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(U.S.A. Fisheries and Research on Tuna and Tuna-like Fisheries in the North Pacific Ocean)[1]

NOAA, National Marine Fisheries Service

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U.S.A. Fisheries and Research on Tuna and Tuna-like Species in the North Pacific Ocean

NOAA, National Marine Fisheries Service

Executive Summary

Various U.S.A. fishing fleets harvest tuna and tuna-like species in the North Pacific Ocean from coastal waters of North America to the archipelagoes of Hawaii, Guam and the Commonwealth of the Northern Mariana Islands (CNMI) in the central and western Pacific Ocean. Small-scale gillnet, harpoon, tropical pole-and-line, troll and handline fleets operate primarily in coastal waters, whereas large-scale purse seine, albacore troll, and longline fleets which account for most of the tuna catches operate both within U.S.A. Exclusive Economic Zones and on the high seas. In terms of changes in catch levels, U.S.A. skipjack tuna (*Katsuwonus pelamis*) landings in the North Pacific Ocean increased from 30,949 t in 2011 to 43,129 t in 2012, mostly due to a increase in the purse-seine catches of this species. Total U.S.A. purse-seine landings also increased from 36,348 in 2011 to 49,359 in 2012. While thousands of trollers and handliners operated in the tropical Pacific Islands during 2012, these fleets represented by far the largest number of vessels but also contributed a minor fraction of the total tuna catch.

The National Oceanic and Atmospheric Administration (NOAA) Fisheries continued to conduct research in 2012 on Pacific tunas and associated species at its Southwest and Pacific Islands Fisheries Science Centers and also in collaboration with scientists from other organizations. Fishery monitoring and socio-economic research was conducted on tunas, billfishes, and bycatch species in U.S.A. Pacific coastal and high seas fisheries. As in previous years, fishery monitoring and angler effort information were compiled in 2012, and economic performance indicators in the Hawaii longline and small-boat fisheries were assessed.

Stock assessment research on tuna and tuna-like species was conducted primarily through collaboration with participating scientists of the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) and other international Regional Fisheries Management Organizations.

NOAA Fisheries successfully completed biological and oceanographic research on tunas, billfishes, and sharks. These research efforts provided empirical information to quantify fish movements, habitat preferences, post-release survival, feeding habits, and age and growth. Important results included: (i) analyses of albacore otolith microchemistry and population structure; (ii) billfish research on vertical habitat and foraging depth studies; (iii) studies of shark survival after capture and release and oxytetracycline age validation of juvenile shortfin mako (*Isurus oxyrinchus*) sharks, (iv) continuing shark tagging studies as well as (v) ongoing studies on sea turtles and sharks focused on bycatch mitigation. New research on opah (*Lampris* spp.) included studies on foraging ecology, gill morphology and regional heterothermy.

I. Introduction

Various U.S.A. fisheries harvest tuna and tuna-like species in the North Pacific Ocean. Large-scale purse seine, albacore (*Thunnus alalunga*) troll, and longline fisheries operate both in coastal waters and on the high seas. Small-scale gillnet, harpoon, handline and pole-and-line fisheries as well as commercial and recreational troll and hook and line fisheries usually operate in coastal waters. Overall, the range of U.S.A. fisheries in the North Pacific Ocean is extensive, from coastal waters of North America to Guam and the Commonwealth of the Northern Mariana Islands (CNMI) in the western Pacific Ocean and from the equatorial region to the upper reaches of the North Pacific Transition Zone.

In U.S.A. Pacific fisheries for tunas and billfishes, fishery monitoring responsibilities are shared by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries or federal agency) and by partner fisheries agencies in the states of California, Oregon, Washington, Hawaii, and territories of American Samoa, Guam, and the CNMI. On the federal side, monitoring is conducted by the Southwest Regional Office (SWRO) and the Southwest Fisheries Science Center (SWFSC) in California, and the Pacific Islands Regional Office (PIRO) and the Pacific Islands Fisheries Science Center (PIFSC) in Hawaii. NOAA Fisheries monitors the landings and sales records, federally-mandated logbook statistics on fishing effort and catch, observer data, and biological sampling data. In California, Washington, and Oregon, landings receipts are collected by state agencies and placed in the Pacific Fisheries Information Network (PacFIN) system. Some state agencies also collect logbook and size-composition data. In the central and western Pacific Ocean, monitoring by partner agencies also involves market sampling and surveys of fishing activity and catch and is coordinated by the Western Pacific Fishery Information Network (WPacFIN), a federally funded program managed by the PIFSC. The management of data on U.S.A. Pacific fisheries for tuna and tuna-like species is coordinated among the SWFSC, SWRO, PIFSC, and PIRO.

This report provides information on the number of active vessels by fleet and their catches of tunas and billfishes in the North Pacific Ocean based on the data available through 15 March 2013. Data for 2011 and 2012 however, are considered preliminary and are subject to change. Although the report is focused on tunas and billfishes, many of the fisheries include catch of other pelagic fish important to the fishing fleets and local economies; catch data for these species are not included in this report but are included in the ISC data submissions.

NOAA Fisheries also conducts scientific research programs in support of marine resource conservation and management both domestically and internationally. These studies include stock assessments, biological and oceanographic studies, socio-economic analysis, and more. This report includes summaries of recent and ongoing scientific work by NOAA Fisheries of relevance to the ISC.

II. Fisheries

A. Purse Seine

The U.S.A. purse-seine fishery consists of two separate components, one that operates in the western-central Pacific Ocean (WCPO), and another that operates in the eastern Pacific Ocean (EPO). The EPO purse-seine fishery started in the mid-1900s and most catch came from there until 1993 when vessels moved to the WCPO in response to dolphin conservation measures in the EPO. Vessels also moved to the WCPO because fishing access was granted by the South Pacific Tuna Treaty. The WCPO fishery operates mainly in areas between 10°N and 10°S latitude and 130°E and 150°W longitude. The EPO fishery operates off the coast of Southern California and outside the exclusive economic zone (EEZ) of Mexico off Baja, California. The number of U.S.A. vessels participating in the U.S.A. purse-seine fishery and fishing north of the equator decreased from a high of 74 in 1988 to 11 in 2006 (Table 1) increasing to 41 in 2009. In 2012, there were 40 licensed vessels Prior to 1995 the fleet fished mainly on free-swimming schools of tunas in the WCPO and on schools associated with dolphins in the EPO. Since 1995 most catches have been made on fish aggregation devices (FADs) and other floating objects in the WCPO. The purse-seine fishery in the EPO consists of smaller vessels that target mostly coastal pelagics, but may target tunas occasionally and larger vessels from the WCPO that occasionally fish in the EPO.

U.S.A. purse-seine vessels fishing in the WCPO have been monitored by NOAA Fisheries under the South Pacific Regional Tuna Treaty since 1988. Logbook and landings data are submitted as a requirement of the Treaty (coverage 100%). Landings are sampled for species and size composition as vessels land their catches in American Samoa by NOAA Fisheries personnel and by samplers in other ports (coverage approximately 1-2% of landings). Species composition samples are used to separate bigeye tuna (*Thunnus obesus*) from yellowfin tuna (*Thunnus albacares*) in the reported landings. The Forum Fisheries Agency (Treaty Manager) places observers on 100% of the vessel trips.

U.S.A. purse seine catches of tunas north of the equator are shown in Table 2. Catches in the North Pacific Ocean, over the past five years (most of the catch is south of the equator), have been primarily skipjack tuna (*Katsuwonus pelamis*) (~83% of retained catch) and yellowfin tuna (14% of retained catch). Skipjack tuna catches peaked in 1988 at 78,250 t (metric tons) then decreased to 4,002 t in 2002 in the North Pacific Ocean. In 2011 30,348 t and in 2012 42,479 t of skipjack tuna were caught by U.S.A. purse seiners in the North Pacific Ocean. Yellowfin tuna catches in the North Pacific Ocean generally decreased from a high of 123,044 t in 1987 to 1,112 t in 2006 and 2007. In 2011 3,996 t and in 2012 5,837 t of yellowfin tuna were caught by U.S.A. purse seiners in the North Pacific Ocean. Figure 1 shows the spatial distribution of reported fishing effort in 2011 by the U.S.A. purse-seine fleet in the WCPO.

The Inter-American Tropical Tuna Commission (IATTC) monitors U.S.A. purse-seine vessels fishing in the EPO by large-scale U.S.A. purse-seine vessels. Logbooks (coverage is 100%) are submitted by vessel operators to NOAA Fisheries or the IATTC, and landings (coverage is also 100%) are obtained for each vessel trip from canneries or fish buyers. IATTC observers are placed on all large purse-seine vessels.

B. Longline

The U.S.A. longline fishery targeting tunas and tuna-like species in the North Pacific Ocean is made up of the Hawaii-based fishery, the California-based fishery, and the American Samoa-based fishery. Vessels operated freely in an overlapping area managed by two domestic management regimes until 2000 when domestic regulations placed restrictions on moving between the two domestic management regimes. The Hawaii-based component of the U.S.A. longline fishery currently comprises a majority of the vessels, fishing effort, and catch. Regulatory restrictions, due to interactions with endangered sea turtles, curtailed Hawaii-based longline effort for swordfish (*Xiphias gladius*) in 2000 and 2001 followed by a prohibition altogether in 2002 and 2003, during which the Hawaii-based longline fishery targeted tunas exclusively. The Hawaii-based fishery for swordfish (shallow-set longline) was reopened in April 2004 under a new set of regulations to reduce sea turtle interactions. The year 2005 was the first complete year in which the Hawaii-based longline fishery was allowed to target swordfish. In the following year, the shallow-set longline fishery reached the annual interaction limit of 17 loggerhead sea turtles (*Caretta caretta)* and the fishery was closed on March 20, 2006. The majority of vessels that targeted swordfish converted to deep-set longline and targeted tunas for the remainder of the year. In the Hawaii-based shallow-set longline fishery in 2012, the interaction limits for leatherback (*Dermochelys coriacea*) and loggerhead sea turtles were increased for the Hawaii shallow-set longline fishery to 26 and 34, respectively, and no fishery restrictions occurred, though in previous years the leatherback interaction limit was reached and the fishery shut down.

The number of vessels in the California-based fishery has always been low compared to the Hawaii-based fishery, and was composed mainly of vessels that targeted swordfish. Most vessels also participated in the Hawaii-based fishery. The California-based longline fishery for swordfish was closed in 2004 and resulted in relocation of most of those vessels back to Hawaii. Only one vessel fished exclusively in the California longline fishery between 2005 and 2012 targeting tunas.

The longline fishery extends from outside the U.S.A. West Coast EEZ to 175°W longitude and from the equator to 35°N latitude in 2012 (Figure 2 and 3). The number of vessels participating in the longline fishery increased from 36 in 1985 to a high of 141 vessels in 1991 (Table 1). Since then, the number of vessels has remained relatively stable. Approximately 129 vessels participated in 2012. In Hawaii and California, swordfish are generally landed dressed (headed, tailed, and gutted). Tunas and large marlins are landed gilled and gutted while other bony fishes are usually landed whole. Sharks are landed headed and gutted. In Hawaii, the landed catch biomass is the reported total fish weight by species recorded at the fish auction. Dressed weights are converted to whole weight for reporting of total catches using standard conversion factors.

