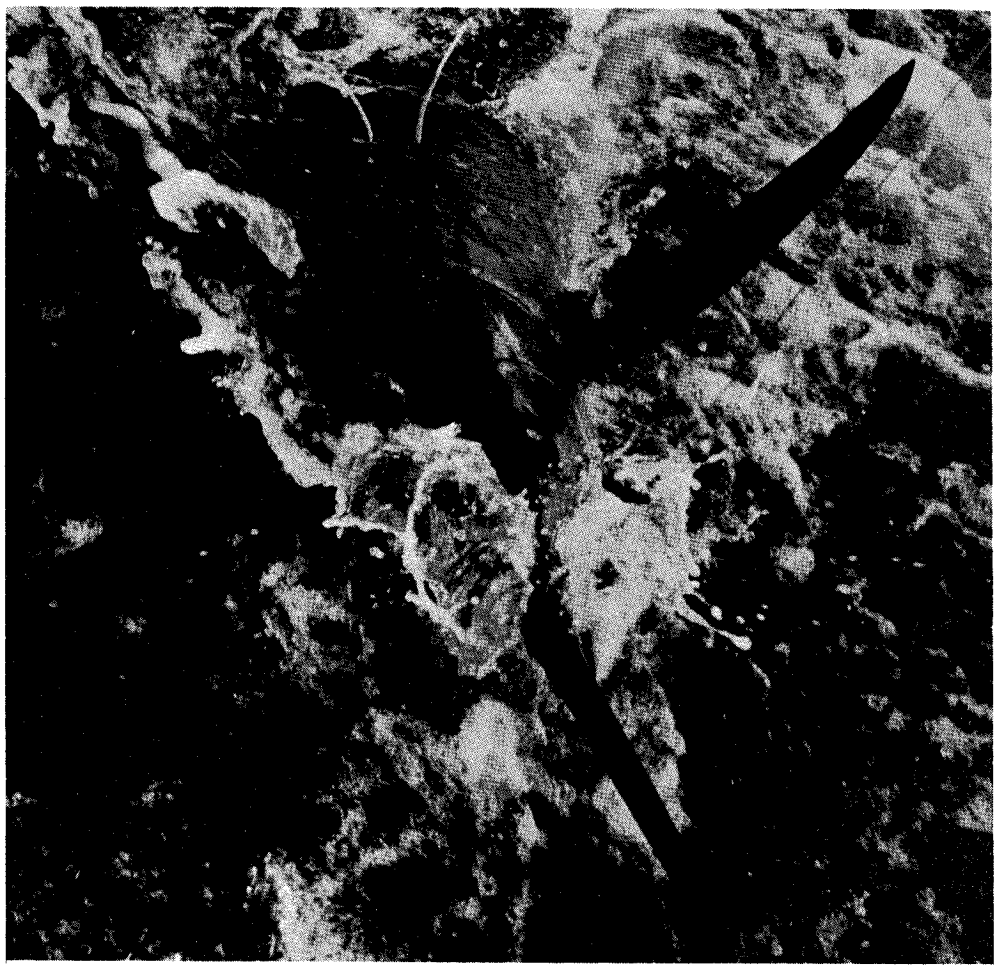
NOAA Technical Memorandum NMFS-SEFSC-377

1993/1994 REPORT OF THE SOUTHEAST FISHERIES SCIENCE CENTER BILLFISH PROGRAM

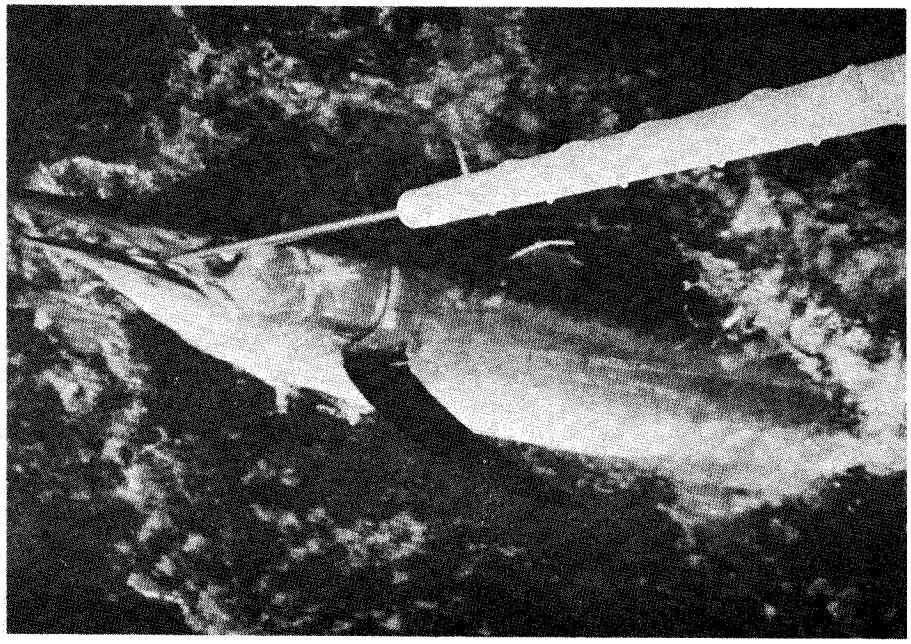


October 1995

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149

NOAA Technical Memorandum NMFS-SEFSC-377

1993/1994 REPORT OF THE SOUTHEAST FISHERIES SCIENCE CENTER BILLFISH PROGRAM



U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
D. James Baker, Under Secretary for Oceans and Atmosphere

NATIONAL MARINE FISHERIES SERVICE
Rolland A. Schmitten, Assistant Administrator for Fisheries

October 1995

NOTICE

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends, or endorses any proprietary product or proprietary material mentioned herein or which has as its purpose any intent to cause directly or indirectly the advertised product to be used or purchased because of NMFS publication.

This report should be cited as follows:

National Marine Fisheries Service. 1995. 1993/1994 Report of the Southeast Fisheries Science Center Billfish Program. NOAA Technical Memorandum NMFS-SEFSC-377, 16 p.

Contribution MIA-94/95-37 from the Southeast Fisheries Science Center, Miami Laboratory, Migratory Fishery Biology Division.

Copies may be obtained by writing:

Dr. Mark I. Farber
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149

or

National Technical Information Service
5258 Port Royal Road
Springfield, Virginia 22161
(703) 487-4650 FAX: (703) 321-8547
Rush Orders: (800) 336-4700

Photos:

Cover: Double-tagged blue marlin before hook-removal and release, using a de-hooking device, off La Guaira, Venezuela, by Jim Edmiston.

Inside: Hook being removed from a double-tagged blue marlin before release, off La Guaira, by Jim Edmiston.

