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ANNUAL REPORT OF THE 1994 HAWAII-BASED LONGLINE FISHERY

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PREFACE

The Western Pacific Regional Fishery Management Council (WPRFMC) developed the Pelagic Species fishery management plan (FMP) authorized by the Magnuson Fishery Conservation and Management Act of 1976 to manage the pelagic resources. This FMP regulates the fisheries for tuna, swordfish, marlin, and other pelagic species. The FMP for the Pelagic Fisheries of the Western Pacific Region was first implemented by the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), on March 23, 1987.

The Fishery Management and Economics Program (FMEP) of the Honolulu Laboratory, Southwest Fisheries Science Center, NMFS, NOAA, collects biological and economic information from domestic longline fishing vessels permitted to fish within the western Pacific U.S. Exclusive Economic Zones. Only information on federally permitted domestic longline vessels landing their catches or based in Hawaii is presented in this report.

CONTENTS

INTRODUCTION

Longline fishing has been a part of Hawaii's fisheries since the early 1900s (June, 1950). In the past, the longline fishery primarily targeted large bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) tunas. In recent years, the Hawaii-based longline fleet has grown rapidly. The number of active longline vessels increased from 37 vessels in 1987 (Kawamoto et al., 1989) and peaked at 140 vessels in 1991 (Dollar, 1992). Most of these relatively new participants in the Hawaii-based longline fishery were originally from U.S. ports in the Gulf of Mexico (Gulf of Mexico boats) and the U.S. east coast swordfish fishery (swordfish boats). Many Hawaii-based longliners target tunas but with the aid of new longline fishing gear and technological advances, almost all have the flexibility to also target broadbill swordfish (*Xiphias gladius*).

The Hawaii-based longline fishery is the largest domestic commercial fishery in Hawaii. Recent developments affecting this fleet are discussed in this report. Fleet activity, effort, catch, catch-per-unit-effort (CPUE), landings, size of catch and market information are presented. Interactions with endangered and protected species are summarized (see Table 1 for scientific names of target fish species and protected species subject to interactions).

DATA SOURCES

The National Marine Fisheries Service (NMFS) Fishery Monitoring and Economics Program (FMEP) relied exclusively on shoreside sampling for longline vessel activity and landings estimates from 1987 to 1991 (Ito, 1992). Subsequently, a Federal logbook system for domestic longliners operating in the western Pacific region was implemented in November 1990. Logbook collection and summary procedures are documented in Dollar and Yoshimoto (1991). Therefore, the time span covered in some summaries in this annual report may differ according to the data source. Summaries based on the shoreside sample data begin from 1986, while summaries based on logbook data begin from 1991. Data sources, data formats, and estimation procedures have changed throughout the period 1986-94, and these changes have increased the level of detail in monitoring the Hawaii-based longline fishery.

Detailed information on vessel operations, area of fishing, fishing effort, CPUE, and interactions with endangered and protected species are based on Federal longline logbook data. These data are separated into three trip type categories according to species targeted: (1) swordfish, (2) tuna, or

(3) mixed (targeting both swordfish and tuna). Target species information is obtained by FMEP personnel from dockside interviews with captains or deck bosses. When a captain is unavailable for an interview or the log sheets are mailed in, trip type is determined by subjectively evaluating the set times, number of hooks and light sticks, area fished, duration of trip, catch composition, and previous history of trip types for that particular vessel. For example, targeting of swordfish is presumed when the gear was soaked overnight, when light sticks were attached to 50 percent or more of the branch lines, when the vessel fished in areas with high concentrations of swordfish, when the trip lasted more than 3 weeks, and when swordfish comprised a significant percentage of the catch. In contrast, targeting of tuna is presumed if the gear was set in the morning and retrieved in the afternoon, no light sticks were used, the vessel fished in areas known for high concentrations of tuna, the trip lasted less than 3 weeks, and the majority of the catch was tuna. The criteria for targeting mixed species (both swordfish and tunas) is similar to the swordfish criteria except mixed trips used fewer lightsticks per day fished, trips were usually shorter, and swordfish was not as predominant in the catch. Exceptions to these generalizations were found in the data: Techniques typically used to target swordfish or mixed species were successfully used to fish for tunas.

Size of fish, average fish prices, and revenue information are based on NMFS FMEP shoreside sampling data. The weight of individual fish landed was collected as nominal weight. When presale processing or loss from damage occurred, the nominal weight was raised to an estimated whole (round) weight. Post-1991 landing estimates are based on the product of the average whole weight for each species from shoreside sampling and the corresponding number of fish kept as summarized from longline logbooks. Fish kept are mostly landed, whereas some of the catch is released. Revenue is estimated as the product of average prices for individual species from shoreside sampling and estimated landings.

Mako and thresher sharks carcasses are kept while only fins from blue sharks and other miscellaneous shark species typically are landed. Currently, there is no market in Hawaii for blue shark and miscellaneous shark carcasses. Therefore, weights of those species could not be estimated by shoreside sampling. Although blue shark and miscellaneous shark carcasses are discarded out at sea, finning still represented a "keep." The average weight of blue sharks was estimated from observer data collected during 1990-91 (Dollar 1994). This procedure for estimating round weight of blue sharks and miscellaneous sharks was developed.

Bluefin tuna was categorized as "other tuna" in the longline logbooks, and landings were estimated from the shoreside sample up to 1993. However, a separate logbook code was assigned for

bluefin tuna in 1994 to more accurately monitor the catch of this highly valued species.

RECENT DEVELOPMENTS

Some of the more important issues concerning the longline fishing industry in 1994 were: (1) the replacement of the moratorium on new entrants to Hawaii's longline fishery with a limited entry permit regulation, (2) mandatory placement of observers onboard longline vessels, and (3) voluntary installation of vessel monitoring systems aboard longline vessels.

The moratorium prohibiting new entrants to the Hawaii-based longline fishery was in effect from April 1991 until it was replaced with a limited entry program by the Western Pacific Regional Fishery Management Council (WPRFMC) in 1994. The purpose of this limited entry program is to regulate the growth of the longline fishery until additional information is available concerning the impacts of the longline fishery on the stocks, on other fisheries in Hawaii, and on protected resources (WPRFMC 1994). Federal limited entry permits are capped at 167 Hawaii-based longline vessels. Some features of the new limited entry permits make them more desirable than permits from the moratorium; i.e., limited entry permits are now freely transferrable and limited vessel upgrading is allowed.

Hawaii longline logbook data and data from voluntary observer trips prior to January 1994 indicated that estimated sea turtle interactions or "take" had exceeded the level allowed by the Biological Opinion. Consequently, there was a potential case for shutting down the Hawaii-based longline fishery. The NMFS Southwest Region (SWR), therefore, instituted a mandatory observer program in February 1994 primarily to document interactions of longline gear with sea turtles. Observer placements on longline fishing vessels were not welcomed at first (Dollar, 1994) but have become accepted.

By the end of 1994, about 50 longline vessels were equipped with a satellite vessel monitoring system (VMS). VMS is used by U.S. Coast Guard and NMFS Enforcement to determine if longline vessels are fishing in restricted areas. Vessels within the Hawaii Exclusive Economic Zone (EEZ) are tracked by VMS. VMS also serves as an additional means for locating a vessel in distress.

The latest printing of the Federal longline logbook, additional detailed information on fishing operations, gear configuration, oceanographic observations, and new Pelagic Management Unit Species (PMUS) are included. Distribution of the new logbooks began in January 1995 and by the end of the first

quarter, most of the data gathered were in the new logbook format.

Three Hawaii-based longline vessels with limited entry permits were contracted to receive shark fins from foreign longline vessels outside of the EEZ in 1994, up from two vessels in 1993. Although no vessels transship shark fins exclusively, transshipment activity has increased. Transhipping operations are appealing because the income from the contract is guaranteed and the risk of poor catches, as well as the uncertainty of receiving poor prices, is avoided. Also, the transhipment operation is usually less than a week and requires fewer crew members than longline fishing operations.

LONGLINE VESSEL OPERATIONS

There were 167 vessels registered with longline permits in 1994. The following is a summary of longline permits in 1994:

Active:	124
Inactive:	37
Permit but no vessel:	6

The number of Hawaii-based longline vessels increased from 37 vessels in 1987 to 141 vessels in 1991 (Fig. 1). One hundred twenty-four Hawaii-based longline vessels operated during 1994;[1] up slightly from 122 vessels in 1993. However, 2 active longline vessels sank in 1994. Thirty-seven longline vessels were not active and 6 limited entry permits did not have a longline vessel. Hawaii-based longline vessels were categorized by FMEP into three classes of overall length: (1) less than 56 feet (small class), (2) between 56 and 74 feet (medium class), and (3) over 74 feet (large class). In 1994, there were 23 small vessels, 57 medium-sized vessels, and 44 large vessels. Forty-three vessels did not report landing longline-caught fish in Hawaii. Inactive vessels were either under repair, impounded, for sale, fishing in other Hawaii fisheries, fishing out of state, or otherwise inactive.

Some longliners, predominantly swordfish and Gulf of Mexico longliners, left Hawaii during 1994. The exact cause for this exodus is not known, but some of the reasons mentioned by fishermen and vessel owners were: (1) poor swordfish catches in the central Pacific area, (2) high cost of operating and maintaining vessels in Hawaii, (3) the time and money spent on

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[1]Date of landing (DOL) is the date when a longline trip is concluded. DOL is used to avoid double counting vessels and trips. Double counting can occur when a trip during the last quarter of a previous year continues into the first quarter of the next year.

traveling between Hawaii and the U.S. mainland, (4) keeping permits active in fisheries elsewhere in the U.S.A. (such as the Atlantic longline fishery), or (5) new fishing opportunities elsewhere (South Pacific area). As a result, 14 fewer vessels fished during the fourth quarter of 1994 than during the fourth quarter of 1993. Six swordfish vessels headed east to the Atlantic Ocean while about 7 Gulf of Mexico vessels went west to the South Pacific (primarily Fiji).

Longline Vessel Trip Activity

The number of trips dropped substantially in 1992 and has declined slowly thereafter (Fig. 2). Hawaii-based longliners made 1,107 trips in 1994; a 7 percent decrease from 1993. The number of trips targeting swordfish appeared relatively steady over the 4-year period but declined slightly to 310 in 1994. The decline in 1994 may be attributed to the absence of swordfish vessels during the latter part of the year. A exceptionally high availability of bigeye tuna during the fourth quarter of 1994 also motivated a few swordfish longliners to target tunas. Tuna trips increased gradually from 530 trips in 1992 to 569 trips in 1994. Increased tuna trip activity was related to Gulf of Mexico longline vessels being purchased by local fishermen and refitted to target tunas. Mixed trips showed the most noticeable decline decreasing from 823 trips in 1991 to 228 trips in 1994. Much of the decline in mixed trips is attributed to fewer vessels targeting mixed species.

Longline trip activity is high during the first, second, and fourth quarters (Fig. 3). The primary factors contributing to the high level of trip activity during that period are high catch rates for bigeye tuna and swordfish near the Northwestern Hawaiian Islands (NWHI) and main Hawaiian Islands (MHI). Fishermen elect to target swordfish, particularly during the second quarter when they are closer to the Hawaiian Islands. Trip activity is lowest in the third quarter primarily because of poor catch rates for swordfish and tuna. Consequently, vessel owners and operators usually schedule repair, dry-dock, and annual maintenance during this time. Longline trip activity increases in the fourth quarter. Vessels reactivated from summer maintenance accentuate the increase in longline fishing activity. High bigeye tuna catch rates and high prices for sashimi (raw tuna) during the holiday season are primary motivating factors for increased activity both during the fourth quarter, as well as carrying over into the first quarter of the following year.

