

Virginia's Recreational Marlin and Tuna Fishery

1983 - 1988

A Report to the Fishermen

Eleanor A. Bochenek, Nancy J. Chartier, Jon A. Lucy

Virginia Sea Grant Marine Advisory Program
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA 23062

Special Report in Applied Marine Science and Ocean Engineering No. 298

Cover photo: Charles Barr
Line conversion: Harold Burrell
Computer Graphics: Nancy Chartier
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Acknowledgments

The success of this project relied upon the assistance of many people and organizations. First and foremost, we would like to recognize the offshore recreational fishermen of Virginia who have participated in this study. We greatly appreciate the time and patience they extended to us while answering our questions repeatedly at the docks and over the telephone. Without their participation, interest, and support, this project would not have been possible.

We wish to thank the owners, operators, and personnel of the Virginia Beach Fishing Center, Fisherman's Wharf Marina, and Wachapreague Marina for their hospitality and cooperation in providing unlimited access to boat captains using their docking facilities. Similarly, we thank the operators of Inlet Station Marina, Rudee's Cove Marina, Lynnhaven Waterway Marina, Cobb's Marina, and Baymark Yacht Haven for their courtesy in providing access to their docks for interviewing boat captains periodically during the study. We also express our appreciation to the many fishing clubs and tournament organizers who provided information and assistance with this project.

Special thanks are extended to the National Marine Fisheries Service (NMFS) and Virginia Institute of Marine Science (VIMS) port samplers who persistently endured thunderstorms, traffic jams, and overwhelming heat to collect dockside data, in addition to the countless evenings spent making phone calls to the fishermen. These individuals include: Charles Barr, Carrollyn Cox, Richard Denzler (NMFS), David Eggleston, Carol Furman, Lisa Kline, Robert McCormack, Kevin McCarthy, Brian Sweeney, and Jay Taylor (NMFS).

We are grateful to the following organizations that provided partial financial support for our data collection efforts:

The Cape Henry Billfish Club (1984)
The Virginia Sea Grant Marine Advisory Services Program (1983-1988)
NMFS Port Sampling Program (1985-1988)
NMFS Saltonstall-Kennedy Funds (1983)
Sport Fish Restoration Act (Wallop-Breaux) Funds (1987-1988)

We particularly wish to thank Mr. William Figley, Fishery Biologist at the Nacote Creek Laboratory of the Division of Fish and Game, New Jersey Marine Fisheries Administration, for inviting us to participate in the 1983 cooperative pelagic fishery project for the mid-Atlantic states (New York through Virginia). This multi-year project was initiated as a result of that participation.

Finally, we wish to thank Dr. William DuPaul, Director of Marine Advisory Services, VIMS, for his support and guidance.

Special Note

Users of any information contained in this report are reminded that the data, tables, figures, and results on which this report is based are derived from the ongoing research of Eleanor Bochenek, Ph.D. Candidate at VIMS, School of Marine Science, College of William and Mary. To protect the academic integrity of this student's graduate program, the authors request that any use of the contents of this report be formally referenced and credited to the following:

Bochenek, E. Virginia's pelagic recreational fishery for tunas and billfishes: biological, socioeconomic, and fishery components for 1983-1985, with comments on the 1986 season. Ph.D. dissertation, Virginia Institute of Marine Science, College of William and Mary (in preparation).

To the fishermen who fish "east of the inlet"

Virginia's Offshore Recreational Fishery

Since the first billfish landing was recorded in Virginia in 1938, fishing for tuna and marlin has been a significant component of Virginia's recreational offerings and, as in many coastal states, continues to expand both in popularity and economic impact. Over the years, increasing numbers of fishermen have been lured to fishing locations off the mid-Atlantic coast, seasonally influenced by the Gulf Stream, in hopes of catching "the big one." With the development and availability of sophisticated navigational equipment, the fishery has become very popular with owners of trailerable boats (primarily less than 26 feet).

In Virginia, offshore fishing for pelagic species begins in late May with the sporadic appearance of small school northern bluefin tuna. The bluefin season peaks in late June or early July, winding down by early August as the fish continue to migrate north, seeking cooler waters. As waters warm in late June, yellowfin tuna, white marlin, and less commonly, blue marlin begin to appear on the fishery grounds. Through mid-October these fish, along with dolphin, wahoo, skipjack tuna, Atlantic bonito, false albacore, king mackerel, and bluefish, are caught off the coasts of Virginia, Maryland, and North Carolina. Occasionally, fishermen also land bigeye tuna and sailfish; bigeye tuna accounted for the Virginia Saltwater Fishing Tournament state record for tuna in 1987 (272 lbs. 4 oz.) and again in 1988 (274 lbs. 8 oz.).

The primary departure points for Virginia's offshore fleet are Rudee, Wachapreague, and Lynnhaven Inlets, and Little Creek. Fishing areas range from 15 to 80 nautical miles offshore. Some locations, such as the 21 and 26 Mile Hills off Wachapreague, and the Hot Dog, Fishhook, Horseshoe, and Southeast Lumps off Virginia Beach,

offer prime fishing opportunities in less than 20 fathoms of water (Figure 1). These areas are especially popular during the bluefin tuna season, since the tuna tend to migrate closer to shore. Fishing areas further offshore include Norfolk and Washington Canyons, the Fingers, 20 Fathom Finger, the Cigar, and the Triple Zero line (LORAN C), with water depths of 20 to more than 1000 fathoms. These locations are popular for yellowfin tuna, marlin, dolphin, and wahoo fishing.

Management of Pelagic Species

In 1976, the Fishery Conservation and Management Act was enacted, establishing a 200 mile fisheries zone under U.S. jurisdiction. Billfishes are among the pelagic species covered under this act. Atlantic tunas are regulated by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Under ICCAT, restrictions have been placed on the northern bluefin tuna fishery in an attempt to counter the substantial decline in the population caused by overfishing. Currently, recreational rod and reel anglers are limited to four small (approximately 7-100 pounds) school bluefin tuna each per day, to one medium-sized (100-285 pounds) bluefin tuna each per day (four per boat), and one giant (>285 pounds) bluefin tuna per boat per day. A permit is required to fish for giants; permit applications can be obtained from the National Marine Fisheries Service (NMFS). ICCAT has established a minimum size limit of 47 inches straight fork length to reduce the landings of bluefin tuna age 1-4 and a minimum weight limit of 14 pounds to reduce the number of bluefin tuna landed that are less than a year old.

According to U.S. ICCAT Advisory Committee reports, no more than 15% of the total U.S. bluefin tuna catch (commercial and recrea-

tional) can be undersized. Recreational fishermen account for the majority of the undersized tuna landed. Most bluefin tuna caught off the coast of Virginia are one to three year old fish (less than 50 pounds). In addition to the size limits on bluefin tuna, ICCAT maintains a seven pound minimum weight restriction for both yellowfin and bigeye tunas.

A fishery management plan (FMP) for the Atlantic billfishes (white marlin, blue marlin, sailfish, longbill spearfish), developed by the South Atlantic Fishery Management Council in cooperation with the New England, Mid-Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils, was approved and became effective in October, 1988. The principal objective of the plan is to maintain the highest availability of billfishes to the traditional recreational fishery by reducing commercial and recreational fishing mortality on billfishes. The major provisions of the FMP, among others, include a prohibition on the sale in the U.S. of billfish harvested in waters where they are managed. To encourage releases by U.S. recreational fishermen, minimum size limits (length from lower jaw to fork of tail) were imposed: 57 inches for sailfish, 62 inches for white marlin, and 86 inches for blue marlin. These measures are aimed at ensuring that immature fish cannot be taken before spawning at least once. Mandatory reporting of billfish catch and effort information may also be required of selected billfish tournaments.

Study Background

Researchers studying the pelagic recreational fishery throughout the coastal United States are attempting to assess the nature of the fishery, its impact on national, state and local economies, and the effect its harvest has on the species and stocks of fish supporting the fishery. These studies are critical to the interests of recreational fishermen so that in the

development of management policies, equitable consideration is given to both the commercial and recreational facets of a fishery. Presently, accurate and comprehensive records of pelagic recreational catches are lacking, particularly along the East Coast.

Researchers at the Virginia Institute of Marine Science (VIMS), College of William and Mary, began examining Virginia's recreational fishery in the late 1970's. In 1978, a study of Virginia's charter and head boat fleet was funded by the Virginia Sea Grant College Program. In 1983, VIMS was invited to participate in a cooperative study of the mid-Atlantic pelagic recreational fishery, coordinated by Bill Figley of the New Jersey Department of Environmental Protection. This project examined the 1983 pelagic recreational fisheries of New York, New Jersey, Maryland, Delaware, and Virginia, concentrating on the number of boats in the fishery, their catches and effort, and the value of the fisheries in the mid-Atlantic region.

In 1984, documentation of the offshore recreational fishery in Virginia was continued by VIMS as part of Eleanor Bochenek's doctoral program (School of Marine Science, College of William and Mary). The study has continued annually through 1988. This report summarizes general catch and effort information for the fishery between 1983 and 1988, focusing primarily on key species supporting the fishery, i.e., bluefin and yellowfin tuna, white and blue marlin, and dolphin. An assessment of the fishery's contribution to the economy for 1983 to 1986 is included. More comprehensive information on the 1983-1985 fishery will be available upon publication of Bochenek's dissertation (Special Note, p. iii).

Study Objectives and Methods

This continuing study has two primary objectives. The first objective

is to improve existing assessments of the extent and impact of the Virginia fishery, as it contributes to the mid-Atlantic, northeast regional, and overall East Coast marlin and tuna fishery. The second objective is to test, compare, and refine the survey techniques used, in an effort to provide the most accurate and comprehensive information possible given the constraints of available funding. The survey methods used varied from year-to-year, as the techniques were modified and the number of fishermen participating in the study grew. A general description of the methods are described below; detailed descriptions may be found in Bochenek's dissertation.

During the six fishing seasons covered in this report, three sampling techniques were used to obtain catch and effort information: dockside interviews, telephone surveys, and logbooks. These methods provided data on catches and releases, hours fished per trip, location and date of capture, sea surface temperatures, number of anglers, inlet of departure, and trip type (private or charter). Interviews (1985-1988) were routinely conducted dockside at Rudee and Wachapreague Inlets, and periodically at other inlets or boat launches. These interviews, targeting boat captains and owners, provided an opportunity to document more "successful" fishing trips and to collect fish length and weight data. Dockside interviews tend to favor successful fishing trips since fishermen who have had a good day typically spend more time dockside discussing and cleaning their catch than those who caught few or no fish.

Random telephone surveys (1983; 1985-1988) provided a means for contacting almost every fisherman at least once during the fishing season. These calls documented more "no catch" fishing trips than dockside interviews. Fishermen are sometimes reluctant to discuss these disappointing trips, feeling they have "nothing to report." In fact, these trips are essential to the accurate estimation of the amount of fishing effort expended by the fishery

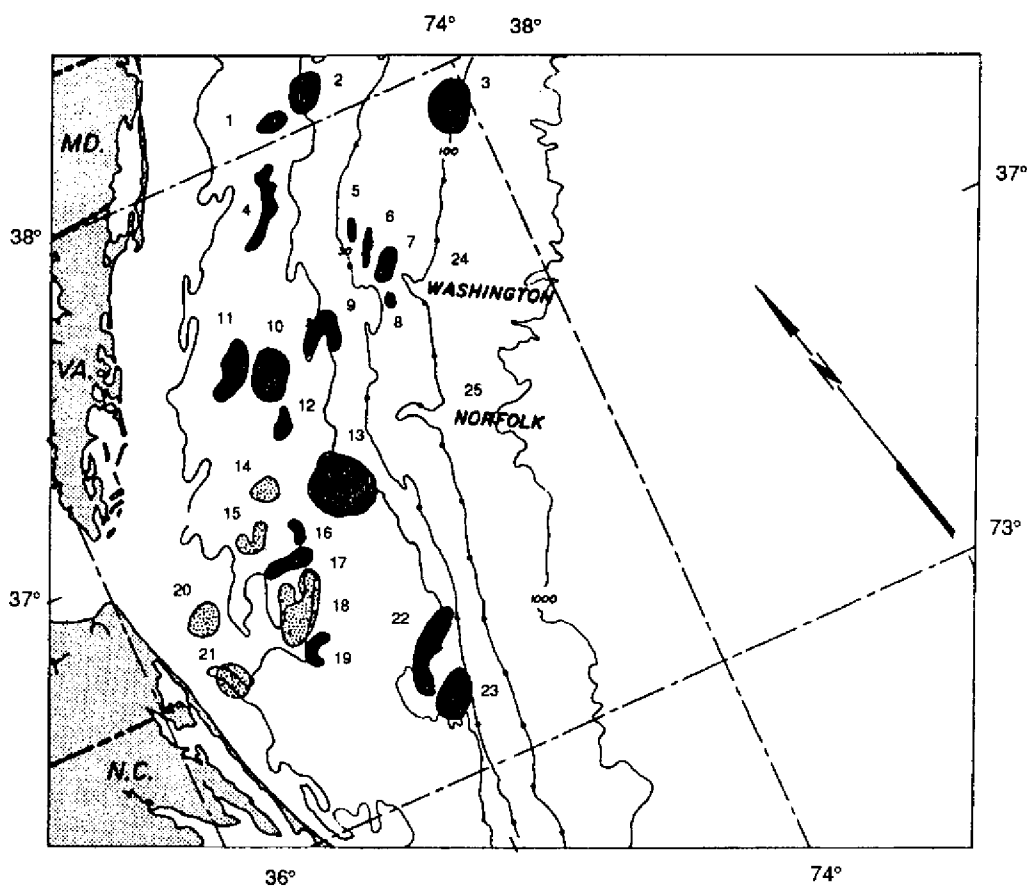
(whether the effort was successful or not). The number of fishermen called weekly was increased from 20 to 48 between 1983 and 1987 to help reduce data variability. (The number of fishermen contacted weekly in 1988 dropped to 30 because of a reduction in manpower.) Each fishing season was divided into sampling periods called "wave dates," which began on Monday and ended on Sunday. The length of the sampling periods depended upon fishing activity and weather conditions. During the busiest part of the fishing season (mid-June to early September), sampling periods were a week. At the beginning of the season and in September, sampling was biweekly, and in October, when offshore fishing is lightest, the entire month counted as a sampling period. Boat captains and owners were asked to recall the number of marlin and tuna trips they had taken in their own boat from a Virginia port during a particular sampling period, as well as any previous trips they could accurately recall.

