# 1988 REPORT OF THE SEFC BILLFISH PROGRAM

NOAA Technical Memorandum
NMFS-SEFC-244

December 1989

Southeast

FISHERIESCENTER

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U.S. Department of Commerce, NOAA
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Southeast Fisheries Center
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Miami, Florida 33149

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Oceanics Pelagic Resources Division
Contribution Number PRD-89/90-7

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# 1988 REPORT OF THE SEFC BILLFISH PROGRAM

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December 1989

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This report should be cited as follows:

National Marine Fisheries Service. 1989. 1988 Report of the SEFC billfish program. NOAA Technical Memorandum NMFS-SEFC-244, 20p.

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# 1988 REPORT OF THE SEFC BILLFISH PROGRAM

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ACKNOWLEDGEMENTS

The employees of the Southeast Fisheries Center are grateful to the recreational and commercial fishermen who voluntarily cooperated in the collection of billfish statistics, and to the numerous state, university, and federal employees who lent their time and support to the billfish program.

# 1988 REPORT OF THE SEFC BILLFISH PROGRAM

For nearly two decades the sport fishing community has helped the Southeast Fisheries Center gather research data throughout much of the oceanic range of the billfish species. These cooperative efforts from fishermen, tournament directors, vessel captains, and others in the fishery, has allowed the Southeast Fisheries Center to accumulate the most comprehensive data base for Atlantic blue marlin, white marlin, sailfish, and spearfish in the world. This report summarizes much of the billfish data collected since 1971, presents the results of 1988 activities, and provides an update of billfish research.

## COOPERATIVE BILLFISH TAGGING PROGRAM

Records of billfish tags can be found in the archives of the Southeast Fisheries Center dating back to the 1950s. The tagging program, however, remained in its infancy until about 1971 when tournament sampling began.

### 1988 TAG RELEASES

Record numbers of billfish were tagged in 1988: 1,652 blue marlin, 1,102 white marlin, 2,464 sailfish, and 12 spearfish (Fig. 1). These are well above the 18-year annual averages of 449 blue marlin, 743 white marlin, 1,643 sailfish, and 6 spearfish.

The leading area for blue marlin tagging in 1988 was St. Thomas, U.S. Virgin Islands where 623 fish were tagged. Other major areas included 213 releases in the Bahamas, 200 in Puerto Rico, 181 in the northeastern Gulf of Mexico, 167 along the west coast of Africa, and 91 in La Guaira, Venezuela. Blue marlin were also tagged in Bermuda, U.S. Atlantic states, Mexico, Columbia, and the U.S. north Atlantic Ocean near the edge of the continental shelf. Tagging at the edge of the shelf often occurs by commercial tuna and swordfish fishermen and by National Marine Fisheries Service observers aboard Japanese longline vessels operating within the 200 mile limit of the U.S. Exclusive Economic Zone.

The leading area for white marlin tagging in 1988 was the middle Atlantic states with 281 releases. Other major areas included 268 releases in the Gulf of Mexico, 152 off La Guaira, Venezuela, 126 off Massachusetts, 74 on Florida's east coast, and 62 in the Bahamas. White marlin were also tagged in Mexico, Puerto Rico, Dominican Republic, St. Thomas, Cuba, Bermuda, and the Atlantic Ocean near the edge of the continental shelf.

The leading area for sailfish tagging in 1988 was the east coast of Florida with 1,119 releases. Other major areas included 420 releases from Cancun, Mexico, 344 from Cozumel, Mexico, 175 from the west coast of Africa, 116 from the northeastern coast of Florida, 108 in the Gulf of Mexico, 84 from La Guaira, Venezuela, and 51 in the Bahamas. Sailfish were also tagged in the Atlantic states north of Florida, Puerto Rico, U.S. Virgin Islands, Cuba, and Brazil.

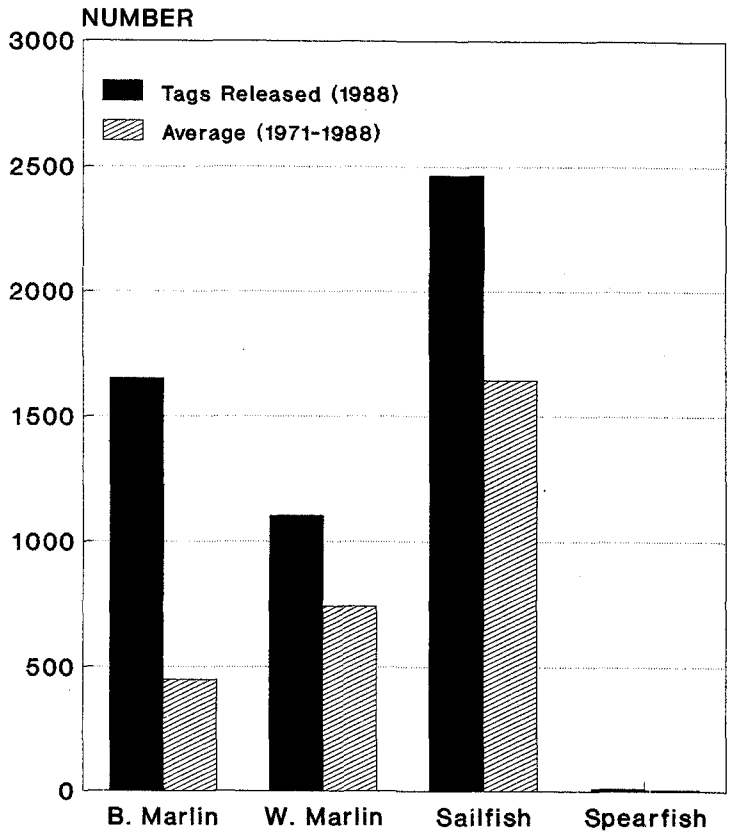



Fig. 1. Billfish tagged in 1988.

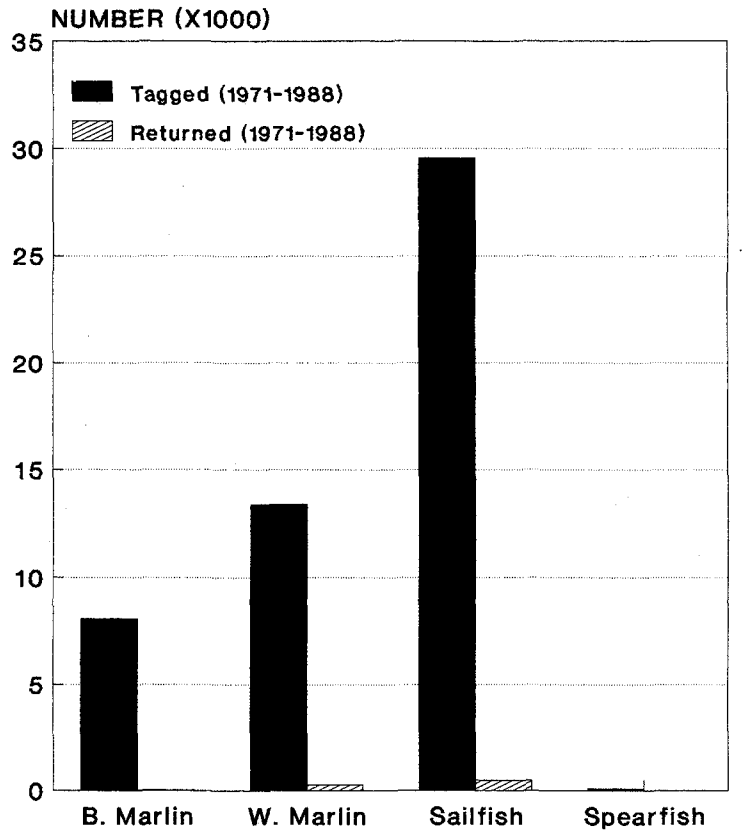



Fig. 2. Billfish tagged 1971-1988.

## 1971-1988 TAG RETURNS

Since 1971 nearly 8,000 blue marlin, 13,000 white marlin, 30,000 sailfish, and 100 spearfish have been tagged by fishermen in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. Although the number of fish tagged during 1971-1988 is in the thousands, the number returned is relatively small: 28 blue marlin, 262 white marlin, and 473 sailfish (Fig. 2). Since 1971, the number of billfish tagged and the number of tags returned each year have generally increased, yet the proportion of tags returned to the Southeast Fisheries Center is relatively small, averaging about 1.5% (Fig. 3).

## TAGGING BY SPECIES

More sailfish are tagged each year than any other billfish species (Fig. 4), and since 1974, more sailfish tags have been returned than for any other species (Fig. 5). White marlin tagging was second in the number of fish tagged per year until 1987 when blue marlin moved into second place. Although a few spearfish are tagged each year, unfortunately no tags have ever been returned to the Southeast Fisheries Center.

The average time-at-large for a blue marlin tag is about one and one-half years (83 weeks). For white marlin the average is under 2 years (96 weeks) and for sailfish, under 1 year (43 weeks).

