A SURVEY OF THE 1978 SPRING RECREATIONAL FISHERY

FOR ATLANTIC MACKEREL, SCOMBER SCOMBRUS,

IN THE MIDDLE ATLANTIC REGION

by

Darryl J. Christensen and Walter J. Clifford

U. S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Sandy Hook Laboratory
Highlands, New Jersey   07732

Paul G. Scarlett

New Jersey Division of Fish, Game and Shellfisheries
Nacote Creek Research Station
Star Route
Absecon, New Jersey   08201

Ronal W. Smith

Delaware Division of Fish and Wildlife
Edward Tatnall Building
Dover, Delaware   19901

Donald Zacchea

New York State Department of Environmental Conservation

Division of Marine Resources
State University of New York
Stony Brook, New York   11794

INTRODUCTION

Atlantic mackerel (Scomber scombrus) seasonally migrate through the Middle Atlantic region usually appearing off Virginia in March with a gradual movement north until they move out of the area by mid-June. They spend the summer and early autumn north of Cape Cod only briefly returning to the coastal waters of the Middle Atlantic in late fall before leaving in late December or January. They are primarily available to recreational anglers during the spring migration as Christensen et al. (1976) found the autumn catch of mackerel in New Jersey in 1975 was less than 1% of the catch the following spring.

Recreational catches have declined from an estimated 32,081 metric tons (MT) in 1970 (Deuel, 1973) to 4,947 MT in 1976 (Christensen et al., 1976). The decline in recreational catch from 1970 to 1976 followed trends in the decline of the stock (Anderson et al., 1976). The stock has continued to decline to an estimated 517,000 MT at the beginning of 1978 and total commercial catches in 1978 are presently estimated at 23,200 MT (Anderson and Overholtz, 1978).

An estimate of total landings is necessary for assessment and management of the stock. This survey was initiated at the request of the Mid-Atlantic Fisheries Management Council to determine the 1978 recreational catch of Atlantic mackerel between Virginia and New York.

METHODS

Sampling Technique

A list of inlets, grouped into 5 regions including Delaware, southern New Jersey, northern New Jersey, coastal Long Island, and Long Island Sound (Figure 1), was prepared for the Middle Atlantic coastline. Inlets were randomly selected for weekly sampling from the list of inlets within the regions where mackerel were anticipated to be present. Boat counts were made at each inlet to determine the number of vessels sailing through the inlet, and interviews were conducted concurrently at associated marinas, docks, and launching ramps to determine the catch per vessel.

Inlet vessel counts were made of party-, charter-, and private-boats. Charter-boats are commercial sportfishing vessels which are usually reserved in advance by a group of fishermen for their exclusive use for a negotiated single fee. Party-boats (head-boats) are commercial sportfishing vessels filled on a first-come, first-served basis at an established fee per person. Party-boats were subdivided into full-day and half-day categories based on their daily activity schedules. Full-day party-boats make a single day trip of about 7-9 hours duration while half-day party-boats make a morning and afternoon trip each of which is usually 4-5 hours in duration. Private-boats are non-commercial sportfishing vessels. The term sportfishing does not exclude the passengers and/or crew from selling part or all of their catch.

Fishing Effort

NMFS and Delaware personnel counted boats either from 0500 to 1300 or from 1300 to 2000. Morning counts and afternoon counts were summed to determine daily counts. New Jersey personnel counted boats passing through inlets for entire days while New York personnel concentrated efforts obtaining interviews and did not make inlet counts.

