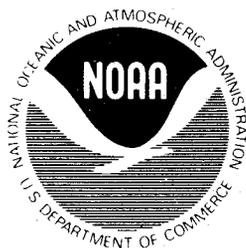


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BIOLOGICAL DATA ON PELAGIC FISHES SAMPLED FROM NORTH CAROLINA CHARTER BOAT LANDINGS, 1978

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ABSTRACT

Pelagic fishes landed by the North Carolina charter boat fleet were sampled from May through November 1978 to gather size, age, reproductive, and dietary information. Approximately 3,900 fish representing 15 species in the families: Pomatomidae, Coryphaenidae, Sphyraenidae, Scombridae, and Istiophoridae were examined. The most frequently encountered species were dolphin Coryphaena hippurus, bluefish, Pomatomus saltatrix, king mackerel, Scomberomorus cavalla, wahoo, Acanthocybium solanderi, yellowfin tuna, Thunnus albacares and blackfin tuna, Thunnus atlanticus. Monthly data are presented here on mean sizes, length frequency distributions, sex ratios, stages of sexual maturity, total length-fork length, and length-weight relationships for most species except billfish. For the billfishes (sailfish, Istiophorus platypterus, blue marlin, Makaira nigricans and white marlin, Tetrapturus albidus) we provide mean weights and weight frequency distributions.

Length and seasonal distributions indicate that at least two stocks of bluefish may occur in the State's coastal waters. The collection of reproductively active female bluefish, king mackerel, dolphin, wahoo, blackfin tuna, little tunny, Euthynnus alletteratus, albacore, Thunnus alalunga, and Atlantic bonito, Sarda sarda suggest these species spawn off North Carolina.

In addition to the above species, bluefin tuna, Thunnus thynnus, skipjack tuna, Euthynnus pelamis, and barracuda, Sphyraena barracuda were sampled infrequently. Mean size and notes on female gonad condition are included for each of these species.

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INTRODUCTION

In 1976, personnel at the Beaufort Laboratory, SEFC, NMFS began a study of the coastal pelagic fishes along the southeastern United States. One of the initial phases of the research was to sample the North Carolina charter boat fleet to gather catch and effort information and also biological data from fish landed. Two reports pertaining to catch and effort have been completed (Manooch and Laws 1979; Manooch and Ross in prep.) and here we present biological data; mean sizes, length frequency distributions, sex ratios, and stages of sexual maturity for the major species sampled in 1978. Materials such as digestive tracts, gonads, and aging structures have been shipped to the Panama City Laboratory, SEFC, NMFS to be analyzed by members of the Bioprofiles Task under the direction of E.L. Nakamura.

There are approximately 134 charter boats operating out of 13 North Carolina ports from Oregon Inlet in the northern part of the State to Shallotte near the South Carolina border (Figure 1). These vessels combined make thousands of trips annually from April through November to catch a variety of fishes. Boats may troll in nearshore waters for coastal pelagic fishes (bluefish, Pomatomus saltatrix, mackerels, Scomberomorus), troll offshore for oceanic pelagic species (dolphin, Coryphaena hippurus, wahoo, Acanthocybium solanderi, tunas, Thunnus, and billfishes, Istiophorus, Makaira, and Tetrapturus), bottomfish offshore for reef fish (snappers, Lutjanus and Rhomboplites, groupers, Mycteroperca and Epinephelus, porgies, Calamus and Pagrus), or bottomfish in estuaries for sciaenids (spot, Leiostomus xanthurus, Atlantic croaker, Micropogon undulatus, sea trouts, Cynoscion) and flounder, Paralichthys. The majority of the boats seek the pelagics, the trophy gamefish that are seasonal visitors to the Continental Shelf waters off North Carolina.

METHODS

Three port samplers, each responsible for a specific geographical section of the State, met the charter boats at the docks late in the afternoon as they returned from fishing. Total length, fork length, weight, sex, and sexual maturity stage for females were recorded for all species except billfish which were only weighed. Gonads, digestive tracts, scales, and otoliths were removed from some individuals and stored for future analysis. All species sampled are listed in Table 1.

After the sex was determined, females were classified according to the developmental stage of the ovaries in the following manner: Stage I-immature; Stage II - resting; Stage III - developing; Stage IV - ripe or spawning; and Stage V - spent or spawned. Immature fish were those considered incapable of spawning during the calendar year. For a more detailed description of the staging criteria see Manooch (1976).

Predictive equations for lengths and length-weight were derived by least squares regression facilitated by a stratified subsampling of lengths from a listing of all fish lengths per species. We did this to reduce the bias inferred by a clustering of fish lengths around a relatively narrow size range.

Data are presented monthly for each species where we consider sample size adequate for such a treatment. Species are grouped under coastal pelagic and oceanic pelagic headings for discussion.

RESULTS

Coastal Pelagics

The coastal pelagic fish caught by charter boats are large predators that roam the nearshore waters. These fish appear seasonally, and schools occur intertidal to the shelf break, and therefore are generally shoreward of the oceanic pelagic species.

Bluefish, Pomatomus saltatrix.

Sample size N=617

Bluefish was one of the most interesting species studied. Based on our seasonal size distribution data and preliminary electrophoretic analyses conducted at the Duke University Marine Laboratory (Bolling Sullivan, pers. com.), there could be a least two populations of bluefish frequenting the North Carolina coast. One, consisting of very large individuals of 10-20 pounds (4.5-9.0 kg) occurs in the spring and fall, and the other, of much smaller fish (0.5-1.5 pounds, 0.2-0.7 kg) is present during the summer and early fall.

Other than length-length and length-weight predictive equations, data on bluefish will not be presented here since the Panama City Laboratory is preparing a more comprehensive report on bluefish, region wide. However, anyone wishing to obtain a copy of our tabular data on monthly mean sizes, length frequency distributions, sex ratios, and monthly stage of sexual maturity may do so by writing the Beaufort Laboratory.