The longest time-at-large for a blue marlin tag was eight years. The fish was tagged in January, 1977, in the Caribbean and recaptured in December, 1984, in the Caribbean. The longest time-at-large for a white marlin tag was nearly 12 years--tagged September, 1970, in the Atlantic north of Florida and recaptured July, 1982, in the same region. The longest time-at-large for a sailfish was nearly 11 years--tagged March, 1973, in the Straits of Florida and recovered June, 1984, along the east coast of Florida.

## 1988 TAG RECOVERIES

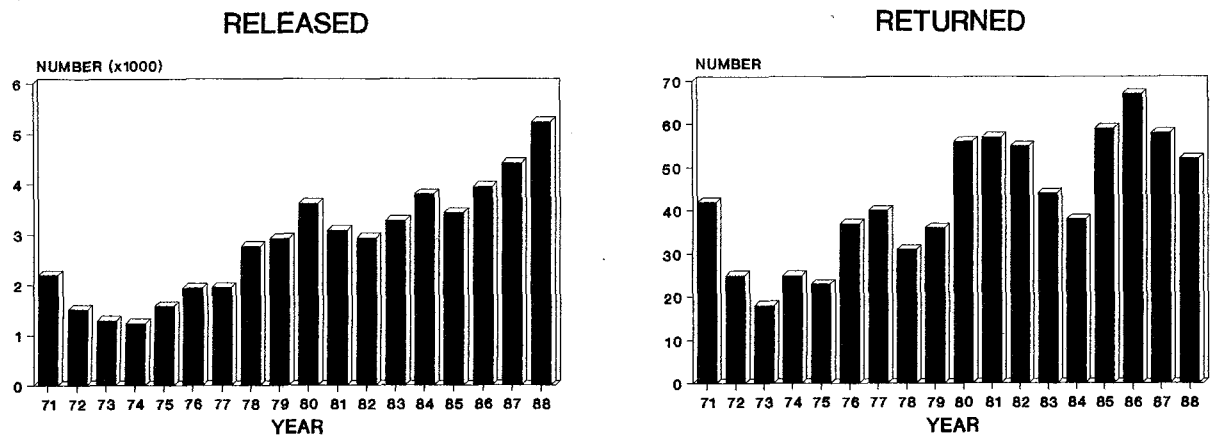
Some 1988 tag recoveries document the ability of blue marlin to travel long distances. Two blue marlin tagged near St. Thomas, U.S. Virgin Islands, were recovered. One was recovered off Venezuela and the other off Puerto Rico.

Long distance migrations of white marlin were also documented by tag returns in 1988. A fish tagged in the Gulf of Mexico was recaptured near Cozumel, Mexico. Two white marlin tagged near Cozumel were recaptured in the Gulf of Mexico and in the area of La Guaira, Venezuela. Two white marlin tagged off Miami, Florida, were recaptured: one in the Gulf of Mexico and one in the mid-Atlantic bight. A white marlin tagged off Hatteras, North Carolina, was recaptured in the northeastern Gulf of Mexico. One white marlin tagged in the Straits of Florida was returned off North Carolina.

A sailfish tagged near Cozumel, Mexico, was recaptured in 1988 near Curacao, Netherlands Antilles. Three sailfish tagged along the east coast of Florida were recaptured: one near Chub Cay, Bahamas, one in the northeastern Gulf of Mexico, and one in the Dominican Republic. Four sailfish tagged in the area of Cozumel or Cancun, Mexico, were recaptured: one each near Cuba, the northwestern Gulf of Mexico, Palm Beach, Florida, and the central Caribbean Sea.

## TAG RECOVERIES SINCE 1950

To define the movement of billfish over vast expanses of ocean, all tagging data since 1950 were computed for 5 regions: northwestern Atlantic, Gulf of Mexico, Caribbean Sea, southwestern Atlantic, and eastern Atlantic (Fig. 6).



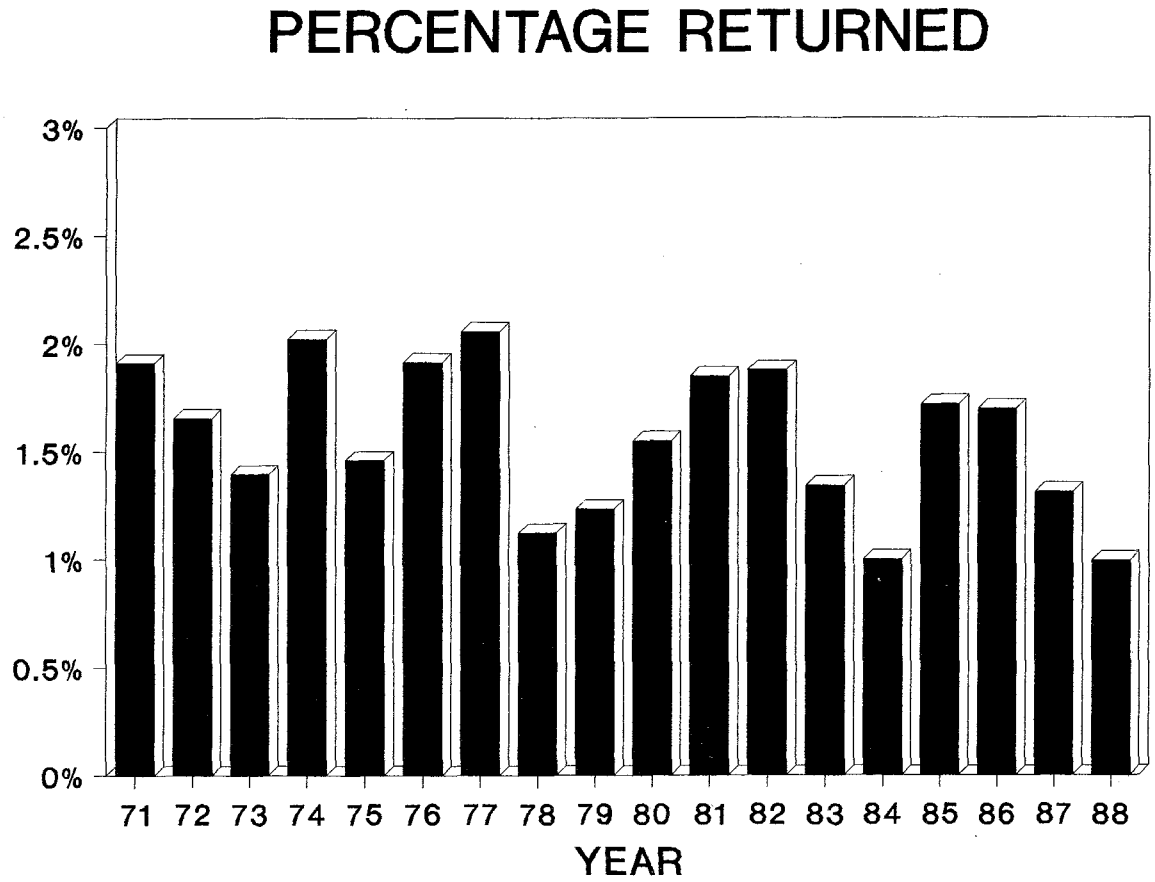




Fig. 3. Percentage of tags recovered.

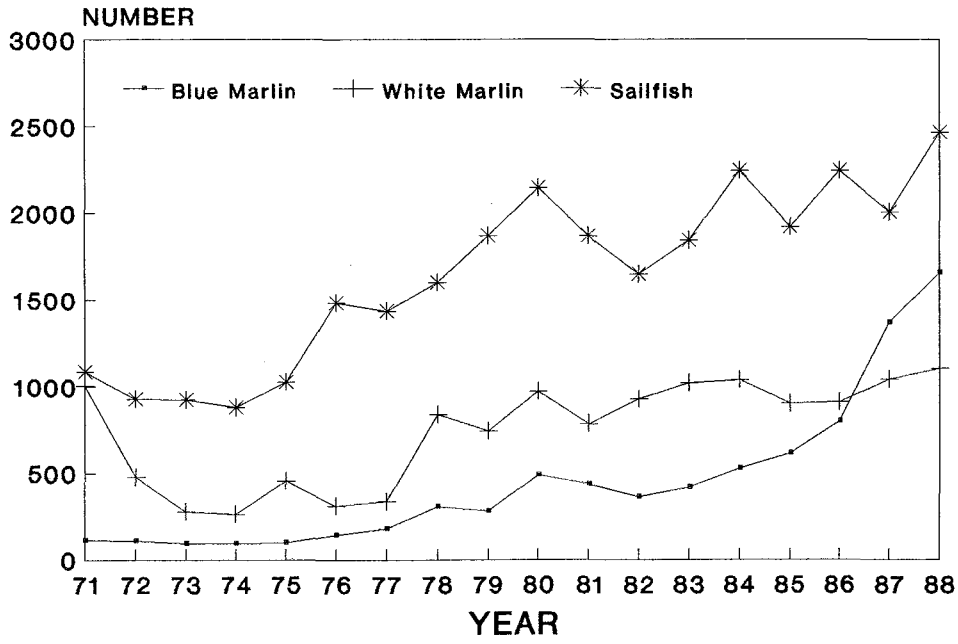



Fig. 4. Tags released by year.