Catch levels and catch-species composition in the U.S.A. longline fishery have changed over the past years in response to fishery and regulatory changes. The majority of the longline catch now consists of tunas and billfishes and exceeded 10,000 t in 1993, 1999, 2000, 2008, and 2011 (Table 2). Bigeye tuna dominates the tuna catch with landings over 4,000 t during the past nine years. The 2012 bigeye tuna catch was 5,854 t. Swordfish has been the dominant component of the billfish catch since 1990 and reached a peak of 5,936 t in 1993 before decreasing to 1,185 t in 2004. The U.S.A. 2012 swordfish catch by longline was 1,418 t, 287 t below the recent three-year average.

The Hawaii-based longline fishery is monitored by combined sampling efforts of the NOAA Fisheries and the State of Hawaii's Division of Aquatic Resources (DAR). Longline fishers are required to complete and submit federal longline logbooks for each fishing operation. The logbook data include information on fishing effort, area fished, catch by species and amount, and other details of the fishing operations. Logbook coverage for the Hawaii-based longline fishery is at or near 100% coverage of vessel by trip. The Hawaii DAR also requires fish dealers to submit reports of landings data, and coverage for the longline fishery and the reporting rate for dealers are very close to 100%. Observers contracted by NOAA Fisheries are also placed on longline vessels to monitor protected species interactions, vessel operations, and multi-species catches. These observers are required by court decree to be aboard Hawaii-based longline vessels at a rate of coverage of no less than 20% for deep-set (tuna-target) vessels and 100% for shallow-set (swordfish-target) vessels. Information on the sizes of tuna fish caught in the Hawaii-based longline fishery indicate, that in general, a higher proportion of smaller tuna and tuna-like fish species are captured in the shallow-set longline fishery (Figures 4-6).

The California-based longline fishery is monitored by NOAA Fisheries and the California Department of Fish and Wildlife (CDFW). Longline landings data are collected from at or near 100% of the fleet by the CDFW landing receipt program. Logbooks, developed by the fishing industry (similar to the federal logbooks used in Hawaii), were submitted voluntarily to NOAA Fisheries until 1994. Landed swordfish were measured for cleithrum to fork length by CDFW port samplers until 1999. NOAA Fisheries currently places observers on all California-based longline trips. The observers collect data on protected species interactions, fish catch and measure the sizes of fish caught (retained and discarded).

C. Albacore troll and pole-and-line

The U.S.A. albacore troll and pole-and-line fishery in the North Pacific Ocean started in the early 1900s. The fishery operates in waters between the U.S.A. west coast and 160°E longitude. Fishing usually starts in May or June and ends in October or November. The number of vessels participating in the fishery ranged from a low of 172 in 1991 to a high of 1,172 in 1997 (Table 1). In 2012, 820 vessels participated in the fishery, up from 687 in 2011. Figure 7 shows the spatial distribution of the albacore troll and pole-and-line fishery in 2012.

The troll and pole-and-line fishery catches almost exclusively albacore with minor incidental catches of skipjack, yellowfin and bluefin (*Thunnus orientalis*) tunas, eastern Pacific bonito (*Sarda chiliensis lineolata*), yellowtail (*Seriola lalandi)*, and mahi mahi (*Coryphaena hippurus*). Since 1985, the albacore catch has ranged from a low of 1,845 t in 1991 to a high of 16,962 t in 1996 (Table 2). In 2011 and 2012, 11,037 t and 14,137 t were caught, respectively. Figure 8 shows the size distribution of albacore caught in 2012.

U.S.A. troll and pole-and-line vessels voluntarily submitted logbook records to NOAA Fisheries until 1995 when those vessels fishing on the high-seas were required to submit logbooks.

Starting in 2005, all vessels must submit logbooks as a requirement of a Highly Migratory Species Fishery Management Plan (HMS FMP). Landings are monitored by NOAA Fisheries and various state fisheries agencies through landing receipts and coverage is 100% of the fleet. Landings are also sampled for fork length by state agency port samplers along the U.S.A. West Coast and by NOAA Fisheries personnel in American Samoa. Since 1961, the port sampling program has been in place for collecting size data from albacore landings along the U.S.A. Pacific coast. State fishery personnel collect the size data according to sampling instructions provided by NOAA Fisheries, who maintains the database. In recent years, cooperative fishermen have also collected size data on selected fishing trips following a random sampling protocol established by NOAA Fisheries. These data are collected to augment data collected through the port sampling program. Fishermen on two vessels measured 1,422 albacore during the 2012 season. During 2011, two vessels measured 1,940 albacore. The sample information provided by the fishermen helped to fill in gaps missed by the port sampling program.

D. Tropical pole-and-line

The tropical pole-and-line fishery targets skipjack around the Hawaiian Islands. The number of vessels participating declined from a high of 27 in 1985 to a low of one in 2012. Skipjack tuna is usually the largest component of the catch by Hawaii pole-and-line vessels. The highest skipjack tuna catch for this fishery was 3,450 t in 1988 (Table 2). The highest yellowfin tuna catch for the pole-and-line fishery was 2,636 t, recorded in 1993. Three vessels have participated in the tropical pole-and-line fishery since 2010. (Note: The 2011 U.S.A. Report combined tropical pole-and-line and albacore pole-and-line. In this report the albacore pole-and-line data are combined with albacore troll, and tropical pole-and-line data are reported separately in order to be consistent with reporting to WCPFC.)

Hawaii DAR monitors the tropical pole-and-line fishery using Commercial Fish Catch reports submitted by fishers and Commercial Marine Dealer reports submitted by fish dealers.

E. Tropical Troll and Tropical Handline

Tropical troll fishing fleets for tuna and tuna-like species operated in Hawaii, Guam, and the CNMI during 2012. Tropical handline fishing fleets also operated in Hawaii during 2012. The vessels in these fisheries were relatively small coastal vessels (typically around 8 m in length) and primarily made one-day fishing trips in coastal waters. Historically, the number of U.S.A troll and handline vessels combined ranged from 1,878 in 1988 to 2,502 in 1999, and there were 2,080 troll vessels and 572 handline vessels in 2012 (Table 1). The operations range from recreational, subsistence, and part-time commercial to full-time commercial. The small vessel catches generally were landed fresh and whole, although some catches were gilled and gutted. Weights of individual fish were obtained when fish were landed for commercial sale. The size distributions of tunas (skipjack and yellowfin) and marlins (striped marlin and blue marlin) caught in these fisheries in 2012 were also summarized (Figures 9 and 10).

The total retained catch from these tropical troll and handline fisheries combined ranged from 1,162 t in 1992 to 2,481 t in 2012 (Table 2). Yellowfin tuna made up 45% of the troll and handline catch in 2012. The next largest species catch components were bigeye tuna, skipjack tuna, and blue marlin (*Makaira nigricans*).

The Guam Division of Aquatic and Wildlife Resources (DAWR) monitored the troll fishery in 2012 using a statistically designed creel survey. The Guam DAWR, with the assistance of NOAA Fisheries, extrapolated the creel survey data to produce estimates of total catch, fishing effort, and fishermen participation estimates by gear type. Similarly, the Hawaii tropical troll and handline fisheries catch and effort summaries were compiled from Hawaii DAR Commercial Fish Catch reports and Commercial Marine Dealer reports. The CNMI monitored the tropical troll fishery in the CNMI region using their Commercial Purchase database.

F. Gillnet

The U.S.A. drift and set gillnet fisheries operate in areas within the EEZ in California waters and sometimes off Oregon. Tuna and tuna-like fishes are caught mainly by pelagic drift gillnet, with minor quantities caught incidentally in set gillnet. The number of vessels participating in the pelagic drift gillnet fishery decreased from a high of 220 in 1986 to 22 in 2012. Swordfish catches are the major portion of the catch and peaked in 1985 at 2,990 t. Since then, swordfish catches have fluctuated while decreasing to 182 in 2004 and rebounding to 490 in 2007 (Table 2). The catches have gone down since then, decreasing to 61 t in 2010, and the preliminary estimate of swordfish caught in the drift gillnet fishery for 2012 is 97 t. Figure 11 shows the spatial distribution of the gillnet fishery in 2012.

Gillnet fishery landings data (100% coverage) are collected by state agencies in California and Oregon (only minor amounts of tuna and tuna-like fishes are landed in Oregon). Logbook data for gillnet fisheries are supposed to be collected from 100% of the fleet by the CDFW. CDFW also collected length data for swordfish landings until 1999 from less than 1% of the landings. NOAA Fisheries observers on drift gillnet vessels have also collected length data since about 1990 and observer coverage is about 20% of effort.

G. Harpoon

The harpoon fishery targets swordfish and operates in areas within the EEZ in California waters between 32°N and 34°N latitude. The number of vessels participating in the fishery generally decreased from 113 in 1986 to nine in 2012 (Table 1). Trends in swordfish catches have fluctuated from a high of 305 t in 1985 to five t in 2012 (Table 2). Twenty four tons were landed in 2011. Figure 11 shows the spatial distribution of the harpoon fishery in 2012.

Landings and logbook data for the harpoon fishery are collected by the CDFW and coverage is 100% of the fleet. Length measurements were taken until 1999, covering less than 1% of swordfish landings.

H. Sport

Sport (recreational) catch and effort data are available from commercial passenger fishing vessels (CPFVs) that target tunas and other pelagic fish. Catch and effort data for CPFVs based in California are obtained from CDFW. Catch and effort data for CPFVs based in

Oregon and Washington are obtained from logbooks submitted by CPFV owners to NOAA Fisheries. The CPFV vessels based in California record catch locations using geographic blocks defined by CDFW. Most of the HMS catch and effort occur in Mexican waters. For reporting, the data have been aggregated into a single large area. Figure 11 shows the spatial distribution of the sport fishery in 2012 but does not display the extent of the fishery in Mexican waters. These data are processed by NOAA Fisheries. Catch is reported in number of fish and effort is reported in vessel-days fished. Total catch estimates for albacore and bluefin tunas are estimated using average weights obtained from port sampling where possible (IATTC sampling for bluefin and U.S.A. port sampling for albacore).

III. Research

NOAA Fisheries research on tunas and billfishes in the Pacific Ocean has largely been focused on improving understanding of the biology and ecology of the animals to support needs for assessing the effects of fishing and the environment on the population or stock. Described below are highlights of a few studies that have recently been completed or are ongoing by NOAA Fisheries. These studies are carried out largely in cooperation with stakeholders and in collaboration with colleagues both in the U.S.A. and abroad.

Central and Western Pacific Fisheries Monitoring

WPacFIN collects and manages data from most of the U.S.A. central and western Pacific fisheries (Hawaii, American Samoa, Guam, Commonwealth of the Northern Mariana Islands). This includes longline, skipjack pole-and-line, tropical troll, and tropical handline fisheries. In 2012, WPacFIN completed and published the 27th edition of Fishery Statistics of the Western Pacific (Hamm et al., 2012). Annual reports for the Hawaii-based longline fishery and the American Samoa longline fishery in 2012 were also published (PIFSC, 2013; PIFSC, 2013).