The predictive equation for converting length is $FL = -3.844 + 0.897TL$, $N=110$ and $r=0.999$. The length-weight relationship is $W = 0.0000178 TL^{2.848}$, $N=110$ and $r=0.996$ where W =weight in grams, and TL =total length in millimeters.

King mackerel, Scomberomorus cavalla.

N=576

This species is primarily a spring and fall visitor to North Carolina's coastal waters although a few are caught offshore in the Gulf Stream throughout the charter boat fishing season. Research fishing suggests they occur offshore all year. Monthly sampling generally reflected the seasonal abundance except in May when fewer fish were examined relative to the landings.

Other than length-length and length-weight predictive equations, data on king mackerel will not be presented here since

the Panama City Laboratory is preparing a more comprehensive report on king mackerel, regionwide. However, anyone wishing to obtain a copy of our tabular data on monthly mean sizes, length frequency distributions sex ratios, and monthly stage of sexual maturity may do so by writing the Beaufort Laboratory.

The equation describing total length-fork length conversion is $FL = -20.702 + 0.933 TL$, $N=74$, and $r=0.989$. The length-weight relationship is $W = 0.0000732 TL^{2.634}$, $N=73$, $r=0.940$ where W =weight in grams, and TL =total length in millimeters.

Little tunny, Euthynnus alletteratus.

N=102

The little tunny, known locally as "false albacore" and "striped ape" is viewed with disdain by most captains, mates, and fishermen. The fighting qualities, which can be superb, are generally overlooked, and the dark colored flesh is discarded or used as bait particularly by Oregon Inlet boats to chum for dolphin.

It is caught throughout the fishing season, but is most common in the fall. Little tunny are frequently landed by boats fishing for large bluefish around shoal waters in October and November.

The average fish sampled was 684.5 mm TL, 639.8 mm FL, and weighed 8.9 pounds (4.0 kg) (Table 2). There was not much difference in size monthly, although sample sizes for all months except October were very small. Males appear slightly larger than females (Table 3).

Females and males were encountered about equally, 51.2 and 48.8%. Ripe females were noted in June and July and spent fish in October and November (Table 4).

The equation predicting length is $FL = 16.385 + 0.908 TL$, $N=80$, $r=0.977$. The length-weight equation is $W = 0.000137 TL^{2.629}$, $N=71$, $r=0.954$.

Atlantic bonito, Sarda sarda.

N=109

The Atlantic bonito was not a very common fish in the landings any time during the year. The fact that fishermen were not particularly fond of it, and often confused it with other small scombrids complicated the situation for the port samplers. Fish were occasionally thrown overboard at sea, and those that made it to the dock often did so under another name or were not reported at all. This rather nonchalant treatment is unwarranted, for as is true with little tunny, Atlantic bonito are game fighters and the meat makes excellent tuna salad if prepared properly.

Atlantic bonito typically ranged from 475 to 600 mm TL and the average fish sampled was 548.2 mm TL, 507.1 mm FL, and weighed 5.6 pounds, 2.5 kg (Table 5). Monthly mean size fluctuated very little. In fact, the largest standard deviation in total length for any month was 66.1 mm in July. Both sexes were approximately the same size, although the smallest fish sampled were males (Table 6).

Ripe females were observed in May and June and spent fish were sampled in June, July, August, and September. More females were sampled than males, 61.2 to 38.8% (Table 7).

The equation converting total length to fork length is $FL = 92.057 + 0.757 TL$, $N=108$, $r=0.919$. The length-weight relationship is described by the equation $W = 0.00000899 TL^{3.086}$, $N=20$, and $r=0.936$.

Oceanic pelagics

The inclusion of some of the following species as oceanic pelagics will probably raise a question about what is and what is not an oceanic pelagic fish. We are referring to those pelagic fish that are normally caught offshore, near or in the Gulf Stream. Fishermen call these fish "blue water" species. Like the coastal pelagics they are highly migratory and appear in the catches seasonally.

Dolphin, Coryphaena hippurus.

N=1,296

Dolphin were by far the most frequently sampled fish. Catches were better in 1978 than the previous year and fishermen commented that dolphin were available for a longer period of time, not for just a couple of months as is usual. Sample sizes were large in June (344), July (484), August (226), and September (191).

Fish averaged 749.2 mm TL, 624.9 mm FL, and 5.8 pounds (2.6 kg) (Table 8.) The average weights in May, June, and October were much greater than those in the summer. The small dolphin, known to the fishermen as "shingles", were probably young-of-year (Beardsley 1967; Rose and Hassler 1968). In fact, 73% of the fish we sampled were less than 800 mm TL (Table 9), well under the mean fork length for age-I described by Rose and Hassler (1968) for dolphin collected off North Carolina. Males were larger than females. Sixty percent of the individuals over 1,200 mm TL were males, and 89% of those 1,350 mm TL or longer were males.

Females were sampled more frequently than males, 69.1% to 30.9%. This predominance of females was evident in all months except May when the sexes were about equally frequent (Table 10). Ripe females were noted in May (80%), June (49.5%), July (15.6%), August (5.0%), and September (4.3%). Spent or spawned females were observed in all months except May.

The equation converting total length to fork length is $FL = 7.543 + 0.823TL$, $N=83$, $r=0.997$. The length-weight relationship is described by the equation $W = 0.0000416TL^{2.693}$, $N=84$, $r=0.988$.

Our data show that the average size of dolphin landed by the charter boat fleet may have decreased drastically since the mid-late sixties (Rose and Hassler 1968). This is a subject which needs investigating.

Wahoo, Acanthocybium solanderi.

N=338

Hogarth (1976) in his doctoral dissertation, accurately described the wahoo as a highly regarded sport fish throughout its range. He added that along the coast of North Carolina it has been an important part of the sport catch since 1964. Indeed, we found some charter boat captains fish specifically for wahoo and rate it as the finest pelagic fish caught off the State.