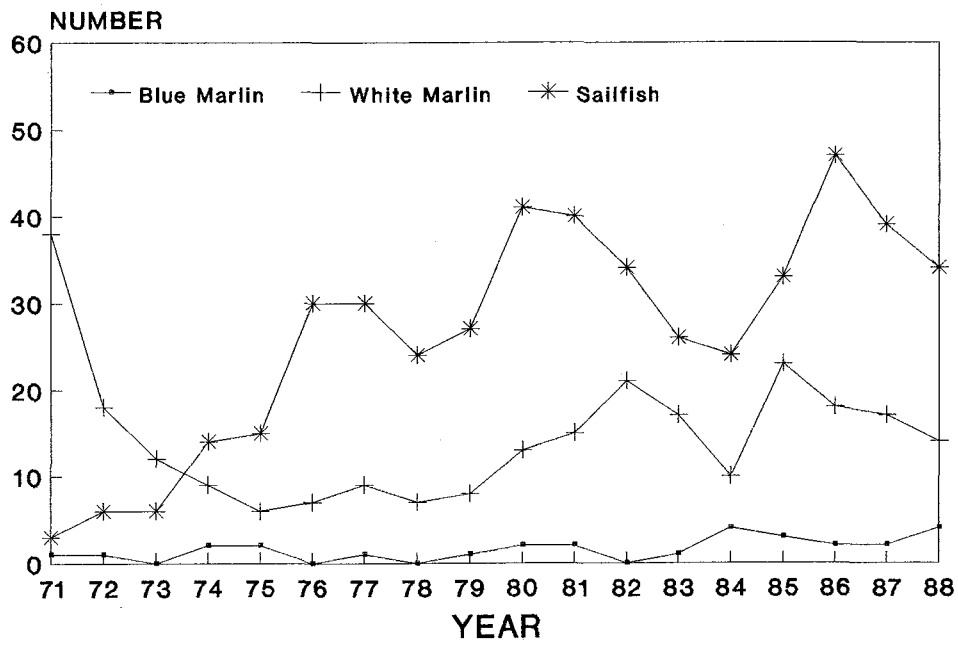



Fig. 5. Tags returned by year.

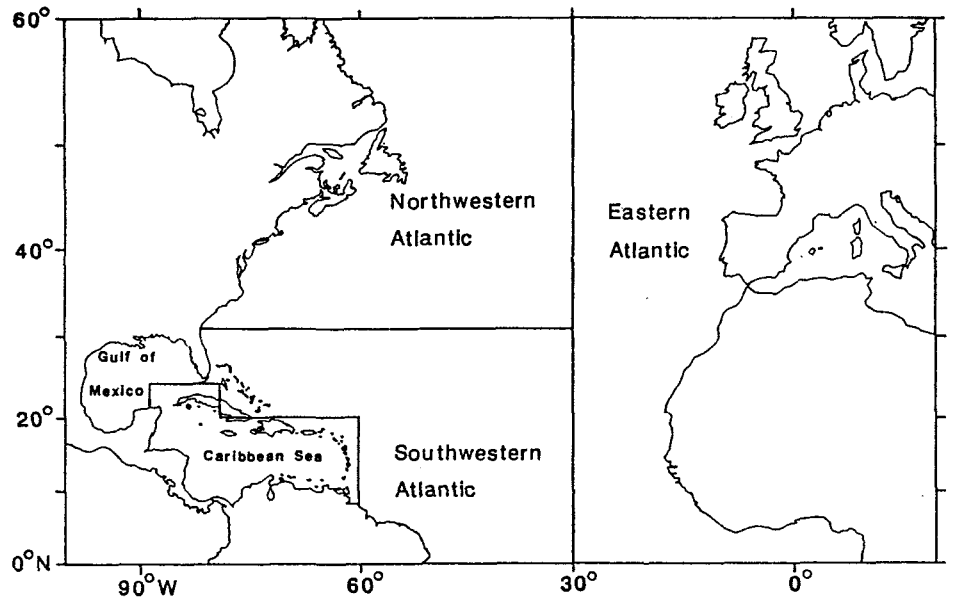



Fig. 6. Regions in the Atlantic Ocean.

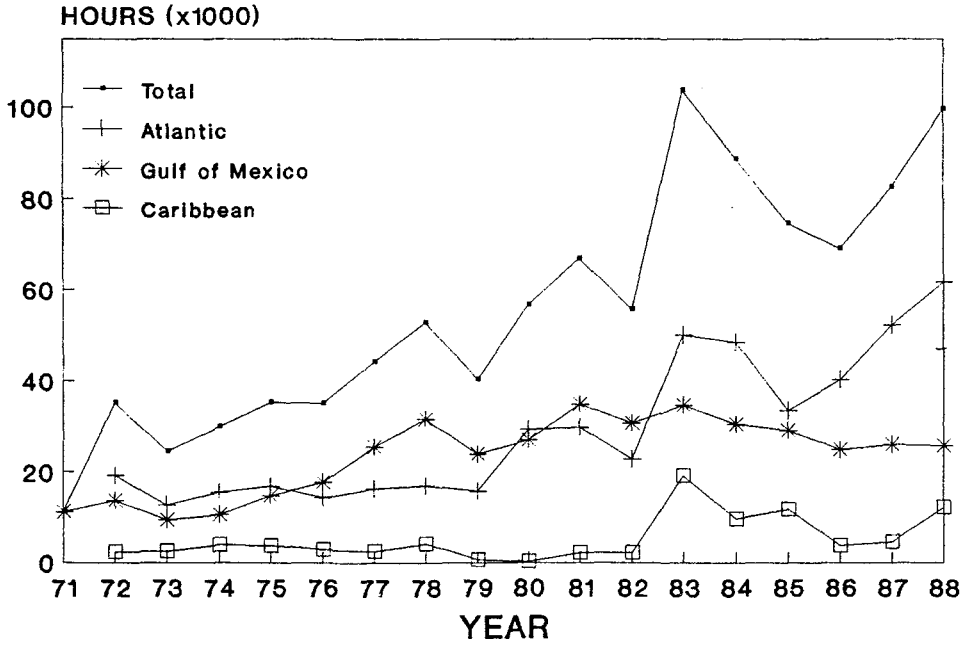



Fig. 7. Fishing hours surveyed.

Although billfish are capable of oceanic migration, most are recaptured in the region in which they were tagged (Table 1).

Table 1. Tags returned by region (1950-1988).

| REGION TAGGED | REGION OF RECOVERY: Northwestern Atlantic | Gulf of Mexico | Caribbean Sea | Southwestern Atlantic | Eastern Atlantic |
|---|---|---|---|---|---|
| BLUE MARLIN: | | | | | |
| Northwestern Atlantic | 2 | 0 | 1 | 1 | 0 |
| Gulf of Mexico | 0 | 5 | 1 | 2 | 0 |
| Caribbean Sea | 0 | 0 | 7 | 2 | 4 |
| Southwestern Atlantic | 0 | 1 | 0 | 5 | 0 |
| Eastern Atlantic | 1 | 0 | 0 | 0 | 0 |
| WHITE MARLIN: | | | | | |
| Northwestern Atlantic | 150 | 9 | 45 | 34 | 1 |
| Gulf of Mexico | 2 | 49 | 6 | 2 | 0 |
| Caribbean Sea | 4 | 2 | 19 | 3 | 0 |
| Southwestern Atlantic | 7 | 6 | 2 | 4 | 0 |
| Eastern Atlantic | 5 | 1 | 0 | 0 | 0 |
| SAILFISH: | | | | | |
| Northwestern Atlantic | 1 | 0 | 0 | 2 | 0 |
| Gulf of Mexico | 0 | 7 | 2 | 14 | 0 |
| Caribbean Sea | 1 | 7 | 31 | 14 | 0 |
| Southwestern Atlantic | 1 | 22 | 10 | 441 | 0 |
| Eastern Atlantic | 0 | 1 | 0 | 23 | 2 |

Since 1971, 59% of the blue marlin tags returned to the Southeast Fisheries Center show no inter-regional movement. Movement among regions, however, was documented from the:

- Northwestern Atlantic Ocean to the Caribbean Sea, and southwestern Atlantic.
- Gulf of Mexico to the Caribbean Sea and southwestern Atlantic.
- Caribbean Sea to the southwestern Atlantic and eastern Atlantic.
- Southwestern Atlantic Ocean to the Gulf of Mexico.
- Eastern Atlantic Ocean to the northwestern Atlantic.

For white marlin, 63% of the tags were returned from the region of release, but inter-regional migration was shown from the:

- Northwestern Atlantic Ocean to the Gulf of Mexico, Caribbean Sea, southwestern Atlantic, and eastern Atlantic.
- Gulf of Mexico to the northwestern Atlantic, Caribbean Sea, and southwestern Atlantic.
- Caribbean Sea to the northwestern Atlantic, Gulf of Mexico, and southwestern Atlantic.
- Southwestern Atlantic Ocean to the northwestern Atlantic, Gulf of Mexico, and Caribbean Sea.
- Eastern Atlantic Ocean to the northwestern Atlantic and Gulf of Mexico.