This report was prepared with individual contributions from scientists at the Miami and Panama City Laboratories of the Southeast Fisheries Science Center

Compiled by
Mark I. Farber

INDIVIDUAL CONTRIBUTORS:

Cooperative Recreational Billfish Surveys:
Mark I. Farber, Michael T. Judge, Anna M. Avrigian, Paul J. Pristas

Cooperative Game Fish Tagging Program:
Christopher D. Jones, Mike T. Judge, David S. Rosenthal

ICCAT Enhanced Research Program for Billfish:
Eric D. Prince

Pelagic Longline Observer Program:
Dennis W. Lee, Cheryl J. Brown, and Tracey L. Jordan

ACKNOWLEDGMENTS

The National Marine Fisheries Service (NMFS) is grateful to the recreational and commercial fishermen who voluntarily cooperated in the collection of billfish statistics, and to the numerous state, university, federal employees and private research organizations who lent their time and support to billfish programs. Additionally, we wish to thank those tournaments that provided NMFS samplers with transportation, hotel accommodations, and food. This assistance facilitated our being able to send NMFS scientists to personally attend their events in order to collect data and biological samples.

We also recognize the cooperation of various international fisheries agencies who participated in the Enhanced Research Program for Billfish, conducted under the auspices of the International Commission for the Conservation of Atlantic Tunas (ICCAT).

INTRODUCTION

Scientists at the Southeast Fisheries Science Center (SEFSC) have been involved in billfish research since the early 1970's. As a result, the SEFSC's billfish database is one of the most comprehensive sources of scientific information on Atlantic blue marlin, white marlin, sailfish, and spearfish. Many different segments of the fishing community – recreational anglers, commercial fishermen, representatives of billfish tournaments, university researchers, state agents, federal employees, and private research organizations – have donated their time, effort, data, and funds to assist our research program for more than two decades.

Billfishes are often referred to as "fish without a country" because their movement patterns encompass virtually the entire ocean and intersect the boundaries of many different nations. For example, very recent information indicates blue marlin make transatlantic, transequatorial, and even transoceanic movements. For this reason, this report provides a comprehensive presentation of research activities involving SEFSC scientists and includes work on Atlantic billfish that occurs outside, as well as inside, United States jurisdictional waters.

Most Atlantic billfish information is gathered through three Programs: the Cooperative Tagging Center (CTC) of the SEFSC; the Cooperative Recreational Billfish Survey (CRBS) of the SEFSC; and the Enhanced Research Program for Billfish (ERPB) conducted under the auspices of the International Commission for the Conservation of Atlantic Tunas (ICCAT), located in Madrid, Spain. The original tagging program initiated in 1954 was a comparatively narrow in scope and depended primarily on recreational anglers to tag tuna and billfish in the western Atlantic Ocean and Gulf of Mexico. This program has expanded to become the CTC which now documents many more target species, with greatly increased volunteer participation by all segments of the fishing community, as well as a cooperative data storage and data manipulation capability for state, international, and private tagging agencies Atlantic-wide. The purpose of the CRBS is to collect data on the number of billfish hooked, boated, tagged, and released during tournament and non-tournament fishing trips and to collect data on length, weight, and sex of individual billfish landed. The goal of the ERPB is to collect the information that will lead to stock assessments of Atlantic billfishes, including: (1) improve the Atlantic-wide biostatistical fishery database for billfish; (2) initiate and maintain an international Atlantic billfish tagging program; and (3) assist in age and growth research. Besides these three major programs for billfish, the tuna and swordfish research programs at the SEFSC also provide data on the number of billfish caught incidentally, and released in the U.S. and by foreign fishing vessels operating within U.S. jurisdictional waters. A review of the data collected from this program is also presented in a separate section: Pelagic Longline Observer Program (PLOP).

This report includes data through 1993 from the CTC and the CRBS because data compilation for these programs are normally not completed until the mid-year following data collection. Data for 1994 are presented for the ICCAT ERPB, and other ICCAT Billfish related activities. Some tagging information from 1994 is also included.

COOPERATIVE TAGGING CENTER

The National Marine Fisheries Service's (NMFS) Southeast Fisheries Science Center (SEFSC) formed the Cooperative Tagging Center (CTC) in 1992 in response to the recent expansion of tag release and recapture activities, data requests from other tagging agencies, and domestic and international tagging research needs. The CTC encompasses a variety of functions and responsibilities. The CTC provides information on the movements and biology of marine fish species in the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea through the direct participation of the public in scientific research.

The CTC provides tagging kits and related equipment free upon request to individual anglers. Each kit contains tags and self-addressed, postage paid tagging report cards and recapture cards to be filled out by the angler and returned to the CTC when fish are tagged or recaptured. Also included with the kit, and available free upon request, is the CTC annual newsletter. The newsletter provides more detailed information on all aspects of the billfish tagging program, along with information on other species targeted by the CTC. Interested persons may contact:

Cooperative Tagging Center
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149

(800) 437-3936

Tag Releases

The number of tagged billfish reported to the NMFS Cooperative Tagging Center (CTC), by species, for the years 1988-1994 is presented in Table 1. This information does not necessarily agree with data previously published because tag releases are very often not reported until months or even years after the fact. This becomes a significant problem when a tag recapture report is submitted to the CTC before the tag release data. Additionally, these data do not include billfish tagged with tags from other organizations. For example, the South Carolina Marine Resources Department (SCMRD), the International Commission for the Conservation of Atlantic Tunas (ICCAT), and The Billfish Foundation (TBF) tagging programs have been playing an increasingly greater role in tagging billfish in recent years.

Blue Marlin

There were 1,679 tag-released blue marlin in 1993, 1,543 by recreational fishermen, 119 by commercial fishermen, and 17 by scientific staff. Most taggings took place in waters around Puerto Rico (where 339 blue marlin were tagged) and the Virgin Islands (331 were tagged). Other blue marlin tagging locations include: the northern Bahamas (181), eastern U.S. coastal waters (144), and Louisiana (92). Smaller quantities of blue marlin were also tagged and released off north Florida and the Carolinas, Texas, Florida Panhandle, Hispaniola, La Guaira (Venezuela), and southeast Florida. The number of blue marlin tagged and released, by gear, are shown in Figure 1. These numbers do not necessarily correspond to the number of fish tagged by fishermen category.

In 1994, 1,103 tag-released blue marlin were reported to the CTC. The drop in tag-released blue marlin in 1994 compared to the previous year (1,679) reflects a shortage of NMFS tagging equipment and was not related to a decrease in tagging effort or catch. Reduced availability of tags in 1994 also affected the number of other target species in the CTC that could be tagged during this period. In many cases, participants contacting the CTC for tags were referred to other Atlantic tagging programs for tagging supplies and these programs experienced proportional increases in tag-released billfish.

Table 1. Number of reported tagged billfish, by species, recorded in the NMFS Cooperative Tagging Center (CTS) database, 1988-1994, as of March 30, 1995.

SPECIES	1988	1989	1990	1991	1992	1993	1994
Blue Marlin	1,698	2,036	2,057	1,856	1,678	1,679	1,103
White Marlin	1,112	1,214	1,286	1,452	1,180	1,461	805
Sailfish	2,484	2,183	3,351	3,229	3,774	2,861	1,796
Spearfish	12	14	20	29	22	51	28

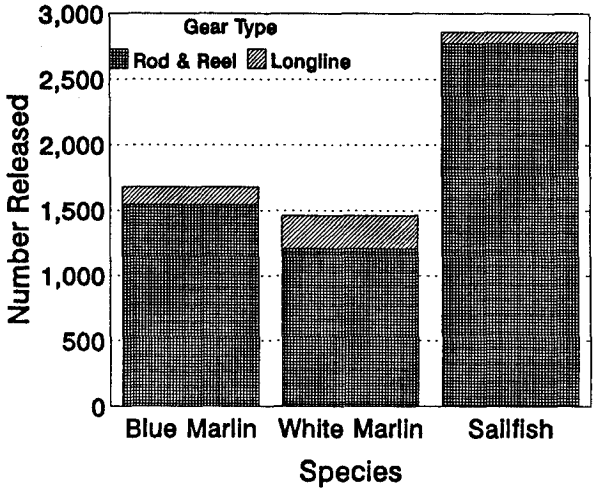


Figure 1. Number of billfish tagged and released in 1993, by gear.

