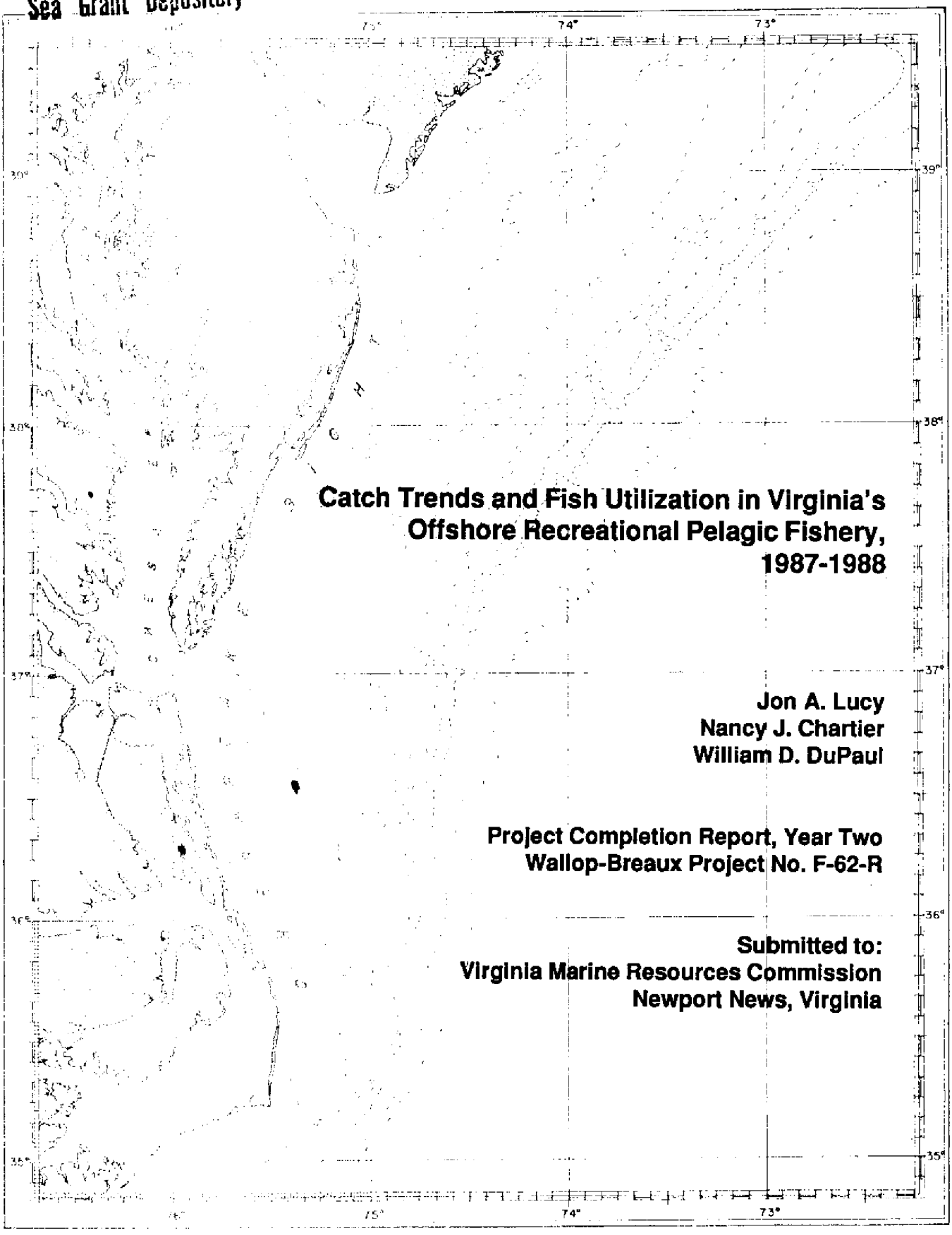

Catch Trends and Fish Utilization in Virginia's Offshore Recreational Pelagic Fishery, 1987-1988

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Project Completion Report, Year Two
Wallop-Breaux Project No. F-62-R

Submitted to:
Virginia Marine Resources Commission
Newport News, Virginia

Department of Marine Advisory Services, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia

Project Completion Report
(Year Two of Two-Year Project)

Wallop-Breaux Project Number F-62-R
(Sport Fish Restoration Act Fund)

Title:

Catch Trends and Fish Utilization in Virginia's Offshore Recreational Pelagic Fishery, 1987-1988

For the Period: January 1, 1988 - December 31, 1988
(Work Period Extended to March 31, 1989

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Ms. Cheryl Teagle of VIMS Sea Grant Marine Advisory Services Program contributed significantly to the smooth working of the project. The draft and final text of the report was prepared by VIMS Word Processing Center and by Ms. Maxine Butler, VIMS Department of Advisory Services. Ms. Butler deserves special thanks for her assistance in coordinating elements of the final report.

Special Note

Users of information contained in this contract report are reminded that the 1986 data and results on which this report is based are derived from ongoing research of Ms. Eleanor Bochenek, Ph.D. Candidate, of VIMS, the School of Marine Science of the College of William and Mary. To protect the academic integrity of Ms. Bochenek's program, the principal and associate investigators of this project request that any use of the 1986 data and results contained within 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, School of Marine Science. College of William and Mary (in preparation).

This work is a result of research sponsored in part by the National Sea Grant College Program of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under Grant NO. NA81AA-D-00025 to the Virginia Graduate Marine Science Consortium and the Virginia Sea Grant College Program. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

INTRODUCTION

The offshore pelagic recreational fishery of the Commonwealth of Virginia supports well over 1000 vessels, better than 60 of which are charter boats. Principally targeting bluefin and yellowfin tuna, white and blue marlin, and dolphin, the fishery accounts for $6-$8 million annually in direct expenditures, not counting purchases of vessels (Lucy et al. 1988a; Bochenek et al. 1989). Offshore catches of bluefish (Pomatomus saltatrix) in late April and May precede the arrival of bluefin tuna (Thunnus thynnus) in late May or early June. False albacore (Euthynnus alletteratus), skipjack tuna (E. pelamis), Atlantic bonito (Sarda sarda), king mackerel (Scomberomorus cavalla), and bluefish also contribute significantly to catches in June but school bluefin, typically 20-40 lb (9-19 kg.) in weight, are the fish principally sought by the fleet. When bluefin schools begin to scatter and move northward in late June, boats range somewhat further offshore in search of yellowfin tuna (T. albacares), white marlin (Tetrapturus albidus), blue marlin (Makaira nigricans) and dolphin fish (Coryphaena hippurus) (Bochenek et al. 1989; Bochenek in prep.). Frequently targeting areas along the edge of the continental shelf in July through September, the fleet also catches a few sailfish (Istiophorus platypterus), wahoo (Acanthocybium solanderi), mako shark (Isurus oxyrinchus), and occasionally bigeye tuna (T. obesus). Catches of yellowfin, white marlin, and dolphin are the mainstay of the fishery after June. The majority of white and blue marlin catches are released.

OBJECTIVE

The objective of the second year of this two-year study was to expand the catch and effort data base for Virginia's recreational fishery for tuna and marlin while concluding the study of tuna handling practices in the fishery. The results of the study will better define catch trends for tuna and billfish species off Virginia's coast while also contributing to a more extensive Atlantic coast data base being developed cooperatively by the Northeast and Southeast Fisheries Centers of the National Marine Fisheries Service (NMFS). Bluefin tuna catch data will also be utilized by the NMFS to evaluate stock trends of this species as part of fishery management recommendations to the International Commission for the Conservation of Atlantic Tunas (ICCAT).

METHODS

Methods used to collect data on the pelagic recreational fishery involved directing survey efforts at boat captains of charter boats and owners of private boats active in the fishery (making two or more trips for marlin and/or tuna per season). Boat captains and owners were systematically interviewed, primarily on weekends, at marina facilities in Virginia Beach (primarily Rudee Inlet and to a lesser extent the Lynnhaven and Little Creek areas) about fishing trips made for marlin and tuna.