Age Validation Studies on Sharks

Age and growth of shortfin mako (*Isurus oxyrinchus*), common thresher (*Alopias vulpinus*), and blue sharks (*Prionace glauca*) are being estimated from band formation in vertebrae. In addition to being important for studying basic biology, accurate age and growth curves are needed in stock assessments. NOAA Fisheries scientists are validating ageing methods for these three species based on band deposition periodicity determined using oxytetracycline (OTC). Annual research surveys provide an opportunity to tag animals with OTC. When the shark is recaptured and the vertebrae recovered, the number of bands laid down since the known date of OTC injection can be used to determine band deposition periodicity. Since the beginning of the program in 1997, 3,183 OTC-marked individuals have been released during juvenile shark surveys. Sharks tagged include 1,221 shortfin mako, 1,187 common thresher, 757 blue, 15 silky (*Carcharhinus falciformis*), and three pelagic thresher (*Alopias pelagicus*) sharks.

Oxytetracycline Age Validation of Juvenile Shortfin Makos – The results of age validation of 29 juvenile shortfin mako sharks tagged with OTC in the Southern California Bight were recently published (Wells et al. 2013) and showed vertebral band pair deposition rates of two per year. The results of this study differ from two other studies on shortfin makos that used a direct age validation technique: one study validated a single band pair deposition rate in an estimated 18 year old shortfin mako shark tagged with OTC and recaptured in the Atlantic after one year at liberty; and the second used a bomb radiocarbon signal as a marker in 37 sharks collected in the Northwest Atlantic between 1950 and 1984 ranging in estimated ages of one to 31 years. Age and growth in shortfin mako sharks continues to be uncertain because growth curves estimated from length frequency analysis and tag-recapture methods tend to show faster growth rates than obtained from vertebral counts based on deposition of a single band pair per year. Furthermore, this validation study applies to juvenile sharks in the northeast Pacific. This study raises questions about potential regional differences in band pair deposition rates or the possibility of an ontogenetic shift from a period of more rapid growth with two band pair deposition per year to slower growth and a switch to a band pair deposition rate of one per year. In winter

2013/2014, the ISC plans to convene its second Shark Age and Growth Workshop during which participants hope to resolve some of the uncertainties regarding shortfin mako age and growth.

Hawaii Longline Fishery Economics

Since 2004, NOAA Fisheries observers have collected data on fishing costs and other economic information from over 3,000 longline trips in order to assess changes in important economic indicators of the Hawaii-based longline fisheries (Pan, 2010). From 2004 to 2012, a total of 1,526 trips with completed economic data have been collected. During the period 2004-2012, the average trip cost in the longline fishery for tuna-targeting trips increased by 120%, from $13,720 per trip in 2004 to $30,700 per trip in 2012. In 2004, fuel cost made up about 45% of the total trip cost (non-labor items). However, in 2012, fuel cost made up about 58% of the total trip cost. During the period 2005-2012, the average trip cost in the longline fishery for swordfish-targeting trips also increased similarly, from $17,600 per trip in 2005 to $39,400 per trip in 2012. Fuel cost made up about 59% of the total trip cost of the swordfish targeting trips in 2012. The routine trip-based economics data collection program is continuing with the Hawaii longline fishery and has extended to the longline fishery in American Samoa.

Hawaii Small Boat Economics

Since 2007, NOAA Fisheries has conducted cost-earnings surveys to assess economic and social characteristics of small boat pelagic fisheries in Hawaii, CNMI, and Guam. The results of these studies provide an important baseline that allow fishery managers to better understand how new fishery regulations and changing macroeconomic conditions may affect the financial performance and behavior of fishers.

In 2011, 147 fishermen from the Guam-based fleet were surveyed. This study detailed fisher classifications, levels of fishing activity, financial performance of the fleet, market participation, and social/cultural motivations towards fishing and selling of catch.

Nearly 86% of vessels were reported to be less than 25 feet in length. Fishermen reported approximately 39 boat fishing trips in the past 12 months. On average, fishermen reported the use of three different gear types/target species during the past 12 months, with pelagic trolling as the most popular gear type followed by shallow-water bottomfish fishing and deepwater bottomfish fishing. On average, fishermen reported selling approximately 24% of their total catch. The majority considers the fish they sell to contribute very little to their personal income, as cost recovery is a major motivation for selling a portion of catch. During 2010 and 2011, the cost of a trolling trip averaged approximately $235, and as anticipated, fuel expenses accounted for a majority (72%) of total trip expenditures (Hospital and Beavers, 2012).

Gear Modification to Reduce Turtle Bycatch

Since 2006 NOAA Fisheries has provided funds and technical expertise to support research experiments to identify means to reduce sea turtle bycatch in both longline and gillnet fisheries. During the last year, trials were underway in Brazil, Peru, Mexico and on board a Taiwanese vessel in the North Atlantic Ocean to test the effects of gear modifications (e.g., use of large circle hooks, hook rings, net illumination) on the rates of hooking and entanglement of sea turtles in longline and gillnet fisheries. These trials are also aimed at determining catch rates of target species in order to understand the potential viability of this modification in a commercial fishery.

Research from the past few years indicates that relatively large circle hooks can effectively reduce the bycatch of both loggerhead and leatherback sea turtles in longline fishing gear (Domingo et al., 2012; Piovano et al. 2012; Serafy et al. 2012). These hooks also show acceptable catch rates of tuna species (Huang et al., in prep), but slightly reduced catch rates of targeted swordfish. In the North Atlantic Ocean, relatively large circle hooks were not found to reduce rates of sea turtle captures, but increased catch rates of bigeye tuna (Huang et al., in prep).

Based on recent findings from studies to reduce capture rates of sea turtles in gillnet fishing gear, work has expanded to Northern Peru where preliminary results also suggest the potential utility of illuminating nets with light sources as a means to both maintain target species catch rates and reduce catch of sea turtles (Ortiz et al., in prep).

Post-release Survival of Turtles in Longline Fisheries

Another NOAA Fisheries objective is to improve estimates of sea turtles' post-release fate, specifically shallow longline gear (Swimmer and Gilman, 2012). Currently, methods to estimate post-release survival of turtles involve pop-up satellite archival tags (PSATs) and platform terminal transmitters (PTTs). Research has been conducted using both methods in the North Pacific and South Atlantic Oceans, as well as the Mediterranean Sea (Swimmer et al., accepted). Preliminary results of tracking studies indicate no differences in duration of transmissions as a function of the turtle's 'severity' of injury, specifically deep or shallow hookings, and that most sea turtles were tracked for the duration of the tag's battery life. Hall et al. (2012) describe additional work to clarify the role of safe handling and the valuable investment of education and outreach with regards to ensuring turtles' maximal chance of survival after their release from fishing gear.

These studies have also lead to new findings regarding the movement patterns of loggerhead sea turtles in the South Atlantic Ocean (Barcelo et al., 2013). Recent work has also identified the energetic costs of various types of sea turtle tags in relation to body size (Jones et al., 2012). And new information on drag effects has been incorporated into NOAA Fisheries permits office regarding guidelines for tagging turtles.

Modeling Swordfish Vertical Habitat from Pop-up Archival Tags

The daytime foraging depth of swordfish in the North Pacific Ocean was studied with data from an eight-year tagging program, using 28 Wildlife Computer PSATs. The tags transmitted data from 1°S to 44°N latitude and from 111° to 154°W longitude. Five tags were recovered, providing a full archival record that showed that when swordfish did not engage in daytime basking behavior, they remained within a narrow range of light level during both day and night. This suggests that swordfish stay within the vertically migrating sound-scattering layer (SSL) to feed during both day and night. Daytime mean depth of non-basking swordfish ranged from 32 to 760 m. Seventy-seven percent of the daytime mean depth could be explained with a generalized additive model that used three environmental indices: satellite-derived surface chlorophyll as a proxy for light at depth, oxygen at 400 m obtained from the World Ocean Atlas, and temperature at 400 m inferred from the tag data. This model, when used in a predictive mode, generated a basin-wide map of swordfish daytime mean depth that showed depths exceeding 600 m to the north of Hawaii and shoaling to 300 m off the coast of California. This information could improve daytime swordfish catch by longliners and potentially allow them to switch from shallow night sets that result in interactions with sea turtles. This approach in effect defines the habitat of swordfish prey, providing insight into the vertical behavior of those mid-trophic level organisms inhabiting the SSL. This model could be easily applied to other deep-foraging species (Abecassis et al., 2012).

Swordfish Deep-Set Buoy Gear Research

NOAA Fisheries and Pfleger Institute of Environmental Research (PIER) are examining how a deep-set vertical line configuration to target swordfish within the California exclusive economic zone affects bycatch and catch rates. Gear trials were conducted during the 2011 and 2012 swordfish seasons off the coast of southern California using both research and cooperative fisher vessels. A total of 54 sets were completed resulting in the capture of 15 swordfish. No interactions with species of concern were recorded across all 4,320 hook-hours. Additional non-target catch included: bigeye thresher sharks, *Alopias superciliosus*, opah (*Lampris* spp.), blue sharks, and common thresher shark. These data suggest that deep-set buoy gear can selectively be used to target swordfish in deep waters during the day off southern California. Additional trials that investigate alternative configurations (i.e., gear modification, bait presentation) and reduce the probability of lost gear are currently underway.

Longline Hook Effects on False Killer Whale Bycatch

The Hawaii-based deep-set longline fleet infrequently takes false killer whales (FKW, *Pseudorca crassidens*) as bycatch. From 2004 to 2008 with 20%–26% observer coverage, NOAA Fisheries documented nine mortalities of and serious injuries to FKW in the deep-set fishery in the Hawaii EEZ, yielding a mean take estimate of 7.3 animals yr^{-1}. Weak hook technology can utilize the size disparity between target and other species to promote the release of larger non-target species. Four longline vessels tested the catch efficacy and size selectivity of 15/0 “strong” circle hooks (4.5 mm wire diameter) that straighten at 138 kg of pull in comparison with 15/0 “weak” (4.0 mm) that straighten at 93 kg of pull. Vessels alternated hook types throughout the longline gear and maintained a 1:1 ratio of strong and weak hooks. Observers monitored a total of 127 sets of 302,738 hooks, and randomization tests were applied to test for significant differences in catch for 22 species. There were no significant catch differences for bigeye tuna; however, there may be limitations to these inferences because trials were not conducted during spring when larger bigeye tuna are available to the fishery. There were no significant differences in mean length of 15 species. Observers collected 76 straightened hooks, of which six were control and 70 were weak hooks. There was one observation of a FKW released from a stronger circle hook. Overall, there was no statistical reduction in catch rates of bycatch species (Bigelow et al., 2012).

Impacts of fishing, climate, and primary productivity changes on the Hawaii longline fishery

NOAA Fisheries updated and modified an existing Ecopath with Ecosim (EwE) model for the Central North Pacific Ocean to focus on the area used by the Hawaii-based pelagic longline fishery. The EwE model was combined with output from a coupled NOAA Geophysical Fluid Dynamics Laboratory climate and biogeochemical model to investigate the likely ecosystem impacts of fishing and climate-induced primary productivity changes. Four simulations were conducted based on 2 fishing effort and climate scenarios from 2010 to 2100. Modeled small and large phytoplankton biomass decreased by 10% and 20% respectively, resulting in a 10% decline in the total biomass of all higher trophic level groups combined. Climate impacts also affected the Hawaii longline fishery, with a 25–29% reduction in modeled target species yield. Climate impacts on the ecosystem and the fishery were partially mitigated by a drop in fishing effort.