White Marlin

A total of 1,461 white marlin were tagged and released, 1,208 by recreational fishermen, 227 by commercial fishermen, and 26 by scientific staff. Most white marlin taggings were in two areas: the eastern U.S. coastal waters, where 726 were tagged; and off La Guaira, where 167 were tagged. White marlin were also tagged and released off the Florida Panhandle, Cozumel, north Florida, and Carolina waters. The number of white marlin tagged and released, by gear, are shown in Figure 1. These numbers do not necessarily correspond to the number of fish tagged by fishermen category.

The number of tag-released white marlin in 1994 (805) represents a 45% decrease from the previous year (1,461) and also reflects the decrease in tag availability during the 1994 tagging season. However, the continued decline in white marlin catch rates (see Figure 7) may also have contributed to the decrease in tag-released white marlin reported to the CTC in 1994.

Sailfish

A total of 2,861 sailfish were tagged and released in 1993, 2,768 by recreational fishermen, 66 by commercial fishermen, and 27 by scientific staff. As in previous years, a majority of sailfish taggings (1,411) took place off the southeast coast of Florida. Other areas where large numbers of sailfish were tagged include: Cancun/Cozumel, Mexico (859), and off the north Florida and the Carolinas coasts (167). Program cooperators also tagged sailfish in La Guaira, the northern Bahamas, off southern Texas, and the U.S. Virgin Islands. The number of sailfish tagged and released, by gear, are shown in Figure 1. These numbers do not necessarily correspond to the number of fish tagged by fishermen category.

The 1,796 sailfish tagged and released in 1994 represented a 37% decrease from the previous year's (2,861) tagging effort. Lack of sufficient tagging supplies to meet the demand in 1994 was also the major factor in reduced tagging of sailfish during the 1994 fishing season.

Tag Recaptures

Blue Marlin

Thirteen tagged blue marlin were recaptured in 1993, 12 by recreational fishermen, and 1 by a commercial fisherman. The locations of the 1993 blue marlin recaptures are given in Table 2, and the numbers recaptured, by gear, are shown in Figure 2.

The longest straight-line distance traveled (a minimum estimate of movement which provides no insight into the true route taken) by a blue marlin

recaptured in 1993 was estimated at 465 nautical miles (nm). This fish was tagged and released off San Juan, Puerto Rico, in May, 1991, by a recreational fisherman, and recaptured by a recreational fisherman off La Guaira in August, 1993. The longest time at-large for a 1993 blue marlin recapture was 2,231 days (6.1 years). This fish was released off Antigua (Leeward Islands) in September, 1987, and recaptured off La Guaira in October, 1993.

Table 2. Release and recapture areas for blue marlin recaptured in 1993.

Release Area	Recapture Area	Total
Virgin Islands	Virgin Islands	1
	Venezuela	1
Antigua	La Guaira	1
Puerto Rico	Hispaniola	1
	Cumaná	1
La Guaira	La Guaira	1
	Barbados	1
Eastern U.S. coastal waters	N. Florida & Carolinas	1
Eastern Atlantic	Eastern Atlantic	1
Texas	Texas	1
Africa/West	Africa/West	1
	Total:	11

White Marlin

Twenty-two tagged white marlin were recaptured in 1993, 16 by recreational fishermen, and 6 by commercial fishermen. The locations of 1993 white marlin recaptures are given in Table 3, and the numbers recaptured, by gear, are shown in Figure 3.

The longest straight-line distance traveled by a white marlin recaptured in 1993 totaled 2,212 nm. This fish was tagged and released off Long Island, NY, in August, 1992, by a recreational fisherman, and recaptured by a longliner off the coast of Guyana (at about 52° W.) in July, 1993.

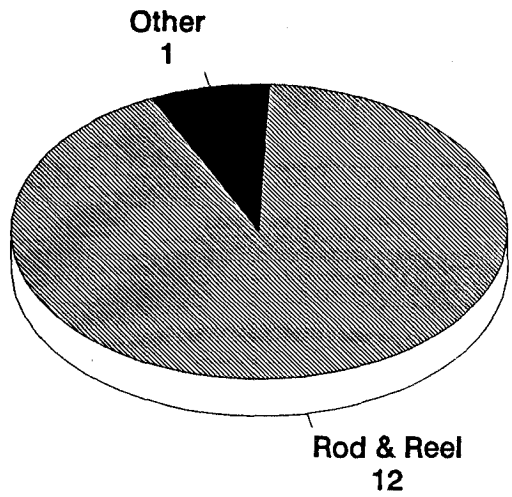


Figure 2. Number of tagged blue marlin recaptured in 1993, by gear.

The longest time at-large for a white marlin recaptured in 1993 was 3,299 days (9.0 years), for a fish both tagged and recaptured off La Guaira, Venezuela. The release and recapture were both by recreational fishermen.

Table 3. Release and recapture areas for white marlin recaptured in 1993.

Release Area	Recapture Area	Total
Eastern U.S. coastal waters	Eastern U.S. coastal waters	6
	N.W. Atlantic (offshore)	1
	Cumaná	2
	Fl. Keys	1
	off Guyana	1
La Guaira	La Guaira	6
	Virgin Islands	1
Gulf of Mexico	N. Bahamas	1
W. Atlantic (offshore)	Venezuela	1
N. Bahamas	Eastern U.S. coastal waters	1
Eastern Atlantic	Eastern Atlantic	1
	Total:	22

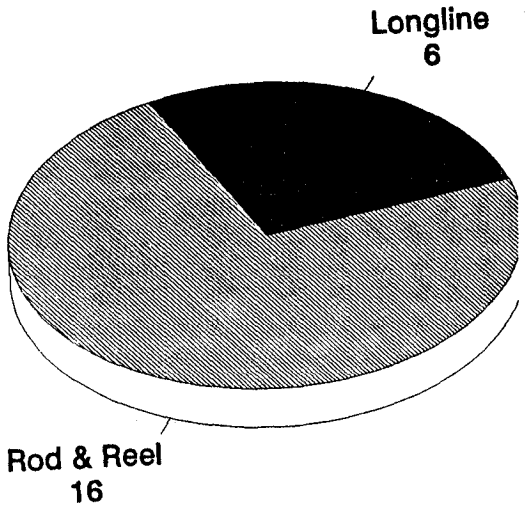


Figure 3. Number of tagged white marlin recaptured in 1993, by gear.

Sailfish

There were 105 tagged sailfish recaptured in 1993, 93 by recreational fishermen, 9 by commercial fishermen, and in 3 cases the type of fisherman was not reported. The locations of 1993 sailfish recaptures are given in Table 4, and the numbers recaptured by gear are shown in Figure 4. Because some recapture locations were not reported, tables summarizing release-recapture areas may contain fewer fish than the total number actually recaptured in 1993.