Captains and owners of boats were "randomly" interviewed as they were encountered at the fuel dock, tying up their boat or loading their boat on a trailer, as in the previous year of the study (Lucy et al. 1988b). Data on area fished, catch, actual trolling time, number of anglers on board, number

of lines fished, number of fish released, etc. was gathered (Bochenek et al. 1989; Lucy et al. 1988b; Appendix). Dockside sampling effort was reduced approximately 50% in 1988 compared to 1987 (Lucy et al. 1988b). The reduction in effort was the result of NMFS funding for temporary fishery reporting aides (port samplers) being unavailable in 1988 for Virginia's large pelagic fishery. A NMFS commercial fishery port sampler, however, was available several weekday afternoons during much of the fishing season to conduct dockside interviews with captains targeting marlin and tuna at Rudee Inlet. The reduced sampling effort required nearly total elimination of dockside interviews at the port of Wachapreague on the Eastern Shore, a principal port of departure for charter and private boats in the fishery. Data on fishing trips out of Wachapreague, however, were captured in the telephone survey.

Dockside sampling of boats in 1988, unlike the 1987 season, was delayed until the last week of June (some weekdays and the last weekend were sampled). Cool water temperatures and windy weather kept many boats at the dock during earlier June weekends, contributing to the late start. Boat captains and owners were interviewed during five weekends in July, three in August, and two in September. Sampling was also conducted on scattered weekdays (Wednesday, Thursday, or Friday) during each week in July and August and three weeks in September. Dockside interviews were not attempted in October because few boats were fishing. As in 1987, boats participating in most major marlin and and or tuna fishing tournaments were sampled at the docks, including the Eastern Shore Marlin Club Release Tournament at Wachapreague.

The telephone survey portion of the study was conducted as in 1987 (Lucy et al. 1988b) but at a reduced level of effort due to NMFS funding

constraints. Only thirty captains and owners were randomly contacted by telephone during each sampling period (weekly during June through August, biweekly in September and once at the end of October), a 38% reduction from the 48 interviews obtained per sampling period in 1987. Telephone interview procedures followed those utilized during year one of the study (Lucy et. al. 1988b). All data were entered into the PRIME mainframe computer at VIMS and analyzed using SPSS-X statistical packages.

RESULTS AND DISCUSSION

Compared to 1987, the 1988 fishing season's dockside and telephone sampling program collected data on significantly fewer numbers of marlin and tuna trips. Dockside interviews captured data on 376 trips (a 47% reduction from 1987) and telephone interviews accounted for 244 trips (a 21% reduction from 1987). As mentioned in the methods section, these reduced sample sizes reflect the loss of NMFS Large Pelagic Recreational Survey port sampler funding (two full-time equivalent positions) for the 1988 season, not necessarily reduced effort in the fishery. Reduced manpower for the study also largely restricted the dockside sampling effort to Rudee Inlet in Virginia Beach, currently the home port for slightly more than 50% of Virginia's marlin and tuna fishing effort, as determined from telephone interviews (Table 5).

As referenced in the year-one study report (Lucy et. al. 1988b), two questionnaires were jointly mailed to 604 boat captains and owners in the spring of 1988, one pertaining to expenditures and estimation of the fishery's fleet size while the other addressed handling practices and disposition of tuna. The questionnaires elicited a 32% response rate and

provided data for calculating fleet size based upon the Lincoln-Peterson Index and the Mark and Recapture Method (Giles 1971; Figley 1984). Based upon the response, an estimated 1021 vessels fished from Virginia ports during 1987 targeting marlin and/or tuna; of these, 68 were charter vessels. Data are currently being collected via telephone interviews to provide estimates of the fleet's size in 1988 and 1989.

Selected results of the questionnaire on catch handling practices for tuna is presented in the following section along with a brief summary of field and laboratory experiments examining effects of handling and storage on bluefin tuna (Chartier 1988; Chartier et al. 1989).

Catch Handling and Disposition

The boat use characteristics of the respondents to the catch handling questionnaire were: 162 private boat owners and captains, 12 charter boat owners and captains, and 16 boat owners and captains whose vessels were used for both private and charter trips throughout the 1987 season.

Icing

Most recreational boats carried portable coolers (75.4%) and/or fishboxes (62.8%) for on-board fish storage. Refrigerated fishboxes were on 2.6% of the boats, while 1.1% were equipped with a refrigerator and freezer. On-board washdown capability existed on 66.5% of the vessels covered by the responses. On average, fishermen carried about eighty pounds of ice per trip, usually combinations of two types (crushed, cubed, or block). Ninety respondents used block ice, averaging 56 pounds per trip. Cube ice was

carried by 136 fishermen, averaging 58 pounds per trip, while an average of 64 pounds of crushed ice per trip was used by 37 fishermen. Just under half (49.2%) of the respondents increased the amount of ice carried as temperatures increased during the season.

Of those fishermen who used block ice, 28.9% rotated their fish around in the cooler and fishbox; 2.2% rotated only yellowfin tuna.

Handling Methods

Several methods for killing and storing tuna were used by fishermen (Table 1). Postmortem handling and storage methods often depended upon the time available and the size of the tuna.

About one-third of the fishermen indicated that they handled tuna differently from other pelagic species. Techniques mentioned included (number of responses in parentheses): bleeding (19), bleeding and gutting (15), using more ice (13), packing ice in the body cavities (6), filleting immediately (1), using ice brine (3), handling more carefully (3), and plans to bleed and gut tuna offshore in 1988 (2). The vast majority of fishermen whose boats were used for both private and charter trips during 1987 indicated that tuna handling was not influenced by the type of trip being made.

Fishermen were asked if there were any occasions during 1987 when too many bluefin and/or yellowfin tuna were caught to fit in the coolers or fishboxes. The breakdown and the resulting action taken by the fishermen are indicated in Table 2.

One question focused on changes in handling and/or storage methods resulting from the number of bluefin or yellowfin tuna landed on any

particular day. About 24% of the fishermen responding to the question indicated that handling was affected by the number caught. From these responses the explanations which were provided included: stopped fishing after cooler or fishbox was filled or caught as many as could use (23%), tagged and/or released the rest (7%), filleted some to make room in the cooler (26%), left extras on deck covered with towels or in trash or body bags of ice (14%), amount of care taken depended on the fishing action (fast or slow) (14%), icing distribution varied depending on the number of fish caught, creating a need to rotate the fish and return to port as soon as possible (16%).

Catch Disposition

The majority of the tuna were kept by the fishermen. However, a substantial percentage were sold (Table 3).

Spoilage

The number of fishermen that encountered any spoilage of tuna in 1987 was small: 3.4% with bluefin and 2.8% with yellowfin. Freezerburn was the predominant problem. No respondents indicated that illness had occurred as a result of ingesting either bluefin or yellowfin tuna during 1987.

Background on Handling Methods

Fishermen were surveyed to determine their knowledge of the proper care of tuna. Over 51% had acquired information from one or more sources.

Seventy-five percent had read articles or brochures; more than eleven percent had attended the Tuna Utilization Workshop sponsored by VIMS Marine Advisory Services, June 1987; just under three percent attended a tuna workshop in North Carolina, May 1987; and eleven percent had acquired information from club meetings and speakers, Japanese buyers, newspapers, sport fishing magazines, retailers or markets, or other fishermen.

As a result of learning more about recommended handling methods for tuna, 53.2% of the fishermen indicated that their handling of tuna had changed.