The average number of days fished per trip (fleet mean) decreased in 1994 (Table 2). This decline is attributed to fewer swordfish trips, which typically last longer than tuna or mixed trips. The average number of days fished per trip for swordfish and tuna increased throughout 1991-94, while the average number of days fished per mixed trip peaked in 1993 and declined slightly in 1994.

FISHING EFFORT

Fishing effort[2] was summarized by the number of sets (equivalent to the number of days fished), and by number of hooks set. The number of sets decreased to 6,371 in 1994 (Fig. 4). This represents a 12 percent decline in number of days fished for 1994. The number of sets within the EEZ has increased since 1992, while the number of sets outside the EEZ decreased substantially in 1994. The change in area fished is due to decreasing effort targeting swordfish and increasing effort targeting tunas. In general, effort directed toward swordfish occurs outside the EEZ. In contrast, much of the effort directed toward tunas occurs within the EEZ.

Sets within the EEZ are usually highest during the first and fourth quarters of the year, with activity subsiding during the second quarter (Fig. 5). This is attributed to the increased seasonal demand for and increased abundance of bigeye tuna inside the EEZ. Activity outside the EEZ is highest during the second quarter of the year due to the increased abundance of swordfish north of the EEZ. Fishing activity, both inside and outside the EEZ, is at its lowest point during the third quarter.

Total hooks set decreased from 13.0 million in 1993 to 12.0 million in 1994 (Fig. 6). Hooks set within the EEZ have increased since 1992, reaching 7.7 million in 1994, up from 5.6 million in 1992. The number of hooks set outside the EEZ decreased to 4.1 million, down by about 2.0 million from the 2 previous years. Reduced effort outside the EEZ is due to less effort directed at targeting mixed species and swordfish.

The average number of hooks set per day fished increased gradually throughout the 1991-94 period (Table 3). An increasing overall mean number of hooks per set was due to a increasing proportion of tuna-targeted sets. Tuna sets had the highest mean number of hooks because tuna longliners set 310 to 550 more hooks per day fished compared to other longliners. The tuna trips also had the most noticeable increase in number of hooks set per fishing day throughout 1991-94. Trips which targeted swordfish and mixed species converged to set about the same number of hooks per day fished.

CATCH

Catch (number of fish) from 1991 to 1994 was grouped into three major categories: billfish, tunas, and miscellaneous pelagics. Of the billfish, swordfish catch peaked at 79,554 fish in 1993 and dropped by 46 percent to 43,345 fish in 1994 (Fig.

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[2]These units of effort are based on date of haul; i.e., the actual date of fishing operations.

7). 1994 was the first year covered by logbook data in which the swordfish catch decreased. Even with the large decrease, swordfish still remained, by far, the dominant component of billfish catch. Striped marlin and blue marlin catches were low in comparison to swordfish catch. Striped marlin catch, at 11,292 fish, was also at a low in 1994; blue marlin catch decreased to 4,677 fish in 1994, down from a peak of 5,124 fish in 1993.

Bigeye tuna remained the dominant component of the tuna catch (Fig. 8). Bigeye tuna catch rose from 41,185 in 1991, to peak at 54,803 fish in 1993, and then decreased to 48,102 fish in 1994. Albacore has become the second largest component of tuna catch, increasing steadily from 1991 to 1993. However, 1994 experienced only a minor increase, up 2 percent to 31,129 fish. Yellowfin tuna catch fluctuated from year to year, bottoming out in 1992, peaking in 1993, and decreasing by 16 percent to 13,516 fish in 1994.

The figures on shark catch data, especially for blue sharks, should be viewed with caution because shark catches are sometimes not counted but only estimated by vessel operators. Although the shark counts may be under estimated, they have been the largest component of the overall catch since the beginning of the logbook program. Shark catch more than doubled from 1991 to 1993 and decreased 26 percent to 114,656 sharks in 1994 (Fig. 9). Blue sharks made up over 90 percent of the sharks caught, and the remainder of shark composition was made up of mako shark, thresher shark, and miscellaneous species. Mahimahi was the dominant component of miscellaneous PMUS. Mahimahi catch exhibited wide variations peaking in 1992, dropping to its lowest level in 1993 and increasing 28 percent to 33,017 fish in 1994. Although the number of moonfish is relatively low, catch has increased from 3,079 fish in 1991 to 5,090 fish in 1994. Ono catch fluctuated during 1991-94 with 2,513 fish caught in 1994. Ono catch appears to have an opposite relation to mahimahi catch in that the highest ono catch was experienced in the same year as the lowest mahimahi catch.

Catch Composition by Area

There was a marked difference in catch composition between areas of catch. In general, the difference in catch by area was a result of targeting tunas within the EEZ and swordfish outside of the EEZ. The three dominant catch components inside the EEZ were sharks, bigeye tuna, and other PMUS (Fig. 10B). These were followed by other tunas (mainly albacore), marlins, and swordfish. The three major components of catch outside the EEZ were sharks, swordfish, and other tunas (Fig. 10C), followed by other PMUS, bigeye tuna, and marlins. Yellowfin tuna composition was low both inside and outside the EEZ.

Seasonality

Strong seasonal patterns occur in many of the pelagic species caught by longliners, the most noticeable pattern being the high catches of swordfish during the first and second quarters (Fig. 11). Swordfish catches are usually lowest usually during the third and fourth quarters. Striped marlin catches are high throughout most of the year except during the third quarter, but blue marlin catches usually peak in the second quarter. Tunas also show strong seasonal patterns. For example, bigeye tuna catches are highest during the fourth and first quarters, decrease during the second quarter, and are lowest during the third quarter (Fig. 12). Albacore catches consistently peak during the fourth quarter and are usually lowest in the third quarter. The number of albacore caught in the fourth quarter of 1993 and 1994 was comparable to bigeye tuna catches. Yellowfin tuna catches are high in the first and second quarters and lowest in the fourth quarter. Sharks and mahimahi catch (Fig. 13) appears to have no clear seasonal pattern.

CATCH-PER-UNIT-EFFORT (CPUE)

The most prominent change in CPUE (number of fish caught per 1,000 hooks) was the dramatic decrease in swordfish CPUE in 1994. Some longliners targeting swordfish experienced substantially lower catch rates, especially in areas northwest of the Hawaiian Islands where swordfish catch rates were high the year before. Swordfish catch rates for swordfish trips dropped by 33 percent from 15.37 in 1991 to 10.34 fish per 1,000 hooks in 1994 (Table 4). Some longliners searching for swordfish ventured to the northeast and had better catch rates. However, low swordfish CPUE is one of the major reasons given by fishermen for the outmigration of swordfish longliners and for the motivation of some swordfish longliners to switch and target tunas. Overall striped marlin CPUE also declined substantially in 1994. Striped marlin CPUE was down 33 percent, but blue marlin CPUE shows little change and was consistently lower than swordfish and striped marlin CPUE.

Bigeye tuna had the highest CPUE of all the major tunas caught by longliners. Bigeye tuna CPUE rose from 3.34 in 1991, peaked at 4.21 in 1993, and decreased slightly to 4.01 in 1994. Albacore CPUE increased at the same rate as bigeye tuna and showed a steady increase from 1.13 in 1991 to 2.59 in 1994. Yellowfin tuna CPUE was lower than that of bigeye tuna and albacore throughout 1991-94, ranging from 0.67 in 1992 to 1.23 in 1993.

Shark CPUE was 5.77 in 1991, more than doubled to 11.87 in 1993, and decreased 19 percent to 9.56 in 1994. Mahimahi CPUE varied substantially from year to year peaking at 4.84 in 1992, dropping to 2.00 in 1993, and increasing in 1994. CPUE for

moonfish and ono was extremely low--less than 0.50 throughout 1991-94.

CPUE by Trip Type

There were substantial differences in CPUE among the three categories of trip types. Some of these patterns were consistent throughout 1991-94. Swordfish trips had the highest CPUE for swordfish, albacore, and sharks. However, CPUE for blue marlin, striped marlin, bigeye tuna, yellowfin tuna, and ono was lower than for the other trip types. Mixed trips usually had the highest CPUE for yellowfin tuna, blue marlin, and mahimahi. Tuna trip experienced the highest CPUE for bigeye tuna, striped marlin, ono, and moonfish, while CPUE for swordfish and sharks were low for tuna trips.

CPUE by Area

A distinct difference in CPUE by area is apparent. CPUE for marlins, bigeye tuna, and yellowfin tuna was consistently higher inside the EEZ (Table 5). CPUE for marlin was about twice as high in the Hawaii EEZ. Swordfish, albacore, mahimahi, and shark CPUE was very high outside the EEZ, with catch rates for swordfish and sharks at least 3 times higher throughout 1991-94. Ono CPUE was low in both areas.

LANDINGS

Longline landings have increased dramatically from the late 1980s to 1993 but declined substantially to an estimated 18 million pounds in 1994 (Fig. 14). This represents a decline of 28 percent from 1993 landings. Reduced billfish landings, primarily swordfish, had the greatest impact on landings, although swordfish still managed to maintain its status as the dominant component. Swordfish landings were estimated at 7 million pounds, down 47 percent in 1994 (Table 6). Landings of blue marlin increased slightly while landings of striped marlin were off by 31 percent in 1994.

Tuna landings in 1994 were down slightly from the previous year, mostly due to a decrease in bigeye tuna landings caused by fewer fish and smaller average size. An estimated 3.9 millions pounds of bigeye tuna were landed in 1994. Bigeye tuna was the second largest component of longline landings and, by far, the largest component of tuna landings. Landings of yellowfin tuna, the second largest component of tuna landings, peaked in 1989. Conversations with local seafood wholesalers indicate that a large volume of the longline-caught bigeye and yellowfin tunas is exported. The highest grade tunas are exported to Japan while the next best grade are exported to U.S. mainland markets. Albacore landings showed steady increase from 1990, but bluefin tuna landings decreased in 1994. Although bluefin tuna landings

are low (estimated at 30,000 pounds in 1994), the high unit price has sparked interest from fishermen and market wholesalers.

Shark landings, predominantly blue sharks, were almost unchanged in 1994. Sharks are the third largest component of the landings and shark landings have been 1.7 million pounds for the past 2 years. Blue sharks and other miscellaneous sharks are landed in processed "fins only" form. Almost all the shark fins landed in Hawaii are shipped out by local traders or shipping agents to Asian markets. The remainder of shark landings was composed of mako and thresher sharks, which are marketable as fillets. The fins of mako and thresher sharks are also kept.

Landings of other PMUS compose a small fraction of the total landings. Mahimahi landings peaked in 1992 and have been somewhat depressed for the last 2 years. Ono landings decreased from 1993.

MARKET

Revenue

Longline ex-vessel revenue has increased four to fivefold since 1987 (Fig. 15). The total longline ex-vessel revenue in 1994 was $40.7 million, down about 22 percent from 1993, primarily due to reduced landings of swordfish (Table 7). Swordfish, the top revenue producer during the past 4 years, are exported to mainland markets. Some of the more common destinations are Boston, New York City, Los Angeles, and San Francisco. Although local demand (mostly in restaurants) has increased, the volume sold is low in comparison to the export market. Estimated revenue from other billfish was $2.6 million, up 35 percent in 1994. Striped marlin and blue marlin provide most of the other billfish revenue.

