may merely be a reflection of fishermen preference for one species over the other.

Increased bluefish landings in 1971 and more recent years may be due to increased abundance. Historically, bluefish abundance is known to vary between years but generally being a major hook and line species as far back as the 1880's (Smith, 1892). Whether increased landings are due to increased abundance or increased availability due to environmental conditions is unknown (McHugh, 1977). The party boat night fishery for bluefish, that probably developed since the 1950's, is another plausible reason for the increase. Christensen and Cliffort (1979b) estimate the night harvest of bluefish from party boats "greatly exceeds the day catch within the study area". Their study area was also, for the most part, the apex. This night fishery also had better results for a few other species as well, including several species of sharks.

The bottom fishery is dependent on a greater variety of species than the surface fishery. Hakes, scup, and summer flounder represented most of the demersal fishes landed, however, the relative importance varied among the vessel types. Silver hake, red hake, and scup were the most numerous species caught by party boat anglers, whereas, both hakes represented the greatest portion of demersal fishes caught by charter boat fishermen. Private boat fishermen caught few hakes and scup, but more summer flounder than party and charter boats combined. Christensen and Clifford (1979a) note that party boats, at least, fish for summer flounder mostly in late spring/early summer but then shift to bluefish when they move into the area and continue to fish for them up to December.

McHugh (1972) points out that the commercial fishery in the Bight has been able to maintain landings by switching from a group of fishes of declining abundance to one of abundance. This is also probably the case with the recreational fishery. For example, during 1949, scup and black sea bass were the most numerous demersal species caught by the party-charter fleet and hakes one of the least numerous, representing 45.5, 13, and 3 percent, respectively, of the total catch (Table 10). In 1971, the representation of scup and black sea bass in the total catch was only 5 percent and 1 percent, respectively, and hakes increased to 16 percent (Table 5). Recreational landings are greatly influenced by the desires or demands of the sportsman which may explain the change in percentage composition of

Atlantic mackerel and bluefish in the charter boat landings.

Other broadscale surveys have reported similar declines in scup and black sea bass landings. Deuel and Clark (1968) and Deuel (1973) noted declines from 1960 to 1970 in the Middle Atlantic recreational fishery. Black sea bass, which has supported a notable fishery since colonial times in the area (Smith, 1892; Pearson, 1972), declined from 19 percent of the total catch to 3 percent and scup declined from 20 to 2 percent. Scup landings from the New York commercial fishery have been declining since 1958 and black sea bass since 1952 (McHugh, 1972). New Jersey landings have also declined, but not as drastic as the New York landings (McHugh, 1977). The decline in scup landings may have been due to a year class failure or overfishing (Briggs, 1968; McHugh, 1972) or a combination of the two. This may have been a temporary fluctuation in the stock size since scup stocks historically are known to vary, perhaps in cycles (Finkelstein, 1969). Our catch-per-unit-effort data indicate that the scup stock may have increased since the average catch per angler-day in 1971 was similar to that in 1949 and 1952 when large landings were made. The small landings of scup in 1971 may be the result of reduced fishing effort being directed specifically for them. McHugh's (1977) summarized New Jersey commercial landings indicated a marked increase in scup landings since 1970 which may represent an increase in abundance or availability or increase in an offshore winter fishery. The difference in black sea bass catch rates in the recreational fishery between 1949 and 1971 suggests the possibility of declining abundance.

The percentage composition of the bottom fishing catch differed among the three types of vessels. This difference is probably attributed to a disproportional amount of fishing effort being directed specifically toward a species or group of species. For example, private boat anglers probably caught a higher percentage of summer flounder and striped bass than party and charter boat anglers because they probably directed a higher percentage of their effort toward these species. The same can be said for the high percentage of scup and hakes in the party and charter boat landings.

Artificial habitat was important to the bottom fishery since it provided additional habitat for fishes normally associated with rocky substrate. These sites were fished by all types of boat anglers (Table 4). Party boat anglers, however, spent a greater relative number of angler-hours over them than did either charter or private boat angler. These results and conclusions are consistent with a study the previous year, 1970, of the same general area (Stone et al., 1974). The difference in effort by party and private boat anglers may be due to the inability of the latter to locate wrecks; many private boat anglers lacked the necessary knowledge of the area and electronic sounding equipment. Whereas, most party boat captains have land ranges or electronic equipment for locating many of these productive sites. Charter boat anglers and many private boat anglers may not have fished much over artificial habitat because a greater desire for nonreef dwelling species, such as silver hake or summer flounder.