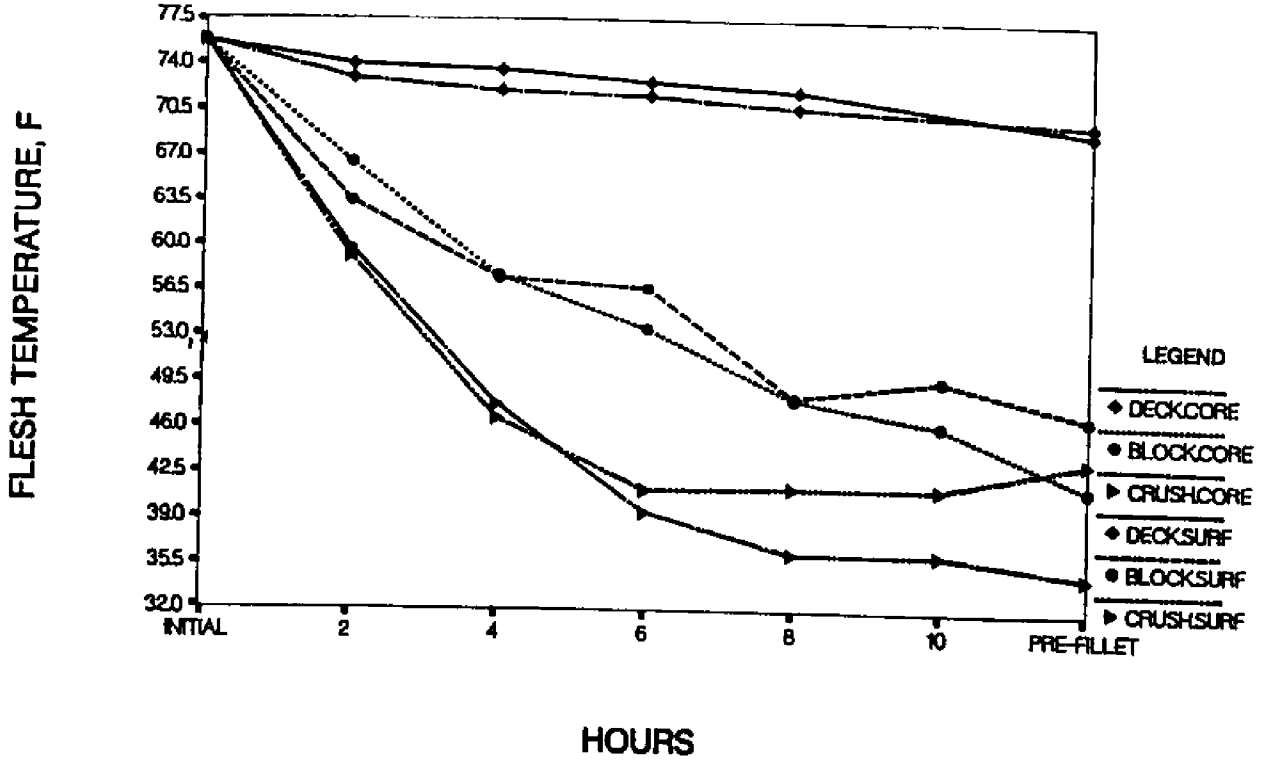
Field and Laboratory Experiments - Bluefin Tuna

Dockside observations and flesh temperatures support concerns over the current handling of many recreational catches. Inadequate icing appears to be the primary problem in maintaining the quality and safety of these catches.

The manner in which a bluefin tuna is stored at sea does affect the cooling rate and temperature of its flesh (Chartier et al. 1989). An ice slurry/crushed ice combination is significantly superior to block ice or no ice in terms of consistent and rapid cooling rates for tuna, and in most cases, quality and freshness retention. Storage of fish un-iced or on deck in ambient conditions is a poor and unacceptable practice, in terms of cooling rates, quality, safety, and potential wastage (Figure 1).

Variability in flesh temperatures and cooling rates does affect the quality and shelf life of a fish product. Cold stable storage temperatures should be maintained to prevent acceleration of bacterial growth. Tuna that will be consumed within two to three days may be stored in a refrigerator.

Figure 1. Comparison of the relative rate of change in surface and core flesh temperatures of bluefin tuna stored at sea in ice slurry/crushed ice (crush), on block ice (block), and un-iced on deck (deck). (Standard starting flesh temperature of 77°F).


FLESH TEMPERATURE, F
77.5
74.0
70.5
67.0
63.5
60.0
56.5
53.0
49.5
46.0
42.5
39.0
35.5
32.0
INITIAL
2
4
6
8
10
PRE-FILLET
HOURS
LEGEND
DECKCORE
BLOCKCORE
CRUSHCORE
DECKSURF
BLOCKSURF
CRUSHSURF

If immediate consumption is not planned, it is advisable to freeze or can the meat.

Quality and freshness indicators do relate to the amount of stress experienced by a tuna during harvest and subsequent handling. Although pH measurements failed, sensory assessments and to a lesser degree, torrymeter scores, exhibited some differences in the rates of decline by storage and killing methods (Table 4). Fighting time was approximately the same for all tuna, and although contributing to the overall stress placed on each tuna, did not show any significant differences between individuals. Sensory assessment of tuna freshness was found to be a better indicator than torrymeter readings (Table 4).

The killing methods used did not prove to be as significant as storage methods in influencing spoilage rates of these small school bluefin. It cannot be stated unequivocally at this time that killing tools produced superior results over clubbing or even natural death with the study tuna. It is anticipated that the differences become more obvious with larger tuna. The incidence of burnt tuna was minimal. The use of a brain spike and taniguchi tool to minimize the occurrence of BTS in larger fish as well as to eliminate thrashing and bruising is recommended. The taniguchi tool is difficult to use on the smaller fish.

Weight and stomach fullness were inconsistent factors in influencing the rate of quality decline in these tuna. In some cases, a negative influence on quality was noted. However, in tuna of similar condition, little or no effect was apparent.

The large number of uncontrollable factors influencing the spoilage rate of a tuna support the need to take as much care as possible with each fish. It would have been useful to have measured histamine levels in the

muscle tissues of these tuna. Since histamine production is accelerated by warm temperatures, tuna left on deck in ambient conditions are prime candidates for histidine decarboxylation (Eitenmiller and DeSouza 1984; Taylor et al. 1984; Frank and Yoshinaga 1984). These measurements would have given some indication of the speed of histamine production in recreational catches of bluefin tuna under certain conditions.

Personal observations had shown that information on recommended handling techniques for recreational catches has already begun to have a positive impact on some members of the recreational fishery.

Catch and Effort Trends

Fishing Effort

Fishing effort out of Virginia ports for marlin and tuna, determined by random telephone interviews of identified boat captains and owners, exhibited a similar pattern in 1988 to that for 1987 (Table 5). The most popular port was Rudee Inlet, accounting for 51% of the trips captured in 1988 telephone interviews. Lynnhaven Inlet, Wachapreague Inlet, and Little Creek, in descending order, accounted for nearly all of the remaining effort. The four ports cumulatively represented 92% of the fishing activity.

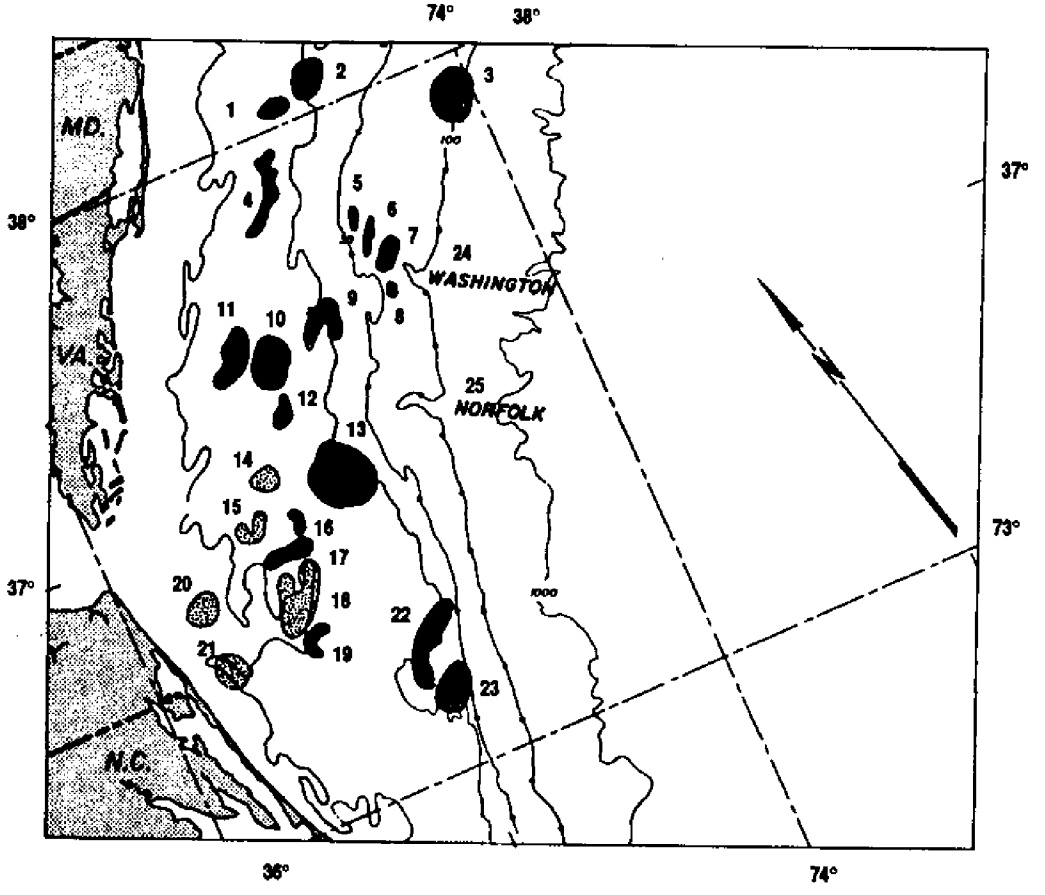
Restrictions in manpower for the 1988 dockside sampling effort, as expected, produced significant changes in the distribution of dockside trip interview data. Compared to 68% of all such interviews being obtained from Rudee Inlet in 1987, 85% of the 1988 data collected dockside was from Rudee (Table 5). The change in distribution of the dockside sampling effort also affected the relative contribution of charter boat trip information to the

data set (Table 5). Accounting for 34% of the dockside sample in 1987, charter trips represented 64% of the total dockside data set in 1988. The distribution of charter and private trips changed only slightly from 1987 to 1988 in the telephone sample data set, declining from 21% to 17% (Table 6).