Scenarios with a 50% reduction in fishing effort partially restored longline target species yield to current levels, and decreased longline non-target species yield. These model results suggest that a reduction in fishery mortality below the 2010 level over time may be necessary to mitigate climate impacts and help sustain yields of commercially preferred fish species targeted by the Hawaii longline fishery through the 21st century (Howell et al., 2012).

Electromagnetic Deterrents to Shark Bycatch in Longline Fisheries

One potential strategy for reducing shark bycatch in the longline fisheries is to exploit the unique electrosensory system of sharks, which can detect the strong electric fields in water produced by lanthanide series metals, neodymium and praseodymium.

NOAA Fisheries tested the effects of an Nd/Pr alloy on shark catch rates. Using longline fishing gear, the catch rates of baited hooks affixed with either a block of the metal alloy (experimental) or a lead weight (control) were compared. Four experiments were conducted in different regions of the Pacific Ocean. Two bottom longline experiments were conducted inside and offshore of Kaneohe Bay, Hawaii. One of these experiments targeted young of the year scalloped hammerhead sharks (*Sphyrna lewini*), while the other targeted sandbar (*Carcharhinus plumbeus*) and tiger sharks (*Galeocerdo cuvier*). In the Southern California Bight (SCB), pelagic longlines were deployed to target shortfin mako and blue sharks, and in the Eastern Tropical Pacific off Ecuador, longlines also targeted pelagic sharks. There was a significant reduction in juvenile hammerhead sharks caught on hooks with the lanthanide metal compared to the controls. In contrast, there was no difference in the catch rates for experiments targeting sandbar sharks in Hawaii or those conducted in the SCB and Ecuador. These results suggest that there are inter-specific differences regarding the effects of lanthanide metals on catch rates. This may reflect the diverse feeding strategies and sensory modalities used by shark species for detecting and attacking prey (Hutchinson et al., 2012).

Electronic Tagging Studies

Since 1999, NOAA Fisheries scientists have used data logging tags and satellite technology to characterize the essential habitats of large pelagic fish and subsequently to better understand how populations might shift in response to changes in environmental conditions on short or long time scales; the target fish are primarily albacore, blue sharks, shortfin mako, and common thresher sharks, while other species are tagged opportunistically. In recent years, NOAA Fisheries has collaborated with Mexican colleagues at CICESE, Canadian colleagues at the DFO Pacific Biological Station in Nanaimo, British Columbia, and the TOPP program (www.topp.org).

In 2001 NOAA Fisheries and American Fishermen's Research Foundation began a five-year program to use archival tagging technology to determine detailed migration patterns of juvenile (3-5 year old) albacore in the North Pacific Ocean. The overall objective of the project is to understand north Pacific albacore movements well enough to be able to use the information effectively in stock assessment modeling or for management purposes. The archival tags are implanted in the abdominal cavity and can record internal temperature, ambient seawater temperature, depth (pressure), and location (using detailed light level data recorded on the tag). In 2011, NOAA Fisheries scientists published a manuscript describing the migration and behavior details of juvenile albacore from the tagging project (Childers et al., 2011). Two tagging trips were conducted in 2012, and as of June 2013 more than 800 archival tags had been deployed on albacore off the west coast of North America. Twenty six tags have been recovered, resulting in a plethora of sample data on temperature and depth along with daily location estimates. Two tagged albacore were recently recaptured near Japan and returned to us with assistance from NRIFSF staff. The data will provide information on their trans-Pacific movements. Prior to these two, only one of the first 23 recaptured albacore had migrated into the western Pacific.

In 2012, a number of other HMS were tagged with satellite tags: five shortfin mako sharks, five blue sharks, and one common thresher were tagged with either PTT tags or towed GPS tags. Three mako sharks, two blue sharks, and six opah were released with PSATs. In addition, five mako sharks were released with acoustic tracking tags to monitor their movements within the vicinity of coastal acoustic receivers. The average size of blue sharks tagged with a PTT in 2012 was 229 cm fork length (FL). Two of the five blue sharks were tracked for close to 200 days. Combined data from many years suggest that both sexes spend considerable time in the California Current, with the females possibly extending farther north and south. When offshore, generally, the females move south into the subtropical convergence zone, whereas the males make more westerly migrations. Both habitat separation by sex, and site fidelity have implications for the assessment and management of blue shark populations. Three PTT tags deployed in July 2012 on mako sharks were still transmitting in early 2013.

Incidental Catch of Opah during Surveys and in Fisheries off California
From 2009 to 2012 a total of 67 opah (*Lampris* spp.) were caught during the cruises associated with the NOAA Fisheries' annual Juvenile Shark Abundance Survey. In contrast, only one opah was caught in the 19 years of the survey prior to 2009. An increase in opah catch in California commercial fisheries has also been seen over the past decade and is likely influenced by many factors including fishing methods and environmental variability. NOAA Fisheries will continue to analyze the variability in survey catch and examine opah catch using logbooks from the California drift gillnet fishery and recreational sportfishing efforts. Additional research efforts will focus on the impacts of environmental variability, and how opah catch rates are influenced by El-Niño Southern Oscillation (ENSO) events.

Opah Foraging Ecology
To characterize the foraging ecology of opah in the California Current NOAA Fisheries has been collecting opah stomachs since 2009; a total of 68 stomachs have been collected to date. Sampled fish ranged from 72 cm to 126 cm FL with a mean of 98 cm FL. Stomach contents included species of squid and fish typically associated with mesopelagic waters. Thirteen species of cephalopods have been identified with three (*Loligo opalescens, Gonatus* spp., *Dosidicus gigas*) making up the most important prey items based on the IRI (index of relative importance). Squid ranged from 30 mm (*Gonatus* spp.) to over 266 mm mantle length (*Dosidicus gigas*). In addition, a few stomachs were dominated by epipelagic fish including Pacific saury (*Cololabis saira*). Interestingly, 30% of stomachs contained either small pieces of kelp or plastic. Regional diet differences comparing central and southern California are also being examined. Based on the data collected to date, opah appear to feed primarily on species associated with the deep scattering layer (DSL). This is consistent with their diel migrations that are similar to those of swordfish that also feed on the DSL. Comparing diets between opah, tunas and swordfish from the Southern California Bight suggests greater niche overlap between opah and swordfish than

between opah and tunas. Considering opah are often caught in association with tunas, differences in their diets could reflect habitat partitioning.

Gill Morphology and Regional Heterothermy

NOAA Fisheries has begun to examine opah gills preserved in 10% formalin in order to determine gill surface area and associated dimensions which allows for insights into both the metabolic requirements and dissolved oxygen concentrations experienced by this species. In addition to a number of morphometric similarities with other pelagic fishes, opah gills show extensive fusion of the gill filaments, a characteristic previously documented only in high-performance teleosts (tunas of the genus *Thunnus*, the wahoo, *Acanthocybium solandri,* and billfishes). The occurrence of filament fusions in opah suggests a role other than that proposed for the high-performance fishes, which use gill fusions to maintain optimal gill orientation and reduce branchial flow rates during ram ventilation. Opah are not thought to be obligate ram ventilators, but like tunas are active predators.

Opah collected during the 2012 shark survey and a deep-set longline cruise were examined to determine blood properties, gill structure, and the ability to retain internal body heat. Pectoral muscle temperatures that were significantly elevated above ambient were recorded for freshly decked opah and for fish outfitted with intramuscular temperature loggers swimming at depth. Morphological work revealed *retia mirabilia* in the gills of the opah that appear to function as countercurrent heat exchangers to conserve heat derived from the pectoral muscles. The unique placement of these countercurrent exchangers potentially allows for warm blood to be distributed throughout the body. In addition to the pectoral muscle, temperatures in the heart, gut, and cranial region are all significantly elevated above ambient allowing for increased function at cold temperatures. Along with their large gill surface area these adaptations allow opah to maintain warm body temperatures and survive in low dissolved oxygen environments.

Microchemistry Analysis of Albacore Otoliths

Since 2011, otolith chemistry has been used to investigate whether there are two substocks of albacore that utilize the waters of the California Current. Based on differences in growth rates and movement patterns, it is hypothesized that albacore caught in southern California and Mexico waters comprise a separate substock from those caught on the commercial fishing grounds off Oregon and Washington with relatively little mixing during their subadult years. Preliminary analyses show that significant differences exist in otolith chemistry from fish aged 2-4 collected between the two regions. Overall cross-validated classification success was 100%, with age-specific comparisons exceeding 90% success. Otolith $\delta^{18}O$ was significantly enriched in the southern region relative to the northern region, similar to reported seawater $\delta^{18}O$ differences. In addition, significantly higher concentrations of sodium and magnesium, combined with lower phosphorus concentrations in otoliths from fish collected in the southern region, are consistent with regional physicochemical conditions (i.e., salinity, temperature, phosphate). These preliminary findings support previous studies that have shown limited regional mixing of albacore in the EPO.

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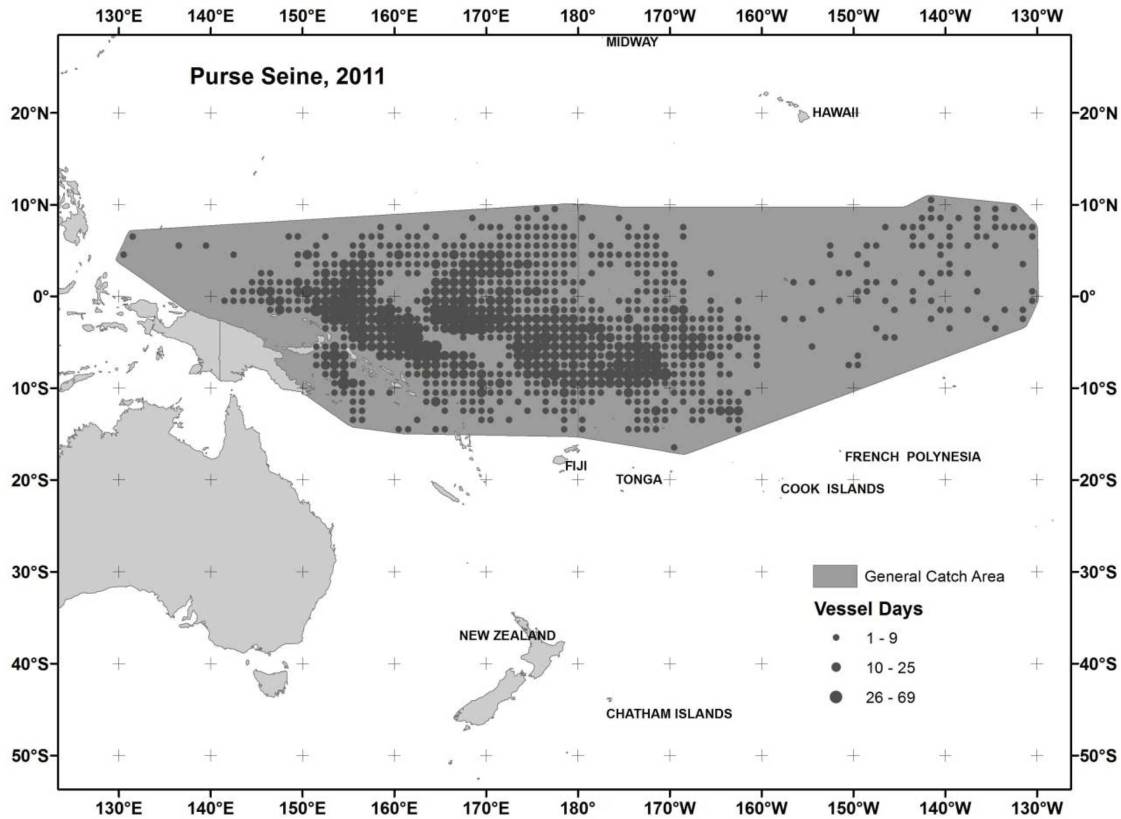