For sailfish, 83% of the tags were recaptured in the region of release. Migrations were shown from the:

- Northwestern Atlantic Ocean to the southwestern Atlantic.
- Gulf of Mexico to the Caribbean Sea, and southwestern Atlantic.
- Caribbean Sea to the northwestern Atlantic, Gulf of Mexico, and southwestern Atlantic.
- Southwestern Atlantic Ocean to the northwestern Atlantic, Gulf of Mexico, and Caribbean Sea.
- Eastern Atlantic Ocean to the Gulf of Mexico and southwestern Atlantic.

## GAMEFISH SURVEY

Personnel from state agencies, universities, fishing clubs, and tournament committees work with employees of the Southeast Fisheries Center to gather data on billfish hooked, boated, tagged, and released, as well as data on length, weight, sex, bait, environmental conditions, etc. The number of hours sampled has generally increased throughout most of the 18 years of the program (Fig. 7). In 1988, nearly 100,000 hours of fishing effort were sampled, representing a 20% increase over 1987.

## AVERAGE SIZE

The median or average size of billfish sampled in 1988 is illustrated in Fig. 8. In each illustration, a box encloses the middle 50% of all data points. Near the middle of each box is a horizontal line which identifies the median. The median size is the size in which half of the fish sampled are larger and half are smaller than the median. A vertical line extending above and below the box illustrates the range of minimum and maximum values except in the cases where data points are unusually large with respect to the remaining data points. When this occurs, the data points are plotted separately above the vertical line.

The median size of blue marlin sampled from all regions was 258 pounds. The smallest blue marlin sampled was 20 pounds; the largest blue marlin was 877 pounds. For white marlin, the median size was 51 pounds with the smallest at 32 pounds and the largest at 89 pounds. The median size for sailfish was 39 pounds with the smallest at 24 pounds and the largest at 85 pounds.

Two changes in the fishery might lead to increases in the average size of billfish in 1989. A trend for several years in tournaments is towards a release format for smaller fish--a practice which increases the chances that a fish will grow to a larger size before it is killed. Also, since October, 1988, new federal fishing regulations prohibit the killing of billfish below a minimum size.

## LARGEST FISH SAMPLED

The largest blue marlin sampled each year ranges from a minimum of 565 pounds in 1971 to 1,085 pounds in 1988 (Fig. 9). The largest white marlin sampled ranges from 84 pounds in 1971 to 148 pounds in 1983. The largest sailfish ranges from 67 pounds in 1971 to 99 pounds in 1983. Spearfish are rare, but the largest sampled was 60.8 pounds in 1982. These statistics, of course, are probabilistic-the more sampling effort in a particular area, the more likely a larger and smaller fish will be weighed and recorded.

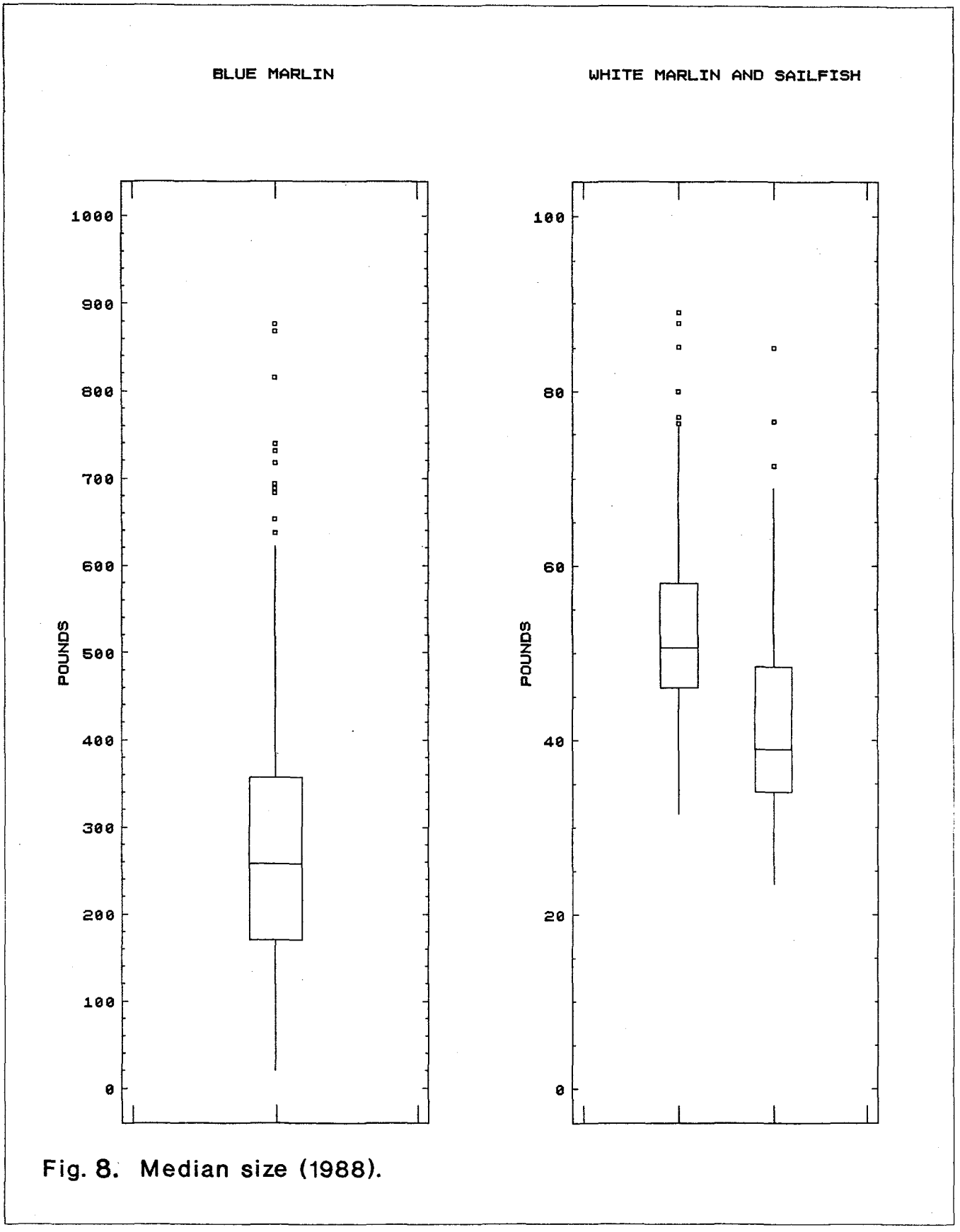
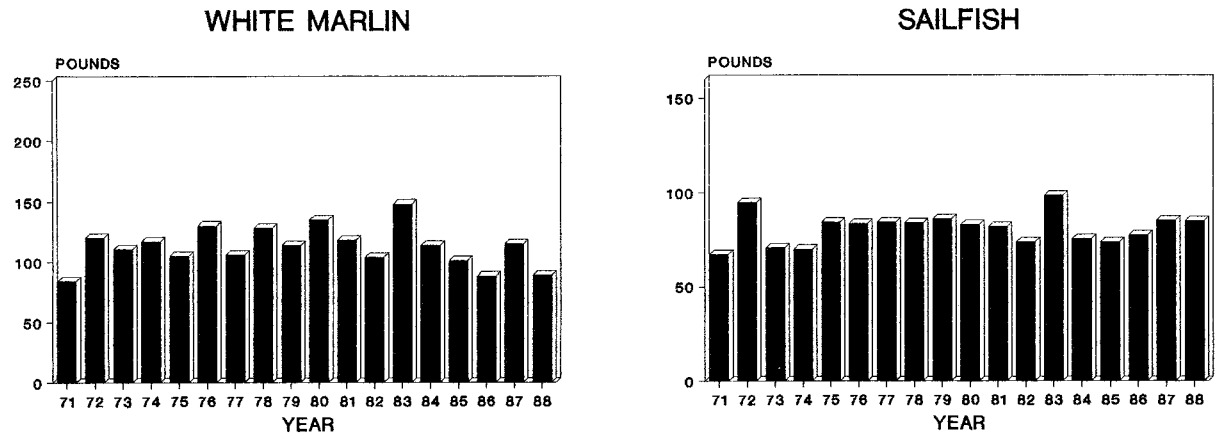



Fig. 8. Median size (1988).