The longest straight-line distance traveled by a sailfish recaptured in 1993 was 2,161 nm. This fish was tagged by a U.S. recreational fisherman off Cape Hatteras, NC, in August, 1992, and recaptured by a longliner, off the coast of Surinam (at about 53° W.) in July, 1993. The longest time at-large for a sailfish recaptured in 1993 was 3,373 days (9.2 years), for a fish released west of the Cayman Islands in April, 1984, and recaptured off the east coast of Cuba in July, 1993.

Table 4. Release and recapture areas for sailfish recaptured in 1993.

Release Area	Recapture Area	Total
S.E. Florida	S.E. Florida	36
	Florida Keys	13
	Texas	2
	Cumaná	1
Florida Keys	S.E. Florida	12
	Florida Keys	9
	E. Atlantic	1
Cancun/Cozumel	Cancun/Cozumel	6
	Cuban Waters	1
	S.E. Florida	1
	Venezuela	1
N. Florida	S.E. Florida	4
	Hispaniola	2
	Mid-U.S.east coast	1
	Cozumel	1
	Puerto Rico	1
	Venezuela	1
LaGuaira	LaGuaira	2
	Cumaná	1
Eastern U.S. coastal waters	off Surinam	1
	S.E. Florida	1
	Florida Keys	1
N. Bahamas	S.E. Florida	1
	Total:	100

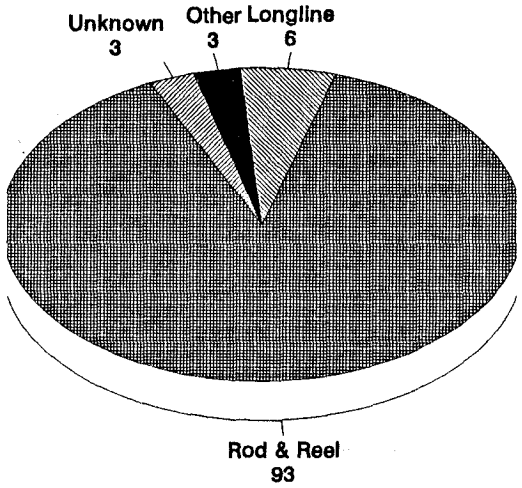


Figure 4. Number of tagged sailfish recaptured in 1993, by gear.

TAG DEVELOPMENT and DOUBLE–TAGGING RESEARCH

Tag Development

The NMFS Miami Laboratory Cooperative Tagging Center recently introduced a new tag design in 1994. This new tag design, referred to as the HM (highly migratory) tag, is similar to The Billfish Foundation (TBF-type) tag. The HM tag is constructed of medical grade nylon and uses a stainless steel applicator for tag placement which is withdrawn, leaving only the nylon anchor inside the fish. The HM tag is designed as a intermuscular tag and in time may replace the R-type steel anchor tags used for most of the 40 years of the tagging program. Improvements incorporated into the HM tag were based primarily on the observations of recaptured specimens initially tagged with R-type and TBF-type tags. By using medical-grade nylon for the anchor tip we hope to reduce the rejection of the tag by the fish, thereby potentially increasing its biological compatibility and retention. While there have been few preliminary studies to confirm this with fish muscle, it has gained widespread acceptance in the bio-medical arena for use in human surgical implants. Additionally, the tag streamer includes an English legend and Japanese characters for the word "reward" in an effort to increase the return of recapture data to the CTC. Japanese symbols were used on the HM tag because Japanese longline fishermen have agreed to start voluntary participation in tag and release of billfish that are alive when they come along-side these vessels.

Double–Tagging

The tagging procedures for the double-tagging study are more demanding than the procedures used in the conventional tagging program. Therefore, double-tagging using the NMFS R tag and the TBF tag is not for everyone and we prefer that only the more experienced taggers attempt this activity. For example, when double-tagging we prefer to have one tag placed on each side of the billfish. This would greatly increase the probability that a tag on a recaptured fish would be seen when brought along-side the boat. However, tagging on both sides of the fish takes longer and is not always possible under field conditions. Some of the more innovative participants in the experiment built tagging sticks that insert both tags into the fish at the same time. Although this simplifies the tagging procedure and saves time, we discourage this practice because having both tags on one side of the fish close enough that they touch each other invalidates the purpose of the experiment. That is, under these conditions the shedding rates of the two tags are not independent of each other.

To date, there has been a total of 2,361 double-tagged billfish released and 25 (about 1%) of these have been recaptured (Table 5). Most of the double-tagging has been with sailfish, but significant numbers of marlin and swordfish have also been double-tagged. Of the 25 recaptured fish, 16 had both tags intact, while 9 had only the TBF tag. The NMFS tag was apparently shed in those 9 fish. Because the total number of double-tagged billfish recaptured is so low, definitive conclusions from these preliminary results are not possible. Participants in the double-tagging program have included commercial (particularly for swordfish), as well as recreational fishermen, and we greatly appreciate their efforts.

Table 5. Summary of double-tagging experiments conducted jointly by The Billfish Foundation and NMFS.

SPECIES	RELEASES	RECAPTURES
Sailfish	834	15
Blue Marlin	606	3
White Marlin	364	5
Swordfish	526	2
Black Marlin[1]	12	0
Striped Marlin[1]	10	0
Spearfish	9	0
TOTAL	2,361	25

[1] Tagged in the Pacific or Indian Oceans.

COOPERATIVE RECREATIONAL BILLFISH SURVEY

The Cooperative Recreational Billfish Survey (CRBS) of the SEFSC documented a total of 83,856 hours of fishing effort from 113 tournament locations throughout the western North Atlantic, Gulf of Mexico, and Caribbean Sea in 1993 (Figure 5). The hours sampled by the survey, or voluntarily submitted to NMFS, represent an unknown fraction of the total

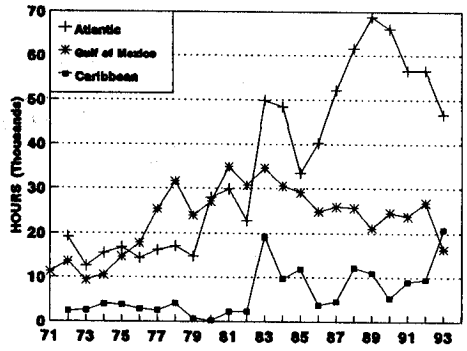
hours fished by the many recreational anglers who target billfish in the Atlantic, Gulf of Mexico, and Caribbean Sea.

A total of 3,292 billfish (1,340 blue marlin, 719 white marlin, 1,231 sailfish, and 2 spearfish) were reported caught (i.e., boated, released, or tagged) in 1993, of which 2,561 (77.8%) were released (Figure 6). The percentage of all billfish caught, by area, as documented by the survey, was: U.S. East Coast - 25.2%; Gulf of Mexico - 9.7%; Florida East Coast and Keys - 29.2%; Caribbean - 25.1%; and Bahamas - 10.8%. The proportion of billfish which are released has generally increased for all three species (Figure 6), particularly over the last 10 years. This coincides with a progressive increase in conservation fishing ethics which has been self-imposed by the U.S. recreational billfishing community for more than a decade. In addition, the U.S. Fishery Management Plan for Atlantic Billfishes, enacted in 1988, also encourages releasing by imposing minimum size limits for each species of billfish (except for spearfish). These minimum sizes (in lower-jaw-fork-length) are: **blue marlin - 86 in; white marlin - 62 in; and sailfish - 57 in.** These restrictions tend to increase the average size of fish landed, thus discrediting comparisons of average sizes before and after 1988.