We sampled wahoo each month from May through October, but the largest samples were obtained in August (105), and September (109). The average fish was 1,022 mm TL, 974 mm FL, and weighed 17.8 pounds (8.1 kg) (Table 11). Fish were somewhat larger in May and June but samples were small for these two months. Two distinct size modes were evident in length frequency distribution, one at 450-650 mm TL, and the other at 1,100 to 1,400 mm TL. According to length at age data (Hogarth 1976) the first group would be young-of-year, and the second consists of fish of ages, I, II, and III. Females were generally larger than males. Ninety-one percent of the individuals 1,400 mm TL and larger were females (Table 12).

Females were more numerous than males (74.3% to 25.7%) for the season, and for each month. Ripe females occurred in July, August, and September and spent fish were found in August and September (Table 13). Hogarth (1976) found 77.6% of the fish landed by charter boats at Hatteras and Oregon Inlet were females, and that spawning occurred off North Carolina in July and August.

The equation converting total length to fork length is $FL = -1.132 + 0.959 TL$, $N=78$, and $r=0.999$. The length-weight relationship is described by the equation $W = 0.000227TL^{2.484}$, $N=50$, $r=0.991$.

Yellowfin tuna, Thunnus albacares.

N=300

The yellowfin tuna is a prized catch, and like most of the other oceanic pelagic species it is caught more commonly in the northern part of the State, near Hatteras and Oregon Inlets. We suspect that many of the tuna are caught while boats troll for billfish, although some boats fish specifically for them.

The average yellowfin tuna was 940 mm TL, 839 mm FL, and weighed 26.1 pounds (11.8 kg) (Table 14). Many fish in the 30-40 pound class were landed as were some weighing 50-70 pounds. The mean fish weight was greater in May, June, and July than for the other three months.

Two distinct size modes were evident, one at 400-500 mm TL and the other at 1,000-1,200 mm TL (Table 15). The smaller fish were more abundant in August, September, and October. We assume these fish to be young-of-year. Many large fish, 50-65 pounds (22.7-29.5 kg), were observed in fall landings, disproportionately to the small number sampled. There was no apparent sex related size difference although sex could not be determined at dockside for most of the smaller individuals.

The sexes were about equally frequent, 54.4% females and 45.6% males although males were more common in four of the six months (Table 16). As mentioned above there were many fish which were not sexed. In fact the unknown sex category had more individuals than either of the two sexed categories.

One spent fish was noted in July. Most of the females staged had gonads in a resting condition. This was also noted for yellowfin collected off Brazil (Zavala-Camin, Instituto de Pesca, Santos, Brasil, pers. com.).

The total length to fork length predictive equation is $FL = 0.313 + 0.875TL$, $N=74$, $r=0.983$. The length-weight relationship is $W = 0.000451 TL^{2.480}$, $N=66$, $r=0.950$.

Blackfin tuna, Thunnus atlanticus.

N=235

Like the yellowfin, the blackfin tuna is highly regarded as a sport fish and it also has white, flaky meat. The species is generally caught offshore, by trolling rapidly.

Excellent catches were made in 1978, and we were able to obtain large samples from each month except November. Fish averaged 627 mm TL, 561 mm FL and 8.2 pounds (3.7kg). Those in May were much larger, and those in August, smaller than the average (Table 17). Most of the fish sampled were 450-700 mm TL (Table 18). The largest fish examined were females.

Females were more abundant than males for all months except May. Female fish in a spawning condition were observed in June, August, and September. Spent fish were noted in 5 of the 7 months (Table 19).

The predictive equation for fork length is $FL = 53.337 + 0.814 TL$, $N = 71$ and $r = 0.988$. The length and weight relationship is $W = 0.00000765TL^{3.113}$, $N = 73$, $r = 0.997$.

Billfishes.

N=331

Three species of billfish, blue marlin, Makaira nigricans white marlin, Tetrapturus albidus, and sailfish, Istiophorus platypterus are included in this report. Mean weights and weight frequency distributions are presented monthly for each species.

Probably more billfish have been caught off North Carolina during recent years than has been published in landing statistics. At least 3,900 (including released fish) were caught in 1978 by North Carolina charter boats alone (Manooch and Ross, in prep.). Our observations indicate that at least 80% of the billfish catch in North Carolina is made by Hatteras and Oregon Inlet boats, and that probably 70% of these are released. Also, North Carolina tournament landings, the basis for most reports, represent a very small fraction (probably <10%) of the total billfish caught in the State. Most tournaments are held during the early to midsummer primarily to catch blue marlin. While these tournaments rely on larger fish, they are generally too early to reflect the availability of white marlin

and the relatively high catch rate associated with this species.

The white marlin is by far the most frequently caught billfish. Weights for 160 fish averaged 48.3 pounds, 21.9kg, with very little variation in mean weight between months. Monthly sample sizes are not proportional to the catches. Individual weights ranged from 20 to 81 pounds (9.1-36.8kg). Forty-three percent of all white marlin sampled were between 41 and 50 pounds (Table 20).

Because of its large size, the blue marlin is the most prized of the three billfishes. The average weight for 138 blue marlin was 239.3 pounds, 108.6 kg. Individuals varied from 50 to 592 pounds, 22.7-268.8 kg, and 59% were 100-300 pounds. The large fish were caught in May, June and July. Fishermen were surprised at the relatively large number of small fish in 1978. We sampled 16 fish less than 100 pounds (Table 21).

Only thirty-three sailfish were weighed, most in July. Sailfish averaged 38.8 pounds (17.6 kg) and ranged in weight from 20 to 75 pounds, 9.0-34.0 kg. Approximately 61% of the fish were in the 30-40 pound class (Table 22).