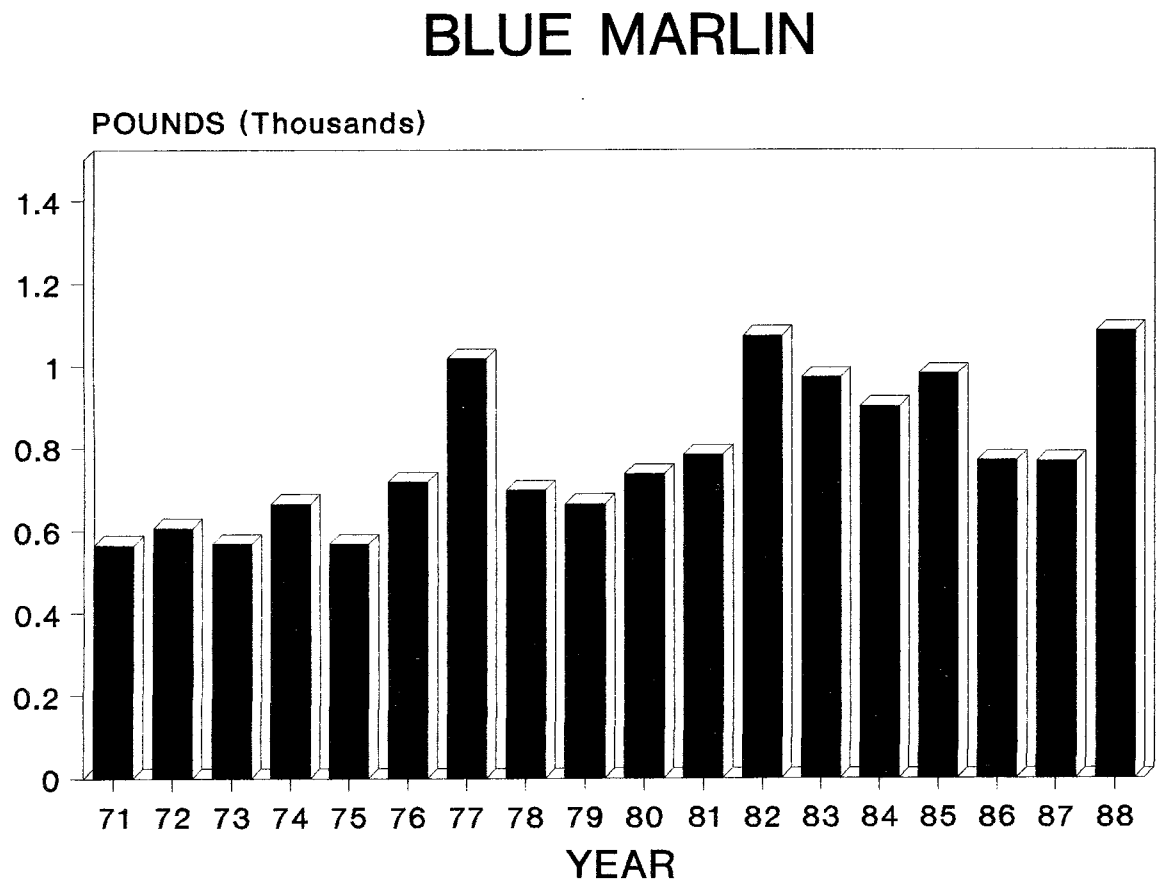




Fig. 9. Largest billfish sampled.

## BAIT ANALYSIS

Interviews with fishermen in the Gulf of Mexico and Atlantic Ocean provide information for the analysis of baits. Two categories are analyzed in the Gulf: baits used independently and baits used simultaneously. If a boat trolls with only one type of bait at a time--dead, alive, or artificial--the use is independent. If the baits are mixed--natural with artificial--the use is simultaneous. From 1988 surveys in the Gulf of Mexico, the success rate was best for the independently used dead baits which averaged nearly 9 fish hooked per 100 hours fished (Fig. 10). Artificial and live baits followed with about 5 fish hooked per 100 hours fished. In simultaneous use, natural baits averaged 3.2 and the artificial baits averaged 4.1 fish hooked per 100 hours fished.

In the Atlantic, bait analyses are conducted for sailfish tournaments only, and instead of fish hooked per 100 hours of fishing, catch per 100 hours of fishing is used. In 1988, live baits averaged 0.9 fish caught per 100 hours, while dead baits averaged slightly less at 0.7 fish caught per 100 hours.

## CATCH RATES

Traditionally, the Southeast Fisheries Center reported an index of abundance as fish hooked-per-hour-fished. However, because of the magnitude of data contributed by tournaments without hook information, this report uses billfish caught per 100 hours of fishing. Fish caught is the total of all fish brought to the boat, either killed or released alive.

The 18-year average for the number of blue marlin caught per 100 hours fished is 1.1 (Fig. 11). The blue marlin catch rate was below average between 1975 and 1980 but increased to above average between 1981 and 1988 with only one exception, 1986. Since 1979, and particularly since 1986, there has been an increasing trend in the percent of fish released by recreational fishermen. In 1988, 66% of all blue marlin caught were released.

White marlin catch rates have averaged 2.0 per 100 hours over the 18 years. An extremely high catch rate was recorded in 1980 of 5.5 fish per 100 hours of fishing. This unusually high value, however, was probably an artifact of the gamefish survey at the time. In 1980 there was extensive sampling of fish in the Atlantic north of Florida, an area where the catch rate is usually higher than in southern waters. White marlin catch rates since 1985 have been below average, and the 1988 rate of 1.0 fish per 100 hours is only 52% of the long-term average.

Sailfish catch rates since 1986 are above the long-term average of 2.1 per 100 hours. The rate was highest in 1977 at 3.2 fish caught per 100 hours and nearly the same again in 1986 at 3.1 fish per 100 hours. Since 1986, sailfish catch rates has declined to the 1988 level of 2.5 fish per 100 hours.

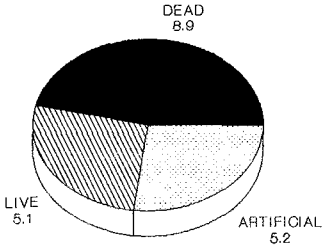
## REGIONAL CATCH RATES

In 1988, about 21,000 hours of fishing effort were sampled in the Atlantic north of Florida. Billfish caught per 100 hours fished was 3.5, down 27% from 4.8 in 1987.

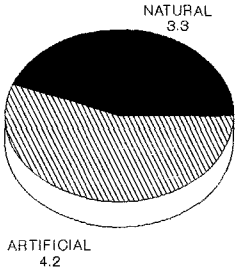
Along Florida's east coast and Keys, about 26,000 hours of fishing effort were sampled in 1988. Billfish catch rate was 8.6, an increase of 23% over 7.0 reported in 1987.

In the northeastern Gulf of Mexico, about 13,000 hours of fishing effort were sampled in 1988. The catch rate for billfish was 3.7, an increase of 12% over 3.3 reported in 1987.

HOOK RATES FOR BAITS USED INDEPENDENTLY
Gulf of Mexico
(Fish hooked per 100 hours fished)




HOOK RATES FOR BAITS USED SIMULTANEOUSLY
Gulf of Mexico
(Fish hooked per 100 hours fished)




CATCH RATES FOR BAITS USED INDEPENDENTLY
Sailfish Tournaments, Florida East Coast
(Fish caught per 100 hours fished)

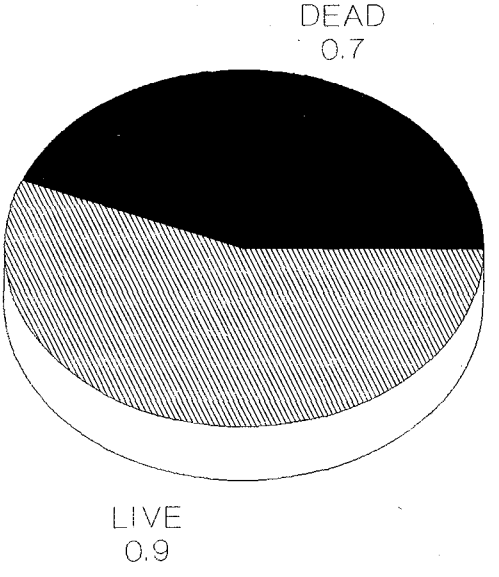
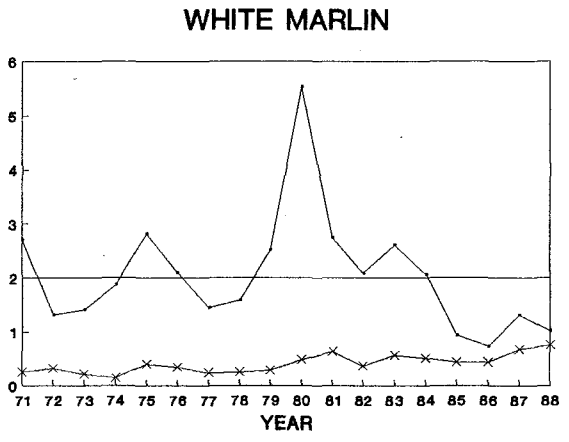
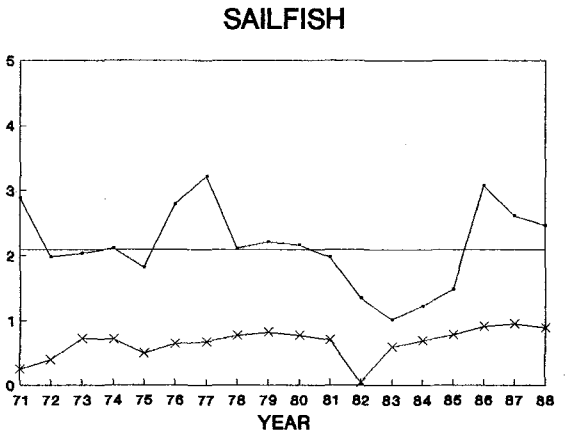



Fig. 10. Bait analyses (1988).