Fishing effort parameters remained relatively constant over the two years of the study. Number of anglers per trip, number of lines fished, and number of hours trolled varied only slightly between dockside and telephone interview data sets (Table 7). Dockside interview data indicated an increase in the number of lines fished per trip from 1987 (6.2 lines) to 1988 (6.8 lines), most likely a result of the increased proportion of charter trips in the 1988 sample. Charter boats fished an average of 7.0 lines per trip in 1988 compared to 6.3 lines for private boats as determined from interviews at the docks.

Popularity ranking of fishing areas targeted by the Virginia fleet (Figure 2) remained relatively unchanged from 1987 to 1988 (Table 8). The "Cigar" accounted for 18-20% of the trips sampled at the dock in both years, making it the most popular area fished according to the dockside data set. The area maintained a fourth place ranking in the telephone interview data during both years. The Norfolk Canyon area was the second most popular fishing area in 1988 dockside interviews. but dropped from third to sixth in popularity in the telephone interview sample. In the dockside sample it tied for second place ranking with the "Fingers", this area ranking first in the telephone interview sample. The "Hot Dog" ranked third in popularity in both dockside and telephone interviews. The "26 Mile Hill" off Wachapreague, while dropping to sixth in the 1988 dockside set from second in 1987, ranked second in the 1988 telephone data. In summary, 1988 dockside interviews indicated the "Cigar", Norfolk Canyon, "Fingers", and

Figure 2. Specific fishing areas targeted by Virginia's pelagic recreational fishing fleet when seeking marlin, tuna or king mackerel.



Tuna and Billfish Grounds Off Virginia

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

the "Hot Dog", in that order, to be the most popular fishing areas. Telephone sampling of boat captains and owners, however, indicated the ranking to be "Fingers", followed by "26 Mile Hill" and the "Hot Dog". The second place ranking of the "26 Mile Hill" in the 1988 telephone data moved the "Cigar" area to fourth place. The inability to conduct dockside interviews at Wachapreague during 1988, except during one marlin tournament, likely resulted in the disproportionately low ranking (sixth place) of the "26 Mile Hill" in the 1988 dockside data.

Catch Rate Trends

Monthly catch rates in 1988 for key species targeted by the Virginia fleet followed the typical pattern of the fishery (Table 9). Bluefin catches dominated the fishery in June. While dockside interview data indicated relatively constant catch rates for bluefin during June of 1987 and 1988, the telephone data showed an apparent decline in catch rate between the two years. Previously mentioned changes in the proportion of interviews representing charter trips between the two years in the dockside data set may be influencing comparisons of the fleet's overall catch rates. This possibility is being examined in more detail (Lucy and Chartier 1989).

Yellowfin tuna, marlin, and dolphin catches dominated the fishery in July (Table 9). As with bluefin, the dockside data catch trend for yellowfin was different from that defined by the telephone data set, again possibly the result of a significant increase in the proportion of dockside data representing charter trips during 1988. Yellowfin catch rates peaked in July with the exception of a few very good catches recorded from telephone interviews in October.

White and blue marlin catch rates remained relatively constant across both dockside and telephone interview data sets in July of 1987 and 1988. September marked the highest catch rates for both species in each year. The 1988 catch rates for September, however, indicated a decline compared to the same period in 1987 (Table 9).

Dolphin catch rates showed some improvement in 1988 during the middle of the season but dropped off slightly in September, in comparison to 1987. Peak catch rates occurred during August with a few good catches also recorded in telephone interviews for October. Dockside and telephone data trends were relatively consistent between years for dolphin.

A broader perspective of the pelagic fishery is gained by examining seasonal catch rates of all major species contributing to the catch (Table 10). While the dominance of the five "key" species is obvious, the importance of other associated species also becomes apparent. Overall seasonal catch rates for skipjack tuna and bluefish were similar to that for bluefin tuna in the 1988 dockside sample. False albacore were also important in providing boats with fish to catch during both 1987 and 1988. King mackerel, Atlantic bonito, and wahoo made significant contributions to seasonal catches in both years, with king mackerel making the strongest contribution of the three species. Sailfish catches also helped diversify offshore trips during 1988.

Examining the combined catch rate for all pelagic species indicated some improvement in the fishery from 1987 to 1988 if only the dockside data set is considered. The telephone data set indicated no change in mean catch rates between years for combined catches of all pelagic species.

Annual trends in the fishery for each of the five major species targeted by the fleet are presented in Table 11 and Figures 3-5. Bluefin

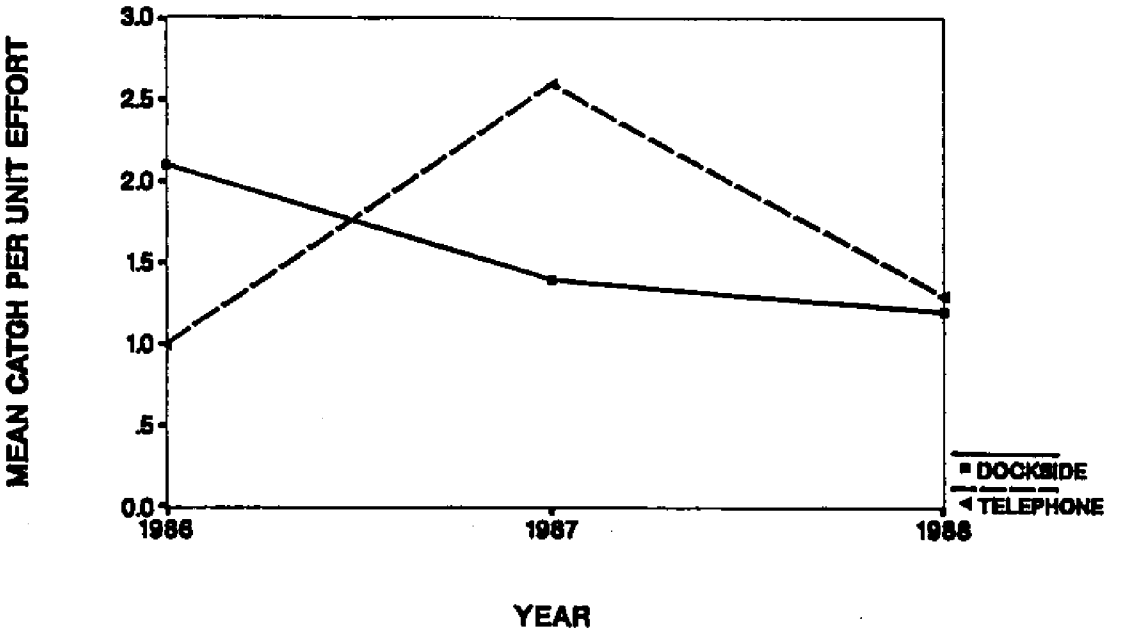
tuna catch trends are inconsistent between the dockside and telephone interview data sets for 1986 through 1988. Dockside sampling of boats indicated a net decline in catch rates from 1986 while the telephone data indicated an increase in catch rates from 1986 to 1987 with a decline from 1987 to 1988 (Table 11 and Figure 3). As mentioned in the year-one report (Lucy et al. 1988b), the increase in catch rates indicated by 1987 telephone data was likely the result of interviewers capturing a few trips where boats "limited out", catching four bluefin per person, while the dockside sampling effort did not capture such trips. Preliminary analysis of the 1987 and 1988 data sets, when examining private and charter boat data separately, indicates a decline in mean seasonal catch rates occurred in both components of the fishery for bluefin from 1987 to 1988 (Lucy and Chartier 1989). The apparent decline for charter boats in the dockside data set, however, was not statistically significant between the two years. It is noteworthy that citations for tuna (bluefin, yellowfin and bigeye are combined) from the Virginia Saltwater Fishing Tournament also declined from 1987 to 1988, these being "trophy" fish weighing a minimum of 75 pounds (34 kg) (VSFT 1986-88; Bochenek et al. 1989).