In 1984, voluntary logbooks were used to obtain catch and effort information. Fishermen were asked to fill out a sheet for each trip made and return the log sheets monthly. As part of a special study of the Rudee Inlet fleet, fishermen utilizing the inlet were also interviewed dockside about fishing activities and expenditures associated with their trips.

Catch per unit effort and total effort estimates were calculated separately for the data acquired by telephone and dockside, using methods devised by Figley (telephone) and Bochenek (dockside). The methods are detailed in Bochenek's dissertation. These estimates were sent to the NMFS for incorporation into their annual advisory report to the ICCAT.

At the end of each fishing season, a socio-economic questionnaire was mailed to all boat owners and captains who had made at least three marlin and tuna trips from a Virginia port during the season. These surveys are kept strictly confidential and anonymous, and have two primary

Figure 1. Popular offshore fishing areas of Virginia's recreational fleet (adapted from Figley, 1984).



Tuna and Billfish Grounds Off Virginia

- | | | |
|----------------------|---------------------------|-----------------------|
| 1. Jackspot | 9. 20 Fathom Fingers | 17. Southeast Lumps |
| 2. The Fingers | 10. 21 Mile Hill | 18. Horseshoe |
| 3. Poor Man's Canyon | 11. No Name | 19. Boomerang |
| 4. Lumps | 12. 26 Mile Hill(Hambone) | 20. V Buoy |
| 5. First Lump | 13. The Fingers | 21. 4A Buoy |
| 6. Second Lump | 14. Triangle Wrecks | 22. Cigar |
| 7. Rockpile | 15. Fishhook | 23. Honey Hole |
| 8. 29 Fathom Lumps | 16. Hot Dog | 24. Washington Canyon |
| | | 25. Norfolk Canyon |

purposes. Some of the information is essential in assessing the economic worth of the pelagic recreational fishery of the mid-Atlantic area, primarily Virginia. These data are crucial to the understanding and balancing of recreational fishery needs and impacts with those of commercial fishing interests. The survey is annual because the fishery constantly changes. Unfortunately, despite anonymity, many fishermen fail to respond to the survey. The lower the response rate, the greater the concern that the data may not accurately describe the fishery.

The second purpose for the socioeconomic questionnaire is to provide a means to annually estimate the size of the recreational marlin and tuna fleet. Boat captains and owners were asked to list ten boats from their homeport that fished for marlin and tuna at least three times from Virginia during the season. Providing counts of boats already included in the study as well as those not contacted by researchers, these lists are used to derive an estimate of the total size of Virginia's marlin and tuna fleet each year, using fishery stock assessment mark-recapture techniques. Determining fleet size is crucial, since it is the basic multiplier in calculations of the total number of trips taken by the fleet, and economic impact of the fishery.

Results and Discussion

The evolution of this study during the last six years has culminated in better and more comprehensive information on Virginia's pelagic recreational fishery. Ultimately, the goal is to determine the methods that will produce reasonable annual estimates of the catches, effort, and value of this fishery. The most important factor influencing this refinement process is the continued willingness of offshore recreational fishermen to participate

in the study by providing complete and accurate trip information.

The number of trip interviews — completed annually from 1983-1988 are shown in Table 1.

Table 1. Breakdown of study interviews.

<u>Year</u>	<u>Tele- phone</u>	<u>Dock- side</u>	<u>Log- books</u>
1983	431	----	----
1984	----	----	377
1985	304	1138	----
1986	212	892	----
1987	305	699	----
1988	376	244	----

The difference in numbers of interviews resulted from changes in sampling design, funding, and available manpower. Voluntary logbooks proved to be the least effective means for obtaining catch information. The response rate from fishermen was low and researchers had no way to determine whether the returned forms were representative of the total fishery.

Estimates of Virginia's recreational marlin and tuna fleet have increased between 1983 and 1987 (Table 2). The increase in these estimates is most likely attributable to the growing number of fishermen participating each year in the survey. The fishery may also be expanding in size. The number of charter boats iden-

Table 2. Annual estimates of Virginia's offshore recreational fishery boat population and the number of charter boats identified by each survey.

<u>Year</u>	<u>Number of Boats</u>	<u>No. Charter Boats</u>
1983	455	40
1984	666	53
1985	774	68
1986	886	65
1987	1021	68
1988	N/A	63

tified in the survey appears to have increased since 1983, although this may be an artifact of the type and amount of sampling used for the estimations. Based on the information from dockside interviews since 1985, approximately 65 charter boats are participating in the fishery annually.

Fishing Effort

The average number of anglers per trip was four for every year except 1985, when it was five. The mean number of lines fished per trip was six for 1985 through 1988, and for all years, the average number of hours spent trolling per offshore trip was six.

Fishing effort is defined as the number of marlin and tuna trips taken from Virginia ports during a fishing season. Catch per boat trip values express the average number of a particular species landed per offshore trip. When examining differences in catch rates and effort between years, it is advisable to compare the dockside and telephone interview data separately, since the two data sets represent different sampling strategies. The estimated number of offshore trips made by the fleet annually were calculated (Table 3), using Figley's method for the telephone interview data and Bochenek's method for both the dockside and logbook interview data.

Table 3. Estimated annual number of offshore trips.

<u>Year</u>	<u>Tele- phone</u>	<u>Dock- side</u>	<u>Log- books</u>
1983	5952	----	----
1984	----	----	6648
1985	5527	5969	----
1986	7103	6747	----
1987	8247	5926	----
1988	N/A	N/A	----

Telephone-acquired data (1983, 1985-1988) and dockside or logbook-acquired data (1984-1988) have been graphed separately (hereafter

referred to as dockside, logbook, or phone interview data, respectively). For all tables and figures, the method by which the information was obtained is designated in parentheses next to the year. Phone interview data are indicated by (P), logbook data by (L), and dockside interview data by (D).

Private and Charter Boat Effort

The number of documented private and charter marlin and tuna trips that originated from Virginia ports is broken down by year in Table 4. Private boat captains comprised more than 70 percent of all boat captains contacted by telephone during 1983 and 1985-1988. This is to be expected since calls are usually made Monday through Thursday (days and evenings). Charter boat captains are more difficult to reach by phone since many fish almost daily. The greater number of charter trips made weekly makes it difficult for captains to recall or distinguish catches for individual trips when contacted (unless their logbooks are available), reducing the catch information for charter trips. Therefore, the interview breakdown does not reflect the percentage of charter trips that actually occurred each season.

Table 4. Annual private and charter Virginia-based marlin and tuna trips. (P = phone, L = logbooks, D = dockside).

Year	Private Boat Trips	Charter Boat Trips
1983(P)	317 (73.5%)	114 (26.5%)
1984(L)	272 (72.1%)	105 (27.9%)
1985(P)	216 (71.5%)	86 (28.5%)
1985(D) ^a	655 (57.6%)	481 (42.2%)
1986(P) ^b	163 (76.9%)	48 (22.6%)
1986(D)	444 (49.8%)	448 (50.2%)
1987(P)	243 (78.9%)	65 (21.1%)
1987(D)	469 (66.4%)	237 (33.6%)
1988(P)	202 (82.8%)	42 (17.2%)
1988(D)	135 (35.9%)	241 (64.1%)

^a 2 unknown (0.2%)

^b 1 unknown (0.5%)

Catch and Effort

This report focuses on catch and effort information for bluefin and yellowfin tuna, white and blue marlin, and dolphin. These species are primary targets of most offshore fishermen. Many other pelagic species such as skipjack tuna, Atlantic bonito, false albacore, and wahoo are caught incidentally on these trips. A brief summary of these catches follows at the end of this section.

Bluefin Tuna

In Virginia, bluefin tuna are the focus of fishing attention from late May to mid-July. The majority of bluefin tuna are caught within 30-35 nautical miles of the coast, since they tend to migrate closer to shore than other species of tuna. Their migratory pattern is a boon to pelagic fishing enthusiasts owning smaller boats, providing good tuna fishing within a reasonable distance from shore. Catch rates are highest in June and early July, slacking off by late July or early August as waters become too warm for this species. The greatest number of bluefin tuna were landed each year during June (Table 5). Landings of a few bluefin tuna were recorded in August 1983, 1984, 1987, and 1988.

Data provided by the NMFS to the U.S. advisory section of the ICCAT in October 1988 indicate an overall decline in the abundance of bluefin tuna. Catches of bluefin tuna have exceeded the number of fish entering the spawning stock (10-30 year old fish) during the 1980's; therefore the spawning stock continues to exhibit the downward trend that has persisted since the 1970's. Six to nine year old bluefin (roughly greater than 100 lbs or 50 inches standard fork length) exhibit a more optimistic picture. The estimated number of tuna entering these age classes has been

Table 5. Recorded and projected catches of bluefin tuna by month for 1983-1988.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
June										
Recorded	410	85	87	500	203	719	731	983	708	235
Projected	5304	1626	3080	13319	N/A	4626	3759	7534	5754	N/A
July										
Recorded	64	34	57	218	78	263	225	379	204	125
Projected	620	571	1869	4559	N/A	4496	900	1924	1066	N/A
August										
Recorded	7	0	0	13	7	20	0	0	9	3
Projected	123	0	0	620	N/A	444	0	0	106	N/A
Total										
Recorded	481	119	144	731	288	1002	956	1362	921	363
Projected	6047	2197	4949	18498	N/A	9566	4659	9458	6926	N/A

greater than the estimated number caught. However, the "surplus" of these fish in the 1980's is not as large as during the 1970's; therefore under current catch quotas, this "surplus" of 6-9 year old fish may not contribute significantly to the spawning stock in the future.

The estimated stock size of 1-5 year old bluefin tuna is also declining. The number of fish entering (recruiting to) this age group during the 1980's is at a lower level than during the 1970's. Fishing mortality on this general age group, which largely comprises the Virginia fishery, consistently approaches the estimated number of fish recruiting to the stock. In short, the Atlantic bluefin tuna stock does not appear to be recovering at present catch quotas. However, during the 1988 ICCAT meeting in Madrid, Spain, the decision was made to maintain the catch quotas at their current levels.

Average catch per boat trip values for bluefin tuna are represented graphically in Figure 2 A-B. The 1984 logbook data produced the highest effort values (5.2 fish per trip in June). These values may not be representative of the fishery since

there were relatively few logbook returns and the data may primarily reflect successful trips. Catch rates calculated from telephone interview data were highest in 1987. A number of trips were recorded in late June and early July during which fishermen "limited out" on bluefin tuna, increasing the 1987 catch rates. Overall seasonal catch rates for bluefin tuna were lowest in 1985. Annual catch rates in 1986, 1987, and 1988 showed some improvement over 1985 (Figure 6A). Only a small percentage of the bluefin tuna caught during any particular year were released.

Catches recorded dockside were graphed by month and fishing area for 1985 and 1986 (Figure 3 A-B). These figures reflect only those bluefin tuna catches that could be specifically attributed to a particular fishing ground, and only those areas supporting large catches were used. At times, port samplers were not able to or did not distinguish where fish were caught when a particular boat fished several different fishing grounds. Therefore, these "combined area" catches are not included.

Popular and productive fishing grounds for bluefin tuna during 1985

and 1986 were the 21 Mile Hill, the Hot Dog, the 26 Mile Hill, and the Horseshoe. At the 21 Mile Hill, anglers had consistently high catches of bluefin tuna and landings from the Hot Dog were extremely high in June 1986. Catches at the 26 Mile Hill were higher in June and July 1986 than in 1985, and large numbers of bluefin tuna were taken at the Horseshoe in June 1985 and 1986. A surprising number of bluefin tuna were taken at the Cigar in June 1985, as well as a few at 20 Fathom Finger in June and July 1985; there were smaller documented bluefin catches in these areas in 1986. In late June and early July 1987 (not shown), there was a period when fishermen were "limiting out" (i.e., taking four bluefin per angler per day) on the hills off Wachapreague.