Figure 1. Spatial distribution of reported logbook fishing effort by the U.S.A. western Pacific Ocean purse seine fishery in vessel-days, in 2011 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

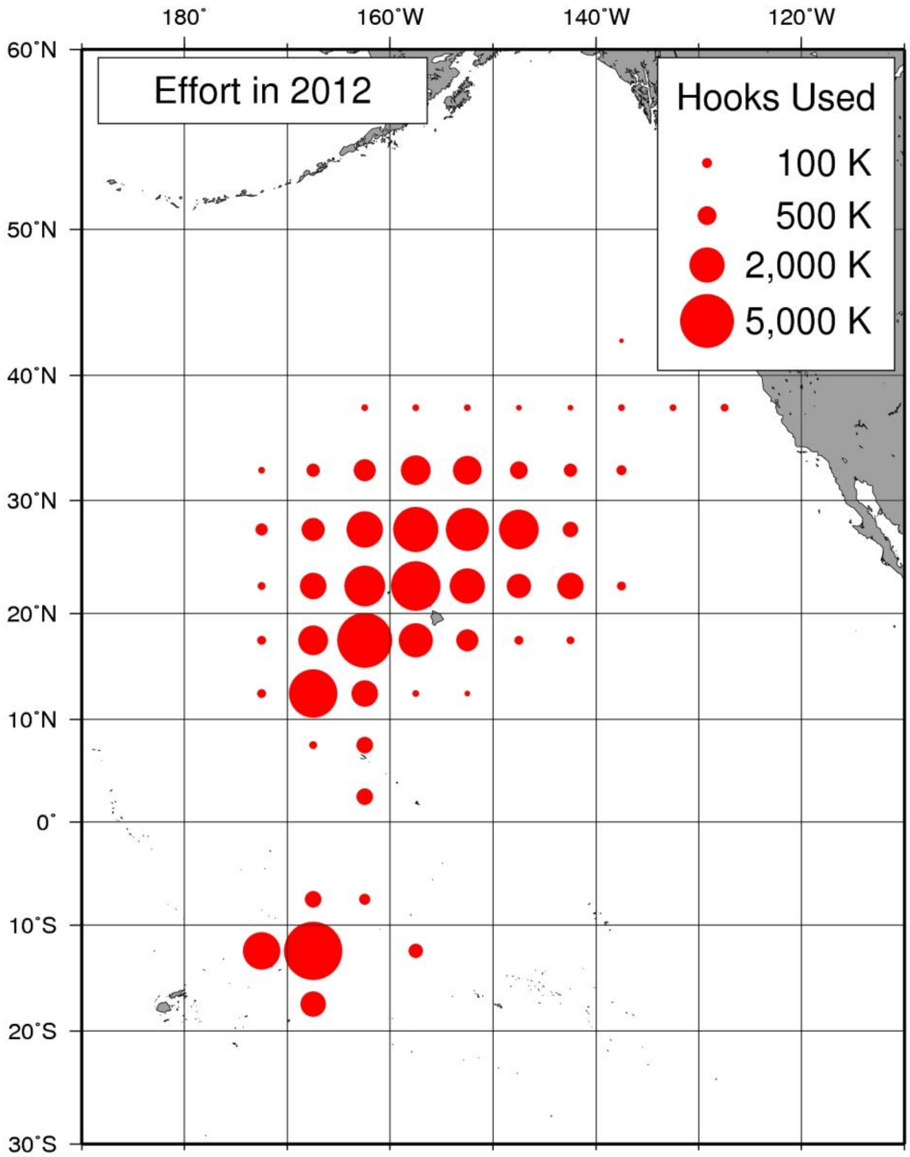


Figure 2. Spatial distribution of reported logbook fishing effort by the U.S.A. longline fishery in 1,000s of hooks, in 2012 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

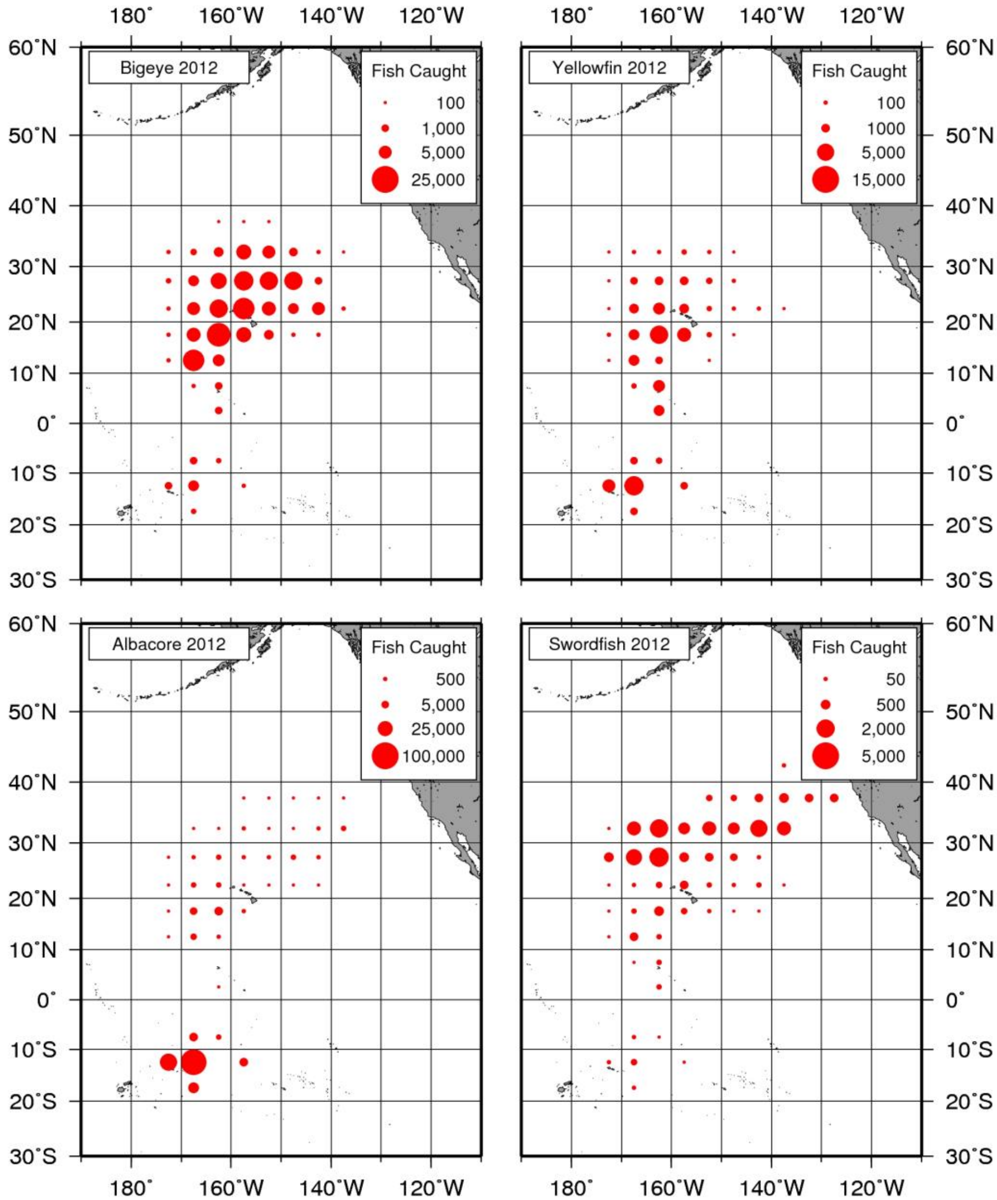


Figure 3. Spatial distribution of reported logbook fishing catch by the U.S.A. longline fishery in numbers of fish, in 2012 (provisional data). Area of circles is proportional to catch. Catch in some areas is not shown in order to preserve data confidentiality.