Yellowfin tuna exhibited more consistent catch rate trends than bluefin in the dockside and telephone interview samples. Catch rates did not vary to the same degree as bluefin tuna with catches only ranging between 1.8 and 1.0 fish per boat trip from 1986 through 1988. A slight net decline in catch rate demonstrated by the telephone interview sample from 1986 to 1988 was not confirmed by the dockside sampling program (Table 11 and Figure 3). Yellowfin catch rates appear to have been relatively stable over the three year period but more attention may need to be paid to possible differences

Figure 3. Mean annual catch rate trends (catch per boat trip) for bluefin and yellowfin tuna in Virginia's pelagic recreational fishery, 1986-1988.

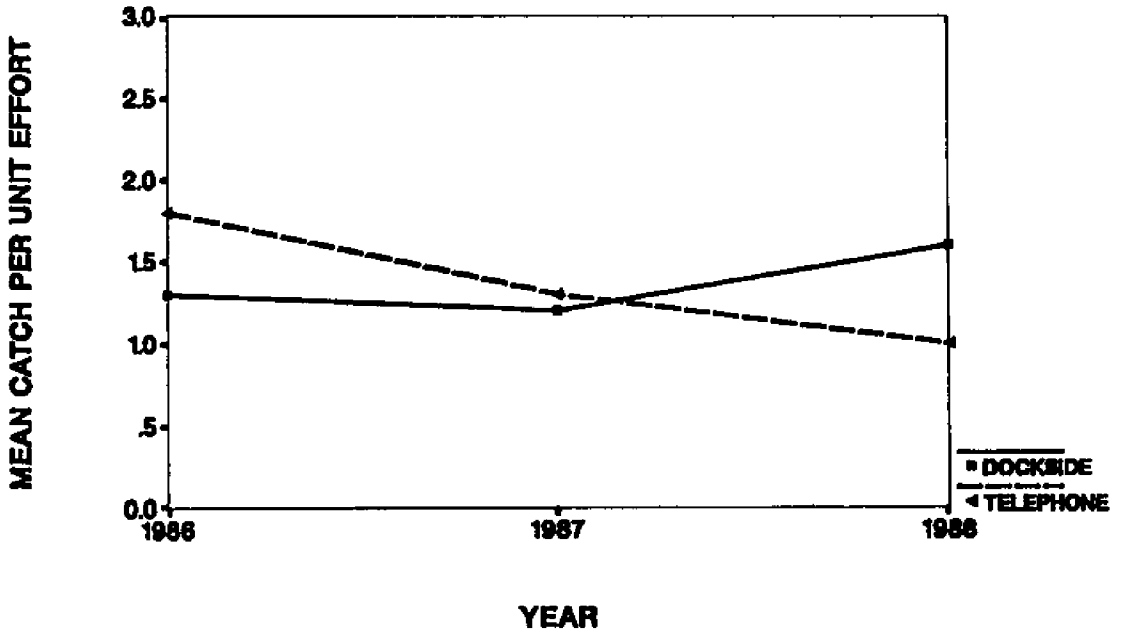
MEAN CPUE FOR BLUEFIN TUNA

1986-1988



MEAN CPUE FOR YELLOWFIN TUNA

1986-1988



in catch rates between private and charter boats and the influence this may have on the catch trend curve (Lucy and Chartier 1989).

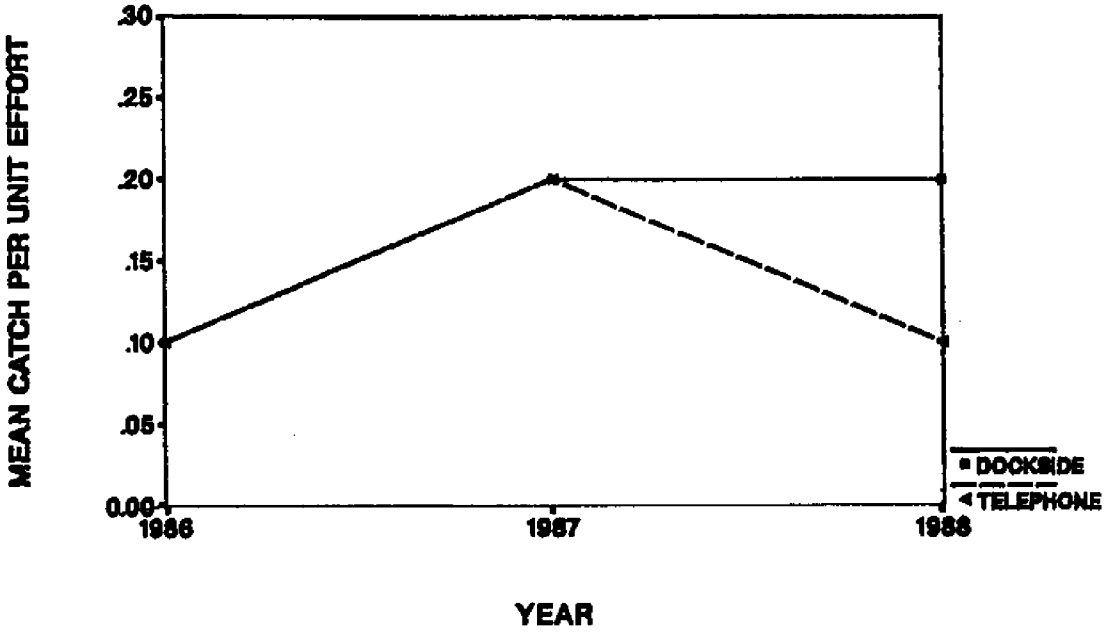
White marlin catch rates were consistent for dockside and telephone data sets from 1986 to 1987 but not from 1987 to 1988 (Table 11 and Figure 4). Although only increasing from 0.1 to 0.2 fish per boat trip, the differences indicated in the dockside data were significant in comparing 1986 to the higher catch rates of the latter two years. The apparent decline in catch rate in the telephone data set from 1987 to 1988 was not significant. As was argued in the year one report (Lucy et al. 1988b), however, the telephone interview process is more random and more representative of the fishery since it samples boat captains and owners fishing out of all ports, not only those ports sampled in the dockside survey program. For this reason the referenced "insignificant" decline in catch rates for white marlin observed in the telephone data may be indicative of a slight downturn in the fishery. Catch and release citation data from the Virginia Saltwater Fishing Tournament indicated a 40% reduction in total white marlin citations from 1987 to 1988 (VSFT 1987-88; Bochenek et al. 1989). Virginia's fishery continues to exhibit one of the highest release rates for white marlin along the Atlantic coast, releasing 88%, 84% and 88% of all fish caught during 1986, 1987 and 1988 respectively (dockside and telephone catch-release data combined) (Bochenek et al. 1989).

Blue marlin catch rates remained relatively constant from 1986 to 1988, ranging only from 0.01 to 0.03 fish per boat trip in both dockside and telephone interview data sets (Table 11; Figure 4). A blue marlin catch is a relatively rare event compared to catches of other major species, the catch rate being an order of magnitude less than catch rates for white marlin. Because of the low catch rate, significant changes in catch rates

Figure 4. Mean annual catch rate trends (catch per boat trip) for white and blue marlin in Virginia's pelagic recreational fishery, 1986-1988.