Average and Maximum Sizes

Only a portion of all billfish landed are actually measured, weighed, and sexed by survey personnel because of the strong release policies and limited number of tournaments sampled by NMFS staff. The overall average weight of blue marlin, white marlin, and sailfish reported from our survey in 1993 was 284.8, 57.3, and 43.7 lbs, respectively. The largest blue marlin recorded during the 1993 survey weighed 885.0 lbs and was landed in the Bahamas in June. The largest white marlin reported in 1993 was caught off Orange Beach, AL in August and weighed 80.2 lbs. The largest sailfish weighed 99.8 lbs and was reported from the Spice Island Billfish Tournament in Grenada. The largest billfish reported from our 1994 survey were all caught in the Bahamas: blue marlin - 920 lbs; white marlin - 74 lbs; and a sailfish of 58 lbs.

FISHING EFFORT DOCUMENTED BY REGION



TOTAL FISHING DOCUMENTED ALL AREAS COMBINED

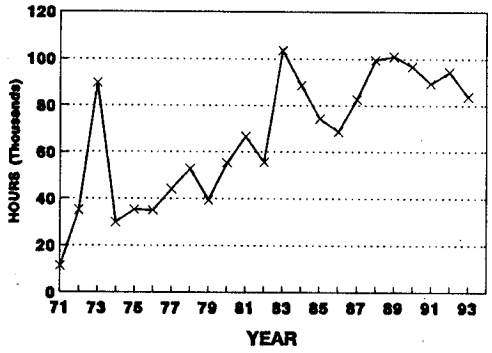
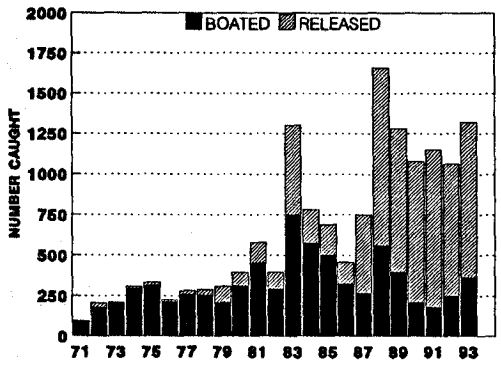
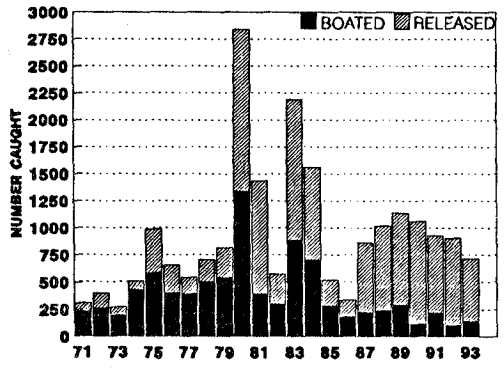


Figure 5. Yearly fishing hours documented by region and for all areas combined, 1971-1993.

BLUE MARLIN



WHITE MARLIN



SAILFISH

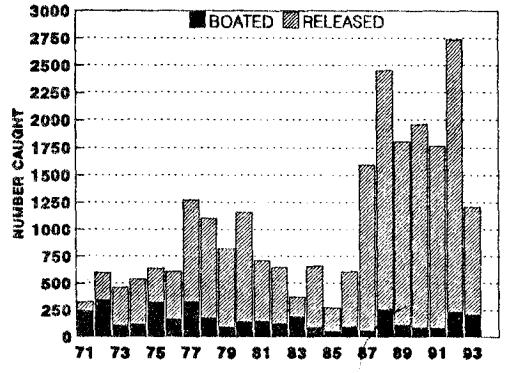


Figure 6. Numbers of billfish boated and released, from all areas combined, for blue marlin, white marlin, and sailfish, 1971-1993, as documented by the NMFS recreational billfish survey.

Catch-Rates and Fishing Effort

A measure of estimated relative abundance of billfish is computed from the number of fish caught per 100 hrs of fishing effort (i.e., trolling). In past reports we often presented hooked-per-unit-effort (HPUE) data for billfish. Although HPUE data has been considered by some scientists to be more desirable than catch-per-unit-effort (CPUE) data as an index of relative abundance for billfish, present stock assessment models use CPUE data because only this information is available for most areas outside U.S. waters. Therefore, CPUE information is emphasized in this report. However, in general, yearly fluctuations in CPUE's can reflect changes in intensity of our sampling program, angling technique, as well as habitat and environmental changes. Therefore, variations in catch-rates reported among years might not reflect true changes in stock abundance or availability.

The overall CPUE, for all areas combined, in 1993 for blue marlin, white marlin, and sailfish was 1.6, 0.9, and 1.5 fish per 100 hrs, respectively. Mean catch-rates indicate that since 1971, the average CPUE for blue marlin is 1.1, for white marlin is 1.9, and for sailfish is 2.2 fish per 100 hrs (Figure 7). An inherent problem in calculating sailfish CPUE (especially for the Florida East Coast and Keys area) is the lack of separation of the type of fishing effort data; i.e., trolling versus live-baiting. This is discussed in more detail below.

Recent trends in the catch-rates of billfish (Figure 7) indicate relatively stable CPUE's for blue marlin over the past decade, with 1993 approaching the peak value recorded in 1988 of 1.7 fish per 100 hrs of effort. The CPUE's for white marlin peaked in 1980 and then sharply declined through 1986, remaining stable over the period 1985-1993 but well below the historical mean value. This trend in CPUE reflects the results of the most recent stock assessment of white marlin presented at the 1992 ICCAT Standing Committee on Research and Statistics (SCRS). These assessments indicate that the stock(s) of Atlantic white marlin have been substantially over-exploited during the last 17 to 20 years.

The historic sailfish catch-rates have been fairly stable (without discernible trend) during most of the time-series, and dropped below the mean in 1993 from the near peak measured during the 1992 season. However, fishing effort, i.e., trolling and live-baiting, is often not separated in the sailfish database.

Also, depending on the geographic location, a substantial (but unquantified) percentage of billfishing effort is really targeted at marlin, making the sailfish catch in this instance an incidental bycatch of the fishery for marlin. Therefore, we believe that of the three species discussed, changes in sailfish CPUE presented in this report are the least reflective of true changes in stock abundance.