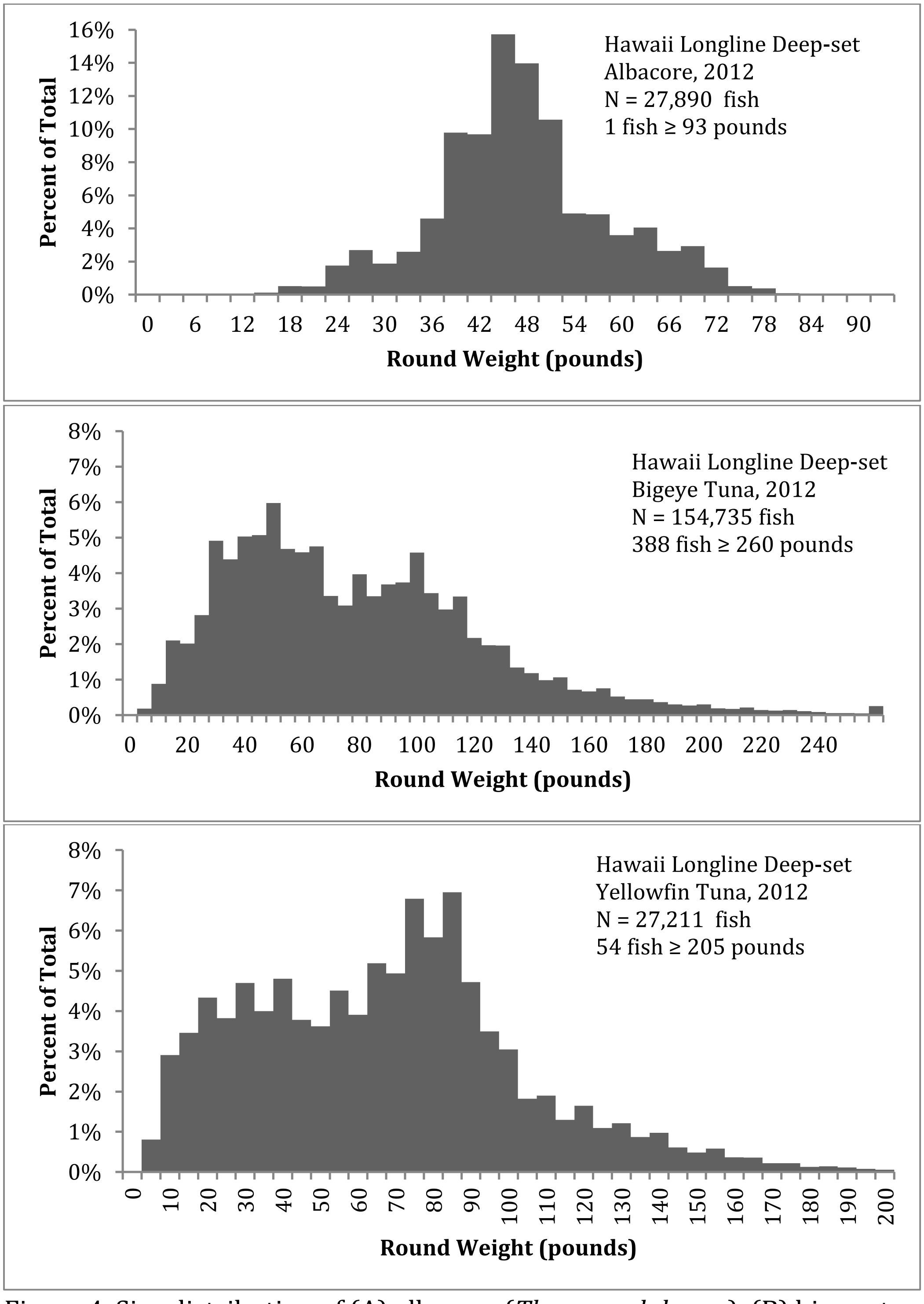


Figure 4. Size distribution of (A) albacore (*Thunnus alalunga*), (B) bigeye tuna (*Thunnus obesus*), and (C) yellowfin tuna (*Thunnas albacares*) caught by the Hawaii-based deep-set longline fishery in the North Pacific Ocean, 2012.

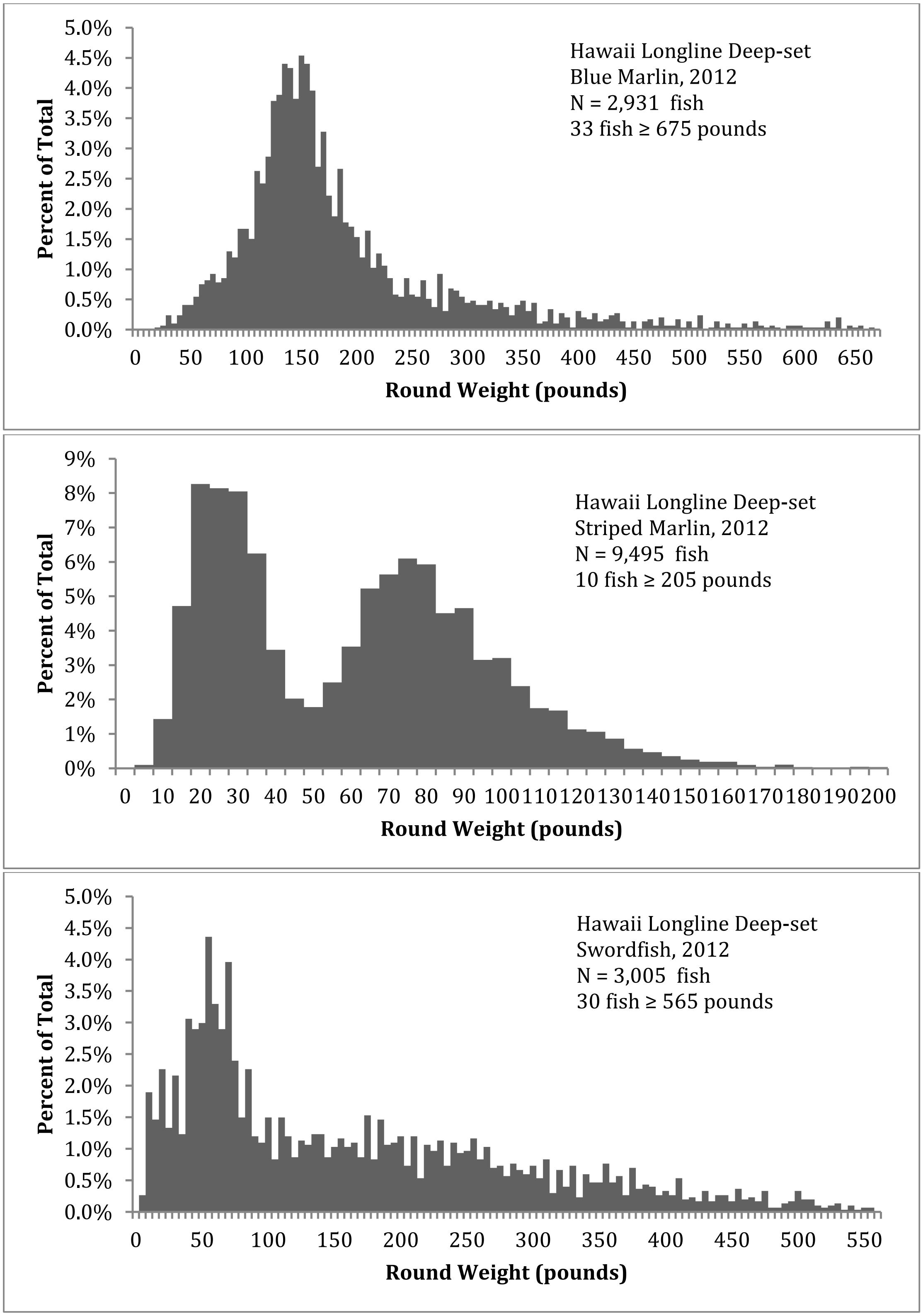
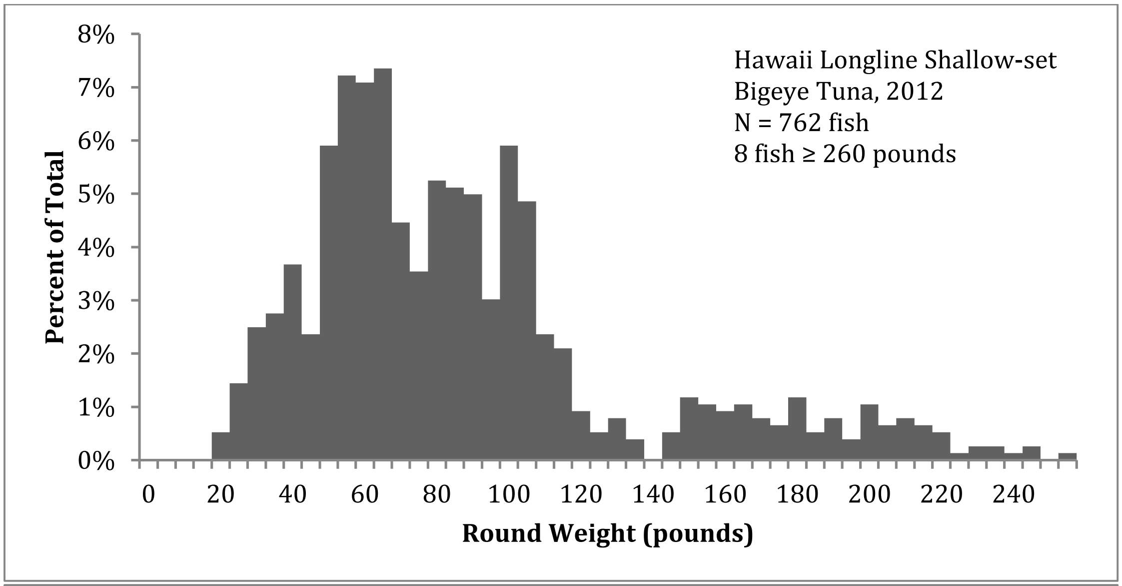


Figure 5. Size distribution of (A) blue marlin (*Makaira mazara*), (B) striped marlin (*Tetrapturus audax*), and (C) swordfish (*Xiphias gladius*) catch by the Hawaii-based deep-set longline fishery in the North Pacific Ocean, 2012.



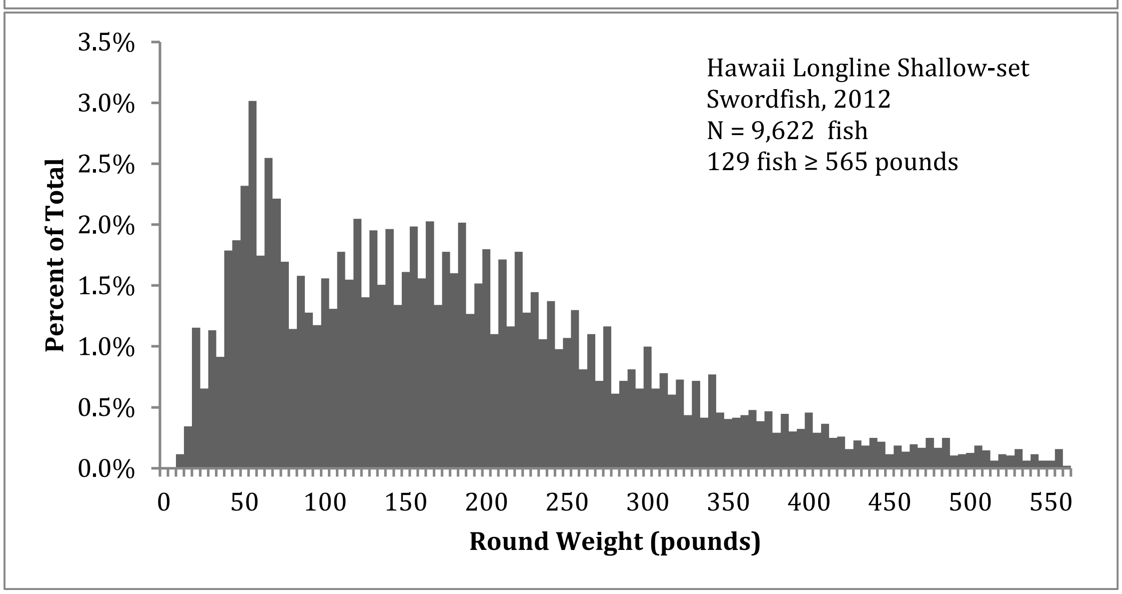


Figure 6. Size distribution of (A) bigeye tuna (*Thunnus obesus*), and (B) swordfish (*Xiphias gladius*) caught by the Hawaii-based shallow-set longline fishery in the North Pacific Ocean, 2012.