We were not able to compare catch composition and angler success among the different habitat types because our sample was too small and the fishing effort was not distributed among all months. In general, Stone et al. (1974) found artificial habitat to provide party boat anglers in the Bight with catch rates higher than those over sandy or mud bottoms. They did not find this to be true for private anglers. The difference in angler success is probably due to the fisherman's ability to locate the exact position of the artificial habitat. From our experience, we found it necessary to fish in close proximity to an artificial habitat to reap the benefits.

Artificial habitat did not appear to be important to the fishermen seeking pelagic fishes. A relatively small amount of surface effort was spent over artificial habitat. This may have been due to possible low catch rates, although we were unable to estimate these rates, as stated earlier. Low surface fishing success was found for fishermen in the Bight during 1970 (Stone et al., 1974); and for fishermen off Murrells Inlet, S.C. (Buchanan et al., 1974).

Although the survey area includes several waste dumping sites and managers are interested in documenting effects, the present survey was not designed to address this question of effects of waste disposal on the apex recreational fishery and it would be very difficult to use the information presented here for this purpose, in hindsight. The reason for this caution is that the waste disposal areas are small portions of the data collection summarization sectors (sewage sludge area is <25 percent of sector 7) or bracket two sectors (dredge spoils are included in sectors 6 and 10) although sector 6 mostly contains the highly contaminated Christiensen Basin. So although there is a suggestion, in the 1971 summarized data (Fig. 2), that: 1) Party boats spent considerable effort (15-20 percent) fishing for pelagic species in sector 7 containing the sewage sludge disposal area; 2) charter boats spent substantial effort (>15 percent) bottom fishing in the Christiensen Basin (sector 6) and Mud Hole (sector 10); and 3) party and private boats spent little time bottom fishing in the same areas and sector 7, these patterns cannot be reasonably associated with waste disposal from the available data. The same is true in attempting to compare the 1971 data to historical data (Fig. 5) as there are too many undefined or unmeasured variables to state or suggest that any of the use patterns of 1971 or 1949 involves a response to waste disposal.

Other survey data, e.g., Long and Figley (1982), are also vague in describing relationships of fisheries to waste disposal practices, with several recreation fishing grounds, e.g. for Atlantic mackerel, various species of tuna, bluefish, silver hake, black sea bass, and tautog, as well as commercial fisheries for some of the same species and lobster being generally defined to include the disposal areas.

Although historical data are insufficient to define impacts of some waste disposal practices, other waste disposal practices in the Bight apex may actually have created fishing grounds. Westman[1] discusses how the dumping of

building rubble off Long Beach, New York in 1949 created "the McAllister Grounds", a type of artificial reef, and the disposal of rocks in the Christiensen Basin from subway excavation under New York City created the "Subway Rocks" ground near Ambrose Light. Westman also reports that when the disposal of acid wastes begun on the Cholera Bank in 1950, the yellow, iron stained waters became a prime bluefishing grounds through the 1950's, although less so later on. Again, the lack of quantitative data reduces the confidence in these reports.

In summary, we have presented a fairly detailed picture of the recreational fishery by party, charter, and private boats in the New York Bight during 1971. It supports the growing recognition of the importance of a relatively intensive recreational fishery in this area, an area under high multiple use pressure and establishes a baseline for future evaluation of fishery changes.

Acknowledgments

This paper was improved by the suggestions of Stuart Wilk, Daryll Christensen, Chester Zawacki, Philip Briggs, Tom Morrissey, Ron Essig, and others. Also special thanks go to the many party and charterboat captains who maintained our logs, to the sport fishermen who took the time to accurately complete our questionnaire, and to Michelle Cox for preparing the figures. This paper is dedicated to the late Lionel A. Walford who devoted his life to bringing scientific management to marine recreational fisheries, and who was a guiding light for at least a generation of fishery scientists.

Literature Cited

Briggs, P. T. 1968. The sport fisheries for scup in the inshore waters of eastern Long Island. N.Y. Fish Game J. 15(2):165-185.