U.S. East Coast (North of Florida)

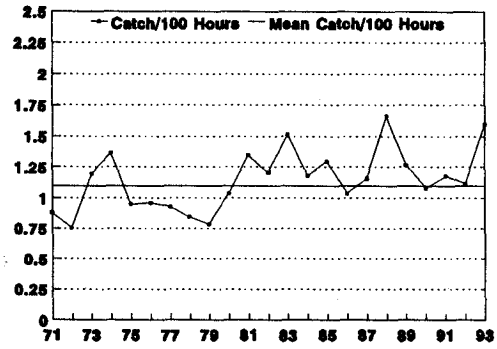
In 1993, a total of 21,449 hrs of fishing effort was sampled from 25 tournaments from Cape Cod, MA, to Savannah, GA (Table 6). Much of this information was provided through our volunteer program, and we thank all those individuals and organizations who contributed data this year. Catch-rates reported in 1993 for blue marlin, white marlin, and sailfish were 0.9, 2.7, and 0.2 fish per 100 hrs, respectively, changing little from 0.7, 2.5, and 0.2 fish per 100 hrs recorded in 1992. The associated catch reported in 1993 from this area (Table 7) was 828 billfish (200 blue marlin, 582 white marlin, and 46 sailfish), of which 675 (i.e., 81%) were released. Monthly CPUE calculations indicated highest overall CPUE values for blue marlin and sailfish occurred in June, while CPUE values were highest for white marlin in September.

Florida East Coast and Keys

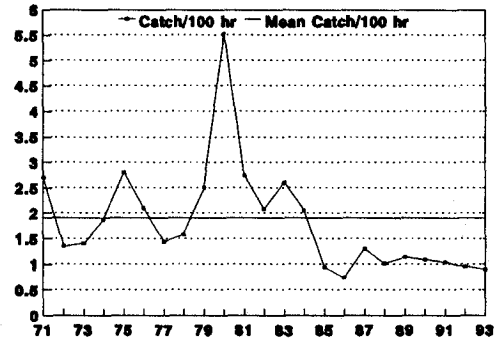
Along the Florida East Coast and Keys, a total of 14,598 hrs of fishing effort were reported in 1993. The documented breakdown was 5,952 hrs trolling and 8,646 hrs live-baiting. The associated catch reported in this area (Table 7) was 964 billfish (957 sailfish, 6 blue marlin, and 1 white marlin), of which 939 (i.e., 97%) were released. Over 99% of the billfish caught in this area were sailfish. Catch-rates in 1993 for both blue marlin and white marlin were 0.0 fish per 100 hrs. The catch-rate in 1993 for sailfish was 6.6 fish per 100 hrs, compared with 9.8 fish per 100 hrs reported in 1992.

The live-baiting effort is generally associated with targeting sailfish. However, sailfish were also caught when the fishing effort was trolling. During any given fishing day a boat could troll part of the day and live-bait part of the day. Further, for some fishing events, data are reported as the total number of boats fishing, the total number of hours fished, and the resulting catch and release by species.

BLUE MARLIN



WHITE MARLIN



SAILFISH

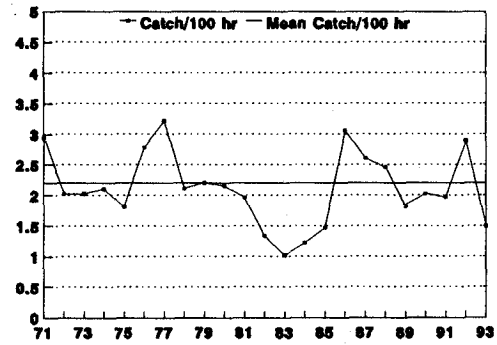


Figure 7. Catch per 100 hours of fishing effort for blue marlin, white marlin, and sailfish, 1971-1993.

Table 6. The number of trolling hours (effort) documented by the NMFS Recreational Billfish Tournament Survey from 1988 through 1993, by areas: Atlantic north of Florida, Florida East Coast and Keys, northeastern Gulf of Mexico (east of the Alabama/Mississippi border), northcentral Gulf (Louisiana/Texas border east to the Alabama/Mississippi border), northwestern Gulf (Texas coast), the Bahamas, and the Caribbean. During 1988-1992, non-tournament data were included in the Gulf of Mexico survey.

AREA	1988	1989	1990	1991	1992	1993
Atl. N. of FL	21,183	27,436	27,771	25,575	27,161	21,449
FEC & Keys	26,056	26,467	23,769	21,131	19,530	14,598
N.E. Gulf of Mexico	12,999	11,530	13,975	13,089	13,289	8,276
N.C. Gulf of Mexico	7,843	5,873	6,630	7,113	8,273	4,780
N.W. Gulf of Mexico	4,833	3,710	3,997	3,596	5,263	3,295
Bahamas	14,427	15,032	14,679	9,936	10,749	10,659
Caribbean	12,218	11,043	5,252	9,017	9,513	20,799
TOTALS:	99,559	101,091	96,073	89,457	93,778	83,856

Hence, the type of fishing effort for sailfish are often very difficult, if not impossible, to separate. Therefore, as noted above, changes in sailfish CPUE reported here (Figure 7) may not be representative of changes in stock abundance.

Bahamas

In the Bahamas, 10,659 hrs of fishing effort from 12 tournaments was sampled in 1993 (Table 6). Of this total, 5,081 hrs (47%), were reported from the six tournaments in the Bahamas Billfish Championship Series. Catch-rates for blue marlin, white marlin, and sailfish in 1993 were 2.8, 0.4, and 0.2 fish per 100 hrs, respectively, changing little from 2.0, 0.4, and 0.4 reported in 1992. The associated catch in 1993 from this area (Table 7) was 355 billfish (295 blue marlin, 40 white marlin, and 20 sailfish), of which 282 (i.e., 79%) were released. As previously noted, the largest blue marlin reported from the Bahamas in 1993 weighed 885.0 lbs and was caught off Boat Harbour (Great Abaco Island) in June. At the time, this fish was the second largest blue marlin ever recorded caught in the Bahamas. However, in the 1994 survey, a 920 lb blue marlin was boated also off Boat Harbour in June. Additionally, the largest white marlin recorded in the 1994 survey, 74 lbs, was caught off Bimini in late February, and the largest sailfish, 58 lbs, from off Boat Harbour in June.

Caribbean

The Caribbean survey documented 20,799 hrs of fishing effort from 18 tournaments (of which 15 were from Puerto Rico) in 1993 (Table 6). Catch-rates for blue marlin, white marlin, and sailfish reported in 1993 were 3.1, 0.0, and 0.8 fish per 100 hrs, respectively, compared with 3.6, 0.1, and 5.8 fish per 100 hrs reported in 1992. The associated catch in 1993 from this area (Table 7) was 827 billfish (644 blue marlin, 9 white marlin, 2 spearfish, and 172 sailfish), of which 432 (i.e.,52%) were released.

Gulf of Mexico

There were 318 billfish (195 blue marlin, 87 white marlin, and 36 sailfish) reported caught (Table 7) during the 16,351 hrs of trolling effort sampled in the northern Gulf of Mexico during 1993 (Table 6). The trolling effort and number of billfish caught by region were: northeastern Gulf 8,276 hrs - 137 billfish; northcentral Gulf 4,780 hrs - 66 billfish; and northwestern Gulf 3,295 hrs - 115 billfish. Catch-rates in the northeastern Gulf in 1993, compared to 1992, were: 1.0 vs 0.9 for blue marlin, 0.6 vs 0.8 for white marlin, and 0.1 vs 0.4 for sailfish. In the north central Gulf, the CPUEs in 1993, compared to 1992, were: 1.1 vs 1.1 for blue marlin, 0.2 vs 0.4 for white marlin, 0.1 vs 0.1 for sailfish. In the northwestern Gulf these rates were: 1.9 vs 1.2 for blue marlin, 0.7 vs 0.5 for white marlin, and 0.8 vs 2.3 for sailfish. The reported percentage of billfish released throughout the northern Gulf of Mexico was 78% in 1993.