MEAN CPUE FOR WHITE MARLIN

1986-1988



MEAN CPUE FOR BLUE MARLIN

1986-1988

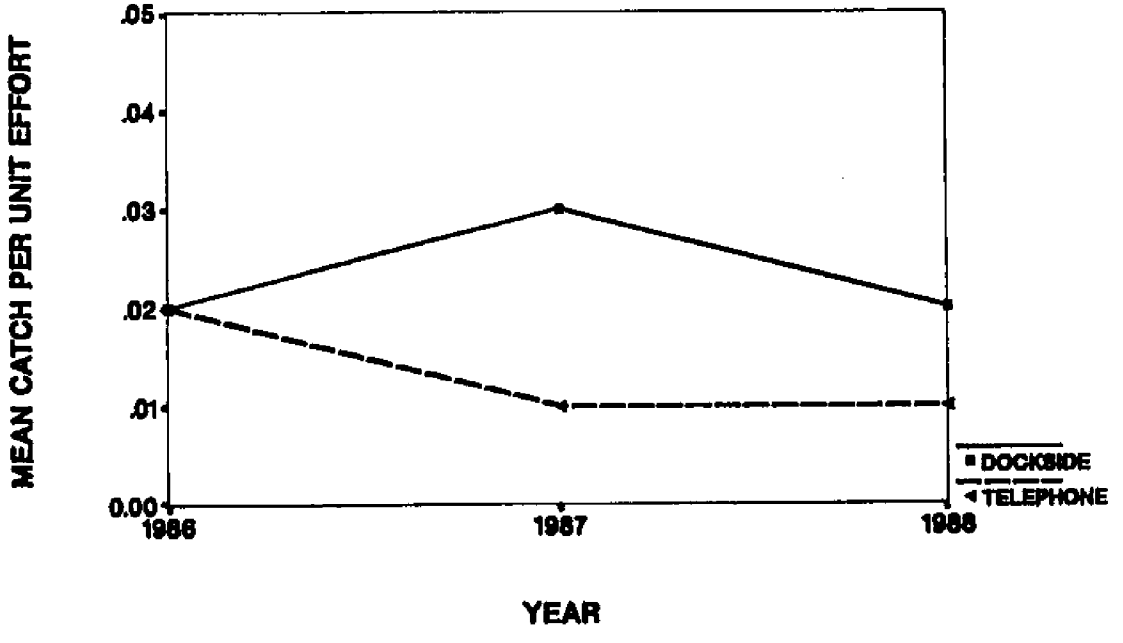
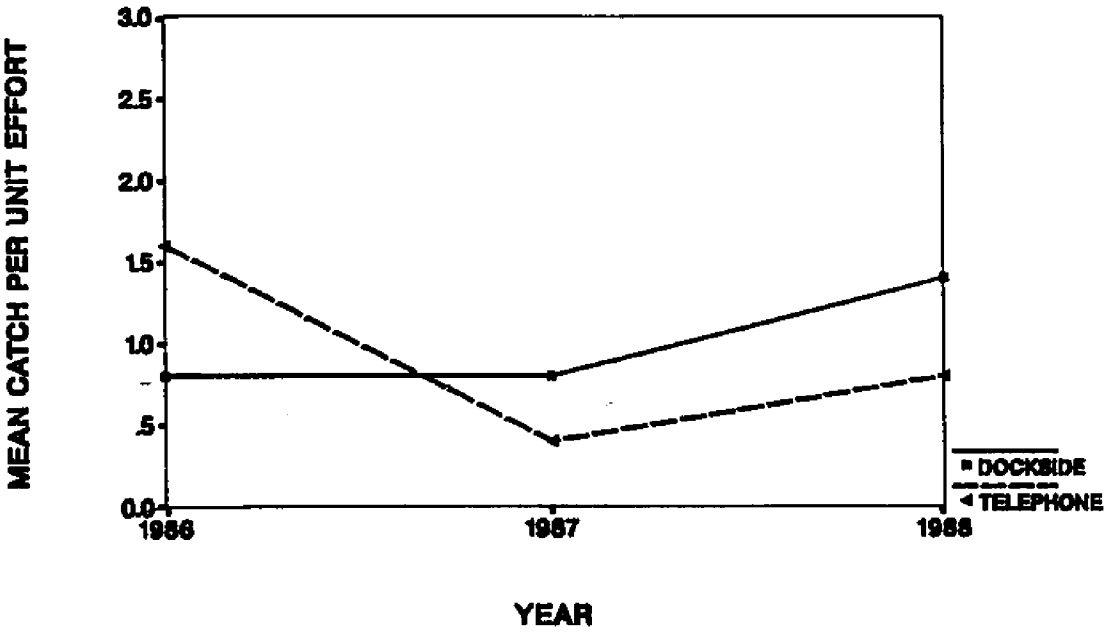


Figure 5. Mean annual catch rate trend (catch per boat trip) for dolphin in Virginia's pelagic recreational fishery, 1986-1988.

MEAN CPUE FOR DOLPHIN

1986-1988



are difficult to observe from year to year. While no decline in catch rate could be documented in this study's sampling effort, the Virginia Saltwater Fishing Tournament citation records for kept and released blue marlin declined 42% from 1987 (55 total citations) to 1988 (32 total citations). This decline could indicate some reduction in overall fishing effort in 1988 but no data is currently available in the tournament records to properly evaluate this possibility. Blue marlin release rates increased in Virginia's fishery from 60% in 1986 to 84% and 88% in 1987 and 1988, respectively (VSFT 1986-88; Bochenek et al. 1989).

Dolphin catch rates showed slight, but statistically insignificant, improvement from 1987 to 1988. Dockside data indicated catch rates almost doubling from 0.8 to 1.4 fish per trip over the two years with the same approximate relative rate of improvement observed in the telephone data set (Table 11; Figure 5). That both data sets showed no statistically significant increases in dolphin catch rates from 1987 to 1988 indicates that catch rates remained relatively stable over the two year period. Virginia citations for dolphin (fish weighing a minimum of 20 pounds or 9.1 kg.) increased 40% from 1986 to 1987 (87 citations) but declined 46% from 1987 to 1988 (VSFT 1986-88). These changes indicate considerable variation in the availability of larger dolphin to the fishery. The majority of dolphin taken by the Virginia fleet, however, are "chicken" dolphin weighing well under the Virginia Saltwater Fishing Tournament citation minimum.

CONCLUSION

The second year of this study, in spite of reduced sampling effort compared to 1987, produced a comprehensive set of data characterizing

Virginia's pelagic recreational fishery. In general, catch trends for tuna, marlin and dolphin appear to have been relatively stable since 1986 although a slight decline in the catch rate of school bluefin tuna may have occurred. Continued monitoring of the fishery will be required to detect significant changes in catch rates of those species on which the fishery depends. The importance of the fishery to Virginia and other Atlantic coastal states warrants such monitoring efforts.

Handling and storage problems associated with tuna catches, particularly bluefin, have been analyzed. Icing techniques typically practiced aboard boats in the fishery and laboratory experiments comparing meat quality degradation rates under various icing protocols indicate improvements in icing practices would improve quality of fish landed at the dock. By focusing attention on icing problems associated with high internal temperatures characteristic of tuna, the study has already positively affected catch handling practices aboard some charter and private boats.

Table 1. Handling methods at sea for bluefin and yellowfin tuna.

Handling Methods	Bluefin only	Yellowfin only	Both species
Killing Method			
Clubbed	1.1 %	1.6 %	21.8 %
Left on deck to die	0.5 %	0.5 %	3.7 %
Put in cooler/fishbox to die	1.6 %	5.3 %	63.8 %
Taniguchi tool	----	----	1.1 %
Gutted	----	----	2.1 %
Bled offshore	----	----	9.6 %
Released fish	----	----	1.1 %
Storage Method			
Ice brine	----	----	0.5 %
Bled & gutted offshore, packed cavity with ice	----	----	1.6 %
Left tuna intact, cleaned dockside	1.1 %	2.1 %	43.0 %
Left tuna intact, cleaned at home	----	1.6 %	15.6 %
Gutted offshore, filleted dockside	0.5 %	----	7.5 %
Filleted offshore	0.5 %	0.5 %	4.3 %
Bled offshore, gut & fillet dockside	----	1.0 %	21.0 %
Bled & gutted offshore, filleted dockside	----	----	16.7 %

Table 2. Frequency of fishermen catching too many tuna to store properly during a trip and breakdown of their resulting action.

Situation/Result	Bluefin only	Yellowfin only	Both species
Too many tuna per trip	7.6 %	11.1 %	8.2 %
As a result:			
Released extras	14.3 %	14.3 %	10.7 %
Tagged and released extras	3.6 %	3.6 %	1.8 %
Gutted and filleted extras	8.9 %	12.5 %	1.8 %
Left extras on deck	8.9 %	8.9 %	10.0 %

(More than 80% of the tuna left on deck were covered in some way.)

Table 3. Disposition of 1987 bluefin and yellowfin tuna catch that were sold.