Yellowfin Tuna

As the water warms in late June, yellowfin tuna begin to appear off Virginia. July and August traditionally exhibit the highest numbers landed (Table 6), but yellowfin tuna can be caught as late as October depending

Table 6. Recorded and projected catches of yellowfin tuna by month for 1983-1988.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
<u>June</u>										
Recorded	61	57	0	52	20	90	143	23	170	21
Projected	789	1113	0	1386	N/A	579	5434	177	1381	N/A
<u>July</u>										
Recorded	213	107	243	272	144	575	489	867	515	448
Projected	2073	4808	8132	5688	N/A	9830	1955	4412	2691	N/A
<u>August</u>										
Recorded	61	76	51	55	53	213	165	203	173	101
Projected	1246	1689	1753	2621	N/A	4729	1023	2217	2021	N/A
<u>September</u>										
Recorded	34	36	34	14	16	34	66	43	12	35
Projected	1300	443	1013	450	N/A	1415	568	740	255	N/A
<u>October</u>										
Recorded	2	15	24	7	12	0	0	0	0	0
Projected	59	132	348	100	N/A	0	0	0	0	N/A
<u>Total</u>										
Recorded	371	291	352	400	245	912	863	1136	870	605
Projected	5467	8185	11246	10245	N/A	16553	8980	7546	6348	N/A

Figure 2 A-B. Mean catch per boat trip values by month for bluefin tuna, 1983-1988.

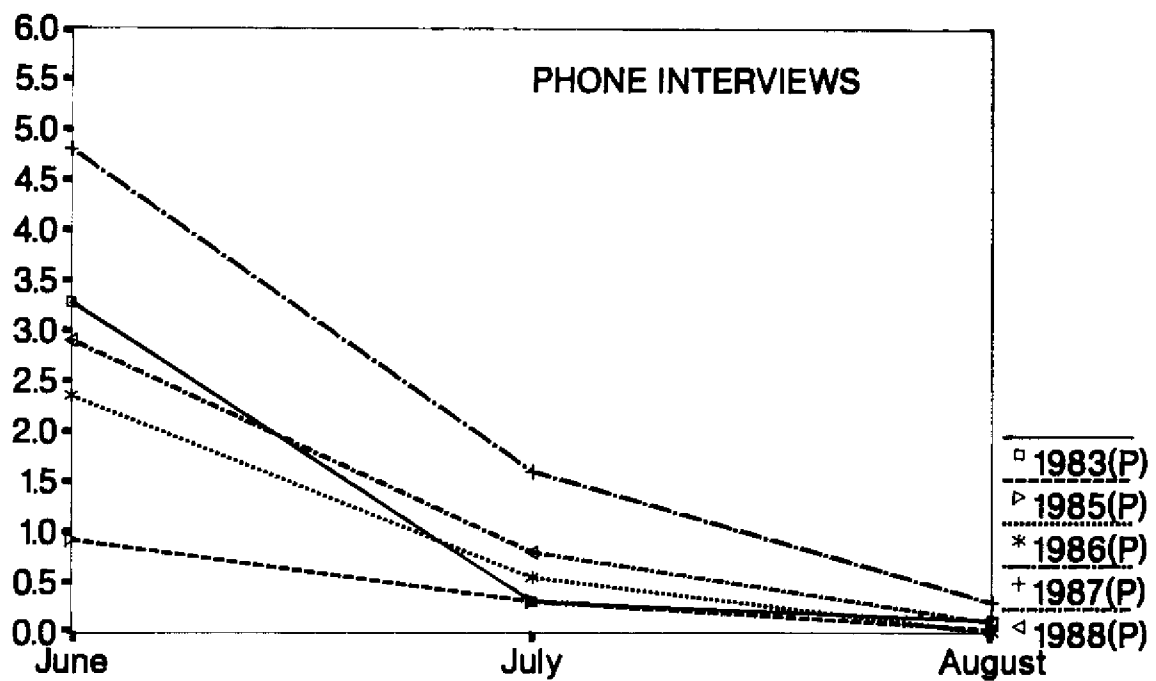
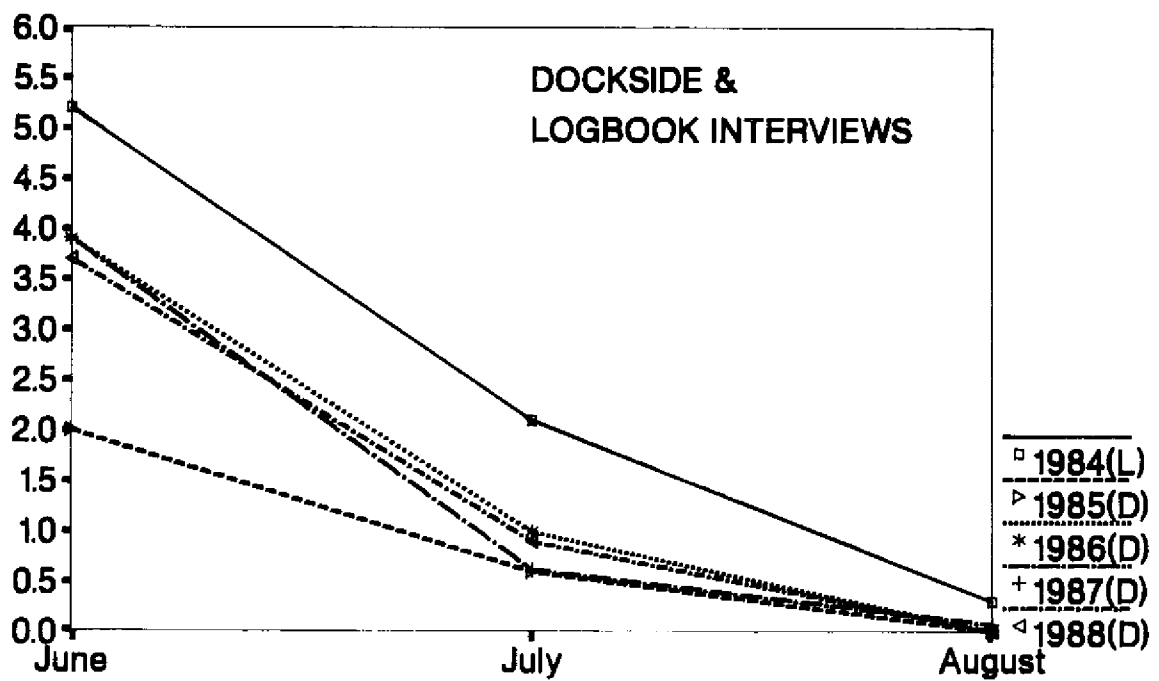
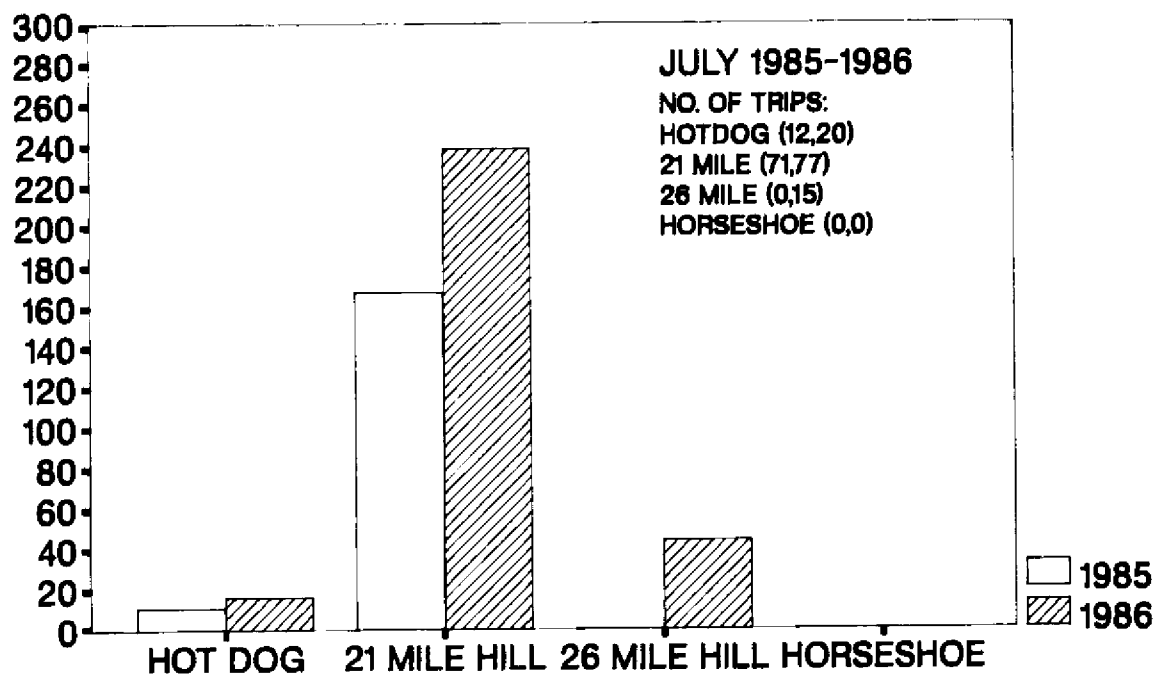
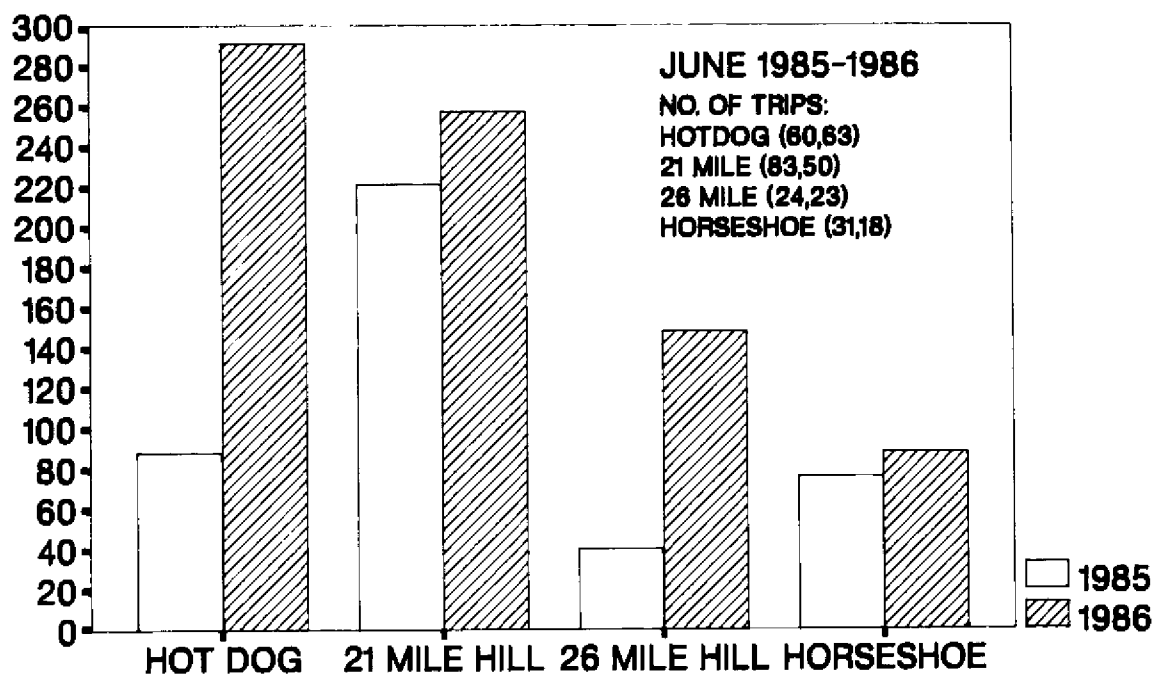


Figure 3 A-B. Number of bluefin tuna caught by fishing area and month for 1985-1986.



upon water temperature and weather conditions. Average catch rates per boat trip are generally lower in June, peak in July, and decline through August, September, and October. The decline in total catch during the latter part of the fishing season reflects the diminishing number of boats fishing offshore as a result of decreasing tourism, unpredictable weather conditions, and the southward migration of the fish.

With the exception of July, catch rates calculated from telephone-acquired data were very similar (Figure 4B). Catch rates calculated from interviews collected dockside were more variable for 1984-1988 (Figure 4A). Mean catch rates calculated from small sample sizes early and late in the year (e.g., June 1985D, October 1987P, October 1988P) were strongly affected by a few good (or poor) catches.

Yellowfin tuna catches for 1985 and 1986 were broken down by fishing location in a manner similar to bluefin tuna (Figure 5 A-B). Substantial catches were made in Norfolk Canyon in both years, especially during July.

July and August 1986 also showed extremely high numbers of yellowfin tuna caught at or near the Cigar. Good catches were made at the Cigar throughout the entire 1985 season. A number of yellowfin tuna were landed along the Triple Zero line (LORAN C) during July and August 1986. Another area of concentrated fishing effort, especially during July 1985, was the 20 Fathom Finger. Some yellowfin tuna were taken at the 21 Mile Hill in July 1985 and 1986, and at the Fingers in July and August 1986.

The number of tuna citations awarded annually by the Virginia Saltwater Fishing Tournament (VSFT) for bluefin, yellowfin, and bigeye tuna weighing at least 75 pounds indicates a slight improvement in catches of larger fish since 1983, leveling off from 1985 through 1987 (Figure 6B). However, tuna citations dropped off in 1988. The VSFT officials decided to lower the minimum size for tuna citations to 70 pounds for the 1989 season, since

there has been an average of only 30 citations awarded annually for tuna since the minimum weight was raised in 1976.