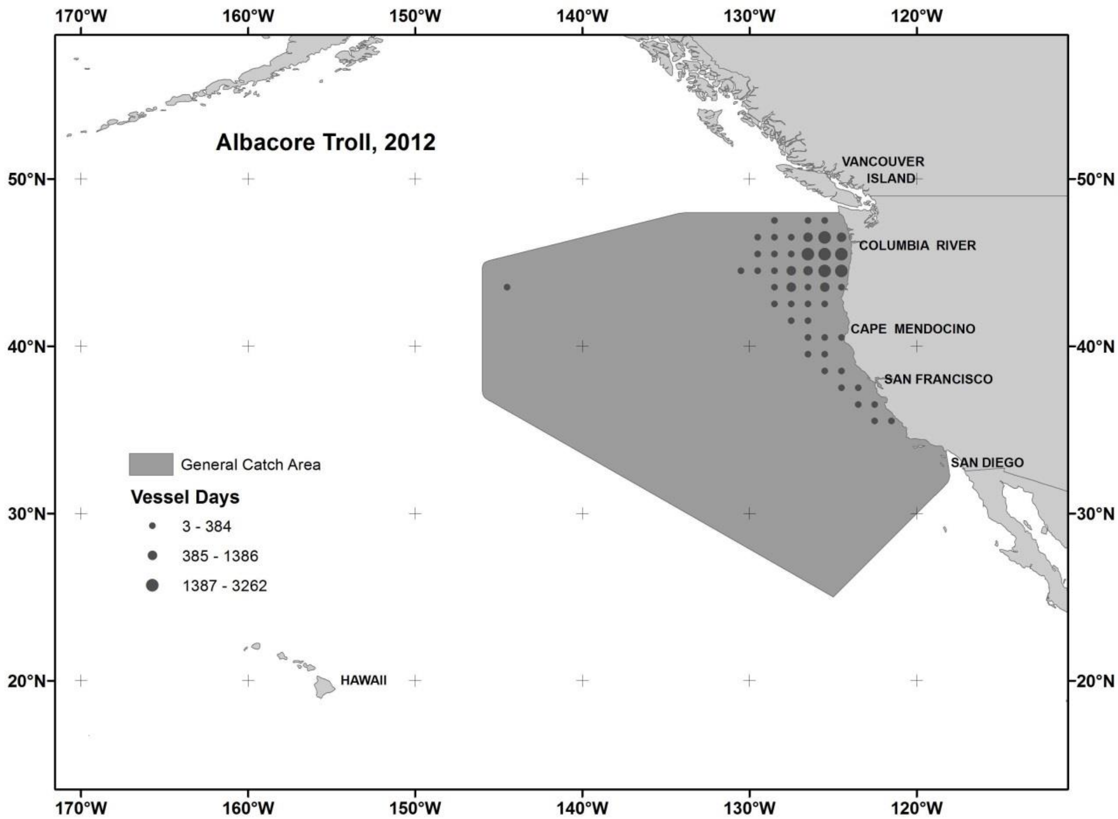


Figure 7. Spatial distribution of reported logbook fishing effort by the U.S.A. albacore (*Thunnus alalunga*) troll and pole-and-line fishery in vessel days in 2012 (provisional data). Area of circles is proportional to effort. Effort in some areas is not shown in order to preserve data confidentiality.

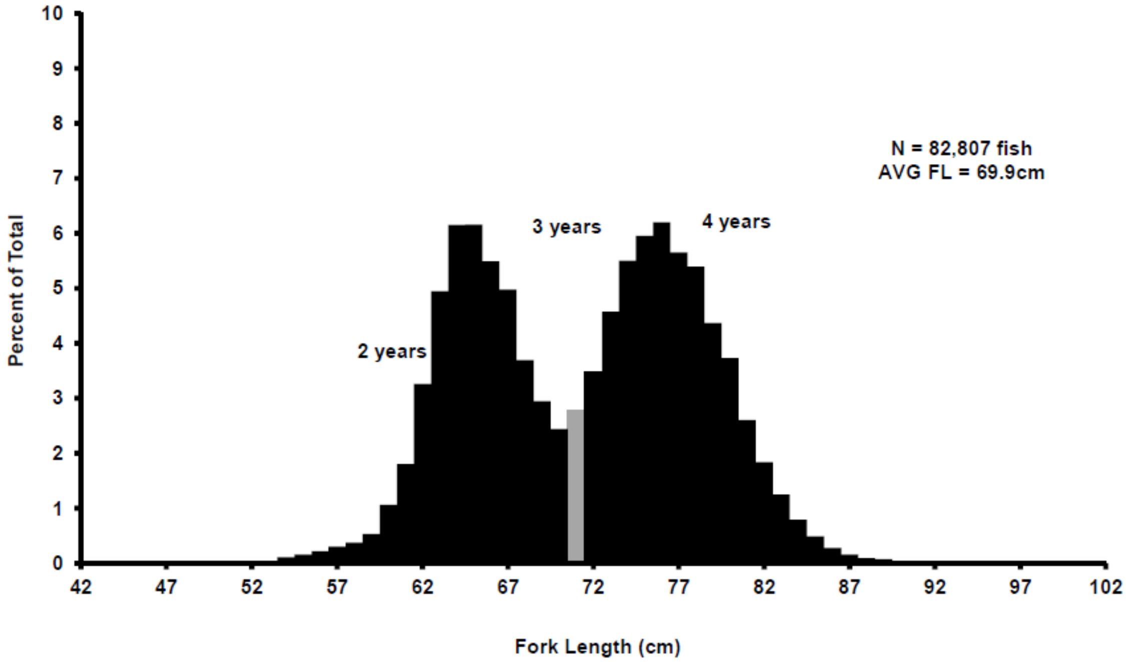


Figure 8. Size distribution of albacore catch by the U.S.A. north Pacific albacore (*Thunnus alalunga*) troll and pole-and-line fishery in 2012.

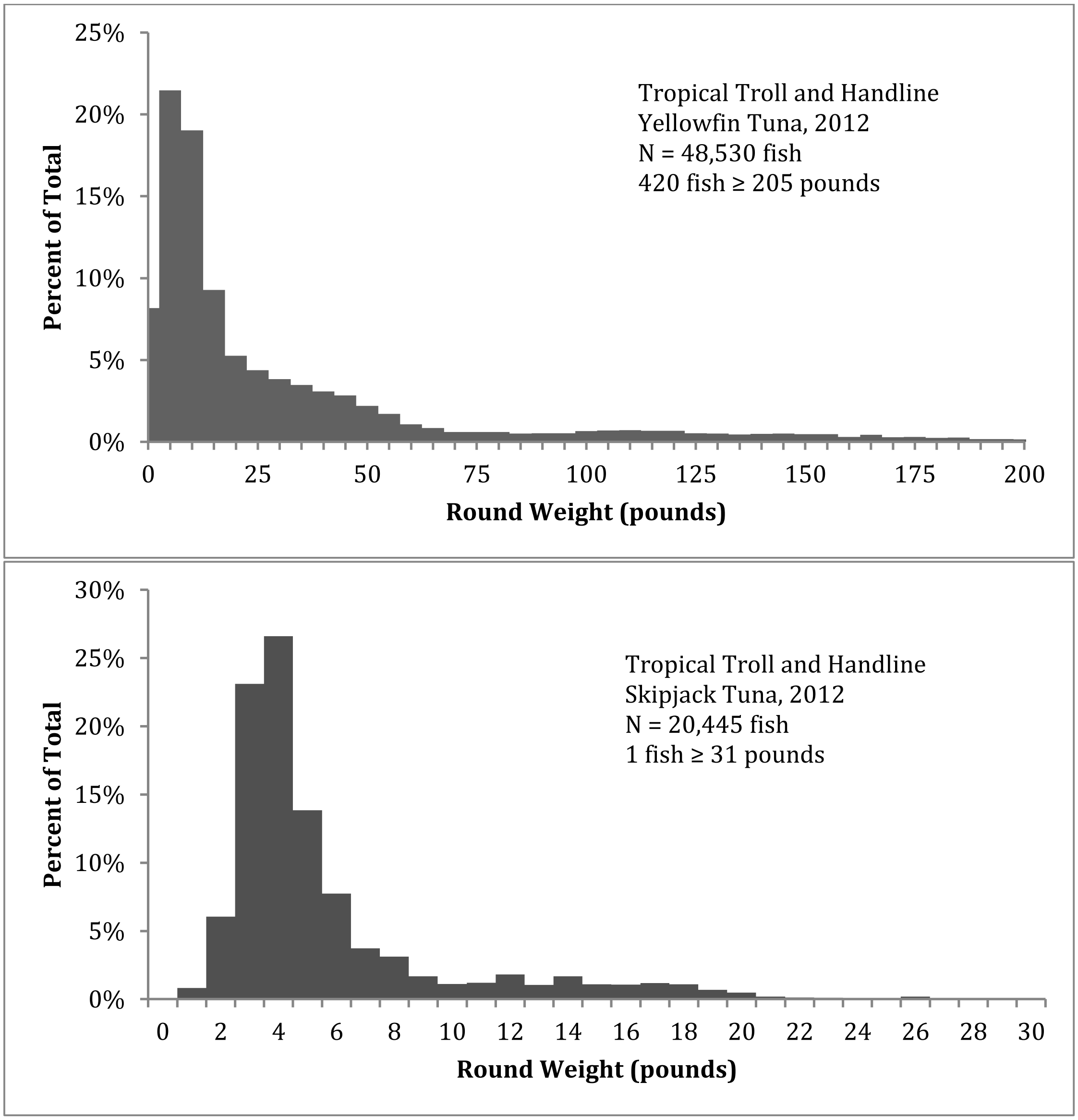
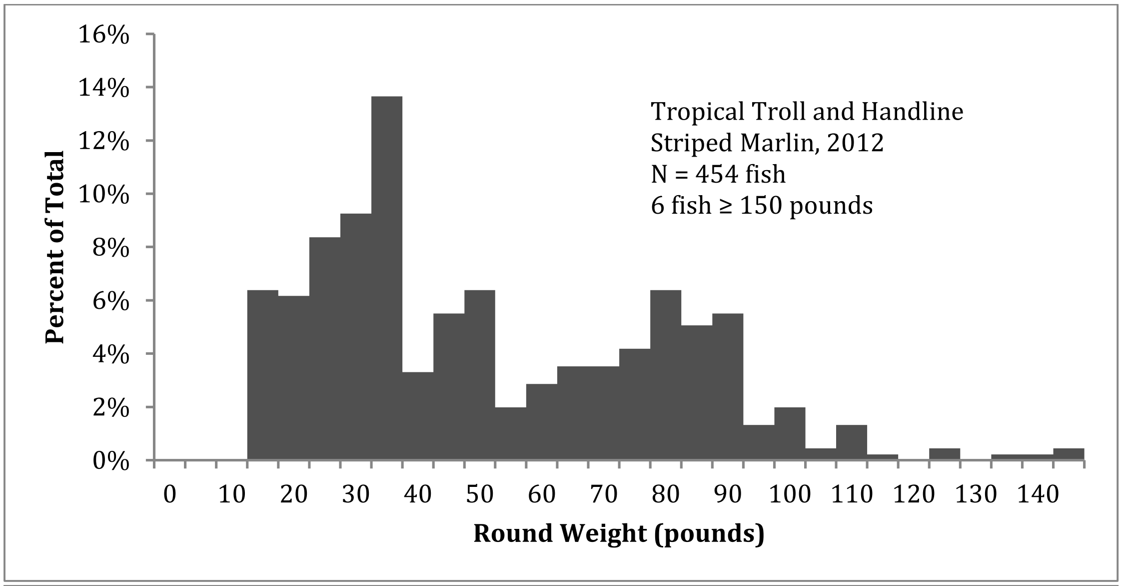


Figure 9. Size distribution of (A) yellowfin tuna (*Thunnus albacares*) and (B) skipjack tuna (*Katsuwonus pelamis*) catch by the Hawaii tropical troll and handline fishery, 2012.