Disposition	Bluefin only	Yellowfin only	Both species
Sold tuna	7.2 %	9.5 %	----
- to restaurants	3.3 %	23.3 %	16.7 %
- to markets	3.3 %	16.7 %	20.0 %
- to buyers dockside	----	10.0 %	6.7 %

Table 4. Comparison of the results of the the torrymeter and the sensory assessments in indicating spoilage of tuna by treatment. Treatment 1 - tuna left on deck wrapped in seawater-soaked towel; Treatment 2 -tuna died naturally and were placed in ice slurry and stored in crushed ice; Treatment 3 - tuna died naturally and were stored on block ice; Treatment 5 - tuna were clubbed and placed in ice slurry, then stored in crushed ice; Treatment 6 - tuna were clubbed and stored on block ice; Treatment 8 - tuna were killed using brain spike and taniguchi tool, placed in ice slurry and stored in crushed ice; and Treatment 9 - tuna were killed using brain spike and taniguchi tool, and stored on block ice.

Treatment	Torrymeter Hrs to Spoilage	Sensory Hrs to Spoilage	Average Weight
Treatment 1	12 (1/2 day)	72 (3 days)	17.5 lbs
Treatment 2	24 (1 day)	126 (5.25 days)	30.6 lbs
Treatment 3	24 (1 day)	96 (4 days)	19.9 lbs
Treatment 5	96 (4 days)	108 (4.5 days)	14.6 lbs
Treatment 6	12 (1/2 day)	96 (4 days)	24.3 lbs
Treatment 8	84 (3.5 days)	96 (4 days)	23.9 lbs
Treatment 9	36 (1.5 days)	102 (4.25 days)	23.8 lbs

Table 5. Distribution of fishing effort by port of departure for Virginia-based offshore fishing boats targeting marlin/tuna.

DOCKSIDE INTERVIEWS

INLET/PORT	TRIP FREQUENCY 1987 (N=706)	1988 (N=376)
Rudee (Va. Beach)	68%	85%
Wachapreague (E. Shore)	28	*
Lynnhaven (Va. Beach)	1	10
Little Creek (Norfolk)	2	4
North Carolina	*	--

TELEPHONE INTERVIEWS

INLET/PORT	TRIP FREQUENCY 1987 (N=308)	1988 (N=244)
Rudee (Va. Beach)	56%	51%
Wachapreague (E. Shore)	14	15
Lynnhaven (Va. Beach)	18	18
Little Creek (Norfolk)	4	8
Back River (Hampton)	1	*
Poquoson (York Co.)	1	1
Oyster (E. Shore)	2	--
Chincoteague (E. Shore)	*	--
Quinby (E. Shore)	2	2
Hampton River (Hampton)	1	1
Grafton (York Co.)	*	--
Machipongo (E. Shore)	--	1
Misc. Chesapeake Bay	--	2

*Less than 1%.

Table 6. Distribution of charter and private boat trip interviews, 1987 and 1988.

	DOCKSIDE		TELEPHONE	
Interview Category	1987 (N=706)	1988 (N=376)	1987 (N=308)	1988 (N=244)
Charter Trips	34%	64%	21%	17%
Private Trips	66	36	79	83

Table 7. Fishing effort parameters characterizing fishing trips sampled in Virginia's marlin/tuna fishery.

Effort Parameter	Dockside Interviews		Telephone Interviews	
	1987	1988	1987	1988
No. Anglers Fishing	4.3[a] (1.3) N=706	4.5 (1.4) N=375	3.9 (1.3) N=307	4.0 (1.3) N=244
No. Lines Fished	6.2 (1.3) N=706	6.8 (1.1) N=375	5.9 (1.2) N=308	6.1 (1.2) N=243
No. Hours Trolled	6.3 (1.2) N=699	6.3 (1.3) N=373	6.2 (1.6) N=305	6.2 (1.4) N=243

[a]Mean; (standard deviation); N = number of observations.

Table 8. Distribution of fishing effort among principal areas fished by Virginia's marlin/tuna fleet in 1987 and 1988.

Principal Area Fished	TRIP FREQUENCY							
	1987				1988			
	Dock-Rank (N=752)		Phone Rank (N=341)		Dock Rank (N=307)		Phone Rank (N=301)	
21 Mile Hill	3%	8	2%	7	2%	7	3%	8
Norfolk Canyon	11	3	12	3	14	2	7	6
Cigar	20	1	11	4	18	1	11	4
East of Cigar/Shelf Edge	5	6	3	6	11	4	4	7
Hot Dog	4	7	12	3	13	3	12	3
26 Mile Hill	16	2	22	1	5	6	15	2
Fishhook	1	10	2	7	6	5	9	5
Fingers	8	4	13	2	14	2	18	1
20 Fathom Finger	6	5	2	7	2	7	2	9
SE Lumps/Lumps	6	5	4	5	2	7	7	6
Washington Canyon	6	5	1	8	2	7	1	10
20 Fathom Curve	2	9	1	8	--		*	
Triple Zero Line (Loran C)	3	8	3	6	6	5	2	9
Horseshoe	1	10	--		*		*	
100 Fathom Curve	--		1	8	*		1	10
1000 Fathom Curve	--		1	8	*		*	
Triangle Wrecks	--		*		2	7	--	
Chesapeake Light Tower	--		1	8	*		--	
29 Fathom Lumps	--		--		1	8	*	
44 Fathom Line	--		--		*		1	10
40 Fathom Line	--		--		*		*	
Honey Hole	--		--		*		--	
V Buoy/Tiger Wreck	--		--		*		--	
Tower #1 (NC)	--		--		1	8	--	
30 Fathom Curve	--		--		*		--	
Tower #2 (NC)	--		--		*		--	
Tower #3 (NC)	--		--		*		--	
100 Fathom Hill	--		--		2	7	--	
Boomerang	--		--		2	7	--	
Poor Man's Canyon	--		--		1	8	--	

*Less than 1%.

Table 9. Mean monthly catch rates (CPUE = catch per boat trip) for key species targeted in Virginia's marlin/tuna fishery (N = number of trips sampled).

Species	Dockside Interviews 1987	Dockside Interviews 1988	Telephone Interviews 1987	Telephone Interviews 1988
JUNE DOCK: N = 180 (1987); 64 (1988) PHONE: N = 103 (1987); 71 (1988)				
Bluefin Tuna	3.9	3.7	4.8	2.9
Yellowfin Tuna	0.9	0.3	0.5	0.3
White Marlin	a	0	0	0
Blue Marlin	0[b]	0	0	0
Dolphin	a	0	a	0
JULY DOCK: N = 328 (1987); 133 (1988) PHONE: N = 134 (1987); 98 (1988)				
Bluefin Tuna	0.6	0.9	1.6	0.8
Yellowfin Tuna	1.6	3.4	2.0	1.5
White Marlin	0.1	0.1	0.1	a
Blue Marlin	0.03[c]	0.01	0.01	0.01
Dolphin	1.0	1.2	0.3	0.7
AUGUST DOCK: N = 137 (1987); 106 (1988) PHONE: N = 42 (1987); 50 (1988)				
Bluefin Tuna	0.1	a	0.3	0.1
Yellowfin Tuna	1.3	1.0	1.3	1.1
White Marlin	0.4	0.2	0.2	0.2
Blue Marlin	0.04	0.01	0.05	0.02
Dolphin	1.4	3.2	1.0	2.0
SEPTEMBER DOCK: N = 54 (1987); 70 (1988) PHONE: N = 20 (1987); 19 (1988)				
Yellowfin Tuna	0.2	0.5	0.7	0.8
White Marlin	1.3	0.5	1.4	0.6
Blue Marlin	0.06	0.07	0.05	0
Dolphin	0.7	0.4	2.3	1.5
OCTOBER DOCK: N = 0 (1987); 0 (1988) PHONE: N = 4 (1987); 5 (1988)				
Yellowfin	d	d	1.8	2.4
White Marlin	d	d	1.0	0.2
Blue Marlin	d	d	0	0
Dolphin	d	d	0	1.4

[a] Occasional catch recorded in sampling effort but monthly average CPUE $\leq$ 0.05 fish.
[b] No catches recorded for species during sampling period.
[c] Catches rare, therefore calculated to two significant decimal places.
[d] Sampling discontinued due to infrequency of offshore fishing trips.

Table 10. Overall mean seasonal catch rates (CPUE = catch per boat trip) for key species (bluefin and yellowfin tuna, white and blue marlin and dolphin) and other pelagic species contributing to successful fishing trips in Virginia's marlin/tuna fishery.