Prior to 1993, non-tournament data were recorded in the Gulf of Mexico surveys. This is one reason that the effort and catch numbers (Tables 6 and 7) are lower in 1993 than in 1992 for each area of the Gulf of Mexico. Additionally, fewer port samplers were hired in 1993 than in 1992, and bad weather was documented frequently on the weekends (during tournaments) in 1993.

Table 7. The number of billfish caught associated with the trolling hours documented (Table 6) by the NMFS Recreational Billfish Tournament Survey from 1988 through 1993, by areas: Atlantic north of Florida, Florida East Coast and Keys, northeastern Gulf of Mexico (east of the Alabama/Mississippi border), northcentral Gulf (Louisiana/Texas border east to the Alabama/Mississippi border), northwestern Gulf (Texas coast), the Bahamas, and the Caribbean. During 1988-1992, non-tournament data were included in the Gulf of Mexico survey. Caught fish are those that were boated, released, or tagged and released.

AREA	1988	1989	1990	1991	1992	1993
Atl. N. of FL	748	959	1,040	775	915	828
FEC & Keys	2,240	1,706	2,023	1,659	1,962	964
N.E. Gulf of Mexico	488	237	276	223	287	137
N.C. Gulf of Mexico	205	92	110	145	132	66
N.W. Gulf of Mexico	216	134	142	119	210	115
Bahamas	390	404	323	291	294	355
Caribbean	853	718	383	666	904	827
TOTALS:	5,140	4,250	4,297	3,878	4,704	3,292

Billfish By-Catch

Billfish are hooked incidentally by U.S. longline vessels targeting swordfish and tuna in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea, as well as by other fisheries. Since October, 1988, the U.S. Fishery Management Plan for Atlantic Billfishes has prohibited the retention of billfishes by commercial fishing vessels. The numbers of billfishes caught and released from this fishery, with associated effort, are recorded on mandatory log books and are shown in Table 8. Effort is recorded as the number of hooks reported fished from all longline sets. Numbers are revised as of July 31, 1995.

Table 8. Billfish reported caught by U.S. swordfish and tuna longline vessels in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea, 1989-1993. Effort is recorded as total hooks reported fished by pelagic longliners.

YEAR	BLUE MARLIN	WHITE MARLIN	SAILFISH	HOOKS REPORTED
1989	3,167	2,919	1,539	7,932,237
1990	2,756	2,159	1,787	7,487,856
1991	2,305	2,387	1,795	7,746,917
1992	3,179	3,154	1,862	9,040,117
1993	3,352	3,167	2,327	9,634,432

ICCAT RELATED ACTIVITIES

The 1994 Standing Committee on Research and Statistics (SCRS) Report on Billfish

During the 1994 November meeting of the ICCAT's Standing Committee on Research and Statistics (SCRS) in Madrid, Spain, scientists from the Miami Laboratory presented three working documents pertaining to billfish research activities. Farber et al. (SCRS/94/150 - Revised) presented a compilation of available catch, effort, and CPUE data needed for an eastern Atlantic Ocean stock assessment of sailfish. This document will serve as the basis for an exploratory stock assessment for East Atlantic sailfish that is planned for the 1995 SCRS meeting. Jones and Carter (SCRS/94/146) reported an analysis of the length-frequency data collected on billfish in the western Atlantic during the first 7 years of the ICCAT Enhanced Research Program for Billfish. All data were converted to lower-jaw fork-length (desired measure of length) and the data were analyzed by species and location. Prince (SCRS/94/147) summarized progress of the ICCAT Enhanced Research Program for Billfish during 1994. Major areas of activity included at-sea sampling, shore-based sampling, and retrieval of tag-recaptured billfish from seven geographical areas within the western Atlantic Ocean. The hardbound copy of the Report of the Second ICCAT Billfish Workshop was finished and distributed during August, 1994. Copies of these documents and the Workshop book can be obtained by writing the Migratory Fishery Biology Division, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, FL, 33149.

No new stock assessments were submitted to the 1994 SCRS. The 1994 SCRS report on billfish concluded that recent stock assessments for the marlins (1992) and West Atlantic sailfish (1993) indicate that these species are either fully or over-exploited and thus warrant consideration for development of methods to reduce billfish mortality at this time. Marlin landings since the recent assessments conducted in 1992 were compared to equilibrium production yields calculated in that year in order to provide insight into current population trends. Based on this analysis, the trends in the trajectories of ratio of biomass/biomass at MSY for each stock hypothesis for blue marlin and white marlin remained unchanged for those identified in the 1992 assessments. Development of management measures to reduce billfish mortality are particularly difficult because the major source of Atlantic billfish mortality results as a by-catch from the off-shore longline fleets targeting tuna and swordfish (i.e., any management measures to reduce billfish mortality in these fisheries risk affecting the target species as well). One possible approach to reduce currently high rates of billfish longline mortality is to release, or tag and release, the billfish still alive when they are brought alongside longline vessels. Data from various observer programs indicate about ½ of these billfish appear alive when brought alongside the vessels. This type of management measure would first have to be implemented on an experimental and selective basis while additional research is conducted to determine survival rates of billfish caught and released off longline vessels. Other recommended research include evaluation of longline deployment methods to avoid or reduce the billfish by-catch. Measures to reduce billfish longline mortality would realistically have to be combined with an observer program to verify survival estimates and compliance. Application of release, or tag and release, management measures for the recreational component of Atlantic fisheries for billfish appear unnecessary because of the current Atlantic-wide practice of volunteer release policies adopted by many participating countries. Debate of these management issues at the 1994 Commission Meeting was met with little resistance, although a management recommendation to release billfish still alive when brought alongside longline vessels did not appear in the Commission report.

ICCAT Enhanced Research Program for Billfish

Highlights of 1994 research in the western Atlantic include a total of over 30 at-sea observer trips, for the third consecutive year, accomplished on Venezuelan longline vessels targeting tuna and swordfish. In addition, biological sampling of over 900 swordfish for reproductive organs and 300 swordfish for calcified structures (age and growth) were also accomplished on these trips. Progress on shore-based sampling in 1994 continued with several thousand carcass measurements accomplished in 1994. In addition, the ICCAT Enhanced Research Program for Billfish continues to make impressive progress on improving tag recapture rates of billfish. During the 1994 sampling season, about 53 tag recaptured billfish were recovered from Venezuelan fishermen - 17 recaptures had NMFS tags while 36 recaptures had TBF tags. Recapture efforts also continued to result in a number of tag-recaptured sharks being reported through the Program. Expansion of tag release activities and acquisition of hardparts for billfish age and growth studies continued in 1994.