# BLUE MARLIN

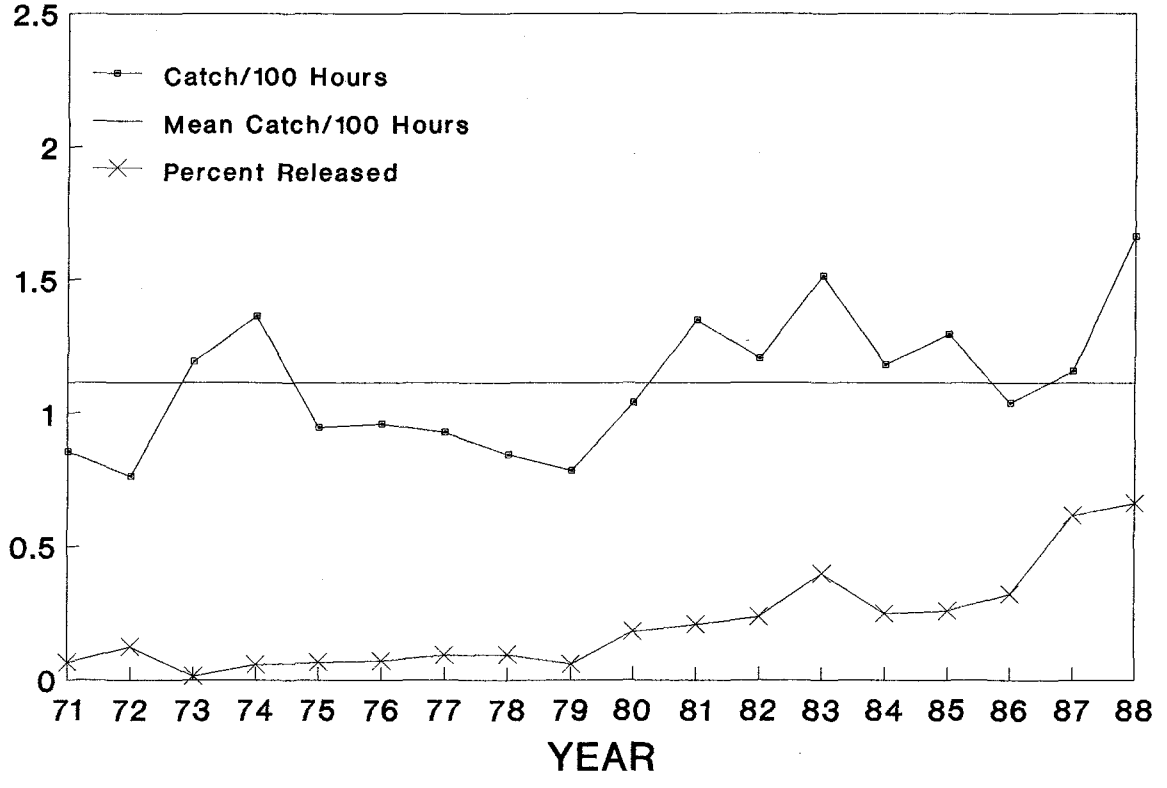



Fig. 11. Catch per 100 hours of fishing.

In the northcentral Gulf of Mexico, nearly 8,000 hours of fishing effort were sampled in 1988. The catch rate of 2.6 was the same as reported in 1987.

In the northwestern Gulf of Mexico, nearly 5,000 hours of fishing effort were sampled in 1988. The catch rate of 4.3 was a decrease of 30% under 6.1 reported in 1987.

In the Bahamas, about 14,000 hours of fishing effort were sampled in 1988. Billfish caught per 100 hours of fishing averaged 2.7, a 13% increase over 2.4 reported in 1987.

In the Caribbean, about 12,000 hours of fishing effort were sampled. Billfish caught per 100 hours of fishing averaged 7.0, a 13% increase over 6.2 reported in 1987.

As with all fisheries, the above variation among years in catch rates might not always reflect true changes in stock abundance or availability. Year-to-year changes in catch rates can be reflective of the "random noise" in sampling.

## BILLFISH RAISED IN THE GULF OF MEXICO

In 1988, sport fishing in the northeastern Gulf of Mexico covered an area the size of about 76 ten-minute squares of latitude and longitude--slightly less than the 78 reported in 1987. Fish raised (i.e., billfish not hooked but sighted from the boat) per hour of trolling ranged from 0.013 to 0.421 (Fig. 12).

Fishing in the northcentral Gulf of Mexico covered about 49 squares in 1988--much less than 57 reported in 1987. Fish raised per hour of trolling ranged from 0.016 to 0.250 with the higher numbers in offshore areas (Fig. 13).

The 1988 addition of a full-time sampler in the northwestern Gulf allowed sampling in the Texas area to be expanded greatly to the south. Fish raised per hour-of-trolling ranged from 0.015 to 0.232 (Fig. 14). Unlike the north-central Gulf, there was no discernible inshore-offshore pattern to the concentrations of billfish.

## JAPANESE LONGLINE TUNA FLEET

The Japanese tuna longline fleet operates along the east coast of the United States in the 200 mile limit of the Exclusive Economic Zone several months per year. U.S. law prohibits the taking aboard of any species other than tuna; however, a small by-catch of billfish, predominantly white marlin, are hooked and released. Since 1982 all Japanese tuna vessels operating in U.S. waters were constantly monitored by National Marine Fisheries Service using on-board agents as observers. The agents ensure compliance of the law and record all animals hooked, including mammals and birds, and they record the live or dead condition of each. Since 1982, the average hook rate was 221 billfish per year (Table 2). The percent of billfish released dead averaged 65%.

In 1987-1988, the Japanese by-catch of billfish was small relative to previous years. Prior to 1987 the fleet targeted bluefin, bigeye, or yellowfin tunas in summer through winter months. But in 1987 and 1988, the fleet primarily targeted bluefin tuna in the winter months when the by-catch of billfish was relatively small.

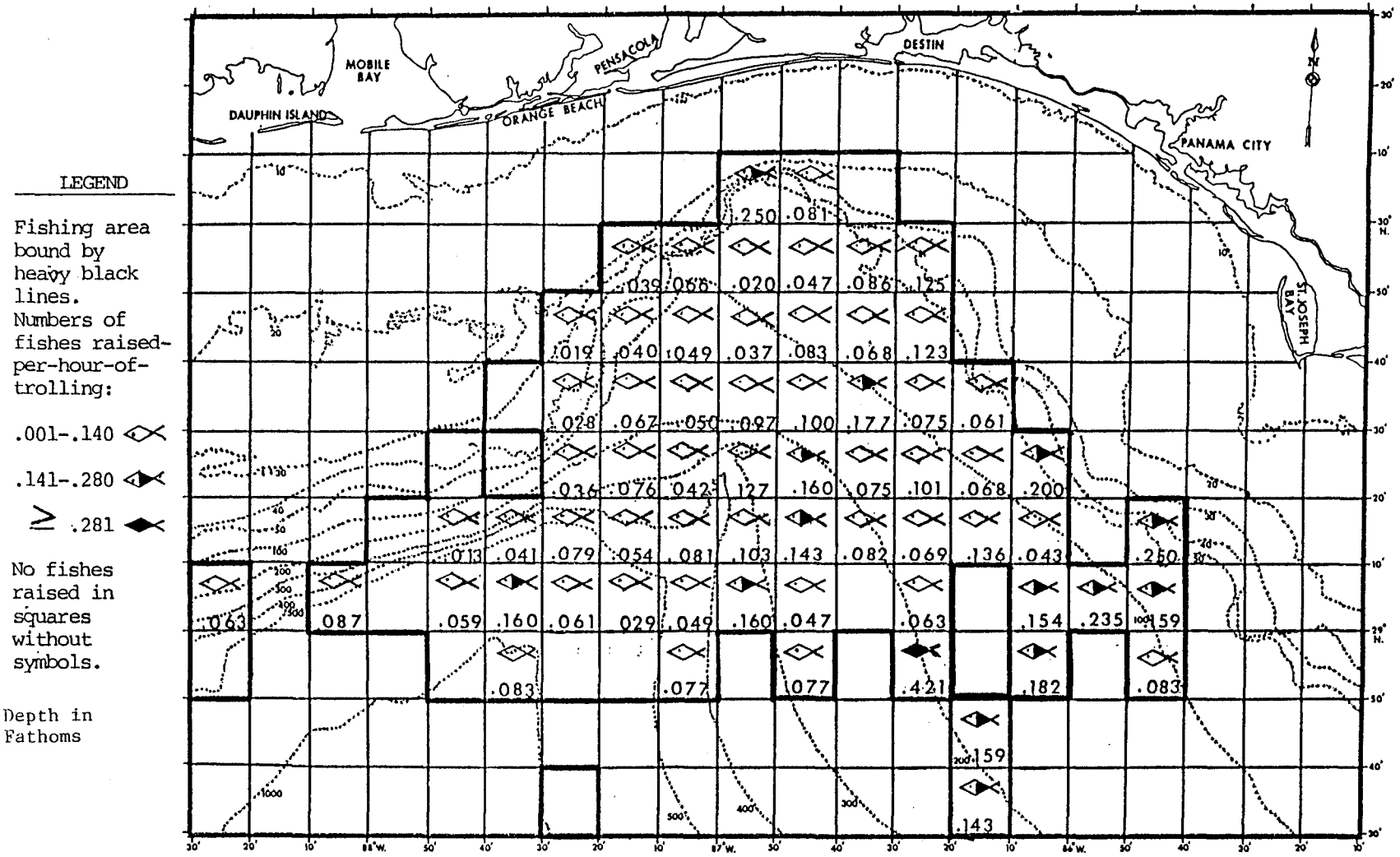



Fig. 12. Number of billfish raised per hour of trolling in the northeastern Gulf of Mexico by 10-minute squares (1988).