Buchanan, C. C., R. B. Stone, and R. O. Parker, Jr. 1974. Effects of artificial reefs on a marine sport fishery off South Carolina. Mar. Fish. Rev. 36(11):32-38.

Butler, R. J., and H. S. Spear. 1950. A survey of the sports fishery of the Middle Atlantic Bight in 1948. U.S. Dep. Int., Fish. Wildl. Serv., Spec. Sci. Rep. 7, 20 p.

Christensen, D. J., and W. J. Clifford. 1979a. Composition of catches made by anglers fishing for summer flounder, *Paralichtys dentatus*, from New Jersey party boats in 1978. Mar. Fish. Rev. 41(12):28-30.

_____ and _____. 1979b. Comparison of daytime and nighttime catches of bluefish, *Pomatomus saltatrix*, made on New Jersey party boats. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Northeast Fish. Cent., Sandy Hook Lab. Rep. SHL 79-04, 19 p.

Clark, J. R. 1962. The 1960 salt-water angling survey. U.S. Dep. Int., Bur. Sport Fish. Wildl., Circ. 153, 36 p.

Deuel, D. G. 1973. 1970 salt-water angling survey. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Fish. Stat. 6200, 54 p.

_____ and J. R. Clark. 1968. The 1965 salt-water angling survey. U.S. Dep. Int., Bur. Sport Fish. Wildl., Resour. Publ. 67, 51 p.

Finklestein, S. L. 1969. Age and growth of scup in the waters of eastern Long Island. N.Y. Fish Game J. 16:84-110.

Freeman, B. L., and L. A. Walford. 1974. Anglers' guide to the U.S. Atlantic Coast. Section III. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., 21 p.

Hathaway, J. C. (editor). 1972. Data file, continental margin program, Atlantic Coast of the U.S., Vol. 2. Woods Hole Oceanogr. Inst. Ref. 71-15, 496 p.

Long, D., and W. Figley. 1982. New Jersey's recreational and commercial ocean fishing grounds. N.J. Div. Fish, Game Wildl., Mar. Fish. Admin. Tech. Ser. 82-1, 38 p.

McHugh, J. L. 1972. Marine fisheries of New York State. Fish. Bull. (U.S.) 70(3):585-610.

_____ . 1977. Fisheries and fishery resources of New York Bight. U.S. Dep. Commer., NOAA Tech. Rep. NMFS CIRC. 401, 50 p.

Mayer, G. F. (editor). 1982. Ecological stress and the New York Bight: Science and management. Est. Res. Fed., Columbia, S.C., 715 p.

Pearson, J. C. 1972. The fish and fisheries of colonial North America, Part III. The Middle Atlantic States. NMFS Rep. COM-72-11150, NTIS, 138 p.

Redfield, A. C., and L. A. Walford. 1951. A study of the disposal of chemical waste at sea. Natl. Acad. Sci., Publ. 201, 49 p.

Smith, H. M. 1892. Economic and natural history notes on fishes of the northern coast of New Jersey. Bull. U.S. Fish. Commiss. XII:365-380.

Stone, R. B., C. C. Buchanan, and F. W. Steimle. 1974. Scrap tires as artificial reefs. U.S. Environ. Prot. Agency. Summ. Rep. SW-119, 33 p.

USDOC. 1984. Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979 (Revised)-1980. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Fish. Stat. 8322, 239 p.

_____ . 1985a. Marine Recreational Fishery Statistics, Atlantic and Gulf Coasts, 1981-1982. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Fish. Stat. 8324, 215 p.

_____ . 1985b. Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1983-1984. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Stat. 8326, 222 p.

Westman, J. R. 1938. The recreational fisheries. *In* A biological survey of the saltwaters of Long Island, 1938, p. 47-62. Part 1, Suppl. 28th Annu. Rep. 1938 (1939). State N.Y. Conserv. Dep.

_____ and W. C. Neville. 1942. The tuna fishery of Long Island, New York. N.Y. State Conserv. Dep., Bur. Mar. Fish. Rep., 31 p.

Younger, R. R., and P. E. Hamer. 1952. Inventory of New Jersey's salt water sport fishery. Fed. Aid Fish. Prog. Rep., F-2-R-1, 47 p.

_____ and J. A. Zamos. 1955. New Jersey's marine sport fishery, N.J. Dep. Conserv. Econ.Develop., Miscell. Rep. 16, 19 p.