Inlets in the survey area were grouped into three size classes (small, a; medium, b; large, c) according to the maximum expected numbers of each type of vessel using the inlet. The mean and variance of the number of vessels sailing daily through inlets in each class was determined separately for weekend days and weekdays as boat traffic was frequently much greater on weekends. The mean and variance for weekend days and weekdays were combined using the following formulae (Cochran, 1977):

$$\overline{s}_i = \frac{\overline{we}_i \, (10) + \overline{wd}_i \, (23)}{10 + 23}$$

where: $\overline{s}_i$ = estimated mean number of vessels sailing daily in inlet class i, where i = a, b, c

$\overline{we}_i$ = estimated mean number of vessels sailing daily on weekend days in inlet class i

$\overline{wd}_i$ = estimated mean number of vessels sailing daily on weekdays in inlet class i

10 = number of weekend days in season

23 = number of weekdays in season

and the estimated variance of $\overline{s}_i$ is:

$$\hat{v}\,(\overline{s}_i) = (\frac{10}{10 + 23})^2 \; \hat{v}\,(\overline{we}_i) + (\frac{23}{10 + 23})^2 \; \hat{v}\,(\overline{wd}_i)$$

where: $\hat{v}\,(\overline{s}_i)$ = estimated variance of mean number of vessels sailing daily in inlet class i

$\hat{v}\,(\overline{we}_i)$ = estimated variance of mean number of vessels sailing daily on weekend days in inlet class i

$\hat{v}\,(\overline{wd}_i)$ = estimated variance of mean number of vessels sailing daily on weekdays in inlet class i

and: 10 and 23 are constants as above

The mean, variance and confidence interval of the number of vessels of each type sailing daily in all inlet classes was determined by combining the means and variances according to the following formulae (Cochran, 1977):

$$\overline{s} = \frac{N_a \; \overline{s}_a + N_b \; \overline{s}_b + N_c \; \overline{s}_c}{N_a + N_b + N_c}$$

where: $\overline{s}$ = mean number of vessels sailing daily through all inlets where the vessel type occurs

N_a, N_b, N_c = number of inlets in inlet classes a, b, and c respectively

s_a, s_b, s_c = mean number of vessels sailing daily through inlet classes a, b, and c respectively

$$\hat{v}\,(\overline{s}) = (\frac{N_a}{N_a + N_b + N_c})^2 \; \hat{v}\,(\overline{s}_a) + (\frac{N_b}{N_a + N_b + N_c})^2 \; \hat{v}\,(\overline{s}_b) +$$

$$(\frac{N_c}{N_a + N_b + N_c})^2 \; \hat{v}\,(\overline{s}_c)$$

where: $\hat{v}\,(\bar{s})$ = estimated variance of $\bar{s}$

$\hat{v}\,(\bar{s}_a)$, $\hat{v}\,(\bar{s}_b)$, $\hat{v}\,(\bar{s}_c)$ = estimated variance of $\bar{s}_a$, $\bar{s}_b$, and $\bar{s}_c$ respectively

$$CI = \bar{s} \pm 1.96 \sqrt{\hat{v}\,(\bar{s})}$$

where: CI = 95% confidence interval about $\bar{s}$

In addition to determining the mean number of boats which sailed per day per inlet for each vessel type in the entire survey area, the mean sailing rates were also determined in the same manner for each of the 5 geographic sampling regions. As the sample sizes within regions were small the variances within regions were very high and generation of confidence intervals was not attempted.

Catch Rates

Interviews were made at dock sites, marinas, and launching ramps to determine vessel catches. The type of vessel, fishing location, interview site location, number of mackerel caught, and fork lengths of mackerel were recorded.

Inspection of the distribution of catch per vessel indicated a lognormal rather than a normal distribution. Therefore, the catch numbers were first converted to natural logs and then the means and variances were calculated for each vessel type over the entire survey area. The log mean and log variance for each vessel type was trans-formed, and the 95% confidence interval about the retransformed mean was calculated according to the following formulae (Aitchison and Brown, 1957):

$$\bar{c} = e^{\left(\bar{L} + 1/2 \left(\frac{n-1}{n}\right) \hat{v}(\bar{L})\right)}$$

where: $\bar{c}$ = mean catch per vessel

$\bar{L}$ = mean natural log of catch per vessel

$\hat{v}(\bar{L})$ = estimated variance of natural logs of catch per vessel

$$\hat{v}(\bar{c}) = \frac{(\bar{c})^2}{n} \{\hat{v}(\bar{L}) + 1/2 (\hat{v}(\bar{L}))^2\}$$