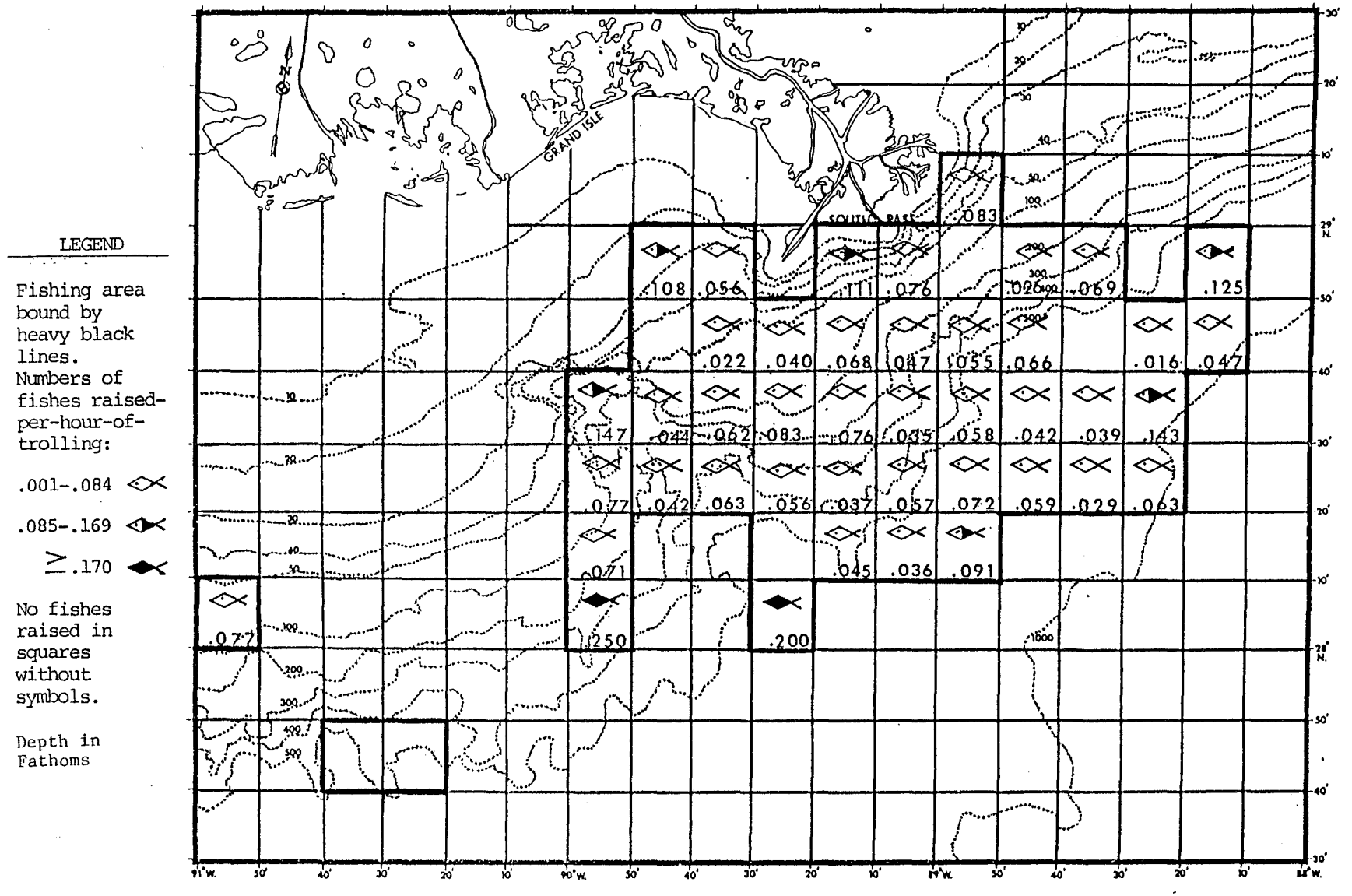



Fig. 13. Number of billfish raised per hour of trolling in the northcentral Gulf of Mexico by 10-minute squares (1988).

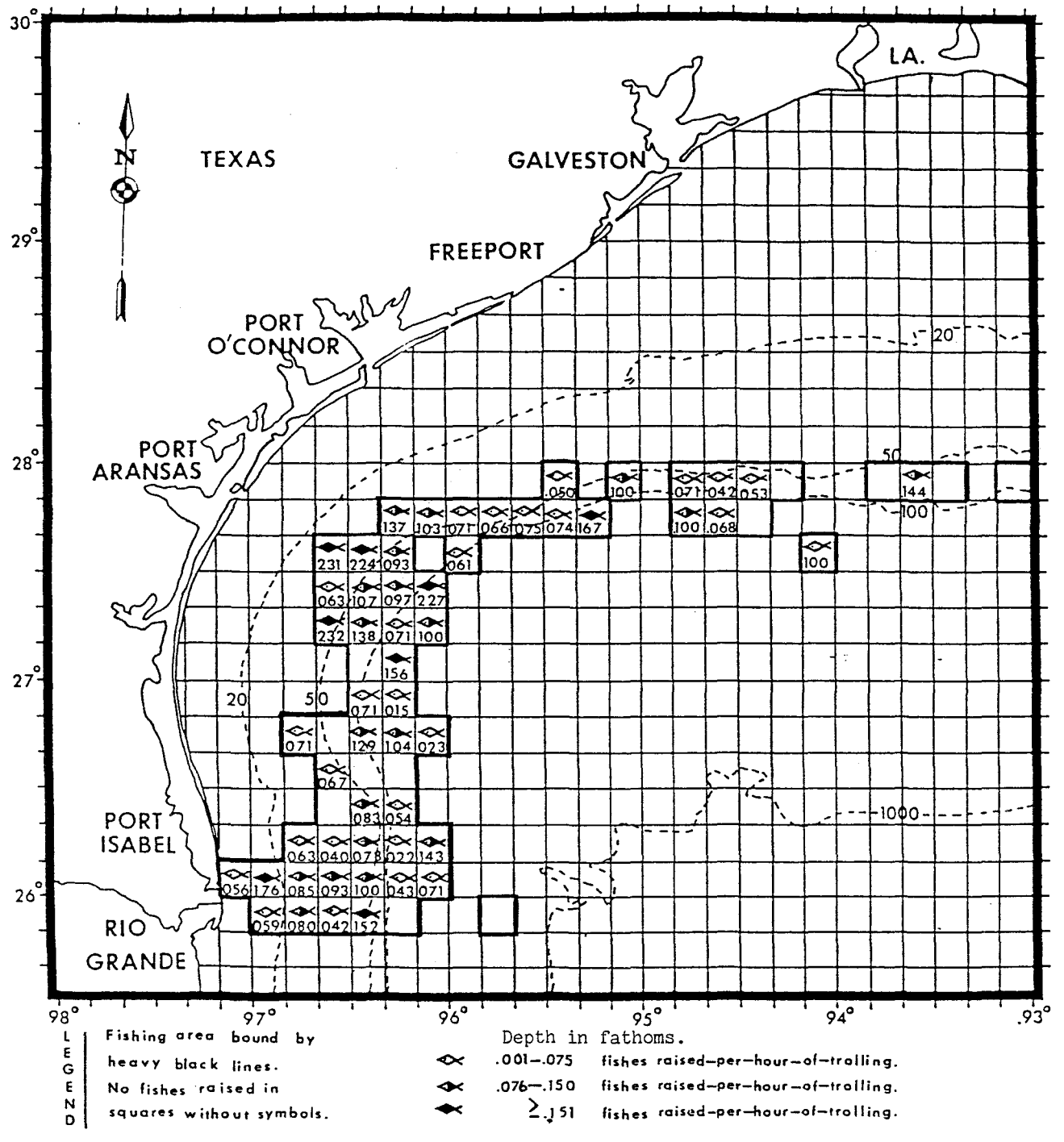



Fig. 14. Number of billfish raised per hour of trolling in the northwestern Gulf of Mexico by 10-minute squares (1988).

Table 2. Billfish hooked since 1982 by the Japanese longline fleet in the U.S. Exclusive Economic Zone.