Infrequently Sampled Species

Four species, albacore, Thunnus alalunga, skipjack tuna, Euthynnus pelamis, bluefin tuna, Thunnus thynnus and barracuda, Sphyraena barracuda, were sampled infrequently (Tables 23,24). They are included merely to indicate their presence in our samples and also to present a few notes for each.

Albacore were sampled in September. Twelve individuals averaged 661 mm TL, 603 mm FL, and 8.1 pounds (3.7 kg). Of the fish sexed, six were males and five females. A ripe and a spent female were observed.

Skipjack tuna were collected in July. Six fish averaged 503 mm TL, 473 mm FL and 4.5 pounds (2.0 kg). The sexes were about equally divided. Two fish were immature, and one female had ovaries stage II, resting.

Two bluefin tuna were sampled. These fish were school tuna caught in June off Oregon Inlet. They averaged 985 mm TL and 35 pounds (15.9 kg).

Fifteen barracuda caught in July and August are referred to in Tables 23 and 24. The mean size was 1,021 mm TL, 946 mm FL, and 13 pounds (5.9 kg). Five of those sexed were females (71.4%), and each had ovaries in a resting condition.

AUTHORS' COMMENTS

We hope the data presented in this report will be useful to those of you who have gotten this far, actually transcended the tables and rows and columns of numbers. Our major objective in writing this report was to make the data available because the sampling program for the North Carolina charter boat fleet has not been refunded. Perhaps at a later time someone will resume this, or a similar study, and our data will be beneficial to them.

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Figure

1. North Carolina charter boat ports.

Tables

1. List of species included in this study; number sampled and number landed by North Carolina charter boats, 1978.
2. Mean size of little tunny sampled from North Carolina charter boats in 1978, monthly.
3. Length frequency distribution of little tunny sampled from North Carolina charter boats in October and November, 1978.
4. Sex ratios and stage of sexual maturity for little tunny, monthly.
5. Mean size of Atlantic bonito sampled from North Carolina charter boats in 1978, monthly.
6. Length frequency distribution of Atlantic bonito sampled from North Carolina charter boats in 1978, monthly.
7. Sex ratios and stage of sexual maturity for Atlantic bonito, monthly.
8. Mean size of dolphin sampled from the North Carolina charter boat fleet in 1978, monthly.
9. Length frequency distribution of dolphin sampled from North Carolina charter boats in 1978, monthly.
10. Sex ratios and stage of sexual maturity for dolphin, monthly.
11. Mean size of wahoo sampled from North Carolina charter boats in 1978, monthly.
12. Length frequency distribution for wahoo sampled from North Carolina charter boats in 1978, monthly.
13. Sex ratios and stage of sexual maturity for wahoo, monthly.
14. Mean size of yellowfin tuna sampled from North Carolina charter boats in 1978, monthly.
15. Length frequency distribution of yellowfin tuna sampled from North Carolina charter boats in 1978, monthly.
16. Sex ratios and stage of sexual maturity for yellowfin tuna, monthly.
17. Mean size of blackfin tuna sampled from North Carolina charter boats in 1978, monthly.

18. Length frequency distribution for blackfin tuna sampled from North Carolina charter boats in 1978, monthly.
19. Sex ratios and stage of sexual maturity for blackfin tuna, monthly.
20. Mean weight and frequency distribution of weight classes for white marlin sampled from the North Carolina charter boat landings, 1978, monthly.
21. Mean weight and frequency distribution of weight classes for blue marlin sampled from the North Carolina charter boat landings, 1978, monthly.
22. Mean weight and frequency distribution of weight classes for sailfish sampled from North Carolina charter boat landings, 1978, monthly.
23. Mean size of several species which were sampled infrequently from North Carolina charter boats.
24. Sex ratios and sexual maturity for several species of fish sampled infrequently.