Summary of Shore-Based Sampling

The shore-based sampling program was initiated in 1987 to obtain size frequency of billfish (i.e., blue marlin, white marlin, sailfish, swordfish, and spearfish) landings from participating countries. Through June, 1994, there have been over 22,000 size measurements collected (Table 9). The seven countries in the western North Atlantic Ocean that have cooperated by providing data from their respective landings include: Barbados, Dominican Republic, Grenada, Jamaica, St. Maarten, Trinidad, and Venezuela. During 1992, 6,265 size measurements were collected from billfish in the western North Atlantic Ocean, with 185 size measurements collected from the eastern North Atlantic (Las Palmas, Canary Islands). During 1993, 6,717 billfish size measurements were collected in the western North Atlantic Ocean. Large sample sizes have been consistently reported by Grenada (particularly sailfish), St. Maarten (particularly white marlin), and Venezuela (Table 9).

Table 9. Number of billfish size measurements, by country and species, for shore-based sampling, 1987-1994. The 1994 data are from Venezuela through June, 1994. Data from Senegal are from 1991. Note: BUM = blue marlin, WHM = white marlin, SAI = sailfish, and SPF = spearfish.

COUNTRY	BUM	WHM	SAI	SPF	TOTAL
BARBADOS	83	38	259	14	394
DOMINICAN REPUBLIC	27	224	38	0	289
GRENADA	219	16	2,197	1	2,433
JAMAICA	330	5	7	0	342
ST. MAARTEN	86	1,708	155	51	2,000
TRINIDAD	115	131	194	142	582
VENEZUELA	1,669	5,247	8,622	124	15,662
LAS PALMAS	197	275	60	68	600
SENEGAL	5	0	540	2	547
TOTAL	2,731	7,644	12,072	402	22,849

At-Sea Sampling in Venezuela

This project involves the sampling of billfish caught on industrial longline vessels by an assigned biological technician (observer) on trips out of the port of Cumaná. The database is comprised of fishing trips divided into sets, and organized by season. Sets are categorized into seasons: winter = (December-February), spring = (March-May), summer = (June-August), and fall = (September-November). Trips are designated as targeting yellowfin tuna or swordfish, depending on the type of bait used (sardines or squid, respectively). Trips targeting yellowfin tuna generally occur during the day, and use sardines. Trips targeting swordfish generally use squid bait, at night. Information collected by the observers includes species, time of landing, sex, various measurements and weight, and the condition of the fish (living vs. dead) when brought alongside the boat.

This program has expanded from 3 monitored trips in 1987, to 37 monitored trips in 1993 (Table 10). In 1993 a fleet of 10 boats averaged about 13 sets per trip, with the number of sets ranging from 4 to 29. The total number of sets recorded has continued to increase over the 7-year period to 488 in 1993. In 1993, observers were present aboard 19 yellowfin tuna longline trips, 10 swordfish trips, 2 billfish trips, and 4 mixed longline trips (targeting both yellowfin and swordfish). Sampling provided information on 1,953 billfish (96 blue marlin, 242 white marlin, 250 sailfish, 66 spearfish, and 1,299 swordfish). The average line length per set was 50 km, with an average of 1,231 hooks per set (Table 10). Again, in 1993, billfish catch-rates were higher in the summer and fall seasons for sailfish, spearfish, and white marlin. However, catch-rates reported for blue marlin and swordfish were higher in the fall and winter. The mortality of billfish brought to the side of the boat ranged from 38% for blue marlin (the lowest recorded mortality for any species over the 7-year period) to 67% for sailfish.

Incomplete data for 1994 recorded 350 sets during 36 trips. There were 173 blue marlin, 352 white marlin, 142 sailfish, and 92 spearfish reported in 1994 (Table 10).

All at-sea and shore-based sampling data are available upon request by writing the NMFS, SEFSC, 75 Virginia Beach Drive, Miami, Florida, 33149 (attention Dr. Mark Farber).

Table 10. Numbers of trips and sets, average number of hooks-per-set and longline length-per-set (km), numbers of billfish caught, and estimated mortality of billfish brought alongside the boat for at-sea sampling in Venezuela, 1987-1994. Data for 1994 are preliminary. Note: BUM = blue marlin, WHM = white marlin, SAI = sailfish, and SPF = spearfish.

	1987	1988	1989	1990	1991	1992	1993	1994	1987-94
No. of trips	3	3	3	7	16	32	37	36	137
No. of sets	23	37	34	43	99	265	488	350	1,339
Avg. hooks/set	1171	1225	2439	1552	1646	1036	1231	1225	1,284
Avg. length/set	57	58	42	46	39	47	50	50	50
No. BUM caught	38	13	11	34	59	87	96	173	511
No. WHM caught	144	60	47	69	60	92	242	352	1,066
No. SAI caught	30	7	18	19	94	148	250	142	708
No. SPF caught	0	0	0	8	36	31	66	92	233
% BUM mortality	68	40	64	76	67	52	38	55	51
% WHM mortality	55	55	65	56	57	65	61	43	59
% SAI mortality	50	67	72	68	78	66	67	46	69
% SPF mortality	N/A	N/A	N/A	75	67	61	65	44	62

AGE AND GROWTH RESEARCH

Sampling of hardparts from juvenile billfish collected out of the stomachs of larger predators (sponsored by The Billfish Foundation) continued in 1994. A total of 32 sets of otoliths (ear bones) from juvenile swordfish one juvenile sailfish were also collected by this program in 1993-94. Additional hardpart samples were obtained from a very large blue marlin (1,199 lbs, courtesy of Dr. Brian Lukehurst) caught in Bermuda in July, 1993.

PELAGIC LONGLINE OBSERVER PROGRAM

The Pelagic Longline Observer Program (PLOP), located at the NMFS, SEFSC, Miami Laboratory, completed its second full year of coverage since its commencement in 1992. The PLOP will continue its 1995 coverage of U.S. commercial longline vessels that are primarily targeting swordfish or tunas (yellowfin and bigeye).

Using the Pelagic Logbook longline set information from the previous year, a list of randomly selected U.S. vessels was generated for the northwest Atlantic region, and for each quarter of the current year, to provide a 5% sample of the number of longline sets made by the fleet. This list is divided between the NEFSC and SEFSC. The chance of selecting an individual vessel depends on how much fishing was reported for that vessel from the previous year. Because information is needed for each quarter of the year and over all of the fishing grounds covered by the U.S. fleet, the same vessel could be selected for observation as many as 4 times in a year. By the

same procedure, a vessel might not be selected at all for any given year.

Over the period March, 1992, through 1994, a total of 169 vessels have been boarded by observers working for NMFS, Miami Laboratory. Some of these vessels have been covered more than once during this time period, though not more than once during any given quarter. Observers spent 1,727 days at-sea aboard these vessels during the 11 quarters in which 1,066 sets were observed. The average minimum length of mainline set for all areas fished was 4.5 nm while the longest average set was 40.0 nm. During the three quarters of 1992, a total of 80,426 hooks were set by vessels, with 549,478 hooks recorded during the eight quarters of 1993 and 1994, combined. From 1992 to 1994, PLOP observer personnel observed and identified to species a total of 30,937 fish, marine mammals, and sea turtles. In some cases, fish were released or lost at the ocean surface (mostly sharks) which the observer could only identify to a general species group. A second summary report of the PLOP activities summarizing 1993 and 1994 results should be available during 1995. The PLOP wishes to thank the owners, captains, and crews of the vessels observed because these kinds of observations and measurements would not be possible without their cooperation.