Annual bluefin tuna catch rates calculated from telephone interview data also indicated some improvement in fishing since 1983 (Figure 6A). The catch rates dropped off in 1988, which may be attributable to the smaller number of trips recorded through interviews that year. Note the substantial change in catch rates from 1986 to 1988. Four percent of the total trips recorded through telephone interviews in 1987 had catches of 15 or more bluefin tuna, accounting for 30% of the total catch documented. These catches were largely responsible for the higher seasonal catch rate calculated for 1987. In comparison, two percent of the trips recorded dockside had catch rates of 15 or more fish per trip, accounting for 23% of the total catch documented. These high catches did not influence the overall catch rates to the same degree as in the telephone data set since there were many more trips recorded dockside than by telephone (Figure 2A).

Annual yellowfin tuna catch rates do not parallel those of bluefin tuna, but remain relatively constant throughout the study period (Figure 6A). Since typical catches of bluefin and yellowfin tunas off Virginia consist of fish averaging under 50 pounds in weight, the VSFT citation data describes the "trophy fish" component of the fishery while the catch per unit effort data is dominated by catches of smaller fish. The two data sets describe largely distinctive elements of the fishery.

White Marlin

The most common billfish off Virginia's coast is the white marlin. The number of billfish encountered seasonally along the mid-Atlantic coast is low and seems to have been on the decline for a number of years. The most numerous catches tend to be in late July, August, and early Sep-

tember, especially when the marlin form schools to begin migrating south. Some responsibility for the decline in numbers has been attributed to incidental catches of billfish by domestic and foreign longlining vessels fishing for tuna or swordfish. Fortunately, billfish have been placed under the jurisdiction of the Exclusive Economic Zone (EEZ), and a federal management plan for Atlantic billfishes recently became effective. The VSFT has increased the minimum citation weight for white marlin from 50 to 60 pounds for the 1989 season.

Equally important, sport fishermen have begun their own conservation measures to protect this segment of their fishery. For example, the majority of billfish tournaments are now "release" tournaments. Marlin brought to the docks must meet a minimum weight to qualify for points and a taxidermist ticket is also required. "Tag and release" taxidermy is advertised in sport fishing magazines. All of these factors help to reduce billfish mortality. Hopefully, the management plan will have as much impact as voluntary policing.

Recorded catches (including releases) of white marlin were about the same for 1984 (L), 1986(D), and 1988(D) (Table 7). In 1987 (D,P), a greater number of white marlin catches and releases were documented, especially during August and early September.

Average catch rates per boat trip for white marlin were extremely low (Figure 7) compared to the tuna species (Figures 2, 4). Catching a white marlin is a relatively uncommon event. In 1986, port samplers began to document the number of white and blue marlin raised, but not actually hooked during a trip. In 1986, 107 white marlin and 44 blue marlin were reported raised during interviews; in 1987, 125 white marlin and 39 blue marlin were raised and in 1988, 177 white marlin and 23 blue marlin were raised.

According to the fishery management plan for billfish, East Coast recreational fishing fleets claim a

Figure 4 A-B. Mean catch per boat trip values for yellowfin tuna, 1983-1988.

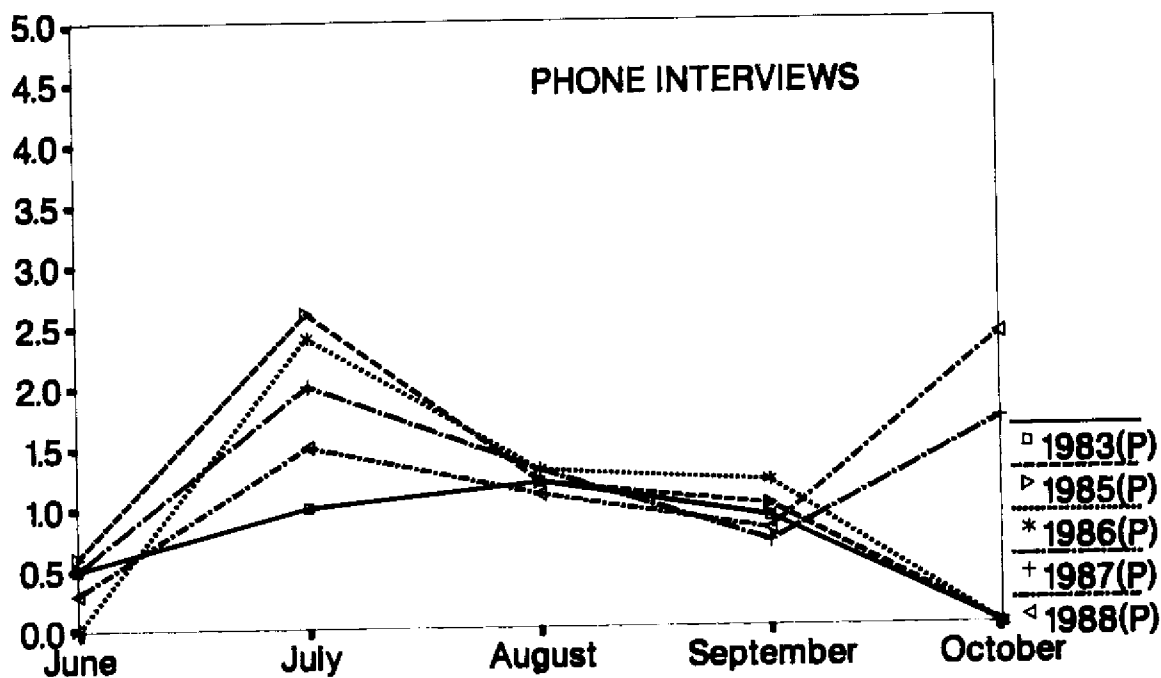
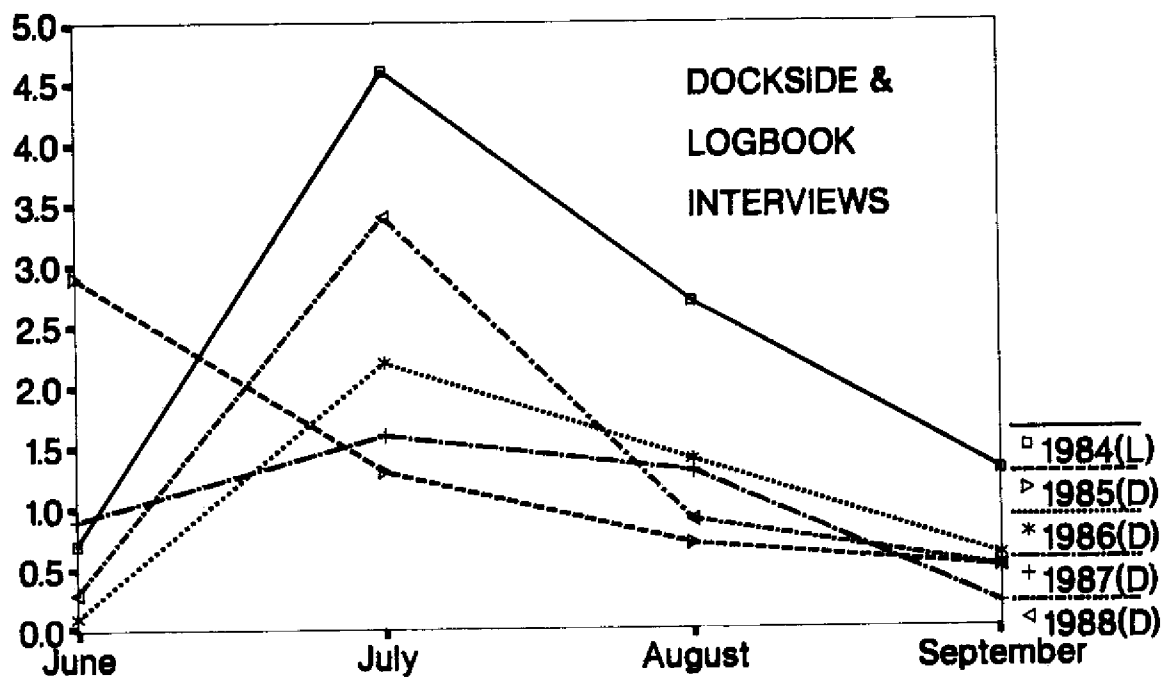


Figure 5 A-B. Number of yellowfin tuna caught by fishing area and month for 1985-1986.

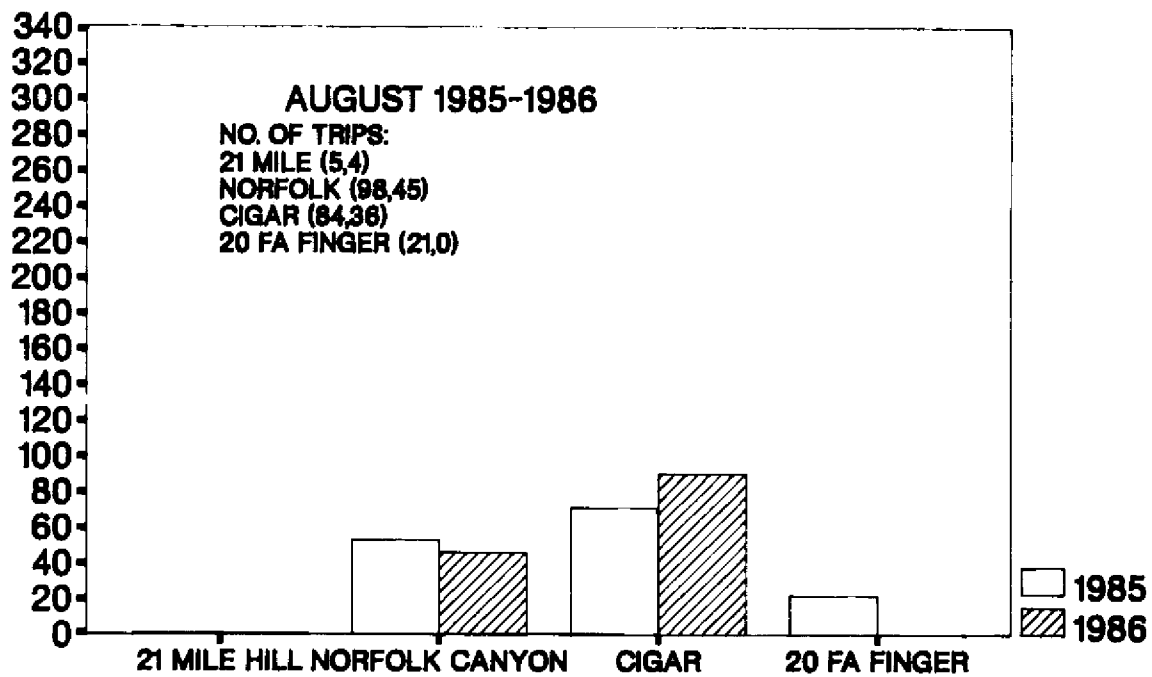
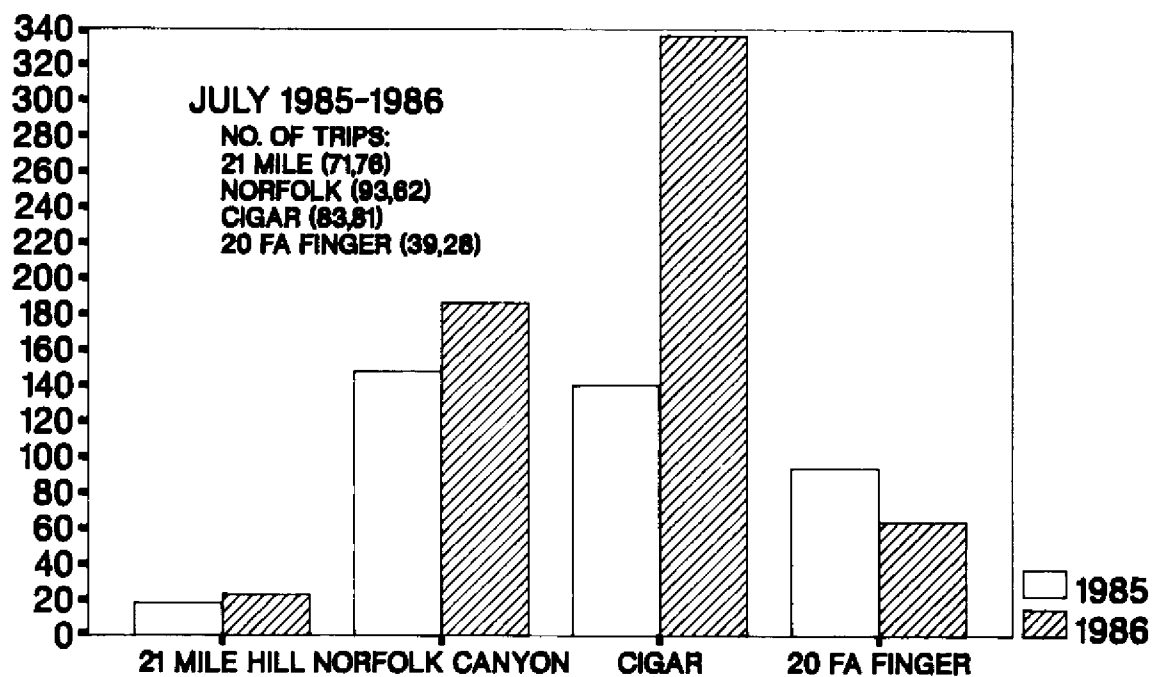


Figure 6 A-B. Annual mean catch per boat trip rates for bluefin and yellowfin tuna (A) calculated from 1983-1988 telephone interview data, and VSFT citations awarded during the same timeframe (B).