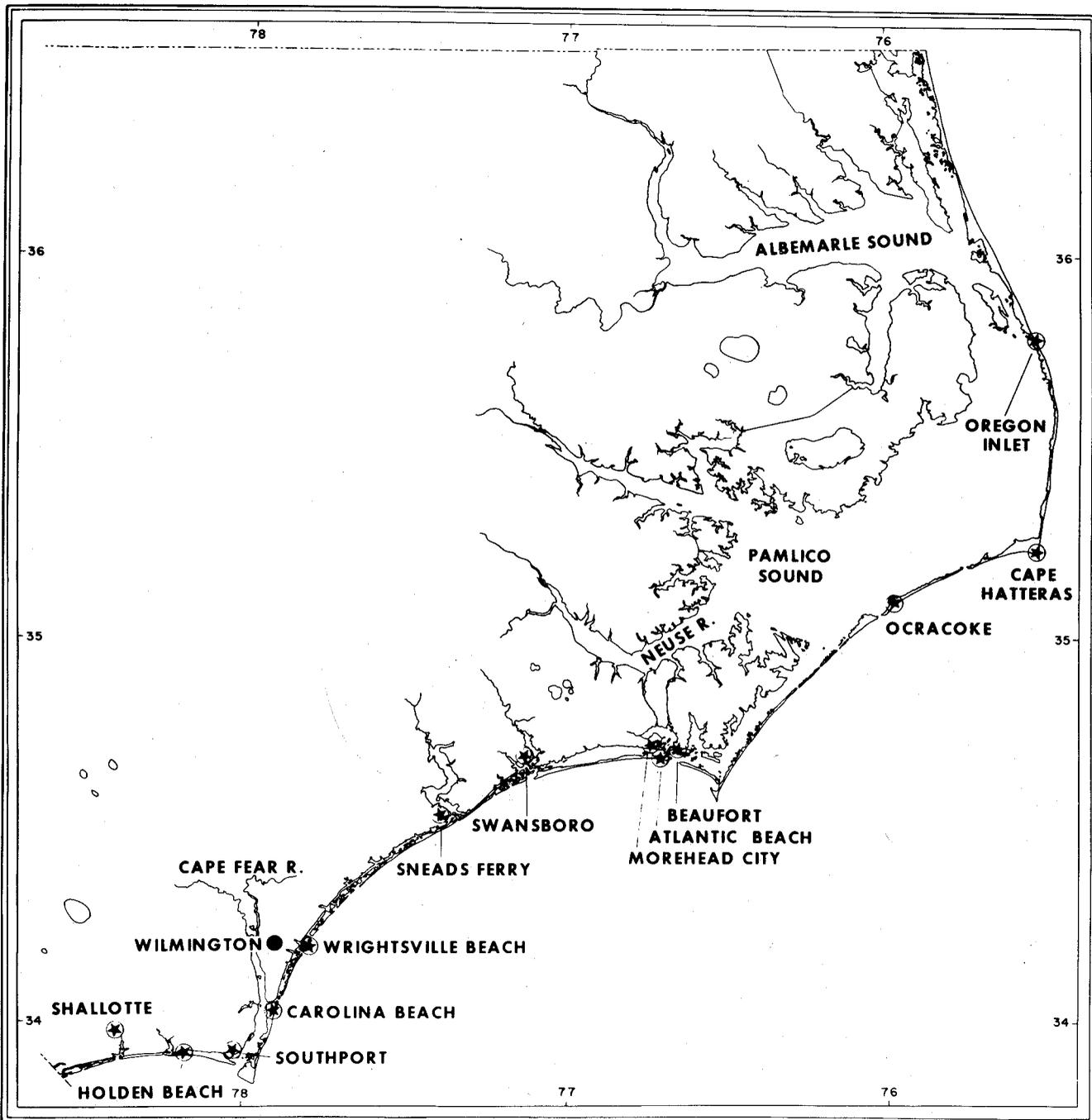


Table 1. List of species included in this study, number sampled, and number landed (from Manooch and Ross, in prep.) by North Carolina charter boats, 1978.

<u>Species</u>	<u>Number caught, 1978</u>	<u>Number sampled</u>
Bluefish, <u>Pomatomus saltatrix</u>	79,745	617
Dolphin, <u>Coryphaena hippurus</u>	52,480	1,296
Great barracuda, <u>Sphyræna barracuda</u>	732	15
Wahoo, <u>Acanthocybium solanderi</u>	2,707	338
Little tunny, <u>Euthynnus alletteratus</u>	4,726	102
Skipjack tuna, <u>Euthynnus pelamis</u>	1,103	6
Atlantic bonito, <u>Sarda sarda</u>	2,702	109
King mackerel <u>Scomberomorus cavalla</u>	49,311	576
Albacore, <u>Thunnus alalunga</u>	14	12
Yellowfin tuna, <u>Thunnus albacares</u>	4,197	300
Blackfin tuna, <u>Thunnus atlanticus</u>	3,934	235
Bluefin tuna, <u>Thunnus thynnus</u>	33	2
Sailfish, <u>Istiophorus platypterus</u>	444	33
Blue marlin, <u>Makaira nigricans</u>	358	138
White marlin, <u>Tetrapturus albidus</u>	3,137	160
Total	205,623	3,939

Table 2. Mean size of little tunny sampled from North Carolina charter boats in 1978, monthly.

Month	N	Σ TL	σ TL	\bar{X} TL	Σ FL	σ FL	\bar{X} FL	Σ wt, lb	owt	\bar{X} wt (gm)
May	1	756	0.0	756	718	0.0	718.0	14.2	0.0	14.2 (6,441)
June	2	1,440	21.2	720.0	1,359	21.9	679.5	-	-	-
July	3	2,032	110.6	677.3	1,902	108.9	634.0	23.4	4.9	7.8 (3,538)
August	1	732	0.0	732.0	686	0.0	686.0	11.0	0.0	11.0 (4,990)
September	-	-	-	-	-	-	-	-	-	-
October	80	54,485	65.4	681.1	50,914	59.1	636.4	696.0	2.1	8.7 (3,946)
November	15	10,373	24.1	691.5	9,676	25.3	645.1	140.5	1.2	9.4 (4,264)
Total	102	69,818			65,255		885.1 (N=100)			
Weighted mean				684.5			639.8			8.9 (4,037)

Table 3. Length frequency distribution of little tunny sampled from North Carolina charter boats in October and November, 1978.

Length, mm	October			November			Total		
	U	M	F	U	M	F	U	M	F
	Total			Total			Total		
300-324									
325-349		1							1
350-374			1						1
375-399									
400-424									
425-449									
450-474									
475-499	1						1		
500-524		1							1
525-549									
550-574									
575-599									
600-624									
625-649	2								1
650-674	6	8					2		7
675-699	5	11					6	11	10
700-724	1	2					5	14	8
725-749	2	2					1	2	6
750-774	1	4					2	3	1
775-799		4					1	4	2
800-824									
825-849									
850-874									
875-899									
900-924									
Total									

95

15

80

Table 4. Sex ratios and stage of sexual maturity for little tunny, monthly.

Month	Sex			Total	I ^{3/}	Sexual maturity (female)					Total	
	M	F	Unknown ^{3/}			II	III	IV	V			
May	1(100.0)			1								
June		2(100.0)		2			2(100.0)					2
July	1(33.3)	2(66.7)		3			2(100.0)					2
August	1(100.0)			1								
September												
October	31(50.0)	31(50.0)	18	80			15(48.4)			16(51.6)		31
November	7(46.7)	8(53.3)		15			6(75.0)			2(25.0)		8
Total	41(48.8)	43(51.2)										

^{3/} Not included in percentage calculations.

Table 5. Mean size of Atlantic bonito sampled from North Carolina charter boats in 1978, monthly.