where: $\hat{v}(\bar{c})$ = estimated variance of catch per vessel

n = number of vessels interviewed

$$CI = \bar{c} \pm 1.96 \sqrt{\hat{v}(\bar{c})}$$

where: CI = 95% confidence interval about $\bar{c}$

In addition to determining the mean catches per vessel type for the entire survey area, the mean catches per vessel type within the 5 regions were estimated by dividing the total catch per vessel type by the number of vessels of each type interviewed. As the number of boats sampled within regions was small the variances of the mean catches were very high and no confidence intervals were calculated for the within region mean catches.

Estimated Total Catches

The mean catch per inlet per day, its variance, and 95% confidence intervals were calculated for each vessel type using the following formulae (Cochran, 1977):

$$\overline{sc} = \overline{s} \times \overline{c}$$

where: $\overline{sc}$ = mean catch per inlet per day

$\overline{s}$ = mean trips per inlet per day

$\overline{c}$ = mean catch per vessel

$$\hat{v}(\overline{sc}) = (\overline{s})^2 \hat{v}(\overline{c}) + (\overline{c})^2 \hat{v}(\overline{s}) + \hat{v}(\overline{c}) \hat{v}(\overline{s})$$

where: $\hat{v}(\overline{sc})$ = estimated variance of catch per inlet per day

$\hat{v}(\overline{s})$ = estimated variance of trips per inlet per day

$\hat{v}(\overline{c})$ = estimated variance of catch per vessel

$$CI = \overline{sc} \pm 1.96 \sqrt{\hat{v}(\overline{sc})}$$

where: CI = 95% confidence interval about $\overline{sc}$

The total estimated catch (TSC) per vessel type and the 95% confidence interval about the estimate was calculated as follows:

$$TSC = \overline{sc} \pm 1.96 \sqrt{\hat{v}(\overline{sc})} \times 33 \times NI$$

where: TSC = total estimated catch

NI = number of inlets where vessel type occurred

33 = number of days in fishing season

The total estimated catch and confidence interval for the total survey area and all vessel types was determined by summing the estimated catches and confidence intervals of all 4 vessel types.

Estimated total catches per vessel type within the 5 regions were calculated using the following formula:

TC = MDIC x MCV x NIR x NDF

where: TC   = total catch by vessel type within a region

MDIC = mean daily inlet count per vessel type within a region

MCV = mean daily catch per vessel type within a region

NIR = number of inlets in a region

NDF = number of days in fishing season

No confidence intervals were calculated for the within region estimated catches due to the high variances of mean trips per inlet and mean catch per vessel.

Lengths and Weights of Catches

Atlantic mackerel were measured to the nearest cm fork length to determine the length frequencies of the catch. Each length was converted to a weight using the formula $\log_{10}$ weight = -5.2314 + 3.0796 $\log_{10}$ length (Wilk et al., 1978), and a mean weight was calculated for all vessel types. The mean weight was multiplied by the total estimated number caught to determine the total weight of the catch.

RESULTS AND DISCUSSION

The inlets surveyed, date ranges of mackerel seasons, and number of days in the season within the 5 coastal sampling regions of the

Middle Atlantic coast are presented in Table I. The date ranges listed are based on conversations with party- and charter-boat captains, marina owners, fishing reports in the press, and by direct observations of NMFS and state personnel. The actual date range at a particular inlet may have varied by several days from the range listed for the region in which the inlet was assigned. The mean number of weekend days and weekdays in the fishing season for all inlets surveyed was 10 and 23, respectively.

The mean number of trips per inlet per day, mean number of Atlantic mackerel caught per vessel trip, and 95% confidence intervals around the means for each vessel type are presented in Table II. The mean catch per inlet per day, number of inlets where each vessel type was present, total estimated catch, and 95% confidence intervals about the mean and total catch for each vessel type is presented in Table III. The total estimated number of mackerel caught in the survey area is 6,792,255 ± 3,300,726.