Bigeye tuna generate the highest revenue of all the tuna species, even though revenue decreased by $2 million in 1994. Yellowfin tuna revenue for 1994 was about the same as 1993. A large part of the revenue from bigeye tuna and yellowfin tuna comes from the Japan and the U.S. mainland export market and the local restaurant market. These markets generate high revenue through premium prices for the best quality bigeye, yellowfin, and bluefin tunas. Revenue from albacore increased throughout the 1991-94 period. Bluefin tuna compose only a small fraction of the landings but are highly valued because of the high unit price. Bluefin tuna revenue was estimated to be $490,000 in 1994.

Other PMUS such as moonfish, mahimahi, ono, and pomfrets, along with miscellaneous pelagic species, contributed about $1.5 million to longline revenue in 1994. Although revenue from other PMUS is low compared to billfish and tunas, the demand is strong

for species with well established reputations (mahimahi and ono), and others are growing in acceptance (moonfish and pomfrets) in the seafood market here and abroad.

Average Price

Ex-vessel prices (Table 8) are based on whole weight (round weight), not the landed product weight (i.e., headed and gutted weight). The ex-vessel price for swordfish which is determined by the U.S. mainland market for swordfish, was the highest of all billfish. Swordfish prices increased in 1994. Most of the marlins are sold locally, and are among the more affordable fish species when they are seasonally abundant. Prices for blue marlin and striped marlin increased in 1994.

Prices for the major tuna species rose in 1994. Large bigeye and yellowfin tunas have a wide range of prices with the best quality tunas destined for the Japan market where they command significantly higher than average prices. The local restaurant and U.S. export market tuna prices are fairly high. Most of the tuna destined for local consumption are more moderately priced, although some higher grade tunas are available locally. Bigeye commanded the highest tuna prices, ranging from $3.20 per pound to $3.70 per pound. Yellowfin tuna prices were about $1 a pound less, ranging from $1.80 per pound to $2.90 per pound. Albacore prices decreased from $1.48 per pound in 1990 to $1.24 per pound in 1994. Decreasing prices are due to a lower price paid for small albacore that have been increasing in volume during the past couple of years. Northern bluefin tuna had the highest average price which has risen from $8.51 per pound in 1991 to $14.62 per pound in 1994.

The average price for mahimahi has been low for the past 4 years. This low price is related to the size and quality of fish. The smaller fish usually draw a lower unit price and do not have as long a shelf life as larger fish. Ono received the highest average price of all miscellaneous PMUS.

SIZE OF FISH

Mean weight of selected pelagic species was based on shoreside sampling data from 1987 to 1994. Sampling data were also used to produce weight-frequency histograms for selected billfish (swordfish, blue marlin, and striped marlin) and tunas (bigeye tuna, yellowfin tuna, and albacore). In calculating mean weight and producing weight-frequency histograms, two problems were encountered. First, there was a substantial difference in mean weight of fish caught among the different trip types. Second, the number of fish sampled for each trip type was not in proportion to the number of fish from the logbook summaries for each trip type. Therefore, fish sampled for each trip type were

weighted to the represent the same proportion of fish for each trip type as in the logbook summaries.

Small and badly damaged swordfish have little or no commercial value and are often discarded or given away (Ito, 1996), which biases the market sample to the larger, more marketable-sized fish. The mean weight of swordfish increased from the late 1980s, peaked at 178 pounds in 1992 (Table 9), and decreased in 1993 and 1994. The mean weight of swordfish was 163 pounds in 1994. Blue marlin is one species with a history of high mean weights. Mean weight of blue marlin ranged from 157 pounds to 175 pounds during 1987-94. Striped marlin were small in comparison to swordfish and blue marlin, mean weight ranged from 56 to 66 pounds.

There was a noticeable difference in mean weight among the major tuna species. The mean weight of bigeye tuna showed little variation ranging from 76 pounds to 87 pounds. The mean weight of yellowfin tuna was consistently higher than bigeye tuna, and yellowfin tuna also showed more variation in mean weight ranging from 81 pounds to 117 pounds throughout 1987-94. Mean weight of albacore decreased from 62 pounds in 1989 to 41 pounds in 1994.

The mean weight of mahimahi decreased from 20-23 pounds in 1987-89 to 11-13 pounds in 1992-94. The mean weight for ono showed the least amount of variation, ranging from 32 to 35 pounds over the 8-year period.

Prior to 1989 longliners targeting tunas accounted for landings of swordfish (Kawamoto et.al. 1989). These incidental swordfish catches were small, predominantly in the 1-25 pound category (Fig. 16). The weight-frequency distribution of larger swordfish was rather flat. With the increasing success of longliners catching swordfish during 1989, swordfish weight histograms showed a higher frequency of large fish and a distribution that tapered off above the 76-100 pound increment. During 1992 and 1993, a second mode of larger fish occurred between 150-200 pounds. The frequency of very large swordfish (> 475 pounds) has become more noticeable since 1990.

Blue marlin showed no substantial changes in weight-frequency distribution throughout 1987-94 (Fig. 17). The dominant mode for blue marlin was consistently in the 101-125 pound increment except in 1990 when the dominant mode shifted up one increment. The weight-frequency distribution of blue marlin gradually decreases after the mode, and there is a low frequency of blue marlin below 50 pounds.

The weight-frequency distribution for striped marlin in 1987 was fairly flat (Fig. 18) but clearly bimodal thereafter. The mode of small striped marlin occurred below the 36-40-pound increment, while the mode of large striped marlin ranged from the

56-60-pound increment up to the 76-80-pound increment. A dominant mode of small fish appeared during 1988 and 1989.

A high frequency of small bigeye tuna appeared in 1987, 1989, 1992, and 1994 (Fig. 19). Modes of small and large bigeye tuna were more evenly distributed in 1988, 1990, 1991, and 1993. The distribution of bigeye tuna tapers off above the 96-100-pound increment.

A high degree of variation occurred in the weight-frequency distribution of yellowfin tuna (Fig. 20). A pronounced peak of small (26-35 pound) yellowfin tuna in 1987 and medium (61-70 pound) yellowfin tuna in 1989 was clearly visible. Larger yellowfin tuna dominate the distribution in 1991, with a weight-frequency more evenly distributed across a wide range of increments in 1990, 1992, 1993, and 1994.

Weight-frequency of albacore showed a distinct change in distribution between the first 4 years of histograms (1987-90) and the following 4 years of histograms (1991-94). The first 4 years showed distribution of albacore clustered toward larger fish (Fig. 21). Weight-frequency of albacore was spread out over a wider range of sizes in subsequent years. The change in weight-frequency distribution is caused by increased landings of small fish caught by swordfish and mixed longliners that were fishing in the higher latitudes of the North Pacific.

INTERACTIONS WITH ENDANGERED AND PROTECTED SPECIES

Interactions between longline gear and endangered and threatened species were summarized from the daily longline logbook data. NMFS SWR longline observers are a second source of data but their data are not presented. Interactions are defined in this report as any endangered or threatened species caught (hooked or entangled) in longline fishing gear. Fishermen may often sight or interact with greater numbers of protected species than are indicated in the longline logbook summary tables. In fact, suspected underreporting of interactions with protected species, turtles in particular, was the major factor which led to the establishment of the mandatory observer program. Consequently, the number of sightings and interactions shown in the summary Table 10 and Figure 22 may well represent a lower number than the actual number of sightings and interactions.

Thirty-six different Hawaii-based longline vessels reported interactions with endangered or protected species on 60 different trips in 1994. Interactions occurred in 227 sets totaling 260,769 hooks set. It is unlawful to retain any endangered or protected species; therefore, interactions are reported as animals released or lost. The condition of animals upon release is categorized as either alive, injured, or dead. A total of 378

interactions with endangered or protected marine species were reported (Table 10).

Two hundred eighty-eight interactions occurred with seabirds, 278 of which were with albatrosses. The exact species of albatross is unknown because no distinction is made between albatross species in the protected species interaction section of the logbooks. A high rate of mortality was reported with seabirds: 76 percent were reported dead upon retrieval, 13 percent were reported released injured, and 11 percent were reported released alive.

Interactions with turtles comprised the second most frequent type of interaction. Of the 84 turtle interactions, 41 were leatherback turtles, 27 were with loggerhead turtles, 15 were with green sea turtles, and 1 was with an olive ridley turtle. Initial condition of most turtles upon retrieval appeared good. Ninety percent of the turtles were reported as alive upon retrieval, 5 percent were reported released injured, and 5 percent were reported dead upon retrieval. All turtles dead upon retrieval were leatherback turtles.

Six incidents of interactions involving 5 false killer whales and 1 dolphin were reported. These interactions may have been a result of cetaceans either taking catch or bait. Observations of this behavior with longline gear and other Hawaii fisheries have been documented (Nitta and Henderson 1993, Dollar 1991). In the longline fishery during 1994, all the cetaceans were reported to have been released alive. No interactions with monk seals were reported.

Interactions were summarized by three general areas: (1) MHI, NWHI, and outside the EEZ. Most of the reported interactions with seabirds occurred in the NWHI and outside the EEZ (Fig. 22). One hundred sixty-nine seabird were reported in areas around the NWHI while 115 seabird interactions were reported outside the EEZ. Turtle interactions were over 2.5 times as frequent outside the EEZ in comparison to all other areas combined. All of the interactions with cetaceans occurred outside the EEZ.

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I would like to thank the United Fishing Agency, Pacific Island Seafoods, and Norpac Fisheries for their cooperation and patience in our data collection effort. I am grateful for the assistance of Walter A. Machado (JIMAR), Jo-Anne Kushima (HDAR), and the Honolulu Laboratory Fishery Data Management Program with the data collection and processing activities. I would also like to thank Samuel G. Pooley, Kurt E. Kawamoto, and Christopher H. Boggs for their helpful comments. The Honolulu Laboratory's Scientific Services staff also deserves credit for preparing this manuscript.

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Table 1.--List of common and scientific names of fishes and endangered or protected species commonly encountered by the Hawaii-based longline fleet.