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Blue Marlin | 36 | 6 | 26 | 88 | 38 | 11 | 1 |
| White Marlin | 210 | 97 | 228 | 339 | 272 | 57 | 6 |
| Sailfish | 30 | 6 | 5 | 7 | 9 | 2 | 0 |
| Spearfish | 19 | 0 | 9 | 0 | 5 | 2 | 1 |
| Unknown Billfish | 19 | 3 | 8 | 0 | 5 | 2 | 1 |

## DOMESTIC LONGLINE TUNA FLEET

Billfish are a by-catch of the U.S. swordfish and tuna longline fleets. The 1988 total commercial mortality of billfish was estimated for the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea (Fig. 15). This was derived by combining two estimates: 1) the mortality of billfish released (an analysis based on logbooks submitted to the Southeast Fisheries Center by captains in the longline fishery), and 2) the reported U.S. commercial landings converted to numbers of fish (landings which occurred prior to the October, 1988, implementation of the Billfish Management Plan prohibiting commercial sales of the species).

A comparison can be made between the commercial landings of billfish and the recreational mortality in the combined geographical areas: U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. A conservative estimate of the 1988 recreational mortality was reported in the U.S. National Report to the International Commission for the Conservation of Atlantic Tunas. The recreational mortality was 19% higher than commercial landings for blue marlin and 43% higher than the commercial landings for white marlin. In contrast, the commercial sailfish landings was 82% higher than recreational mortality.

## INTERNATIONAL BILLFISH DATA COLLECTION

In 1988, significant time was spent by Southeast Fisheries Center personal implementing plans of the International Commission for the Conservation of Atlantic Tunas (ICCAT) to collect additional billfish data from regions outside the jurisdiction of the United States. Objectives of this program--the ICCAT Enhanced Research Program for Billfish--were to collect more detailed catch and effort statistics from other countries, expand the existing ICCAT billfish tagging program, and assist scientists in other countries in the collection of data and biological samples for age and growth studies. Two geographic regions were targeted: the Caribbean Sea and the west coast of Africa. Visits by Southeast Fisheries Center scientists were made to fishery scientists in Grenada, Barbados, Jamaica, Dominican Republic, Venezuela, and St. Maarten of the Netherlands Antilles. Through extended cooperation between scientists, much needed information and samples will be available for future studies of mutual billfish stocks.

Scientists in the west African nations of Senegal and Cote d'Ivoire are also assembling information under the auspices of ICCAT and in cooperation with scientists at the Southeast Fisheries Center. Their work includes the collection of billfish catch and effort data from artisan, sport, and industrial fisheries; taking biological measurements of specimens, and the tagging of billfish in collaboration with the sport fishing center in Dakar, Senegal.

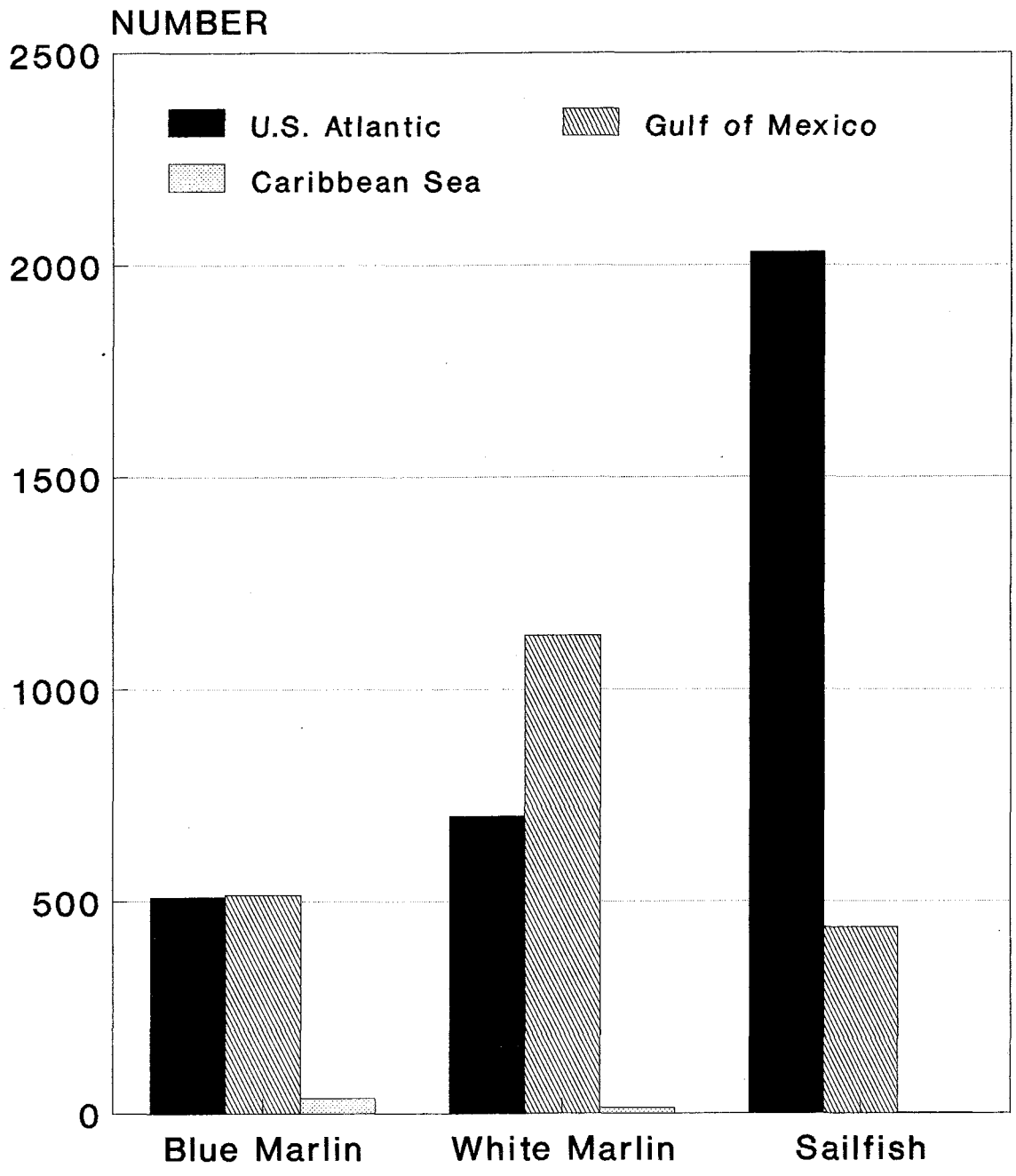



Fig. 15. Mortality estimates.

The ICCAT Enhanced Research Program for Billfish has been funded primarily by recreational fishing groups in the United States, Jamaica, and France. Groups or individuals wishing to provide support to this program can contact the Southeast Fisheries Center.

## BILLFISH AGE AND GROWTH

A research paper will appear in the National Marine Fisheries Service scientific journal "Fisheries Bulletin" which provides the results of billfish age and growth studies at the Southeast Fisheries Center conducted over the last nine years. The paper, entitled: "Estimating Age and Growth of Young Atlantic Blue Marlin from Otolith Microstructure," was prepared by E.D. Prince, D. W. Lee, J. R. Zweifel, and E. B. Brothers. A shortened version of the same information (i.e. Summary Paper) will also appear in the Proceedings of the Second International Billfish Symposium. The findings of the paper indicate that within the first 100 days of life, the growth rate in length of blue marlin is one of the fastest ever examined in a fish of any species, particularly for the early stages of development. The use of otolith ear bones to determine age, based on counts of "daily" rings, was successful for blue marlin up to the age of about 1.4 years. An age of 1.4 years for a female blue marlin corresponds to a length slightly less than 7 feet when measured from the tip of the lower jaw to the fork of the tail. Because the daily rings in older fish become progressively harder to count, the use of this technique to age larger or older specimens (beyond 1.4 years) was found inadequate. When published, copies of the report will become available from the authors at the Southeast Fisheries Center.

## BILLFISH LENGTH AND WEIGHT

A paper containing formulas for estimating length and weight of billfish species has been prepared at the Southeast Fisheries Center by Dennis W. Lee and Eric D. Prince. The report, prepared for ICCAT meetings in Spain, provides mathematical formulas for estimating whole fish weight and lower-jaw-fork length (distance from the tip of the lower jaw to the fork of the tail) when total-length measurements (distance from the tip of the bill to the midpoint between the caudal tips of the tail) are known. The usefulness of the formulas is in their ability to convert total-length data on billfish from taxidermy shops, mounted specimens, scientific institutions, etc. into units of measure commonly used by the Southeast Fisheries Center in billfish research. Copies of the paper titled, "Further Development of Length and Weight Regression Parameters for Atlantic Blue Marlin, White Marlin, and Sailfish" (ICCAT Working Document SCRS/89/70) are available from the authors.

## BIBLIOGRAPHY ON BILLFISH RESEARCH

An annotated bibliography of 83 billfish research papers has been published by Dennis W. Lee of the Southeast Fisheries Center. The bibliography comments on research papers that relate to billfish ageing techniques: ageing methods, growth rates, or mathematical formulas for the computation of growth. Copies of the bibliography titled, "Annotated List of Selected References on Age and Growth Studies of Istiophoridae and Xiphiidae" (NOAA Technical Memorandum NMFS-SEFC-224) are available from the author.