Estimates of effort and catch were also made for each vessel type within the 5 geographic sampling regions. These estimates are presented only to illustrate relative catches by vessel types within geographic regions as the variances of inlet counts and vessel catches within regions were very high. Because the variances were high no confidence limits were calculated for the within region estimates. The mean regional trips per inlet per day and estimated trips made, the mean regional catch by vessel type, and the estimated regional total numbers caught by vessel types are presented in Tables IV, V, and VI. The estimates indicate

that except for coastal Delaware and Long Island Sound, full-day party-boats accounted for 70% of the catch. Charter-boats and private-boats accounted for 94% of the Delaware coastal catch and private-boats accounted for 96% of the Long Island Sound catch. The sum of the within regional estimates was 6,863,019 fish which was slightly higher than the overall estimate of 6,792,255. However, the within region sum lies well within the 95% confidence intervals for the overall estimate and the difference is due to determining means of inlet counts and vessel catches using different groupings of the same data.

The length frequency of the entire sample of mackerel measured during the survey is presented in Figure 2. The mean length was 37.9 cm and the calculated mean weight was 515 g per fish. The total estimated weight caught was 3,498 ± 1,700 MT. Age samples were taken and the age composition of the catch is currently being determined.

The survey was initiated after mackerel had already progressed north into waters off Delaware and southern New Jersey. Therefore, it was too late to survey catches in the southern portion of the Middle Atlantic region. Maryland has a single inlet at Ocean City with a few party-boats, a modest number of charter-boats, and facilities for private-boats. Virginia has several locations such as Chincoteague, Wachapreage, and Quinby along the coast of the Delmarva Peninsula where some charter- and private-boats have ocean access, and 2 inlets (Rudee and Lynnhaven) near the mouth of Chesapeake Bay where a few party-boats

and a number of charter- and private-boats have ocean access to fish for mackerel. The Delaware catch made from 2 inlets was approximately 8% of the Delaware and New Jersey total (Table VI). Assuming similar levels of effort and catch at the 6 inlets in Maryland and Virginia then the Maryland and Virginia catches were approximately 25% of the New Jersey and Delaware total. The combined catch within the Delaware and New Jersey regions (Table VI) was approximately 34% of the catch (3,498 MT) of the three-state area surveyed or 1,189 MT. Thus, the total estimated catch for Virginia-New Jersey was 125% of 1,189 MT or 1,486 MT.

The number of party- and charter-boats in New York was found to be approximately equal to the combined fleets in Connecticut-Maine (Fraser et al., 1977). Assuming similar levels of mackerel catch by commercial sportfishing vessels and private vessels in Connecticut-Maine, then New York catches accounted for 50% of the North Atlantic regional catch (New York-Maine) (Deuel, 1973). The New York portion of the three-state catch was approximately 66% (Table VI) or 2,309 MT of the 3,498 MT total catch. Therefore, the Connecticut-Maine catch was assumed to also be 2,309 MT, giving a New York-Maine total of 4,617 MT.

The total recreational catch of Atlantic mackerel taken by boat in the Virginia-Maine area was estimated to be 6,103 MT with a 95% confidence interval of ±50% of which 3,795 MT was caught in the New York-Virginia area.

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ACKNOWLEDGMENTS

Table I. Inlets and major access sites surveyed, approximate date ranges and numbers of days Atlantic mackerel were present in five sampling regions along the Middle Atlantic coast.

Region	Inlets Included in Region	Date Range of Season	Number of Days Atlantic Mackerel Were Present	
			Weekdays	
- Delaware	Indian River Roosevelt	April 4 to May 8	25	10
I - Southern New Jersey	Cape May Hereford Townsend Corson Great Egg Absecon Beach Haven	April 8 to May 12	25	10
II - Northern New Jersey	Barnegat Manasquan Shark River Sandy Hook	April 18 to May 4 *15* *14*	20	10
/ - South Shore Long Island	Rockaway East Rockaway Jones Fire Island Shinnecock Montauk	April 29 to May 28	20	10
- North Shore Long Island	Greenport Mattituck Mt. Sinai Port Jefferson Stony Brook Nissequogue Northport Huntington Oyster Bay Hempstead Manhasset Bay Little Neck Bay City Island	May 5 to June 8	25	10

Table II. Mean trips per inlet per day, mean catch per vessel trip, and 95%
confidence intervals for each vessel type in the entire survey
area.