Common name	Scientific Name
	PELAGIC MANAGEMENT UNIT SPECIES
Billfish	
Swordfish	*Xiphias gladius*
Black marlin	*Makaira indica*
Blue marlin	*Makaira mazara*
Striped marlin	*Tetrapturus audax*
Shortbill spearfish	*T. angustirostris*
Sailfish	*Istiophorus platypterus*
Tunas	
Bigeye tuna	*Thunnus obesus*
Albacore	*T. alalunga*
Yellowfin tuna	*T. albacares*
Northern bluefin tuna	*T. thunnus orientalis*
Skipjack tuna	*Katsuwonus pelamis*
Kawakawa	*Euthynnus affinis*
Sharks	
Blue shark	*Prionace glauca*
Thresher (big eye)	*Alopias superciliosus*
Mako (short fin)	*Isurus oxyrinchus*
White tip (oceanic)	*Carcharhinus longimanus*
Tiger shark	*Galeocerdo cuvieri*
Miscellaneous sharks	Carcharhinidae, Alopiidae, Sphynudae, and Laminidae
Miscellaneous PMUS	
Mahimahi	*Coryphaena hippurus*
Wahoo (ono)	*Acanthocybium solandri*
Moonfish	*Lampris guttatus*
Pomfret	family Bramidae
Oilfish	family Gempylidae
	MISCELLANEOUS PELAGICS
Lancet fish	*Alepisaurus* spp.
Barracuda	*Sphyraena barracuda*
Brown stingray	*Dasyatis violacea*
	ENDANGERED OR PROTECTED SPECIES
Hawaiian monk seal	*Monachus schauinslandi*
Humpback whale	*Megaptera novaengliae*
Dolphins	Family Delphinidae
Green turtle	*Chelonia mydas*
Olive ridley turtle	*Lepidochelys olivacea*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coricea*
Laysan albatross	*Diomedea immutabilis*
Black-footed albatross	*D. nigripes*
Brown booby	*Sula leucogaster plotus*

Table 2.--Average number of days fished by trip type, 1991-94

Trip type	1991	1992	1993	1994
Swordfish	10.7	12.7	13.2	13.4
Tuna	7.8	8.4	8.8	8.9
Mixed	6.3	7.7	8.9	8.0
Fleet mean	7.6	9.1	10.3	10.0

Table 3.--Average number of hooks set per day fished by trip type, 1991-94.

Trip type	1991	1992	1993	1994
Swordfish	750	800	870	860
Tuna	1220	1350	1360	1400
Mixed	910	880	870	870
Fleet mean	980	1010	1060	1110

Table 4.--Hawaii-based longline fleet catch-per-unit-effort (number of fish per 100 hooks), 1991-94.

	Billfish			Tunas			Miscellaneous		
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono	Sharks
Fleet mean									
1991	5.38	0.73	1.48	3.32	1.08	1.14	3.21	0.22	5.78
1992	6.34	0.39	1.37	3.75	0.67	1.69	4.84	0.21	8.10
1993	6.11	0.39	1.40	4.21	1.23	2.34	2.00	0.34	11.87
1994	3.61	0.39	0.94	4.01	1.13	2.59	2.75	0.21	9.56
Swordfish trips									
1991	15.37	0.31	0.99	2.29	0.79	1.53	3.62	0.06	15.94
1992	14.76	0.20	0.78	1.61	0.46	3.09	4.78	0.06	19.74
1993	13.18	0.27	0.96	2.61	0.72	3.70	2.29	0.13	26.19
1994	10.34	0.21	0.45	1.01	0.41	4.48	2.62	0.04	23.43
Mixed trips									
1991	5.84	0.99	1.23	3.41	1.64	0.97	4.13	0.12	5.16
1992	8.60	0.56	0.71	3.96	1.04	1.81	9.43	0.14	7.33
1993	9.97	0.52	0.96	5.46	1.38	2.10	2.75	0.14	13.19
1994	4.12	1.30	0.71	3.92	2.69	0.80	6.56	0.06	11.64
Tuna trips									
1991	0.41	0.69	1.93	3.70	0.70	1.12	2.18	0.39	1.71
1992	0.27	0.37	2.15	4.74	0.53	0.86	1.67	0.34	2.40
1993	0.21	0.41	1.84	4.68	1.49	1.60	1.51	0.55	2.56
1994	0.16	0.29	1.24	5.52	1.16	2.03	2.03	0.32	2.22

Table 5.--Hawaii-based longline fleet catch-per-unit-effort (number of fish per 1,000 hooks) by area, 1991-94.

	Billfish			Tunas			Miscellaneous		
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono	Sharks
Inside the EEZ									
1991	2.92	0.86	1.77	3.41	1.08	0.79	2.49	0.20	3.02
1992	2.21	0.54	2.08	4.59	0.76	0.77	2.80	0.41	3.74
1993	2.03	0.47	1.94	4.78	1.59	1.15	1.70	0.23	4.43
1994	1.64	0.51	1.19	4.92	1.15	2.14	2.70	0.26	5.58
Outside the EEZ									
1991	9.90	0.49	0.98	3.11	0.99	1.78	4.53	0.21	10.30
1992	10.12	0.25	0.72	2.98	0.59	2.53	6.70	0.26	11.62
1993	10.64	0.31	0.80	3.57	0.83	3.66	2.33	0.19	19.91
1994	7.44	0.18	0.47	2.24	0.74	3.53	2.98	0.16	16.89

Table 6.--Hawaii-based longline fleet landings (x 1,000 lb) of selected pelagic species, 1987-94.

	Billfish			Tunas			Miscellaneous		
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono	Sharks
1987	50	110	600	1,790	580	330	50	50	40
1988	50	230	1,110	2,740	1,310	680	40	90	100
1989	620	770	1,340	3,140	2,160	550	180	200	200
1990	4,190	760	1,100	3,020	2,230	370	350	70	200
1991	10,120	660	1,500	3,420	1,620	690	520	110	200
1992	12,570	760	1,010	3,280	760	730	590	90	430
1993	13,100	750	1,040	4,660	1,390	970	320	140	1,730
1994	7,000	800	720	3,940	1,340	1,100	380	90	1,710

Table 7.--Hawaii-based longline fleet ex-vessel revenue (x $1,000) of species, 1987-94.

	Billfish			Tunas			Miscellaneous	
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono
1987	170	140	810	6,510	1,500	520	100	150
1988	160	190	1,200	9,160	3,270	910	110	240
1989	1,130	640	1,370	10,640	5,070	710	400	450
1990	9,710	710	1,530	10,940	5,750	550	590	200
1991	21,450	510	1,490	12,760	4,440	910	670	230
1992	24,130	880	1,280	11,710	2,210	910	830	220
1993	26,590	640	1,070	16,640	3,810	1,170	440	270
1994	16,240	1,020	1,220	14,620	3,910	1,360	540	240

Table 8.--Hawaii-based longline fleet nominal ex-vessel prices (US$) by species, 1987-94.

	Billfish			Tunas			Miscellaneous	
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono
1987	3.23	1.02	1.39	3.56	1.86	1.57	2.31	2.60
1988	2.87	0.84	1.02	3.33	1.81	1.30	2.73	2.56
1989	2.28	0.84	1.10	3.24	2.14	1.30	2.26	2.47
1990	2.32	0.92	1.38	3.33	2.19	1.48	1.97	2.52
1991	2.12	0.78	0.99	3.73	2.74	1.32	1.28	2.10
1992	1.92	1.16	1.27	3.57	2.91	1.24	1.40	2.46
1993	2.03	0.85	1.03	3.57	2.74	1.21	1.36	1.94
1994	2.32	1.28	1.70	3.71	2.92	1.24	1.41	2.70

Table 9.--Mean weight of Hawaii-based longline catch (in pounds), 1987-94.

	Billfish			Tunas			Miscellaneous	
Year	Swordfish	Blue marlin	Striped marlin	Bigeye tuna	Yellowfin tuna	Albacore	Mahimahi	Ono
1987	129.3	161.4	66.2	76.3	81.9	62.3	21.1	33.3
1988	119.2	157.3	56.9	83.2	102.5	59.7	20.0	31.9
1989	131.1	164.7	61.5	77.0	103.7	62.0	23.0	34.6
1990	147.6	172.0	55.8	85.5	117.2	53.3	14.5	31.6
1991	155.3	174.6	59.2	85.0	117.7	51.9	14.0	35.3
1992	177.6	174.5	65.5	76.8	99.2	45.2	11.0	35.1
1993	172.2	156.7	63.7	87.9	92.1	44.1	12.9	32.6
1994	162.6	170.6	63.5	80.9	97.4	41.3	11.8	34.2

Table 10.--Hawaii-based longline logbook summary for protected species interactions for January-December 1994
(Vessels landing or based in Hawaii)
Report: Date of haul; All Areas - All Species

Trip Information

Number of vessels reporting sightings	23
Number of vessels reporting RAID interactions*	36
Number of trips reporting sightings	42
Number of trips reporting RAID interactions	60
Number of sets reporting sightings	74
Number of sets reporting RAID interactions	227
Number of RAID interactions reported	378
Number of hooks set with interactions	260769

Reported Protected Species Interactions

Species	Sighted in area of gear	Released Alive	Released Injured	Or Lost/ Dead	Total
Seals					
Monk seals	0	0	0	0	0
Other seals	0	0	0	0	0
Total	0	0	0	0	0
Whales/Dolphins					
Whales	9	0	0	0	0
False killer whales	147	5	0	0	5
Dolphins	97	1	0	0	1
Total	253	6	0	0	6
Turtles					
Green turtles	16	14	1	0	15
Leatherback turtles	14	37	0	4	41
Loggerhead turtles	7	25	2	0	27
Olive ridley turtles	0	0	1	0	1
Other Turtles	0	0	0	0	0
Total	37	76	4	4	84
Birds					
Albatrosses	NA	32	32	214	278
Boobies	NA	0	0	2	2
Other Birds	NA	0	4	4	8
Total	NA	32	36	220	288
Other Species	0	0	0	0	0

*RAID = Released alive, injured or dead
NA = Not applicable

Figure 1.--Number of Hawaii-based longline vessels, 1987-94.

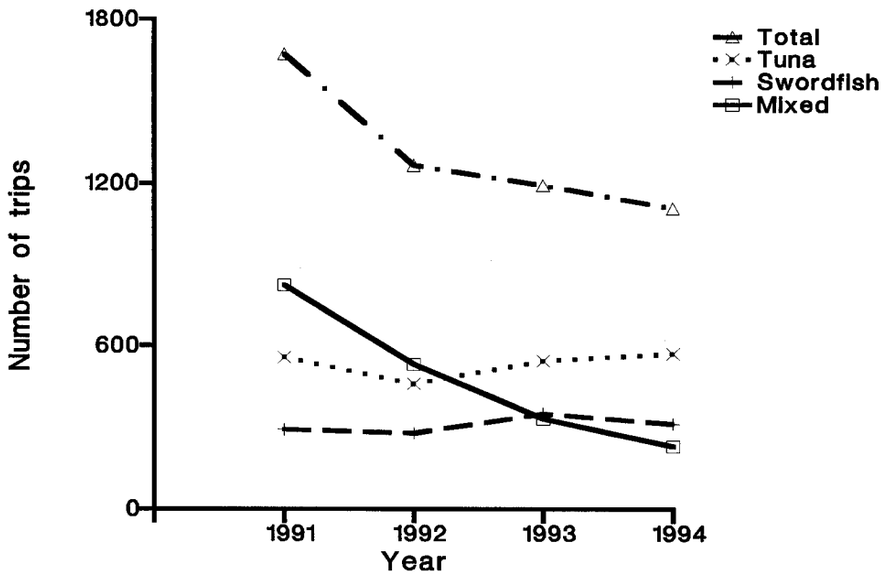

Figure 2.--Number of trips by the Hawaii-based longline fleet, 1991-94.