Month	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt., lb$	$\sigma wt.$	$\bar{X} wt (gm)$
May	5	3,055	20.6	611.0	2,834	20.7	556.8	29.5	0.8	5.9 (2,676)
June	16	8,192	51.2	512.0	7,529	50.7	470.6	62.6	2.1	3.9 (1,769)
July	26	15,134	66.1	582.1	13,626	38.1	524.1	143.0	1.5	5.5 (2,495)
August	33	17,395	54.0	527.1	16,260	48.7	492.7	194.7	1.9	5.9 (2,676)
September	29	15,978	52.9	551.0	15,020	48.9	517.9	179.3	1.7	6.2 (2,812)
Total	109	59,754			55,269			609.1		
Weighted mean				548.2			507.1			5.6 (2,540)

Table 6. Length frequency distribution of Atlantic bonito sampled from North Carolina charter boats in 1978, monthly.

Length, mm	May			June			July			Total	
	U	M	F	U	M	F	U	M	F		
	Total										
300-324											
325-349											
350-374											
375-399											
400-424				1							
425-449											1
450-474				1							1
475-499				2	5						1
500-524				2	2						2
525-549				2							2
550-574											2
575-599											1
600-624											2
625-649											1
650-674											1
675-699											2
700-724											
725-749											
750-774											
775-799											
800-824											
Total											

26

16

5

26

Table 7. Sex ratios and stage of sexual maturity for Atlantic bonito, monthly.

Month	Sex			I ³ / ₃	Sexual maturity (female)					Total
	M	F	Unknown ³ / ₃		Total	II	III	IV	V	
May	-	4(100.0)	1	5			4(100.0)			4
June	5(31.3)	11(68.7)	-	16	(1)	1(10.0)	6(60.0)	1(10.0)	2(20.0)	11
July	9(37.5)	15(62.5)	2	26	(1)	10(71.4)	2(14.3)		2(14.3)	15
August	16(48.5)	17(51.5)	-	33		3(17.6)	3(17.6)	1(5.9)	10(58.8)	17
Sept.	10(38.5)	16(61.5)	3	29		7(43.8)			9(56.2)	16
Total	40(38.8)	63(61.2)								

Table 8. Mean size of dolphin sampled from the North Carolina charter boat fleet in 1978, monthly.

Month	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt, lb$	σwt	$\bar{X} wt.$	(gm)
May	29	25,317	179.1	873.0	21,120	149.0	728.3	229.1	4.6	7.9	(3,583)
June	344	296,652	215.2	862.4	247,611	182.4	719.8	2,786.4	6.4	8.1	(3,674)
July	484	341,220	184.5	705.0	284,786	153.4	588.4	2,323.2	4.4	4.8	(2,177)
August	226	152,747	139.8	675.9	127,352	116.0	563.5	994.4	3.8	4.4	(1,996)
September	191	136,437	173.4	714.3	113,581	149.8	594.7	1,012.3	5.1	5.3	(2,404)
October	22	18,624	222.6	846.5	15,436	186.5	701.6	197.5	7.7	9.0	(4,082)
Total	1,296	970,997			809,886			7,542.9			
Weighted mean				749.2			624.9			5.8	(2,631)

Table 9. Con't

Length, mm	September				October				Total			
	U	M	F	Total	U	M	F	Total	U	M	F	Total
	300-349					1			1			
350-399												
400-449					2			2				2
450-499		2	12	14							6	6
500-549		7	19	20						11	20	31
550-599	1	10	25	33					2	52	101	155
600-649	3	7	38	51					2	82	260	344
650-699	1	7	17	25					3	80	174	257
700-749		4	9	13		1		1	2	31	56	89
750-799	1	4	6	11		1		2	1	16	44	61
800-849		1	2	3		1	5	7	2	19	34	55
850-899						1		1		6	24	30
900-949	1			1			2	2	1	4	29	34
950-999						2	1	3		9	21	30
1000-1049		1	2	3					1	18	26	45
1050-1099			3	3						7	28	35
1100-1149		1	2	3						12	23	35
1150-1199			1	1		1		1		11	14	25
1200-1249		2	1	3		1		1		19	12	31
1250-1299		1	3	4			1	1		9	9	18
1300-1349										1	3	4
1350-1399										4	1	5
1400-1449										2		2
1450-1499										1		1
1500-1549												
1550-1599												
1600-1649												
1650-1699										1		1
Total				191				22				1,296

Table 10. Sex ratios and stage of sexual maturity for dolphin, monthly.

Month	Sex			Sexual maturity (female)					Total	
	M	F	Unknown ^{3/}	Total	I ^{3/}	II	III	IV		V
May	15(51.7)	14(84.3)	-	29	(1)		2(20.0)	8(80.0)		11
June	95(27.8)	247(72.2)	2	344	(1)	1(0.5)	71(35.5)	99(49.5)	29(14.5)	201
July	166(34.4)	317(65.6)	1	484	(12)	32(10.8)	114(38.6)	46(15.6)	103(34.9)	307
August	71(31.6)	154(68.4)	1	226	(11)	63(44.7)	37(26.2)	7(5.0)	34(24.1)	152
Sept.	41(22.4)	142(77.6)	8	191	(29)	49(70.0)	-	3(4.3)	18(25.7)	99
Oct.	8(40.0)	12(60.0)	2	22	(2)	6(75.0)	1(12.5)		1(12.5)	10
Total	396(30.9)	886(69.1)								

Table 11. Mean size of wahoo sampled from North Carolina charter boats in 1978, monthly

Month	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt lb$	σwt	$\bar{X} wt,$ (gms)
May	7	8,152	311.5	1,164.6	7,886	306.0	1,126.6	171.8	18.4	24.5 (11,113)
June	15	18,634	304.9	1,242.3	17,862	293.3	1,190.8	393.0	14.9	26.2 (11,884)
July	77	78,721	358.5	1,022.4	76,346	344.4	991.5	1,370.6	12.7	17.8 (8,074)
August	105	97,776	338.1	931.2	92,880	326.6	884.6	1,484.0	9.7	14.1 (6,396)
September	109	123,017	289.4	1,128.6	115,760	288.9	1,062.0	2,245.4	10.3	20.6 (9,344)
October	25	19,225	365.0	769.0	18,555	354.3	742.2	349.3	12.7	14.0 (6,350)
Total	338	345,525			329,289			6,014.1		
Weighted mean				1,022.3			974.2			17.8 (8,074)