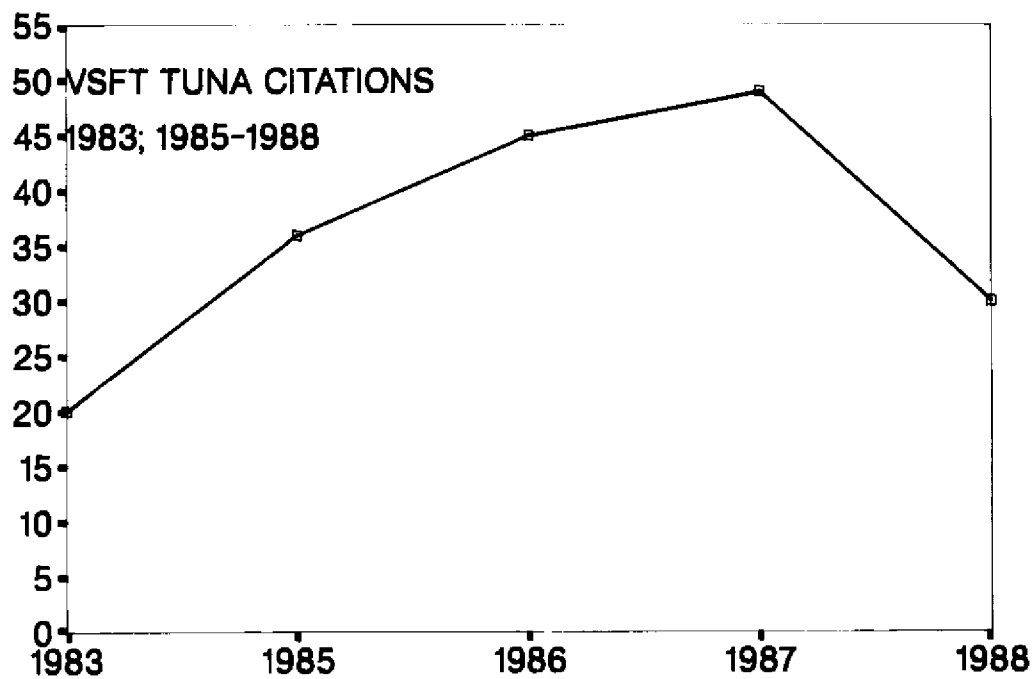
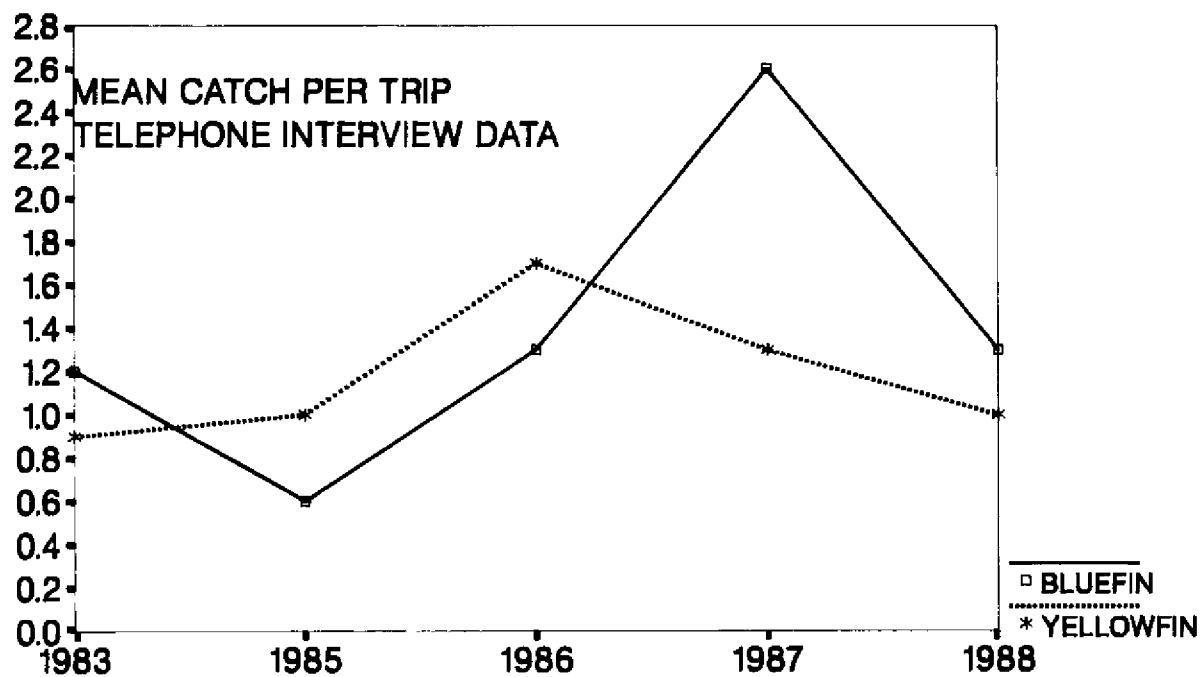


Table 7. Recorded and projected catches of white marlin by month for 1983-1988.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
<u>June</u>										
Recorded	2	0	0	0	0	1	5	0	2	0
Projected	26	0	0	0	0	6	26	0	16	0
<u>July</u>										
Recorded	52	10	4	8	3	26	29	25	45	12
Projected	504	166	132	168	N/A	444	119	136	235	N/A
<u>August</u>										
Recorded	31	5	12	10	11	40	33	27	48	24
Projected	561	111	413	476	N/A	887	211	273	560	N/A
<u>September</u>										
Recorded	45	4	0	27	12	8	34	22	69	35
Projected	1210	49	0	868	N/A	333	295	374	1468	N/A
<u>October</u>										
Recorded	4	0	0	4	1	0	0	0	0	0
Projected	117	0	0	57	N/A	0	0	0	0	0
<u>Total</u>										
Recorded	134	19	16	49	27	75	101	74	164	71
Projected	2418	326	545	1569	N/A	1670	651	783	2279	N/A

release rate for billfish of 50 percent. However, Virginia fishermen tend to release a much higher percentage of their billfish catches. Catch and release information from this study and that of the annual VSFT citation records is shown in Table 8. According to VSFT citation records, the release rate was greater than 80 percent for all years. With the exception of 1985, release rates for white marlin were similar for the VSFT program and this study. Over six years, this study documented an average annual white marlin release rate of 79.5 percent.

In this study, projected catches for the Virginia fishery are higher for both white and blue marlin than shown in the VSFT records (Tables 7, 8, 9). VSFT records do not include white and blue marlin that were landed dockside and did not meet the respective 50 and 250 pound minimum weights for citation. This study includes such fish in recorded and projected catches as well as multiple releases of billfish that may not always be registered with the VSFT program (C. Bain, VSFT Director, personal communication). For white marlin weights obtained during interviews, the percentage of fish landed weigh-

ing less than 50 pounds was 66% (37 fish) in 1983, 50% (15 fish) in 1985, 33% (1 fish) in 1986, and 35% (6 fish) in 1987 and 12.5% (1 fish) in 1988.

The VSFT program is not designed to record all catches of any

species, including billfish, but only those fish that qualify for release or minimum weight citations. Since a significant percentage of billfish recorded in this study during recent years could not qualify for VSFT cita-

Table 8. Annual catch and release information for white (WM) and blue marlin (BM) comparing recorded totals from study interviews (June through October) and Virginia Saltwater Fishing Tournament citation^a records (VSFT, 1983-1988).

Year		Study Interviews		State Tournament	
		No. Recorded	Percent Released	No. Recorded	Percent Released
1983	(WM)	129	82%	664	89%
	(BM)	8	63	27	48
1984	(WM)	75	79	406	86
	(BM)	1	100	11	82
1985	(WM)	120 ^b	56	167	81
	(BM)	29 ^b	51	26	65
1986	(WM)	90 ^b	88	138	89
	(BM)	25 ^b	60	28	75
1987	(WM)	213 ^b	84	455	87
	(BM)	23 ^b	74	55	71
1988	(WM)	98 ^b	88	274	87
	(BM)	9 ^b	89	32	81

^a Minimum citation weights for the VSFT (through 1988) were 250 pounds for blue marlin and 50 pounds for white marlin. Citations are also given for all marlin releases.

^b Dockside and telephone interviews combined.

Figure 7 A-B. Mean catch per boat trip values for white marlin, 1983-1988.

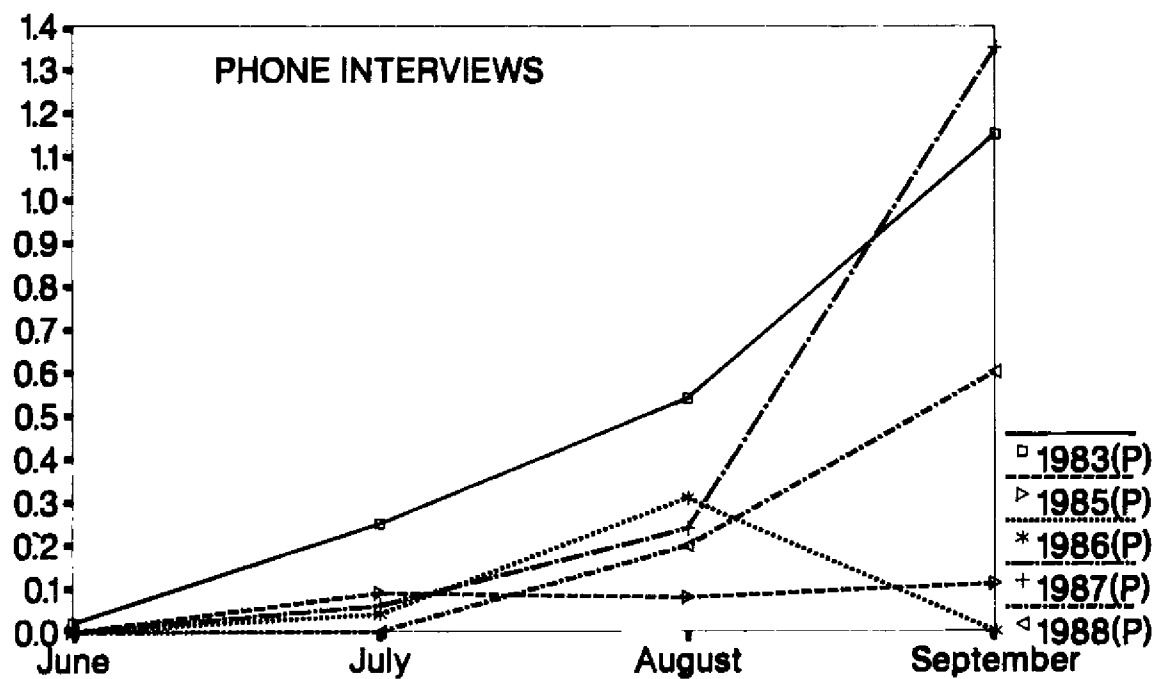
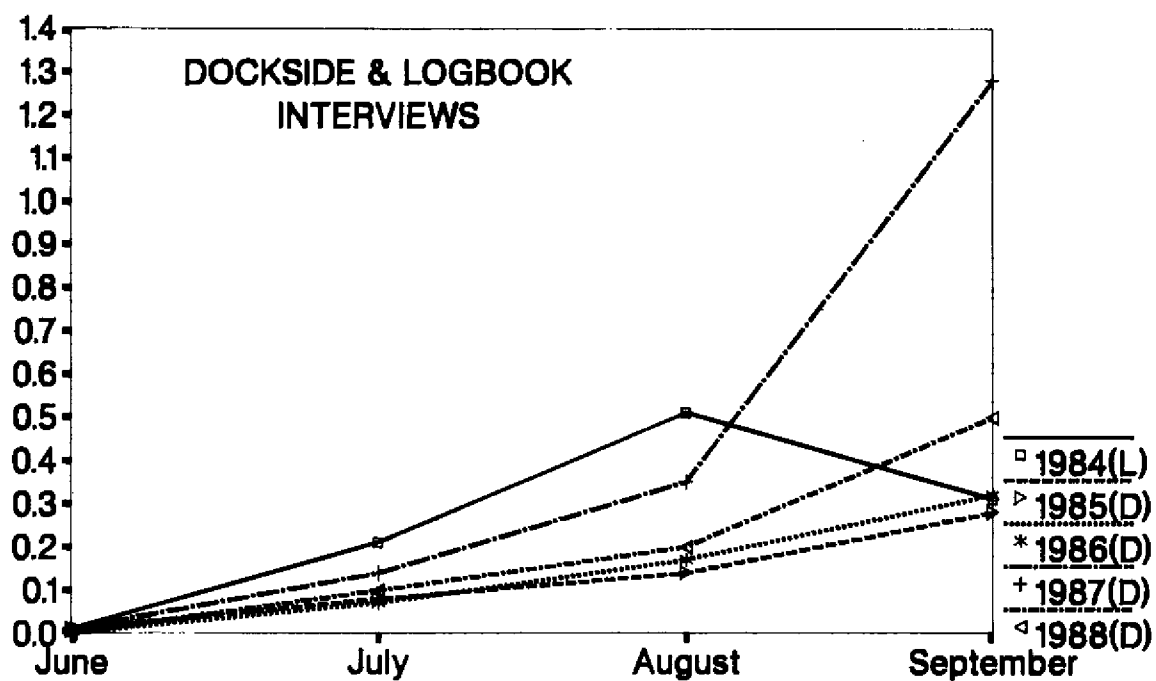


Table 9. Recorded and projected catches of blue marlin by month for 1983-1988.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
June										
Recorded	0	0	0	0	0	0	1	0	0	0
Projected	0	0	0	0	0	0	5	0	0	0
July										
Recorded	3	3	3	0	1	0	10	11	11	1
Projected	30	52	98	0	N/A	0	40	55	50	N/A
August										
Recorded	3	2	0	2	1	1	8	5	6	1
Projected	53	44	0	96	N/A	23	50	55	75	N/A
September										
Recorded	2	3	2	1	0	0	2	4	3	5
Projected	53	37	68	32	0	0	17	50	90	N/A
Total										
Recorded	8	8	5	3	2	1	21	20	20	7
Projected	136	133	166	128	N/A	23	112	160	215	N/A

tions, the study's projected billfish catch should exceed that documented by the VSFT program. However, the study's projected catches are two to six times greater than those recorded by the VSFT program. In light of these differences, the study's projected billfish catches seem disproportionately high; as a result, the technique used to calculate projected catches is currently being re-evaluated.