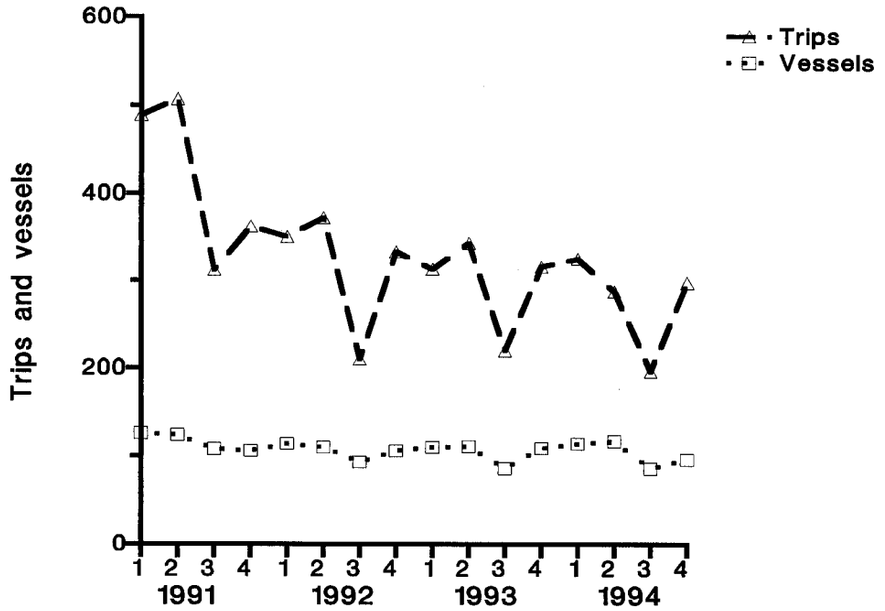

Figure 3.--Vessel activity of the Hawaii-based longline fleet by quarter, 1991-94.

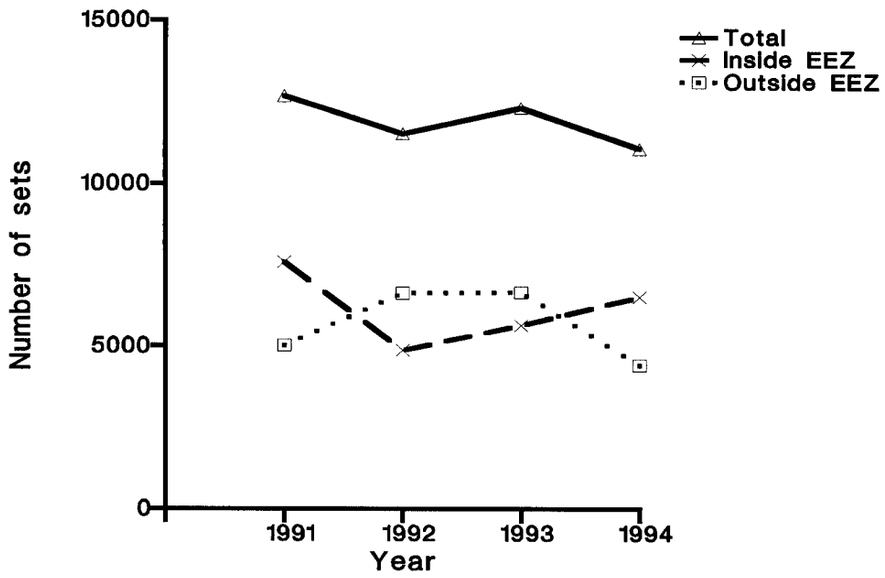

Figure 4.--Number of days fished by area, 1991-94.

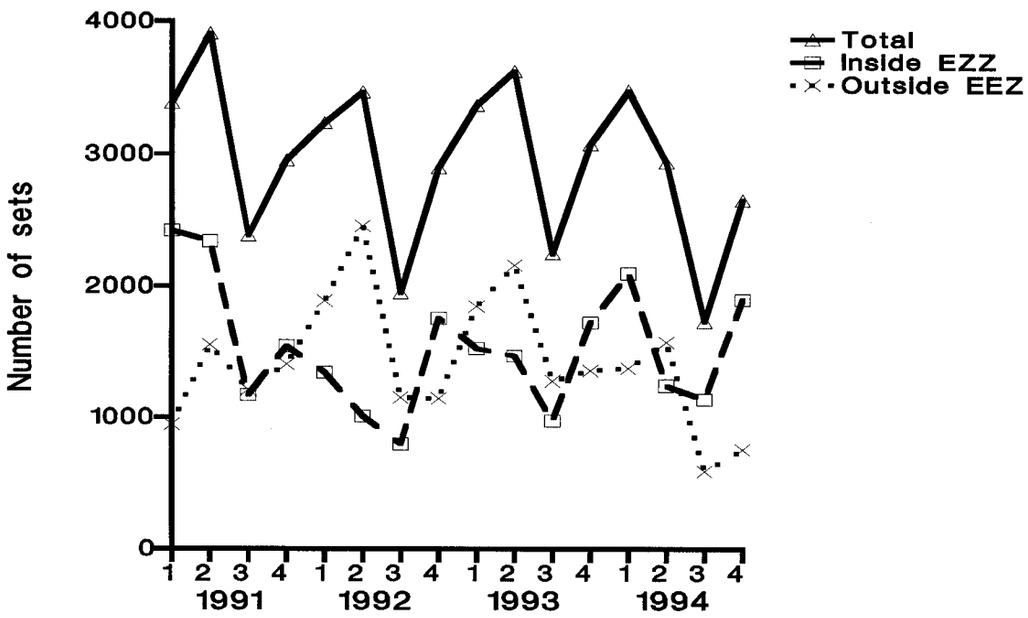

Figure 5.--Number of days fished by area and quarter, 1991-94.

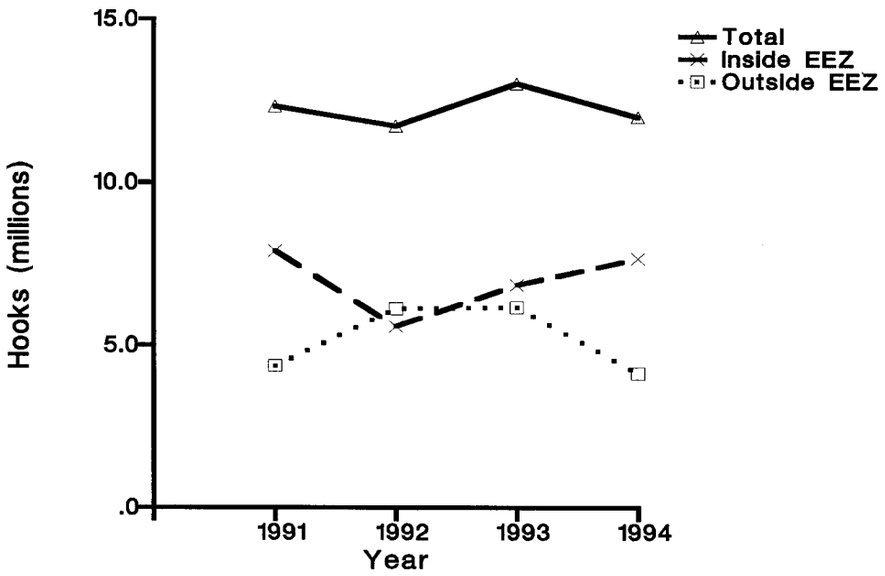

Figure 6.--Number of hooks set by area, 1991-94.

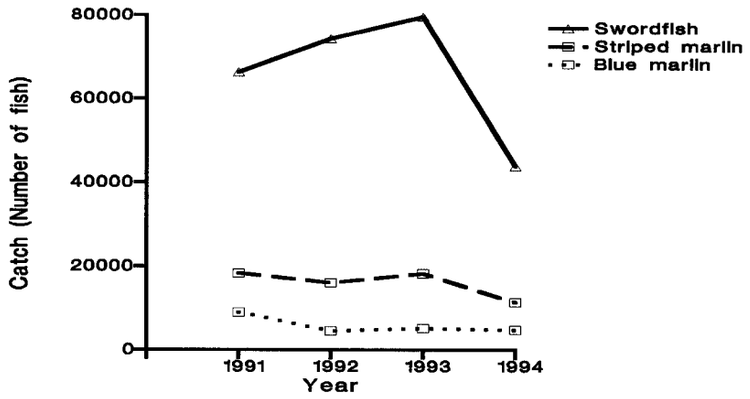

Figure 7.--Catch of selected billfish species, 1991-94.

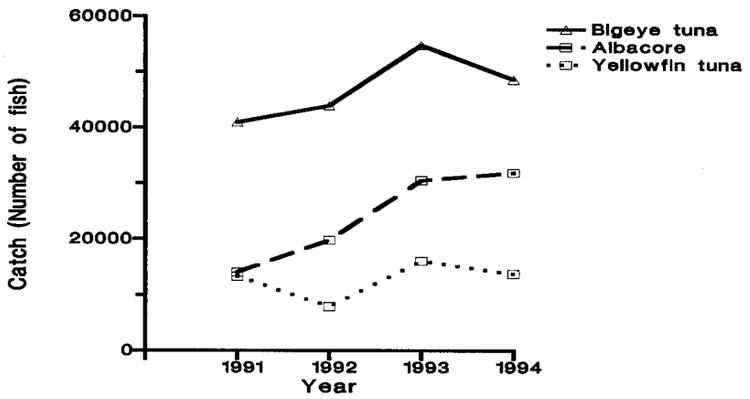

Figure 8.--Catch of selected tuna species, 1991-94.

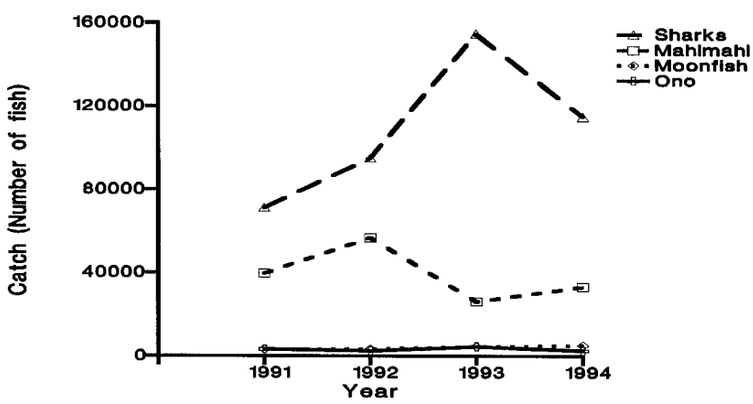

Figure 9.--Catch of selected miscellaneous pelagic management unit species, 1991-94.