Table 12. Con't

Length, mm	September			October			Total			
	U	M	F	U	M	F	U	M	F	Total
	Total			Total			Total			
400-449	1					1	5	7	5	10
450-499			7			8	3	33	33	43
500-549	1	4	6	1	1	3	5	7	21	33
550-599			5				2	4	18	24
600-649			2				1	1	4	6
650-699			2	1	1				2	2
700-749			2							
750-799										
800-849									2	2
850-899										
900-949										
950-999			1						1	1
1000-1049										
1050-1099								3	1	3
1100-1149			1					4	6	11
1150-1199		5	6					5	22	36
1200-1249	1	3	13			1	2	16	30	48
1250-1299	1	8	22	1	1	3	3	17	42	62
1300-1349	1		9		2		1	2	15	18
1350-1399			6			1			11	11
1400-1449			2						9	9
1450-1499								2	3	5
1500-1549									4	4
1550-1599			1						3	3
1600-1649									2	2
1650-1699										
Total			109			25				338

Table 13. Sex ratios and stage of sexual maturity for wahoo, monthly.

Month	Sex			Total	I ^{3/}	Sexual maturity (female)					Total
	M	F	Unknown ^{3/}			II	III	IV	V		
May	3(42.9)	4(57.1)		7		1(25.0)	3(75.0)				4
June	3(21.4)	11(78.6)	1	15		1(10.0)	9(90.0)				10
July	21(31.3)	46(68.7)	10	77		5(11.9)	35(83.3)	2(4.8)			42
August	28(27.7)	73(72.3)	4	105	(2)	40(58.8)	8(11.8)	2(2.9)	18(26.5)		70
September	21(20.2)	83(79.8)	5	109		47(58.0)	1(1.2)	2(2.5)	31(38.3)		81
October	5(22.7)	17(77.3)	3	25		17(100.0)					17
Total	81(25.7)	234(74.3)									

Table 14. Mean size of yellowfin tuna sampled from North Carolina charter boats in 1978, monthly.

Month	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt, lb$	owt.	$\bar{X} wgt.$	(gm)
May	2	1,956	2.8	978.0	1,737	7.8	868.5	55.0	2.1	27.5	(12,474)
June	40	39,533	212.1	988.3	34,669	193.9	866.7	992.0	13.7	24.8	(11,249)
July	194	201,791	157.7	1,040.2	179,760	141.6	926.6	6,052.8	10.8	31.2	(14,152)
August	24	14,532	239.8	605.5	14,258	236.7	594.1	333.6	16.8	13.9	(6,305)
September	19	10,612	102.0	558.5	9,743	91.6	512.8	153.8	3.9	8.1	(3,674)
October	21	12,668	269.2	603.2	11,617	253.3	553.2	233.1	15.9	11.1	(5,035)
Total	300	281,092			251,784			7,820.3			
Weighted mean				940.0			839.3			26.1	(11,839)

Table 15. Length frequency distribution of yellowfin tuna sampled from North Carolina charter boats in 1978, monthly.

Length, mm	May			June			July			August			
	U	M	F	U	M	F	U	M	F	U	M	F	
	Total	Total	Total										
300-349											1		1
350-399											2	1	3
400-449											6	4	10
450-499											2		2
500-549													
550-599													
600-649						4							
650-699							1						2
700-749													1
750-799							1						1
800-849													
850-899													
900-949													
950-999			2										
1000-1049													
1050-1099													
1100-1149													
1150-1199													
1200-1249													
1250-1299													
Total													

24

194

40

2

24

Table 16. Sex ratios and stage of sexual maturity for yellowfin tuna, monthly.

Month	Sex			Sexual maturity (female)					Total	
	M	F	Unknown ^{3/}	Total	I ^{3/}	II	III	IV		V
May		2(100.0)		2		2(100.0)				2
June	10(52.6)	9(47.4)	21	40	(1)	3(75.0)	1(25.0)			5
July	61(43.6)	79(56.4)	54	194	(14)	45(88.2)	5(9.8)		1(2.0)	65
August	6(54.5)	5(45.5)	13	24	(1)	3(100.0)				4
September	4(57.1)	3(42.9)	12	19	(1)	2(100.0)				3
October	2(66.7)	1(33.3)	18	21		1(100.0)				1
Total	83(45.6)	99(54.4)								

Table 17. Mean size of blackfin tuna sampled from North Carolina charter boats in 1978, monthly.

Month	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt, lb$	σwt	$\bar{X} wt (gm)$
May	25	18,861	115.7	754.4	17,157	107.8	686.3	426.3	7.3	17.1 (7,757)
June	65	44,708	239.2	687.8	38,922	184.1	598.8	494.0	5.2	7.6 (3,447)
July	26	15,703	185.4	604.0	13,840	136.5	532.3	143.0	1.1	5.5 (2,495)
August	31	14,609	156.6	471.3	13,002	136.0	419.4	150.6	4.2	4.9 (2,223)
September	61	37,810	92.2	619.8	34,527	88.2	566.0	518.6	3.4	8.5 (3,856)
October	22	12,518	78.3	569.0	11,473	72.6	521.5	145.0	2.1	6.6 (2,994)
November	5	3,099	55.6	619.8	2,867	51.8	573.4	44.6	2.6	8.9 (4,037)
Total	235	147,308			131,788			1,922.1		
Weighted mean				626.8			560.8			8.2 (3,720)

Table 18. Length frequency distribution for blackfin tuna sampled from North Carolina charter boats in 1978, monthly.