The Cigar and Norfolk Canyon were two popular fishing grounds for white marlin in 1985(D) and 1986(D). In 1986, a considerable number of catches were made on the Triple Zero line, and a few were also taken at the Fingers. In both years, a few white marlin were landed at the 20 Fathom Finger.

Blue Marlin

Although this species is not "key" in terms of numbers, it has been included in this report as one of definite interest to the fishery. Encounters with blue marlin are relatively rare events. This species must attain a weight of at least 200 pounds to become sexually mature; unfortunately, directed and incidental overfishing as well as landing of undersized blue marlin (250 pounds required for citation) for mounts seem to have con-

tributed to the decline in numbers. The new management plan should help in this endeavour, with the minimum fork length requirement of 86 inches. In addition, the VSFT has increased its minimum citation weight requirement for blue marlin from 250 to 350 pounds for the 1989 season.

In 1984, the VIMS study recorded the catch of only one blue marlin. More blue marlin were probably landed but few logbooks were returned in 1984 for use in the population estimates. The highest landings were recorded from 1985 to 1987. Catches were primarily in July, August, and early September, with a few fish taken in June (Table 9). Average catch per boat trip values were extremely low, almost negligible, and therefore are not shown graphically.

Unfortunately, in conjunction with lower catch rates, this species also suffers lower release rates (Table 8). A release rate of 100 percent was recorded in 1984, but is not a true measure of the annual release rate since only one blue marlin was recorded. Release rates vary from 51 to 89 percent for the other five years, with an overall average (excluding 1984) of 67 percent (73% including 1984) (Table 8). The survey documented a larger catch of blue marlin in 1985 than the VSFT. This difference could be attributed to the fact

that the VSFT does not record landings of blue marlin that do not qualify by weight for a citation. According to VSFT citation records, the average release rate for the six years was 70 percent. Again, annual catches (Table 9) are much higher than the totals for the VSFT.

Catches of blue marlin were limited in distribution among fishing areas; the majority of the catches and releases during 1985 and 1986 were at the Cigar or Norfolk Canyon.

Annual catch rates for white and blue marlin calculated from telephone interview data are illustrated in Figure 8A. The rates calculated from dockside interview data for 1984-1988 are virtually the same. The VSFT citation data for the same period (1983-1988) is shown in Figure 8B. Assuming that fishing effort was approximately the same for each year, the trends for the marlin catch rates and the citation data are very similar.

Dolphin

In 1985, more than 1800 dolphin (primarily small "chicken" dolphin) were recorded by dockside samplers (Table 10). A large number were also caught during 1986. The 1983 and 1984 surveys reported similar catches of dolphin. Generally, the greatest

Table 10. Recorded and projected catches of dolphin by month for 1983-1988.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
June										
Recorded	38	40	1	5	0	6	60	31	8	0
Projected	492	760	35	134	0	43	316	239	64	0
July										
Recorded	80	101	355	36	65	93	146	377	330	157
Projected	774	1713	4935	754	N/A	1590	1412	1914	1724	N/A
August										
Recorded	59	194	135	41	97	126	730	166	195	351
Projected	1142	4297	4761	1953	N/A	5614	4542	1813	2277	N/A
September										
Recorded	68	164	52	46	29	20	867	90	37	27
Projected	1829	2013	1756	1479	N/A	832	7480	1550	787	N/A
October										
Recorded	4	45	2	0	7	0	0	0	0	0
Projected	117	386	29	0	N/A	0	0	0	0	0
Total										
Recorded	249	544	545	128	198	245	1803	664	570	535
Projected	4354	9169	11516	4320	N/A	8079	13750	5516	4852	N/A

number of dolphin were landed in late July and August.

Dolphin were frequently caught in the same fishing areas as white marlin and yellowfin tuna. In 1985, Norfolk Canyon had high catches of dolphin, while the Cigar produced a phenomenal number of dolphin in September. During August 1985(D), prime fishing for dolphin was found at the 20 Fathom Finger. No overwhelming numbers of dolphin were taken at any one particular area in 1986(D)—catches were made at the Cigar, Nor-

folk Canyon, as well as the Hot Dog, on the Triple Zero line, and the 21 Mile Hill.

All Pelagic Species

Documented catches of other pelagic species are listed in Table 11, and the overall success rates of the offshore recreational fishery are summarized in Table 12. Included are any species that could be caught while trolling for tuna or marlin. The pelagic fishes represented in Table 11

are yellowfin, bluefin, bigeye, true albacore, skipjack and blackfin tuna; false albacore; Atlantic bonito; white and blue marlin; sailfish; dolphin; king mackerel and other mackerel species; wahoo; bluefish; mako, hammerhead, and blue shark; and barracuda.

The average catch per boat trip for all pelagics was very high in 1984, again probably not representative of the fishery overall. The highest rates were generally recorded in June, with numerous trips made and large numbers of bluefin tuna, bluefish, and false albacore caught. There were high catch rates in September also. These most likely resulted from a few trips that had large catches of dolphin or king mackerel.

Socio-Economic Analysis

Marlin and tuna fishing is an expensive pastime. Most offshore fishermen own boats at least 20 feet in length and have sophisticated electronic navigation equipment. High quality rods and reels are required to withstand the rigors of offshore fishing. Fishing lures and other tackle, ice, and bait all add to the expense. Travel to fishing locations off the coasts of Virginia, North Carolina,

Table 11. Recorded catches of other pelagic species, 1983-1988.

	1983	1984	1985	1986	1987	1988
Albacore tuna	8	12	2	3	3	1
Atlantic bonito	45	4	156	107	31	36
Barracuda	---	---	1	9	5	6
Blackfin tuna	---	---	1	---	8	---
Bluefish	---	826	1227	830	521	783
Bigeye tuna	---	---	---	1	9	1
False albacore	115	475	762	285	503	415
King mackerel	64	22	57	100	181	135
Mako	2	4	6	7	8	N/A
Sailfish	---	---	5	2	1	11
Skipjack tuna	88	310	219	940	368	347
Wahoo	66	33	50	27	68	31

* Not recorded in 1983

Figure 8 A-B. Annual mean catch per boat trip rates for white and blue marlin calculated from 1983-1988 telephone interview data (A), and VSFT citations awards during the same timeframe (B).

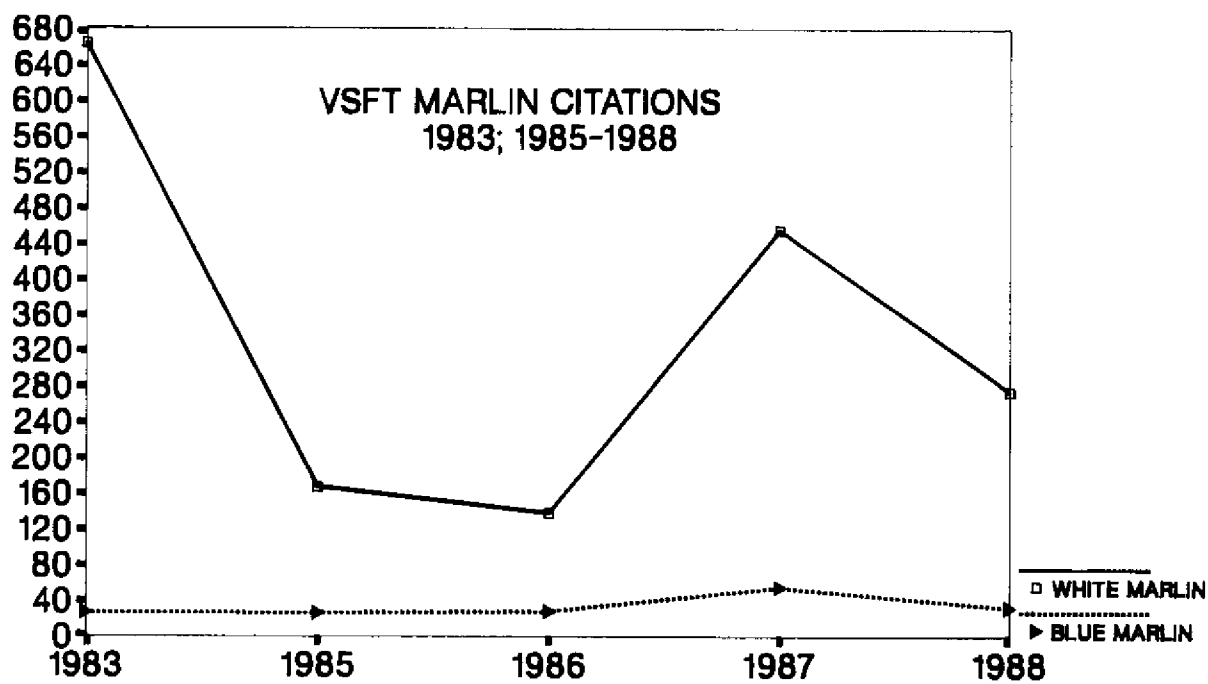
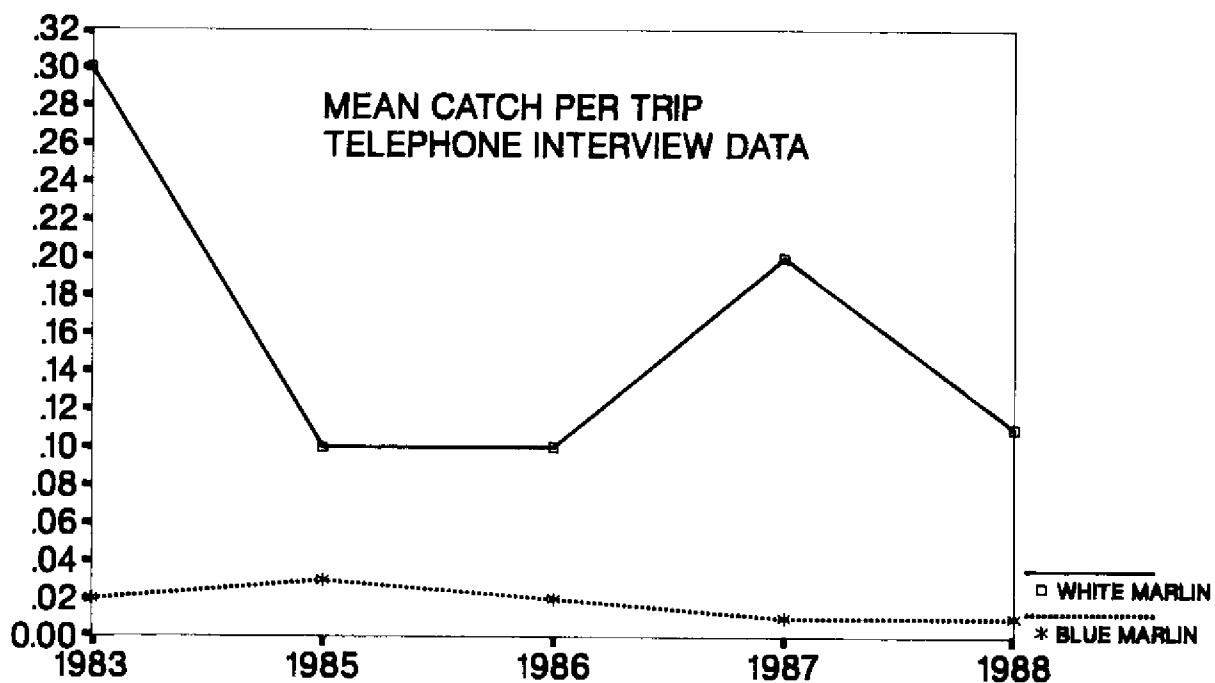


Table 12. Catches per boat trip of all pelagic species^a landed by month for 1983-1988. The range of catches is also indicated.