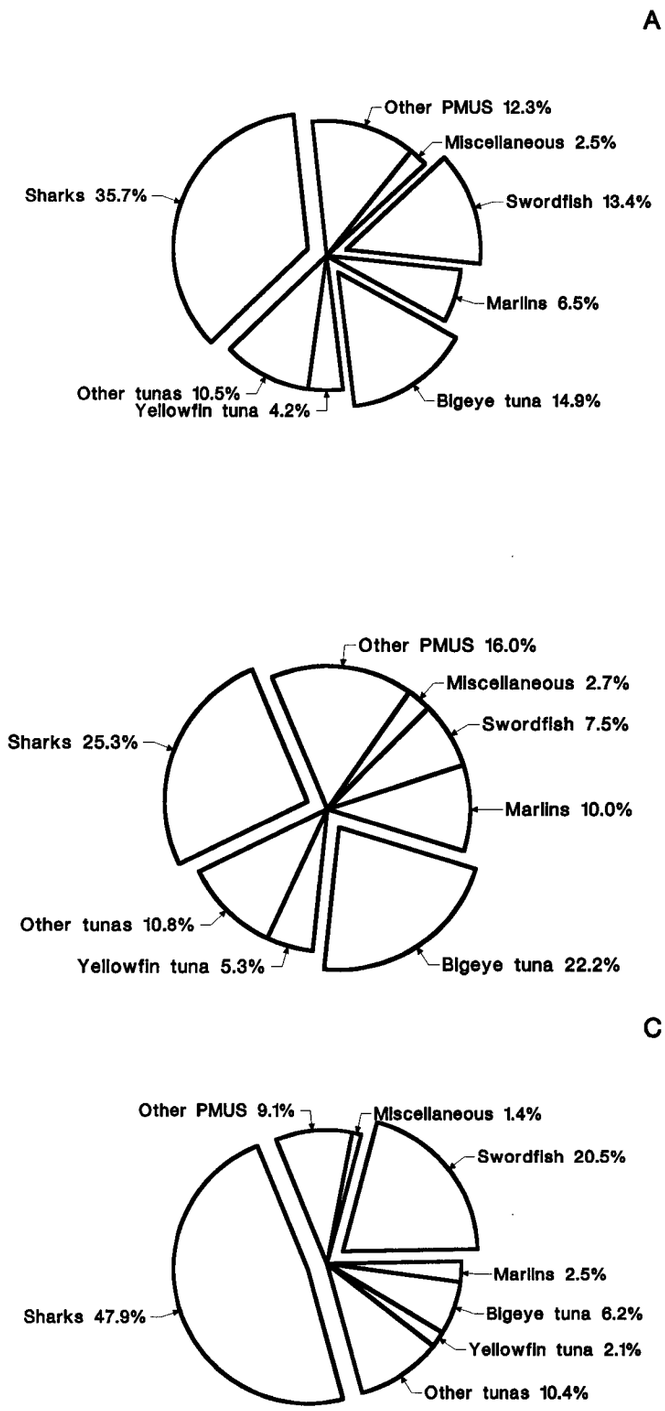

Figure 10.--Species composition of the catch (by numbers of fish) for A) composition for the total catch, B) composition inside of the exclusive economic zone (EEZ), and C) composition outside of the EEZ, 1994.

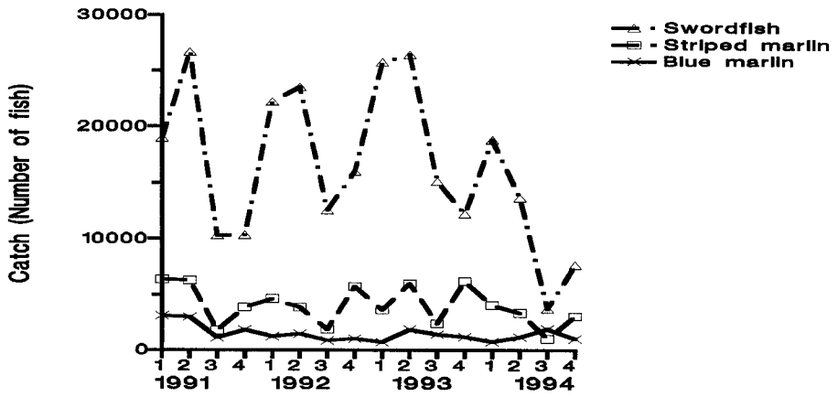

Figure 11.--Catch of selected billfish species by quarter, 1991-94.

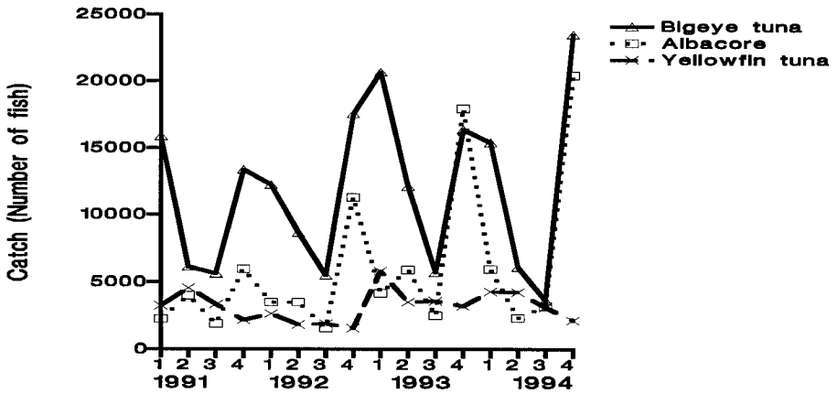

Figure 12.--Catch of selected tuna species by quarter, 1991-94.

Figure 13.--Catch of selected pelagic management unit species, 1991-94.

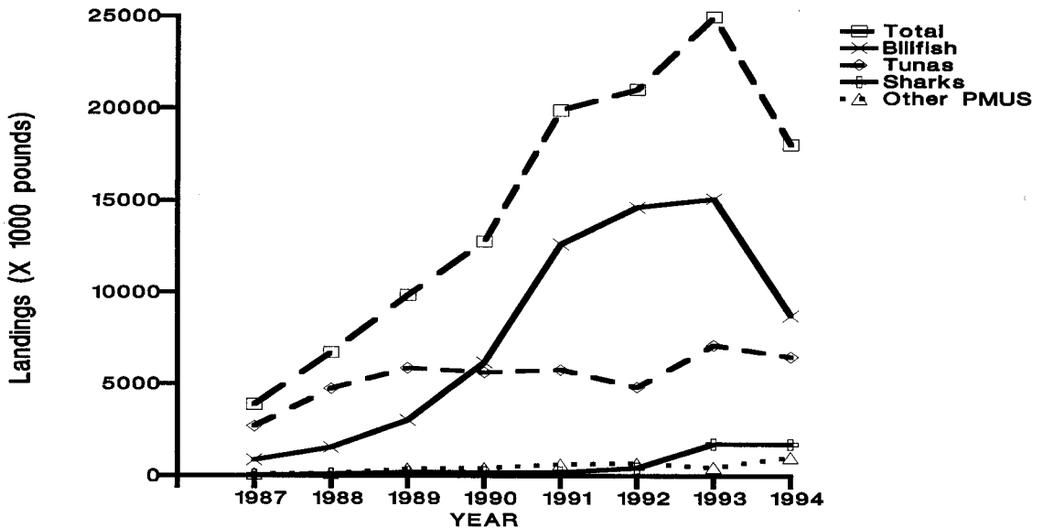

Figure 14.--Landings by major pelgic groups, 1987-94.

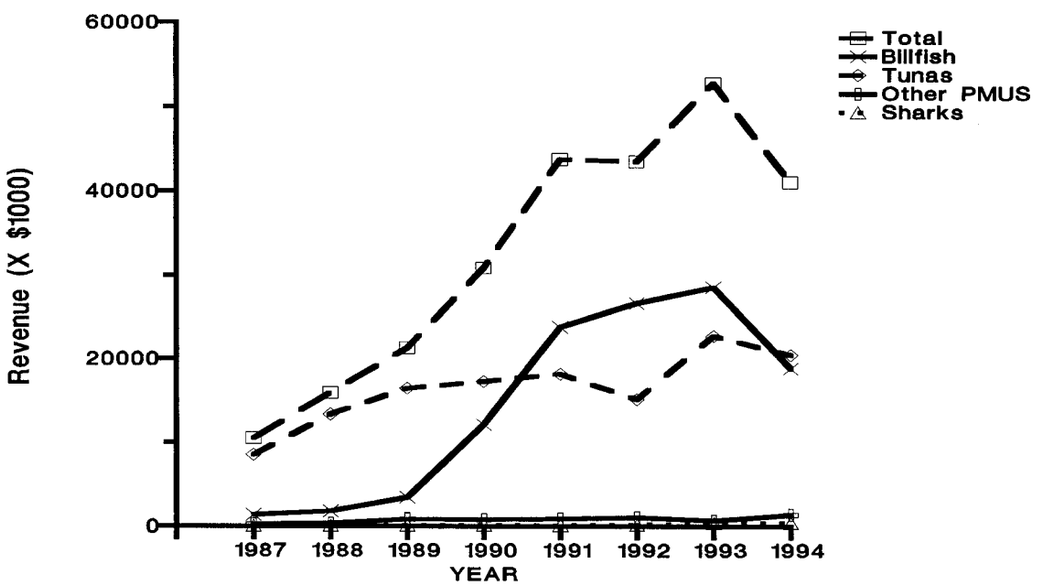

Figure 15.--Ex-vessel revenue by major pelagic groups, 1987-94.

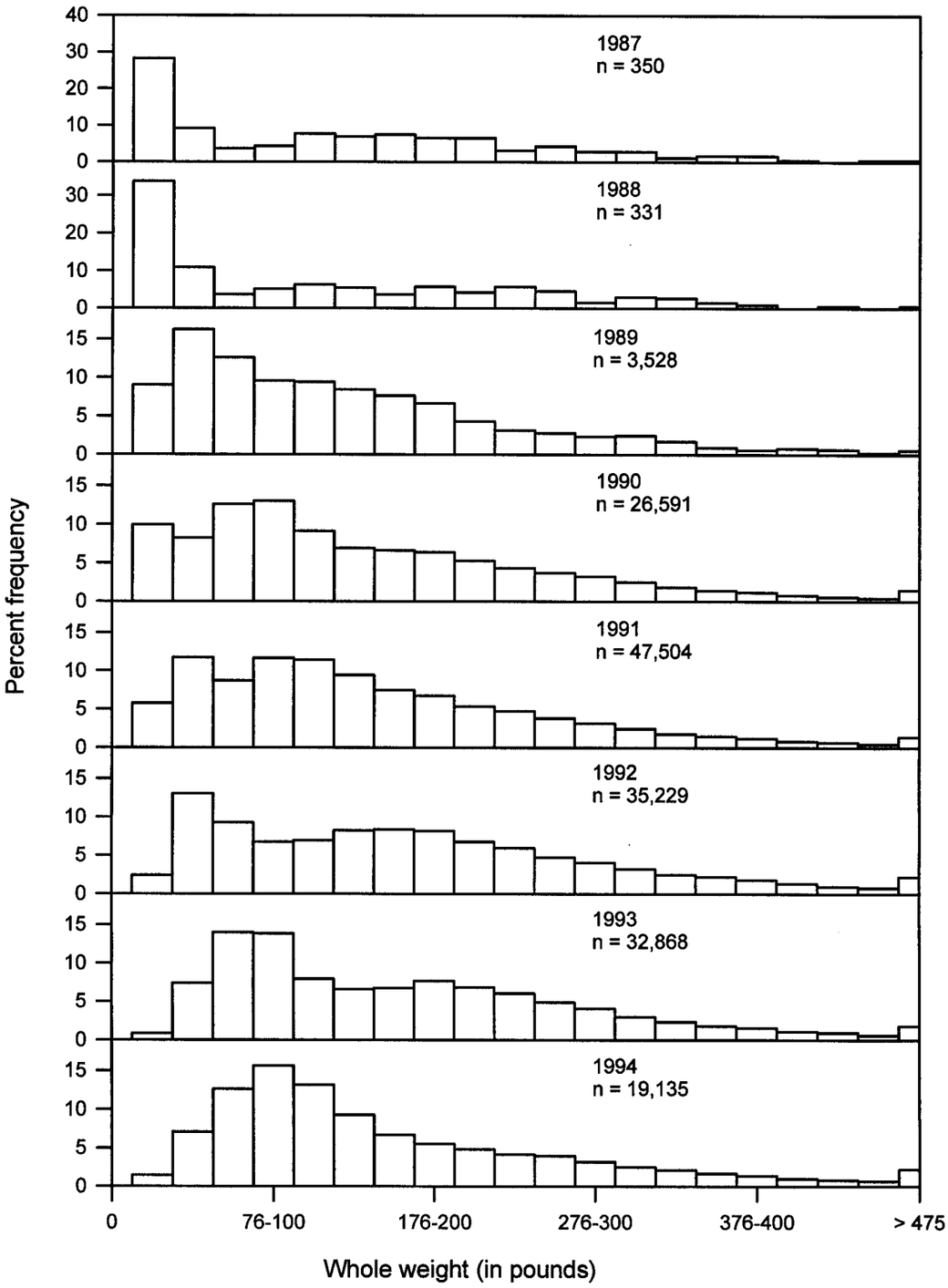

Figure 16.--Swordfish weight-frequency histograms, 1987-94.