Vessel type	Mean trips per inlet per day	95% confidence interval	Mean catch per vessel trip	95% confidence interval
Full-day party-boats	3.87	±1.37	1425	±542
Half-day party-boats	3.92	±1.75	352	±154
Charter-boats	2.82	±1.11	346	±106
Private-boats	56.41	±7.25	45	± 8

Table III. Mean catch per inlet per day, with 95% confidence interval, number of inlets where vessel types occurred, and total estimated catch with 95% confidence interval.

Vessel type	Mean catch per inlet per day	95% confidence interval	Number of inlets where vessel type occurred	Total estimate catch	95% confidence interval
Full-day party-boats	5515	±3673	19	3,457,905	±2,302,971
Half-day party-boats	1380	± 604	8	364,320	± 159,456
Charter-boats	976	± 483	9	289,872	± 143,451
Private-boats	2538	± 658	32	2,680,128	± 694,848
Total				6,792,225	±3,300,726

Table IV. Mean daily vessel sailing rates and total estimated trips made during the Atlantic mackerel season by vessel type and day class for five sampling regions along the Middle Atlantic coast.

Region	Vessel Type	Regional Mean Daily Sailing Rates		Regional Estimated Total Trips in Season		
		Weekend	Weekday	Weekend	Weekday	Total
I	Party	.75	.38	8	9	17
	Charter	13.50	4.88	135	122	257
	Private	75.00	4.50	750	113	863
II	Party	25.97	9.80	260	245	505
	½-Day Party	24.78	1/	248	1/	248
	Charter	7.98	1/	80	1/	80
	Private	664.51	146.09	6,645	3,652	10,297
III	Party	24.00	11.20	240	224	464
	½-Day Party	28.00	14.80	280	296	576
	Charter	16.00	2.68	160	54	214
	Private	446.80	33.20	4,468	664	5,132
IV	Party	51.60	43.80	516	876	1,392
	½-Day Party	30.00	1/	300	1/	300
	Charter	1.98	1/	20	1/	20
	Private	238.80	338.40	2,388	6,768	9,156
V	Party	21.19	8.71	212	218	430
	Charter	1/	2.21	1/	55	55
	Private	2,815.80	780.00	28,158	19,500	47,658

1/ No trips observed by vessels of this type in this region and day class.

Table V. Mean daily catch of Atlantic mackerel per vessel trip by vessel
         type and region.

| | Mean Daily Catch Per Vessel Trip | | | |
Region	Full-Day Party-Boats	Half-Day Party-Boats	Charter Boats	Private Boats
I	685	1/	313	104
II	1,322	201	250	34
III	1,079	311	455	53
IV	1,693	488	207	35
V	155	1/	156	34

1/ No vessels of this type encountered in this region.

ble VI. Estimated total number of Atlantic mackerel caught by vessel type
and region.

| gion | Estimated Number Caught | | | | |
	Full-Day Party-Boats	Half-Day Party-Boats	Charter-Boats	Private-Boats	Regional Total
I	11,560	1/	80,402	89,700	181,662
II	667,213	49,808	19,950	350,110	1,087,081
II	500,656	179,136	97,188	271,996	1,048,976
IV	2,356,656	164,400	8,197	320,460	2,849,713
V	66,596	1/	8,619	1,620,372	1,695,587
ssel pe tals	3,602,681	393,344	214,356	2,652,638	6,863,019

No vessels of this type encountered in this region.

Figure 1. Location of regions along the middle Atlantic coast which were surveyed for recreational catch of Atlantic mackerel (Scomber scombrus).

Figure 2. Length frequency of a sample of 2,778 Atlantic mackerel caught by recreational anglers along the middle Atlantic coast.