Length mm	May			June			July			August				
	U	M	F	U	M	F	U	M	F	U	M	F	Total	
	Total			Total			Total			Total			Total	
200-249														
250-299														
300-349														
350-399														
400-449														
450-499														
500-549														
550-599														
600-649														
650-699														
700-749														
750-799														
800-849														
850-899														
900-949														
950-999														
1000-1049														
1050-1099														
1100-1149														
1150-1199														
1200-1249														
1250-1299														
1300-1349														
1350-1399														
1400-1449														
1450-1499														
Total														

Table 19. Sex ratios and stage of sexual maturity for blackfin tuna, monthly.

Month	Sex			I ³ / _{Total}	Sexual maturity (female)					Total
	M	F	Unknown ³		II	III	IV	V		
May	20(80.0)	5(20.0)		25	1(25.0)				3(75.0)	4
June	25(39.7)	38(60.3)	2	65	(6)	1(3.1)	16(50.0)		4(12.5)	38
July	7(29.2)	17(70.8)	2	26	(1)	13(81.3)	3(18.7)			17
August	9(30.0)	21(70.0)	1	31	(11)	4(40.0)		1(10.0)	5(50.0)	21
September	26(48.1)	28(51.9)	7	61	(3)	13(52.0)		1(4.0)	11(44.0)	28
October	8(44.4)	10(55.6)	4	22		9(90.0)			1(10.0)	10
November	3(60.0)	2(40.0)		5		2(100.0)				2
Total	98(44.7)	121(55.3)								

Table 20. Mean weight and frequency distribution of weight classes for white marlin sampled from the North Carolina charter boat landings, 1978, monthly.

Month	Sample Statistics			Weight classes (lb)						
	N	Σ wt, lb	\bar{X} wt.	<30	30-40	41-50	51-60	61-70	71-80	>80
May	5	255	51.0		2(40.0)	1(20.0)	1(20.0)	1(20.0)		
June	30	1,484	49.5		9(30.0)	8(26.7)	8(26.7)	4(13.3)	1(3.3)	
July	95	4,590	48.3	1(1.0)	19(20.0)	50(52.6)	17(17.9)	5(5.3)	2(2.1)	1(1.0)
August	8	307	38.4		7(87.5)	1(12.5)				
September	22	1,085	49.3		5(22.7)	9(40.9)	6(27.3)	2(9.1)		
Total	160	7,721	48.3	1(0.6)	42(26.3)	69(43.1)	32(20.0)	12(7.5)	3(1.9)	1(0.6)

Table 21. Mean weight and frequency distribution of weight classes for blue marlin sampled from the North Carolina charter boat landings, 1978, monthly.

Month	Sample statistics				Weight classes (lb)						
	N	Σ wt, lb	σ wt.	\bar{X} wt.	<100	100-200	201-300	301-400	401-500	>500	
May	15	4,671	88.0	311.4	-	2(13.3)	5(33.3)	4(26.7)	4(26.7)	-	
June	42	11,729	122.1	279.3	1(2.4)	11(26.2)	13(30.9)	11(26.2)	5(11.9)	1(2.4)	
July	62	12,841	124.6	207.1	11(17.7)	29(46.8)	9(14.5)	7(11.3)	4(6.5)	2(3.2)	
August	6	715	49.3	119.2	3(50.0)	3(50.0)					
September	11	2,458	88.2	223.5	1(9.0)	4(36.4)	4(36.4)	2(18.2)			
October	2	608	147.1	304.0		1(50.0)			1(50.0)		
Total	138	33,022		239.3	16(11.6)	50(36.2)	31(22.5)	24(17.4)	14(10.1)	3(2.2)	

Table 22. Mean weight and frequency distribution of weight classes for sailfish sampled from North Carolina charter boat landings, 1978, monthly.

Month	Sample statistics				Weight classes (lb)					
	N	Σ wt, lb	σ wt.	\bar{X} wt.	<30	30-40	41-50	51-60	61-70	71-80
June	3	95	13.9	31.7	2(66.7)		1(33.3)			
July	17	623	7.3	36.6	1(5.9)	14(82.3)	1(5.9)	1(5.9)		
August	5	218	19.9	43.6	1(20.0)	2(40.0)	1(20.0)			1(20.0)
September	8	346	9.5	43.3		4(50.0)	3(37.5)		1(12.5)	
Total	33	1,282		38.8	4(12.1)	20(60.6)	6(18.2)	1(3.0)	1(3.0)	1(3.0)

Table 23. Mean size of several species which were sampled infrequently from North Carolina charter boats.

Species	Month(s)	N	ΣTL	σTL	$\bar{X} TL$	ΣFL	σFL	$\bar{X} FL$	$\Sigma wt, lb$	$\sigma wt.$	$\bar{X} wt (gm)$
Albacore	September	12	7,928	55.0	660.7	7,238	45.1	603.2	97.4	1.8	8.1 (3,674)
Skipjack tuna	July	6	3,017	51.1	502.8	2,838	48.5	473.0	27.0	1.5	4.5 (2,041)
Bluefin tuna	June	2	1,969	212.8	984.5	1,809	191.6	904.5	70.0	21.2	35.0 (15,876)
Great barracuda	July and August	15	15,321	222.5	1,021.4	14,184	205.0	945.6	195.4	4.7	13.0 (5,897)

Table 24. Sex ratios and sexual maturity for several species of fish sampled infrequently.

Species	Month	M	F	Unknown ^{3/}	Total	I ^{3/}					Total
						II	III	IV	V		
Albacore	September	6(54.4)	5(45.5)	1	12	1(20.0)	1(20.0)	1(20.0)	3(60.0)	5	
Skipjack tuna	July	2(40.0)	3(60.0)	1	6	(2)	1(100.0)			3	
Great barracuda	July and August	2(28.6)	5(71.4)	8	15	5(100.0)				5	