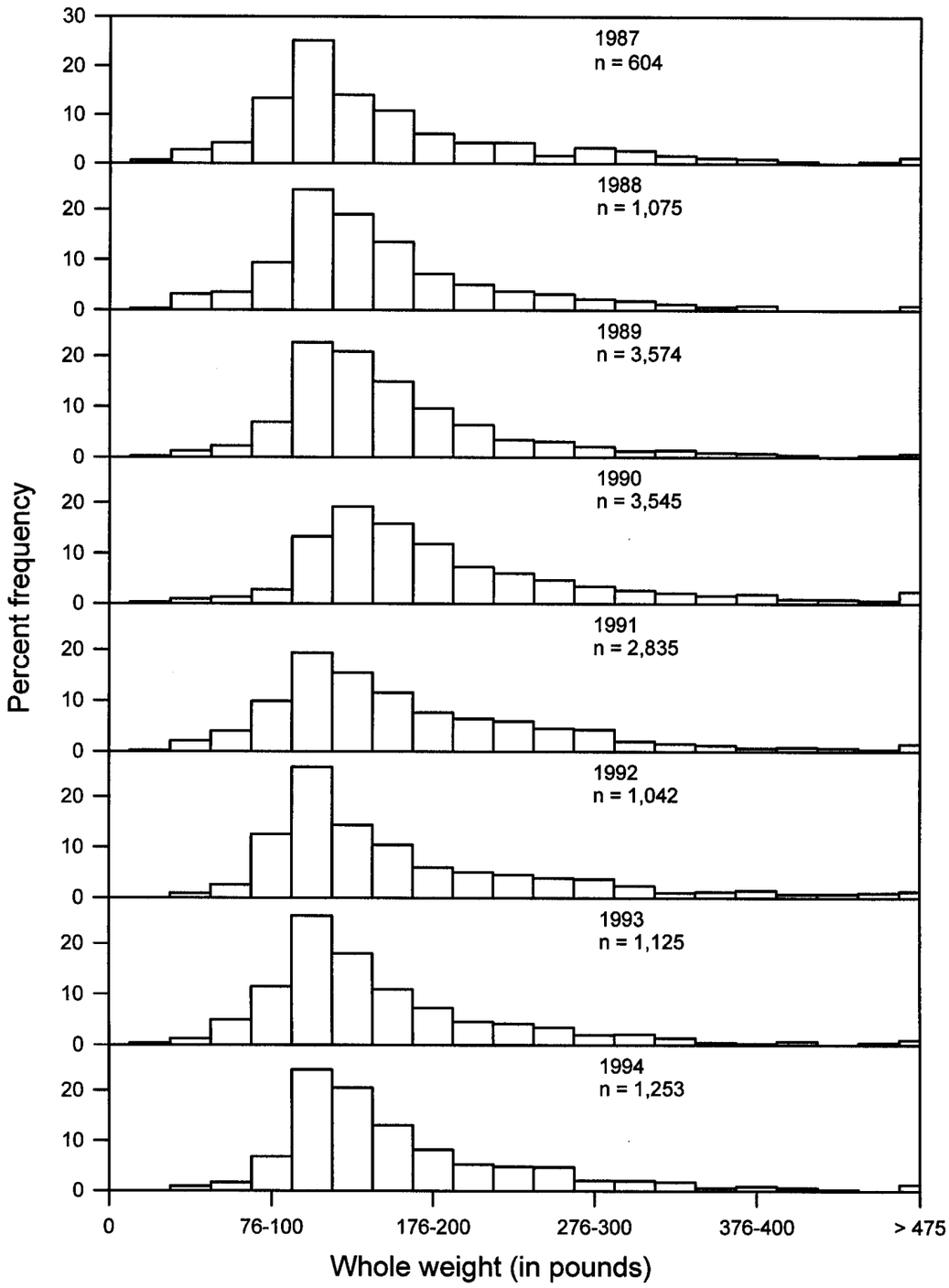

Figure 17.--Blue marlin weight-frequency histograms, 1987-94.

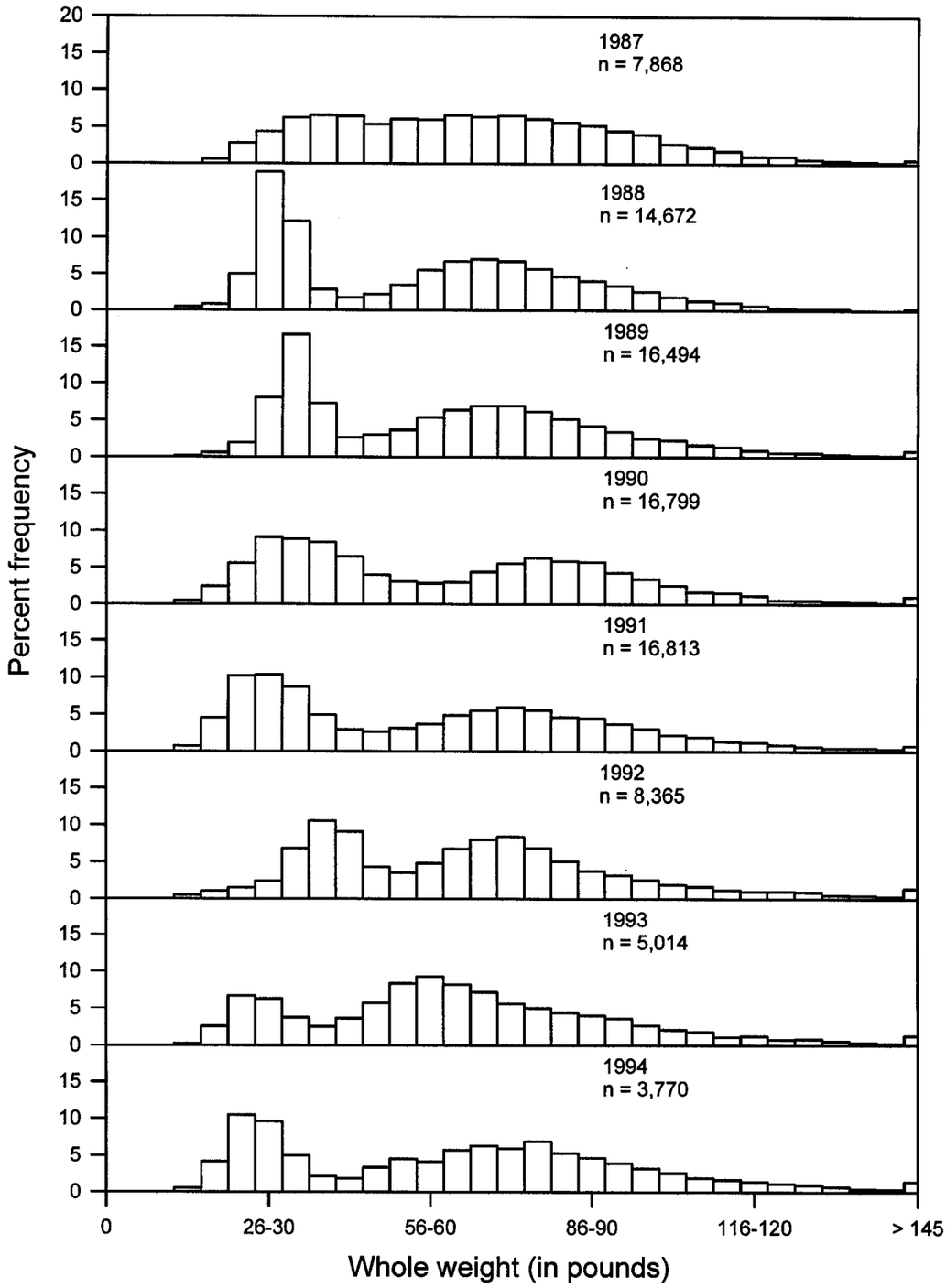

Figure 18.--Striped marlin weight-frequency histograms, 1987-94.

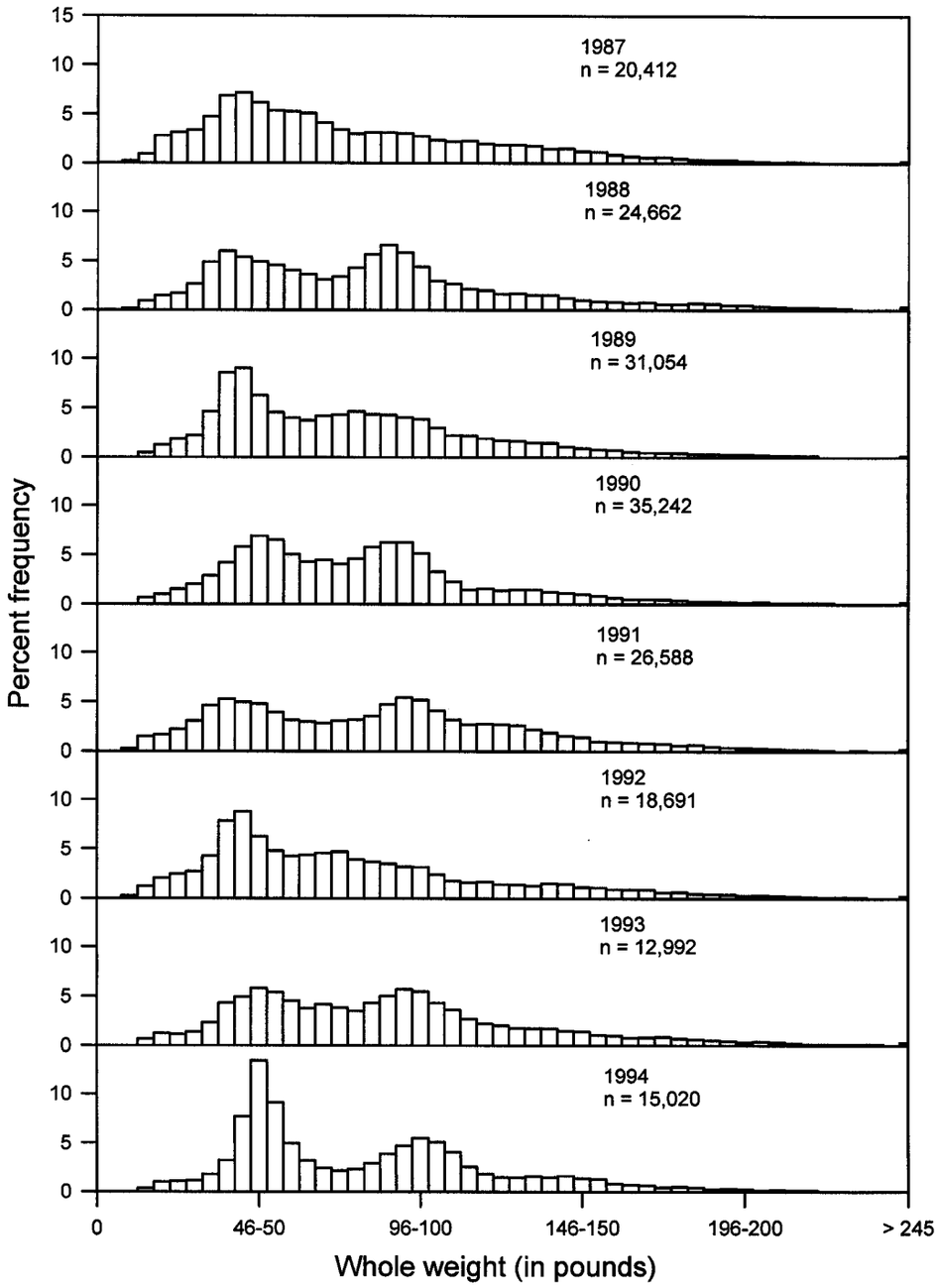

Figure 19.--Bigeye tuna weight-frequency histograms, 1987-94.