	Telephone					Dockside/Logbook				
	1983	1985	1986	1987	1988	1984	1985	1986	1987	1988
June										
Mean catch ^b	5.1 ^c	6.5	6.5	8.0	8.5	11.5	5.7	8.6	7.0	10.3
Range	0-39	0-58	0-28	0-40	0-39	0-46	0-46	0-47	0-31	0-34
July										
Mean catch	2.6	3.0	5.4	5.6	3.9	10.2	3.9	5.9	3.9	7.7
Range	0-23	0-40	0-40	0-36	0-27	0-80	0-56	0-74	0-43	0-67
August										
Mean catch	3.6	4.8	5.5	3.9	7.0	7.7	4.8	4.7	5.7	7.3
Range	0-19	0-62	0-75	0-19	0-50	0-38	0-68	0-46	0-79	0-67
September										
Mean catch	5.4	7.0	4.1	6.0	4.5	12.6	8.1	2.3	2.4	2.6
Range	0-34	0-61	0-16	0-21	0-22	0-60	0-100	0-26	0-10	0-56
October										
Mean catch	8.4	15.0	13.5	2.7	8.6	0.0	0.0	0.0	0.0	0.0
Range	0-23	0-25	0-18	0-9	0-27					

^a Includes yellowfin, bluefin, bigeye, albacore, skipjack, and blackfin tunas, false albacore, Atlantic bonito, white marlin, blue marlin, sailfish, dolphin, king mackerel, bluefish, wahoo, mako, hammerhead, and blue sharks.

^b Mean catch per boat trip

^c Means are based upon the number of trips documented monthly in the sampling effort each year. The number of trips ranged from 36 - 362 in June, 98 - 403 in July, 39 - 242 in August, 19 - 122 in September, and 0 - 5 trips in October for the six years.

and Maryland result in substantial fuel costs. In addition to these forementioned costs, there are many "hidden" costs.

To determine the extent of the monetary outlays made on an annual basis, economic questionnaires were sent to all participating boat captains and owners at the end of each fishing season. Over 40 percent of the survey forms were returned in 1983 (45.8%), 1985 (43.9%), and 1986 (42.2%). However, only 32 percent of the forms were returned in 1987 when a very lengthy survey was sent out late, and 25.7 percent of the forms were returned in 1984 when the logbook collection method was used. The 1987 economic information is not detailed in this report. The information obtained from the returns is useful in characterizing the economic aspect of the fishery. However, there is always the question as to whether the responses received from fishermen accurately portray the percent-

age of fishermen who did not return the survey forms.

During 1983-1986, boat captains averaged 10-12 trips annually with a range of 1 to 80 trips per year. Charter vessels averaged from 15 to 27 marlin and tuna charters per year. Total estimated charter fees were calculated for the 1983-1986 fishing seasons, these fees were lowest in 1983 and greatest in 1985 (Table 13).

Approximately 90 percent of the participants in this study reside in Virginia. The remainder of the Virginia fishery is comprised of residents of Maryland, New Jersey, North Carolina, Pennsylvania, and Delaware.

Demographic information on fishermen was obtained in 1983. The age of the boat captains ranged from 23-73, with an average age of 42 years. These captains had fished in saltwater an average of 21 years, and fished for marlin and tuna an average of 11 years. More than 29 percent of the boat captains responding to the survey had annual incomes of \$80,000 or

more. Ranked second were the \$30,000-\$39,999 and the \$40,000-\$49,999 income ranges, with 16 percent of the boat captains having either of these incomes. Annual incomes ranged from \$10,000-\$19,999 to the \$80,000 and over category.

Fishermen were asked to estimate the original value of all marlin and tuna tackle such as rods, reels, gaffs, lures, hooks, etc., for each fishing season from 1983-1986. The approximate value of this gear increased from \$1,644,400 in 1983 to \$3,500,600 in 1986 (Table 13).

Ranging from 17-55 feet in length (averaging 27-30 feet), these fishing vessels can burn a great deal of fuel during a single trip. Approximately 20 percent of the boats have diesel engines and the rest have gasoline engines. Fuel expenditures declined between 1983 and 1985, perhaps as a result of falling fuel prices. However, in 1986, fuel costs rose again.

Participation in marlin and tuna tournaments has apparently increased

Table 13. Annual and per trip expenditures^a for marlin and tuna trips.

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
<u>Purchase price of boat & outfitings</u>				
Average	\$64,869	55,035	56,822	57,797
Range	\$5,000-468,000	4,500-700,000	1,500-750,000	5,000-750,000
Overall ^b	\$29,515,395	36,653,310	43,980,228	51,208,142
<u>Annual initial boat preparation</u>				
Average	\$3,713	2,357	3,951	2,769
Range	\$0-55,000	0-25,000	0-106,600	0-75,000
Overall ^b	\$1,689,415	1,569,762	3,058,074	2,453,334
<u>Annual slip rental & winter storage</u>				
Average	\$876	806	710	650 ^c
Range	\$0-6,000	0-10,000	0-7,200	-----
Overall ^b	\$398,125	536,796	549,540	575,900
<u>Annual boat insurance</u>				
Average	\$762	648	839	804 ^c
Range	\$0-6,000	0-5,000	0-8,000	-----
Overall ^b	\$346,710	430,902	649,386	712,344
<u>Ice, natural bait, etc. per trip</u>				
Average	\$35	38	43	32
Range	\$4-150	1-150	0-400	2-200
Overall ^d	\$208,320	248,026	247,164	218,400
<u>On-board food & beverages per trip</u>				
Average	\$ ----	----	----	26
Range	\$ ----	----	----	0-150
Overall ^d	\$ ----	----	----	177,450
<u>Meals, entertainment ashore per trip</u>				
Average	\$ ----	----	----	28
Range	\$ ----	----	----	0-300
Overall ^d	\$ ----	----	----	191,100
<u>Original value of tackle</u>				
Average	\$3,615	3,403	3,512	3,951
Range	\$450-25,000	200-25,000	200-20,000	200-26,000
Overall ^b	\$1,644,370	2,266,571	2,718,288	3,500,586

(continued)

Table 13 (continued)

	1983	1984	1985	1986
<u>Fuel cost per trip</u>				
Average	\$165	144	132	119
Range	\$60-500	12-600	23-685	20-500
Overall ^d	\$982,080	939,888	758,736	812,175
<u>Entry fees for tournaments</u>				
Average	\$565	465	364	222
Range	\$0-10,000	0-10,000	0-8,000	0-5,000
Overall ^b	\$257,075	609,690	281,736	196,692
<u>Charter fees</u>				
Average	\$451	481	509	510
Range	\$100-700	175-895	150-650	200-850
Overall ^e	\$270,600	433,381	934,524	663,000
<u>Total expenditures^f</u>	\$4,152,325	4,768,445	6,479,160	6,000,395

^a Total expenditures were calculated by multiplying the average expense by the estimated number of marlin and tuna trips originating from Virginia each year. For 1985 and 1986, the estimates of the total number of trips made during the season by the fleet calculated from the telephone-acquired and dockside-acquired data were averaged to derive one value of effort for use with the economic data

^b Overall=(mean cost)(estimated boat population size)

^c Information not requested in 1986; average of 1985 and 1987 mean expenses

^d Overall=(mean cost)(estimated number of marlin and tuna trips)

^e Overall=(mean cost)(estimated number of charter trips)

^f Value does not include purchase price of boat, outfitings, and tackle

over the course of this study. Between 1983 and 1986, anglers spent the greatest amount on tournaments in 1984 (Table 13). Tournament expenditures may not have really declined since 1984, but may be the same or greater. There is a clear need to refine the information obtained on marlin and tuna tournament fees to determine this trend accurately.

Marlin and tuna fishermen spent more than \$29,000,000 for the initial purchasing of their boats and all outfitings. Seasonal boat preparation costs ranged from \$1,700,000 in 1983 to a high of \$3,000,000 in 1985. Slip rental and winter storage fees are expenses incurred by owners of non-trailerable boats. These costs varied from \$400,000 in 1983 to \$576,000 in 1986. Most boat owners purchase insurance for their boats and these annual expenditures grew from \$350,000 in 1983 to \$712,000 in 1986. Unfor-

tunately, the questions regarding slip rental, winter storage fees, and insurance were inadvertently left off the 1986 economic questionnaire. Therefore, the values listed for 1986 are estimates averaged from the 1985 and 1987 data (Table 13).

Fishermen were asked to estimate their expenses for ice, natural bait, and other perishable items for a typical marlin and tuna trip. Average expenditures were \$32-43 per trip and overall expenditures were more than \$200,000 annually. On-board food and beverage expenses per trip were surveyed in 1986, averaging \$26 per trip and totalling \$177,450 overall. Average expenses for meals and entertainment ashore in 1986 were \$28 per trip and \$191,100 overall (Table 13). Mean total expenses per marlin and tuna trip were calculated on an annual basis. For the 1983, 1984, and 1985 fishing seasons, total average trip

costs included fuel, bait, ice, and other perishable items, while the mean trip cost in 1986 also included on-board food and beverage costs. These figures do not include the costs of replacing lost or damaged gear, parking fees, tolls, gasoline for automobiles, or lodging.

Total expenditures were estimated for each fishing season, ranging from \$4.1 million in 1983 to \$6.5 million in 1985. In 1987, total expenses were an estimated \$6.4 million, reflecting the increase in estimated fleet size, and the inclusion of questions surveying tackle, rod and reel, and auto fuel expenses. These figures are actually too low; they do not include annual cost estimates for new or replacement rods, reels, lines, lures, gaffs, and other tackle, fishing club dues, auto fuel expenses, tolls, or lodging. On-board food and beverage costs, as well those for meals and

entertainment ashore were not included until the 1986 fishing season. In addition, the purchase price of any new boats and outfitings was not solicited on an annual basis.

The initial purchase price of the boats and all outfitings, as well as the original value of all gear and tackle was also surveyed. While these estimates cannot be added to the annual total economic worth without accounting for depreciation, it is interesting to note that estimates of these fixed assets of the fleet, unadjusted for inflation or depreciation, increased from 1983 to 1986. This annual increase in value may be attributed to the greater percentage of the total estimated fleet participating in the study, the entry of new boats to the fishery, inflation, and purchases of new or upgraded boats and gear.

Sea Surface Temperatures—1986 to 1988

Landings of bluefin tuna first occur in late May or early June depending upon, among other factors, sea surface temperature. The bluefin season continues until the water becomes too warm for this species, usually in late July or early August. Bluefin tuna catches typically peak near the end of June or the beginning of July. In 1988, the season began unusually late, probably as a result of persisting cool nearshore waters.

In 1986, fishermen reported catching bluefin tuna at sea surface temperatures ranging from 67-83°F, primarily between 70 and 74°F. In 1987, bluefin tuna were caught in surface waters of 65-86°F, primarily between 70 and 75°F. In 1988, bluefin tuna were caught in sea surface temperatures of 58-81°F, the majority between 68-69°F. This reflects the presence of the cooler nearshore water, which persisted throughout the first part of the season (Figure 9A-C).

Yellowfin tuna predominantly inhabit slightly warmer water than the bluefin tuna, and as a result, fisher-

men pursue them further offshore nearer to the Gulf Stream. This species appears off the Virginia coast in late June and can remain through September or October, depending on weather conditions. The bluefin and yellowfin tuna seasons overlap from late June through July.

During 1986, yellowfin tuna catches were reported by Virginia anglers in sea surface temperatures ranging from 68-86°F, primarily in the 75-82°F range. In 1987, the yellowfin were caught in water temperatures ranging from 68-88°F, primarily 75-82°F. In 1988, catches of yellowfin were made in surface waters measuring 64-85°F, with the majority being landed in 70, 74, and 81°F waters (Figure 10A-C).

White marlin are landed by Virginia marlin and tuna recreational fishermen from June through October depending on weather conditions both early and late in the season. June and October catches are generally made off the coast of North Carolina.

In 1986, white marlin were caught in water temperatures ranging from 69-86°F, primarily at 74°F and 81°F (the two temperature peaks accounting for more than 85 fish). In 1987, catches were reported in temperatures ranging from 70-88°F, centering primarily around 82-83°F. In 1988, white marlin catches were made in surface waters measuring 69-85°F, the majority in 80-82°F waters (Figure 11A-C).

Other factors that can influence tuna and marlin distribution are forage availability, fronts, and bottom topography. This brief discussion of sea surface temperature does not consider other environmental factors such as warm core eddies, which also affect tuna and marlin distribution. A more detailed analysis of sea surface temperatures will be presented in Bochenek's dissertation.

Concluding Remarks

This time series data set for 1983-1988 has documented both good and poor years for Virginia's offshore recreational fishery. Although the documentation indicates that the trends are difficult to define because of the fluctuations in the fishery (and in the survey effort expended annually), some general observations can be made about the principal tuna species and the billfish.

According to the ICCAT and NMFS assessments, the bluefin tuna stock appears to be continuing its general decline overall, although the Virginia fishery experienced improved catch rates since 1985. Yellowfin tuna catch rates were fairly consistent, and do not appear to have had the same upward trend. Blue marlin catch rates have remained constant, but at an extremely low level. White marlin catches declined from a high in 1983, but have been recovering since 1986.

For further information, see the following list of related publications:

- Bochenek, E., and J. Lucy. 1988. A comparison of two sampling methods for analyzing Virginia's recreational marlin and tuna fishery. In: Proceedings of International Billfish Symposium II, August 1-5, 1988, Kailua-Kona, Hawaii. Ed. Richard Stroud. In press.
- Chartier, N. J. 1988. The effects of at-sea killing and storage methods on the quality of recreationally-caught northern bluefin tuna, *Thunnus thynnus*. Masters thesis, School of Marine Science, Virginia Institute of Marine Science, College of William and Mary. 191 pp.
- Eggleston, David B. 1988. Remote sensing of offshore water mass features: present and potential benefits to Virginia's recreational

Figure9A-C. Bluefin tuna catches by sea surface temperature for the 1986-1988 fishing seasons.