Species	Dockside Interviews 1987 (N=645/699[a])	Dockside Interviews 1988 (N=306/376)	Telephone Interviews 1987 (N=280/305)	Telephone Interviews 1988 (N=220/244)
Bluefin Tuna	1.4	1.2	2.6	1.3
Yellowfin Tuna	1.2	1.6	1.3	1.0
White Marlin	0.2	0.2	0.2	0.1
Blue Marlin[b]	0.03	0.02	0.01	0.01
Dolphin	0.8	1.4	0.4	0.8
Skipjack Tuna	0.3	0.9	0.6	0.1
False Albacore	0.5	0.5	0.2	0.9
Bluefish	0.5	1.1	0.6	1.5
King Mackerel[b]	0.05	0.23	0.16	0.21
Atlantic Bonito[b]	0.02	0.04	0.05	0.08
Wahoo[b]	0.03	0.06	0.05	0.04
Sailfish[b]	c	0.02	0	0.01
Bigeye Tuna[b]	0.01	c	0.01	0
Mako Shark[b]	0.01	0	0.01	0
Other Sharks[b]	c	0	0	0
Spanish Mackerel[b]	c	0.02	0.01	0.03
Barracuda[b]	c	0.01	0.01	0.01
Other Tuna (Albacore/ Blackfin)[b]	0	0	0.02	0
All Species Combined	4.9	7.1	6.1	6.0

[a]Bluefin tuna are not typically available to the fishery during September and October; therefore the first value of N is the number of trips sampled during June through August while the second value is the total number of trips sampled for the entire season; bluefin CPUE is calculated based upon the first value while CPUE for all other species is based upon the second, larger sample size.

[b]Species important to the fishery for trophy status or edibility but whose catches are rare, if not highly variable, from year to year; CPUE expressed to two significant decimal places only to indicate differences in magnitude of catch rates in comparison to more commonly caught species.

[c]Occasional catch recorded in sampling effort but mean CPUE $\leq$ 0.005 fish.

Table 11. Yearly comparisons of mean CPUE (catch per boat trip) for key species targeted in Virginia's marlin/tuna fishery (data from Bochenek et al., 1989).

Species	Mean CPUE					
	Dockside Interviews			Telephone Interviews		
	1986	1987	1988	1986	1987	1988
Bluefin Tuna	2.1	1.4[a]	1.2[c]	1.0	2.6[a]	1.3[bd]
Yellowfin Tuna	1.3	1.2[b]	1.6	1.8	1.3	1.0[d]
White Marlin	0.1	0.2[a]	0.2[c]	0.1	0.2	0.1
Blue Marlin	0.02	0.03	0.02	0.02	0.01	0.01
Dolphin	0.8	0.8	1.4	1.6	0.4[a]	0.8[c]

[a]Catch rate significantly different ($P \leq 0.001$) between this year and previous year; Mann-Whitney U-Test, corrected for ties (Zar 1984).

[b]Catch rate significantly different ($P \leq 0.01$) between this year and previous year; Mann-Whitney U-Test, corrected for ties.

[c]Catch rate significantly different ($P \leq 0.001$) between 1988 and 1986; Mann-Whitney U-Test, corrected for ties.

[d]Catch rate significantly different ($P \leq 0.01$) between 1988 and 1986; Mann-Whitney U-Test, corrected for ties.

REFERENCES

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, School of Marine Science. College of William and Mary (in preparation).

Bochenek, E., N. Chartier, and J. Lucy. 1989. Virginia's Recreational Marlin and Tuna Fishery, 1983-1988: A Report to the Fishermen. Special Report in Applied Marine Science and Ocean Engineering No. 298. Virginia Institute of Marine Science, College of William and Mary, 25 p.

Chartier, N. 1988. The effects of at-sea filling and storage methods on the quality of recreationally-caught northern bluefin tuna (Thunnus thynnus) as affected by on-board handling and storage methods. Masters thesis, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, 190 p.

Chartier, N., J. Lucy and W. DuPaul. 1989. Catch handling trends of Virginia's recreatonal tuna fishery: the effects of killing and storage methods on the quality of northern bluefin tuna Thunnus thynnus (abstract), p. 18-19. In: Proc. of the 40th Annual Tuna Conference, M. Hinton (ed.), Inter-American Tropical Tuna Comm. and U.S. NMFS, Lake Arrowhead, CA, May 23-25, 1989, 59 p.

Eitenmiler, R. and S. DeSouza. 1984. Enzymatic mechanisms for amine formation in fish. p. 431-442. In: Seafood Toxins. Amer. Chem. Soc. Symp. Series, Washington, D.C. E.P. Ragelis (Ed.). Series No. 262 460 p.

Figley, W. 1984. Recreational fishery for large offshore pelagic fishes of the mid-Atlantic coast. Final Contract Report prepared for National Marine Fisheries Service Project NA-83-FA-S-00001, 66p.

Frank, H. and D. Yoshinaga. 1984. Histamine formation in tuna. Pg. 443-451. In: Seafood Toxins. Amer. Chem. Soc. Symp. Series, Washington, D.C. E. P. Ragelis (Ed.). Series No. 262. 460 p.

Giles, R. 1971. Wildlife management techniques. The Wildlife Society, Wash., D.C. 432 pp.

Lucy, J. and N. Chartier. 1989. Characteristics and catch trends of Virginia's recreational pelagic fishery for the 1987-1988 seasons (abstract), p. 44-45. In: Proc. of the 40th Annual Tuna Conference, M. Hinton (ed.). Inter-American Tropical Tuna Comm. and U.S. NMFS) Lake Arrowhead, CA, May 23-25, 1989, 59 p.

Lucy, J., E. Bochenek and N. Chartier. 1988a. Fleet characteristics and boat owner expenditures associated with Virginia's recreational marlin/tuna fishery. Paper presented at the International Billfish Symp. II, Kailua-Kona, HI, Aug. 1-5, 1988.

Lucy, J., N. Chartier and W. DuPaul. 1988b. Catch trends and fish utilization in Virginia's offshore recreational pelagic fishery. Project Completion Report, Year I. Wallop-Breaux Proj. No. F-62-R, Virginia Marine Resources Commission, Newport News, VA 43p.

Taylor, S., J. Hui, and D. Lyons. 1984. Toxicology of scombroid poising. p. 417-429. In: Seafood Toxins Amer. Chem. Soc. Symp. Series, Washington, D.C. E.P. Ragelis (Ed.). Series No. 262. 460 p.

Virginia Saltwater Fishing Tournament (VSFT). 1986-1988. Annual Summary Reports, Department of Economic Development, Commonwealth of Virginia.

Zar, J. 1984. Biostatistical Analysis, second edition, Prentice Hall, Inc., Englewood Cliffs, NJ:138-143.

APPENDIX

Phone:_____
Address:_____
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OFFSHORE PELAGIC FISH SURVEY - VIRGINIA 1988

Interviewer_____ Date_____ Dockside(1)_____ Phone(2)_____
Tournament: Yes(1)_____ No(2)_____ Tournament Name_____
Marina_____ Inlet left from_____ State_____
Boat Name_____ Boat Length(FT)_____ Capt Name_____
Private(1)_____ Charter(2)_____
Target species: M/T(1)_____ Shk(2)_____ Tuna_____ Bluefish_____ Other_____
Method: Troll(1)_____ Chum(2)_____ Other(3)_____
Anglers_____ # Lines_____ Hours fished_____ Depth (ft/fa)_____
Fishing Locations (1)_____ (2)_____ (3)_____
Miles Offshore_____ Water temp by area(F) (1)_____ (2)_____ (3)_____

SPECIES		KEPT	RELEASED	AREA
yellowfin	4655			
bigeye	4657			
albacore	4651			
bluefin	4652			
skipjack	4654			
blackfin	4658			
false albacore	4653			
atlantic bonito	0330			
white marlin	2177			
blue marlin	2179			
sailfish	3026			
dolphin	1050			
pompano dolphin	0101			
king mackerel	2129			
mackerel (gen)	0027			
bluefish	0230			
wahoo	4710			
swordfish	4320			
mako	3505			
white	3512			
sandbar	3513			
dusky	3514			
blue shark	3504			
hammerhead	3516			
tiger	3515			
thresher	3509			
other shark	3508			
_____	XXXX			

WHITE/BLUE MARLIN RAISED _____ / # SAILFISH RAISED _____
WHITE/BLUE MARLIN HOOKED/LOST _____ / # SAILFISH HOOKED/LOST _____

SPECIES	LENGTH IN/CM	WEIGHT LBS	SEX M/F	SPECIES	LENGTH IN/CM	WEIGHT LBS	SEX M/F