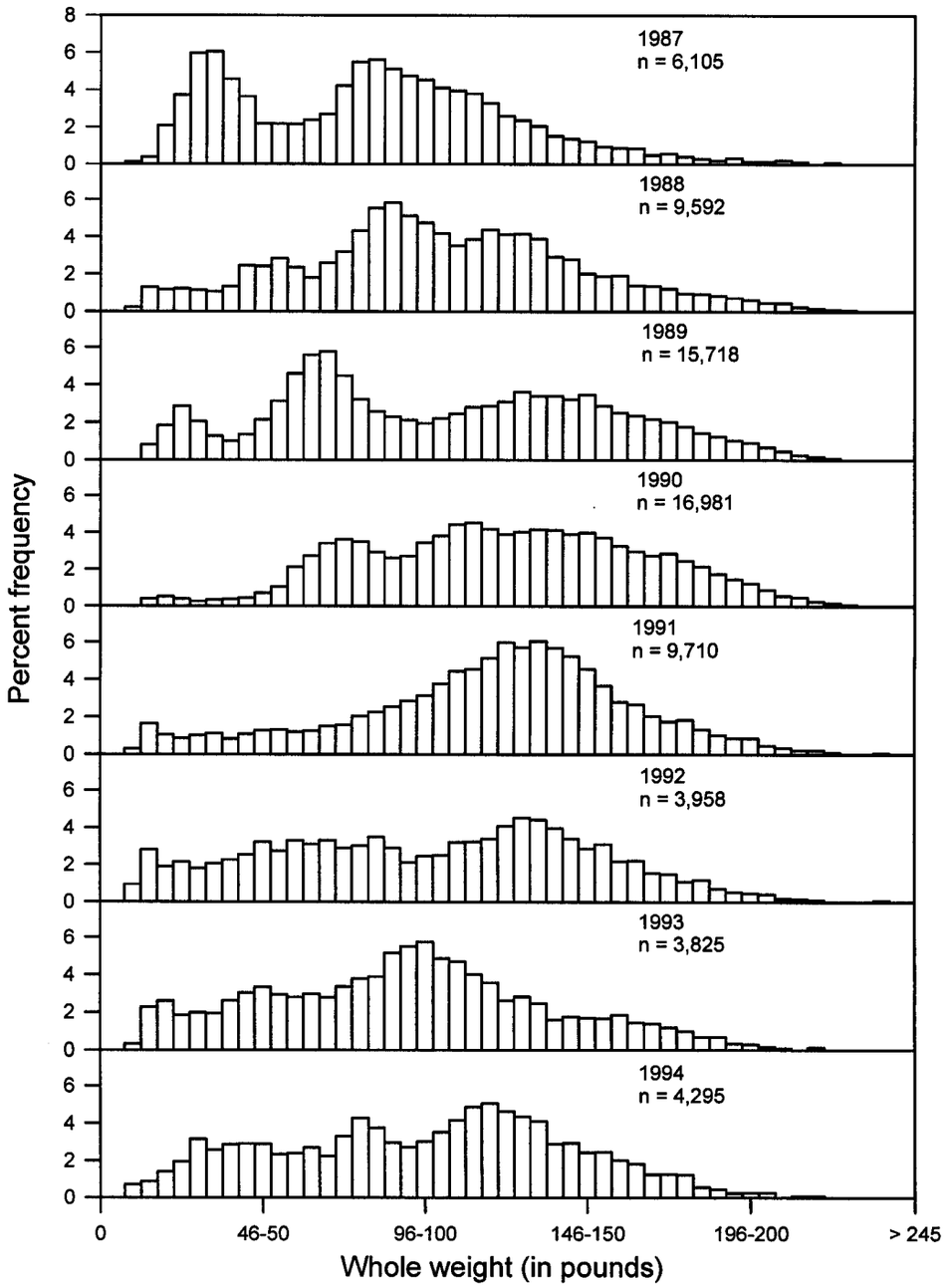

Figure 20.--Yellowfin tuna weight-frequency histograms, 1987-94.

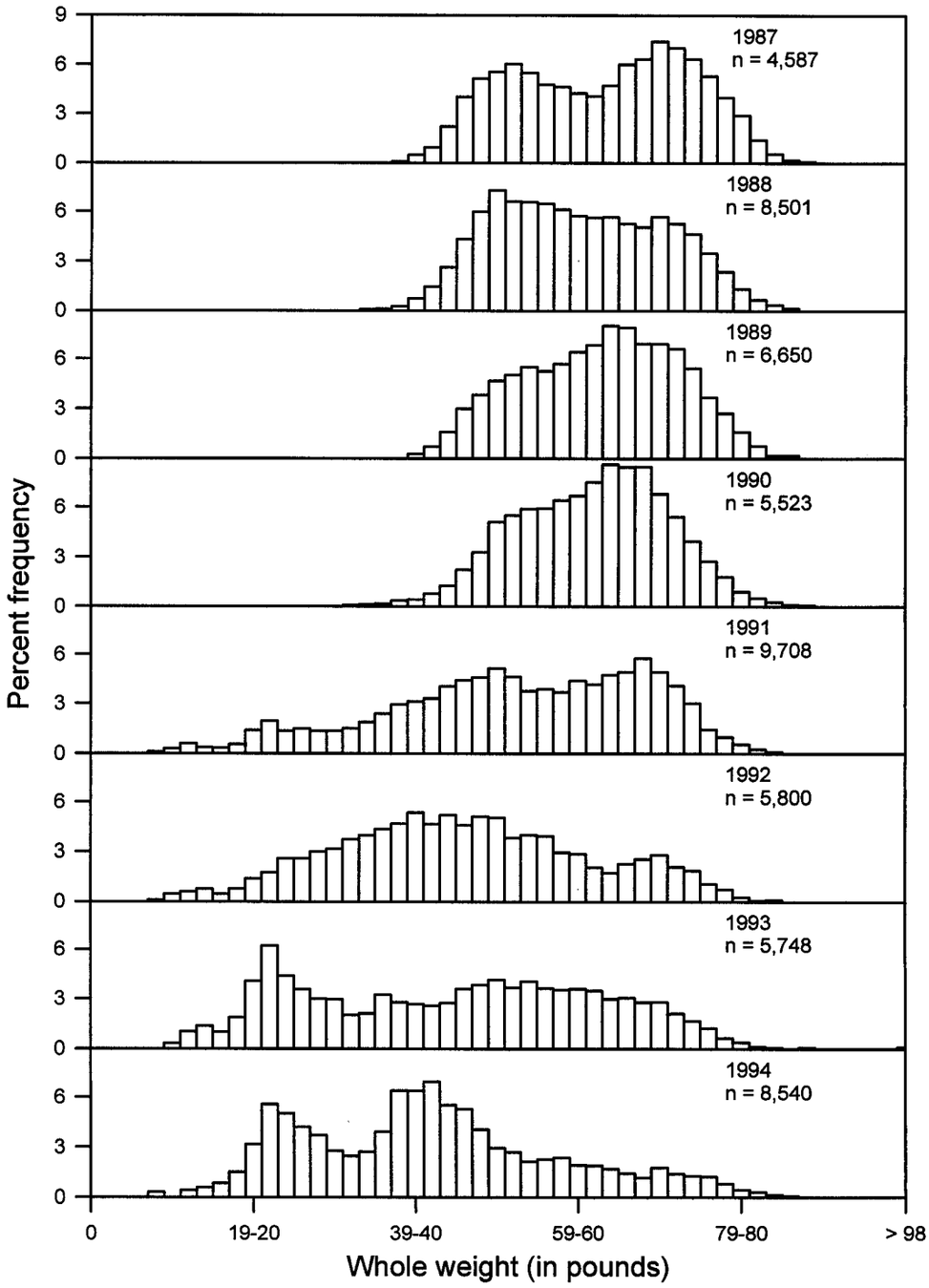

Figure 21.--Albacore weight-frequency histograms, 1987-94.

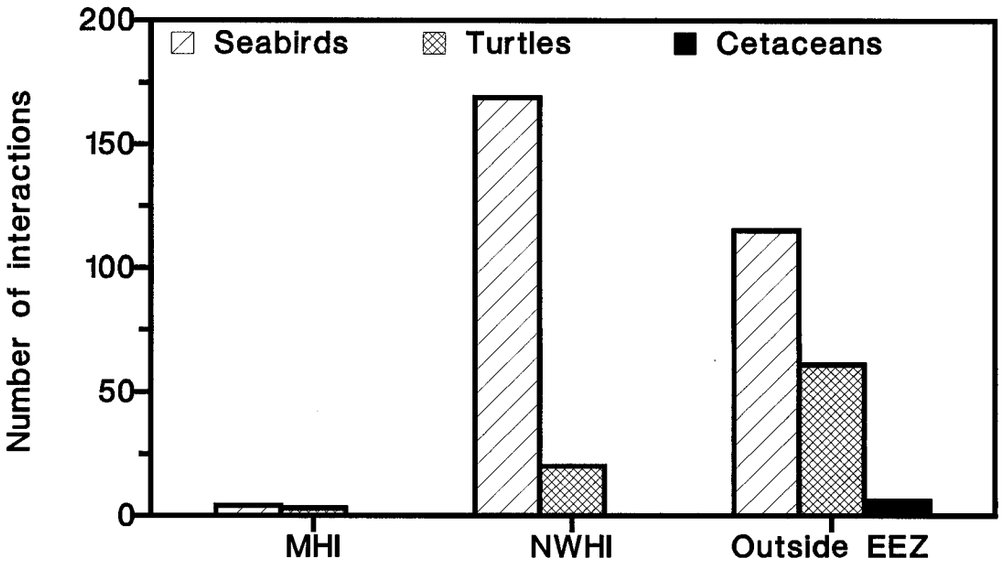

Figure 22.--Protected or endangered species interactions by area, 1994.