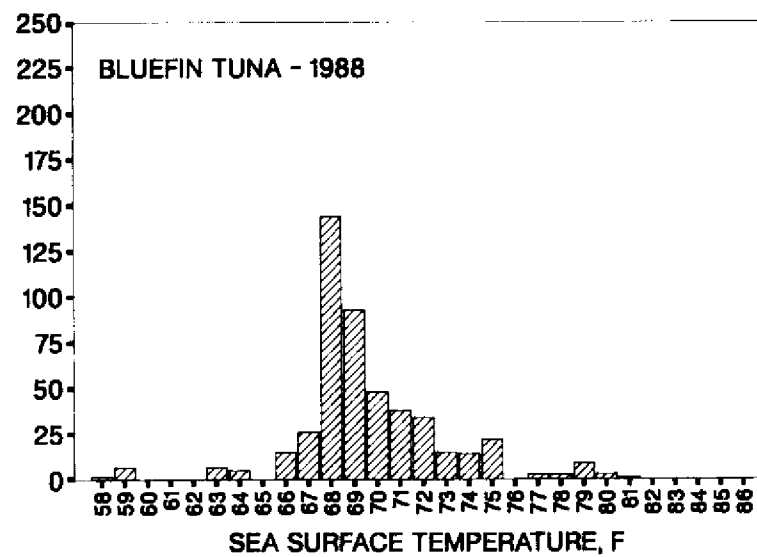
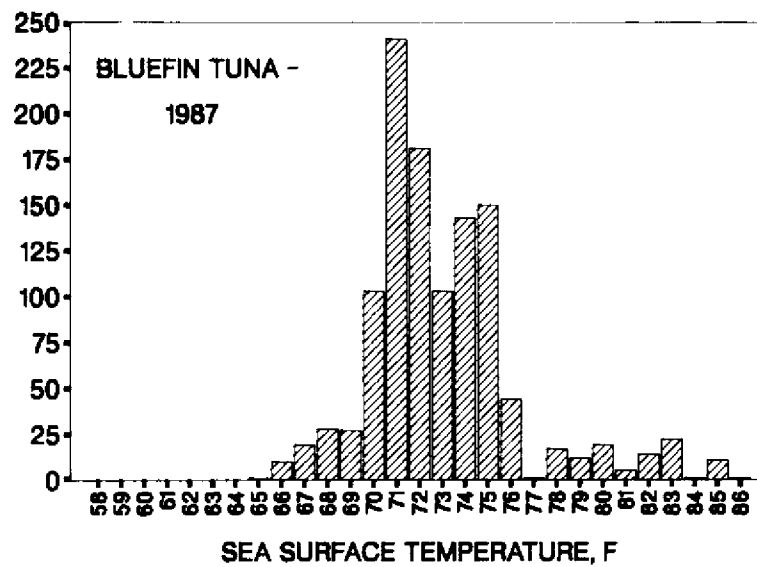
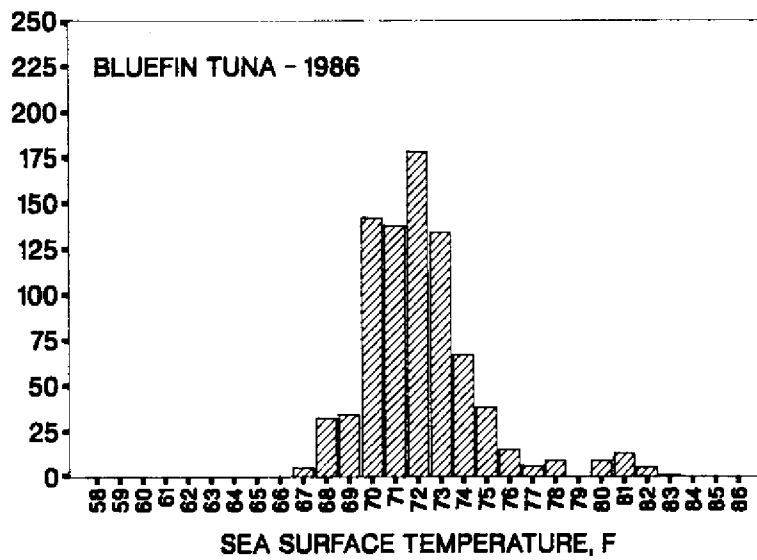


Figure10A-C. Yellowfin tuna catches by sea surface temperature for the 1986-1988 fishing seasons.

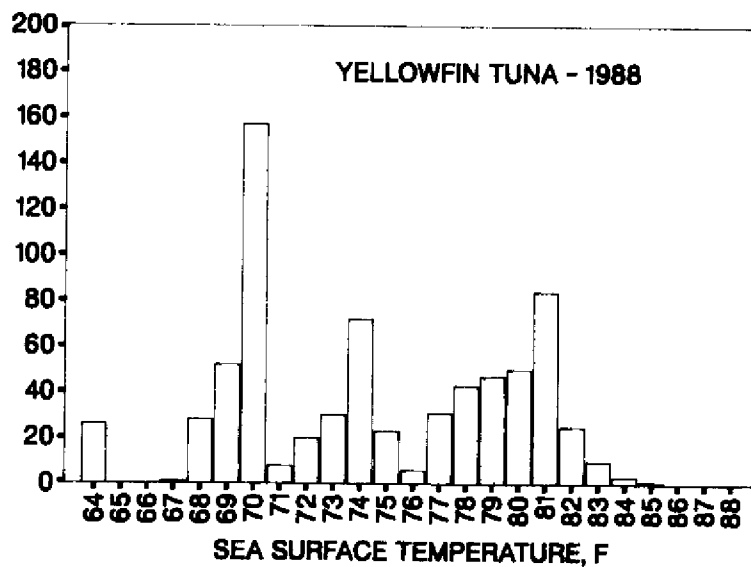
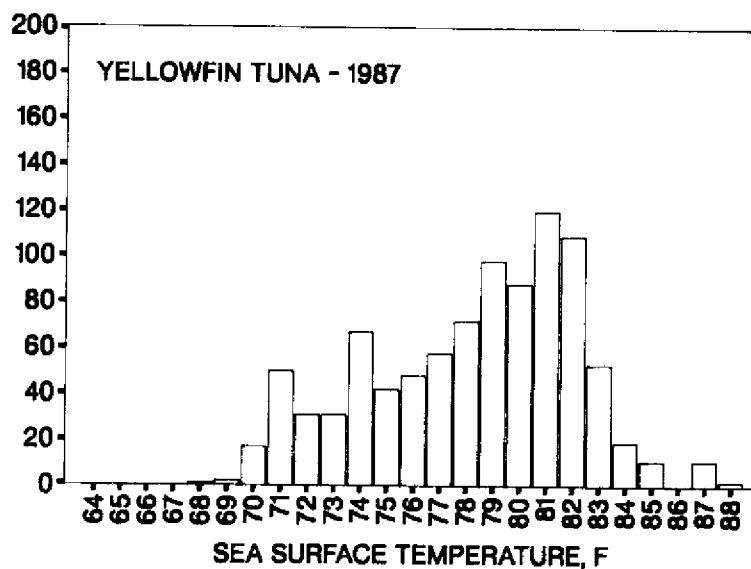
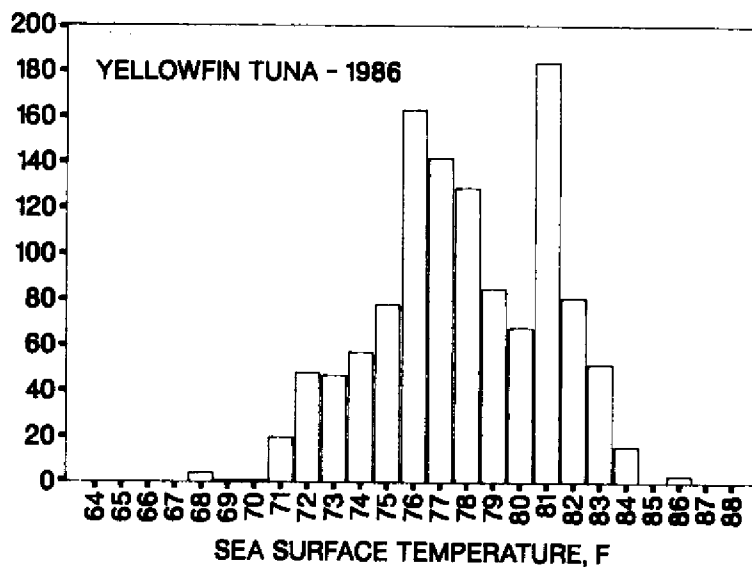
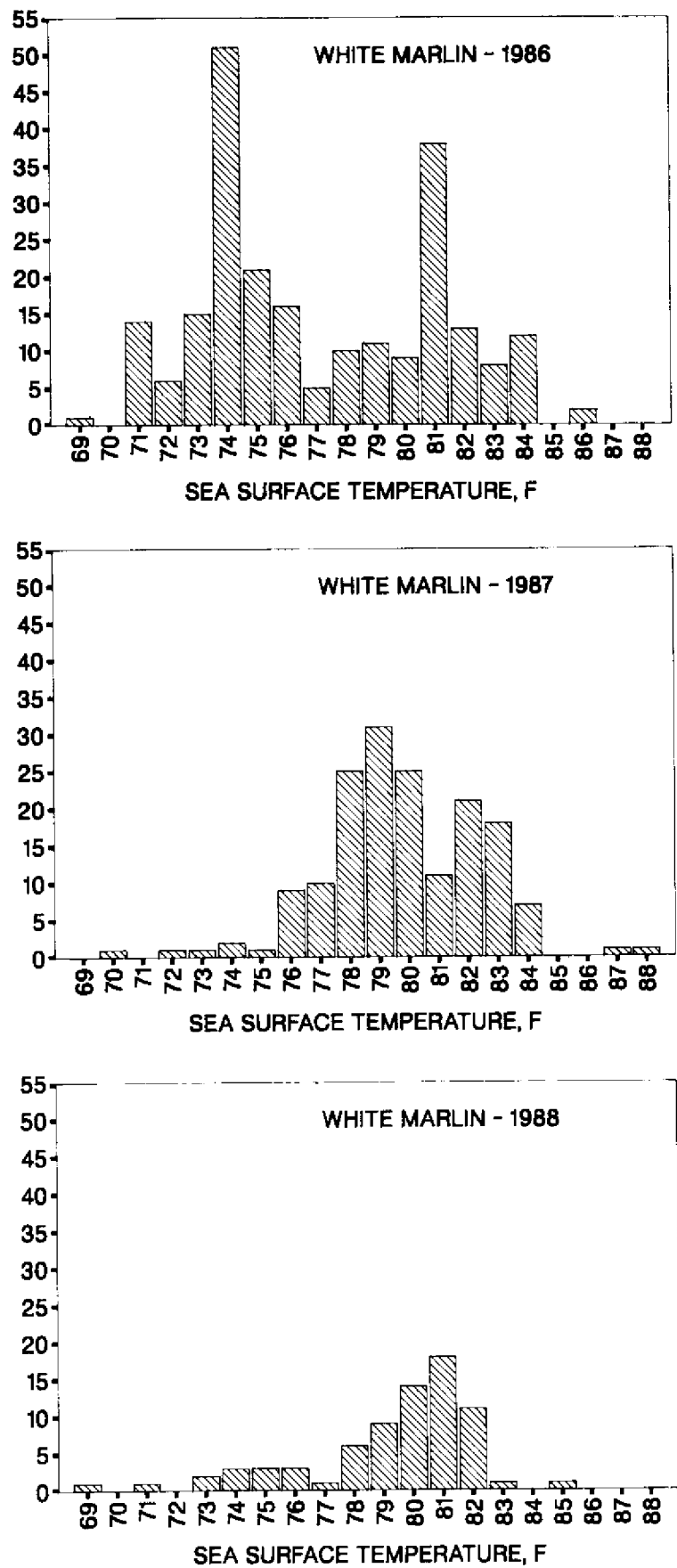


Figure11A-C. White marlin catches by sea surface temperature for the 1986-1988 fishing seasons.



- fishery for marlin and tuna. SRAMSOE No. 295, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062. September. 52pp.
- Figley, W. 1984. Survey of recreational tuna and marlin fishing in the mid-Atlantic, 1983. Summary report for National Marine Fisheries Project: NA-83-FA-D-00001. 8pp.
- Figley, W. 1984. Recreational fishery for large offshore pelagic fishes of the mid-Atlantic coast. Final report prepared for National Marine Fisheries Project: NA-83-FA-D-00001. 66pp.
- Lucy, J., E. Bochenek, and N. Chartier. 1988. Fleet characteristics and boat owners expenditures associated with Virginia's recreational marlin and tuna fishery. In: Proceedings of International Billfish Symposium II, August 1-5, 1988, Kailua-Kona, Hawaii. Ed. Richard Stroud. In press.
- Lucy, J., E. Bochenek, and T. Sminkey. 1988. Analysis of expenditures associated with the recreational fishing fleet utilizing Rudee Inlet, Virginia Beach, Virginia. Special Report in Applied Marine Science and Ocean Engineering No. . Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062. In press.
- Lucy, J., N. Chartier and W. DuPaul. 1988. Catch trends and fish utilization in Virginia's offshore recreational pelagic fishery. Contract report, Wallop-Breux Project No. F-62-R. Submitted to Virginia Marine Resources Commission, Newport News, VA. 44pp.



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