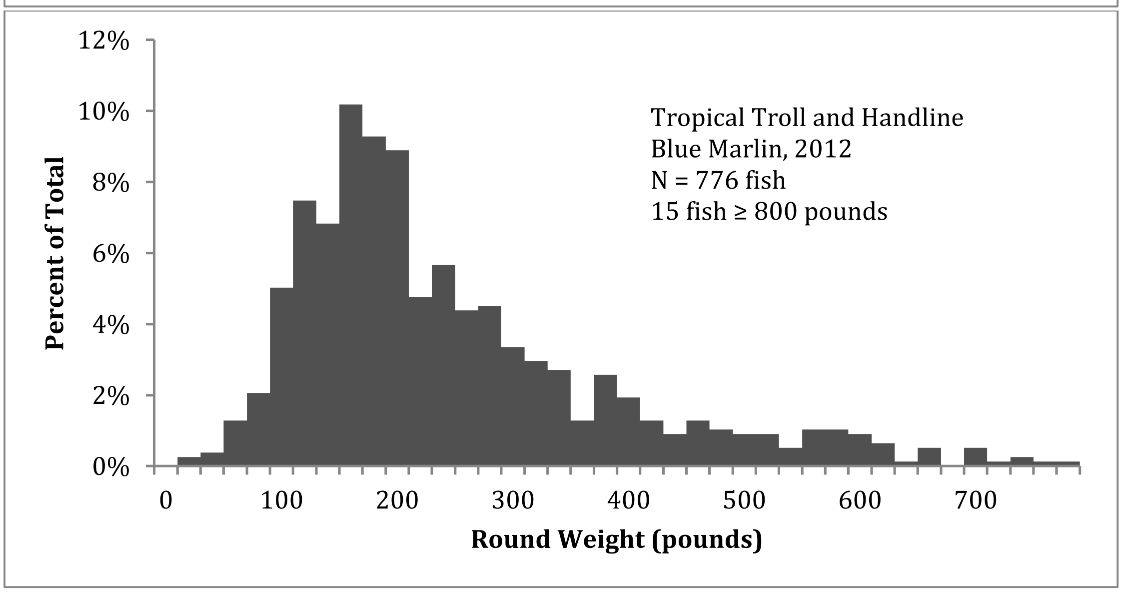


Figure 10. Size distribution of (A) striped marlin (*Tetrapturus audax*) and (B) blue marlin*(Makaira mazara*) catch by the Hawaii tropical troll and handline fishery, 2012.

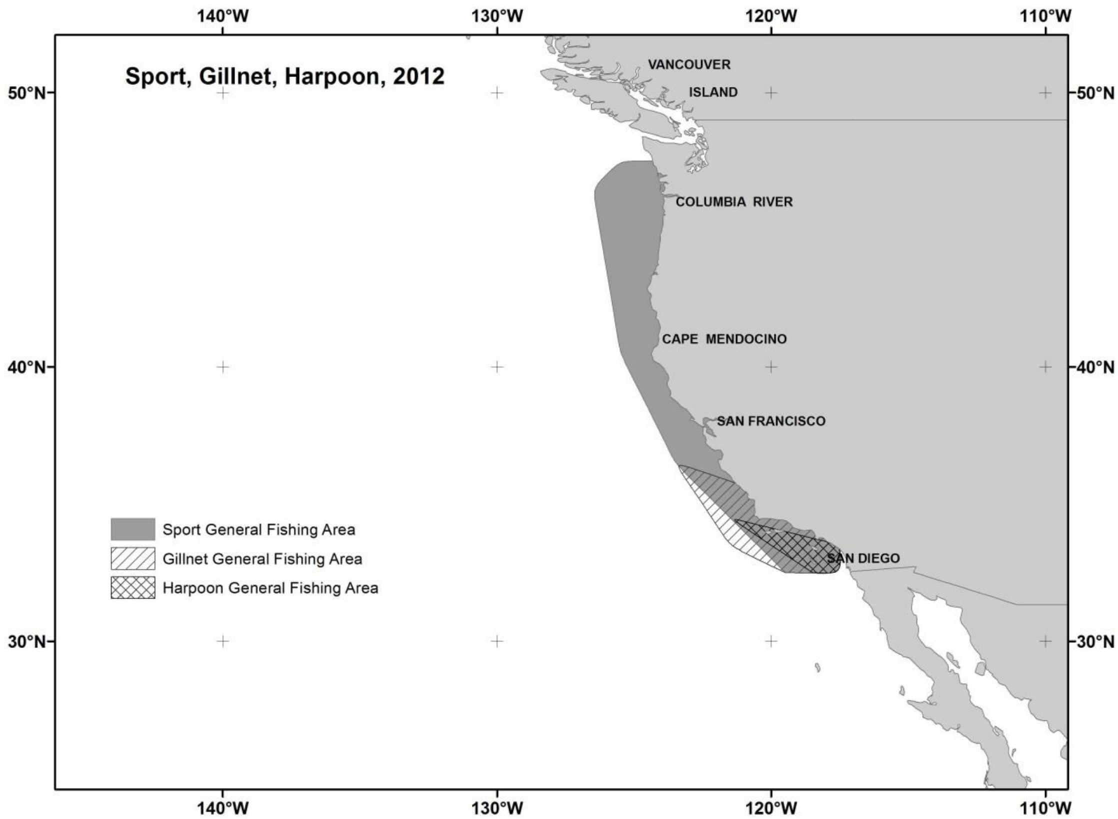


Figure 11. Spatial extent of reported logbook fishing effort by U.S.A. West Coast sport fleet, the U.S.A. pelagic drift gillnet fishery, and the U.S.A. harpoon fishery in the North Pacific Ocean in 2012 (provisional data).

Table 1. Number of vessels fishing in the North Pacific Ocean in various U.S.A. fisheries. Data for 2012 are preliminary[1.] -- indicates data are not available.

Year	Purse Seine[2]	Longline	Albacore Troll and Pole-and-Line	Tropical Pole and Line	Tropical Troll[3]	Tropical Handline	Gillnet	Harpoon	Sport[4]	Other
1985	53	36	792	27			210	99	127	331
1986	51	39	419	19			220	113	101	296
1987	47	37	486	18	1,899		210	98	96	265
1988	74	50	531	17	1,878		192	83	81	239
1989	73	88	338	18	2,002		158	44	106	174
1990	71	138	368	12	2,042		146	49	117	200
1991	59	141	172	12	2,117		123	32	86	163
1992	72	124	602	11	2,160		113	48	126	172
1993	68	122	608	13	2,132		105	44	103	190
1994	72	127	721	11	2,210		112	49	88	139
1995	65	116	471	11	2,387		127	39	136	129
1996	61	114	676	9	2,411		100	30	132	112
1997	68	117	1,172	9	2,400		104	31	206	178
1998	68	122	841	9	2,370		87	26	202	185
1999	42	140	776	9	2,502		78	30	200	154
2000	40	130	645	7	2,229		77	26	206	164
2001	43	125	860	9	2,208		64	23	220	140
2002	31	123	644	13	2,045		45	29	175	94
2003	29	128	729	14	1,960		37	34	214	120
2004	28	126	695	11	2,012		33	29	184	90
2005	23	126	541	10	1,917		37	24	186	76
2006	11	128	601	11	1,916		45	24	200	91
2007	22	130	676	3	1,869	424	49	28	197	78
2008	36	130	525	3	1,978	475	51	32	169	70
2009	41	128	686	6	2,083	552	61	28	200	82
2010	37	125	657	2	2,042	480	53	26	145	77
2011	39	129	687	2	2,100	508	22	17	165	86
2012	40	129	820	1	2,080	572	17	9	--	102

[1] Estimations of west coast vessels targeting ISC species is currently under revision.
[2] Number of Purse Seine vessels are counts of unique vessels from EPO and WCPO fisheries in the North Pacific Ocean
[3] Number of tropical troll vessels for 1987-2006 include tropical handline vessels
[4] Number of sport vessels targeting HMS for 1985-2004 are from CDFW CPFV database. Estimates for 2005-2011 include charter vessels from Washington and Oregon.

Table 2. U.S.A. catches (metric tons) of tunas and tuna-like species (FAO codes) by fishery in the North Pacific Ocean, north of the equator. Data for 2012 are preliminary. Species codes: ALB = albacore, YFT = yellowfin tuna, SKJ = skipjack tuna, BET = bigeye tuna, PBF = Pacific bluefin tuna, SWO = swordfish, BUM = blue marlin, MLS = striped marlin, BIL = other billfish, TUN = other tunas, ALV = common thresher shark, PTH = pelagic thresher shark, BTH = bigeye thresher shark, SMA = shortfin mako shark, BSH = blue shark, SKH = other sharks . Zeros indicate less than 0.5 metric tons. -- indicates data are not available.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	SWO	BUM	MLS	BIL	TUN	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Purse Seine [1]																	
1985	26	92,623	47,634	1,751	3,320												145,354
1986	47	102,736	52,817	264	4,851												160,715
1987	1	123,044	48,667	222	861												172,795
1988	17	88,302	78,250	1,120	923												168,612
1989	1	77,744	35,671	516	1,046												114,978
1990	71	63,722	53,213	674	1,380												119,060
1991		26,789	50,107	415	410												77,721
1992		29,668	74,234	3,709	1,928												109,539
1993		23,805	60,485	3,035	580												87,905
1994		10,516	30,183	2,472	906												44,077
1995		16,934	60,036	5,803	657												83,430
1996	11	6,653	20,646	6,884	4,639												38,833
1997	2	20,866	37,525	8,702	2,240												69,335
1998	33	20,831	25,258	3,645	1,771												51,538
1999	48	4,989	18,710	3,236	184												27,167
2000	4	1,670	5,508	454	693												8,329
2001	51	5,362	17,794	1,122	292												24,621
2002	4	6,612	4,002	580	50												11,248
2003	44	3,562	21,212	3,528	22												28,368
2004	1	3,810	6,860	1,437													12,108
2005		6,792	19,171	3,992	201												30,156
2006		1,112	5,075	1,492													7,679
2007	77	1,112	5,075	1,492	42												7,797
2008	--	2,725	11,045	555													14,325
2009	39	3,694	14,378	512	410												19,033
2010	--	7,136	41,523	1,557		0	1	1	15	--	--	--	--	--	--	34	50,267
2011	--	3,996	30,348	1,893		0	6	0	10	65	--	--	--	0	--	30	36,348
2012	5	5,837	42,479	1,038													49,359
Longline [2]																	
1985						2											2
1986						2											2
1987	150	261	1	815		24	51	272	45								1,619
1988	307	594	4	1,239		24	102	504	68								2,842
1989	248	986	10	1,442		218	356	612	132								4,004
1990	177	1,098	5	1,514		2,437	378	538	58								6,205
1991	312	733	30	1,555	2	4,535	297	663	69								8,196
1992	334	346	22	1,486	38	5,762	347	459	142								8,936
1993	438	633	36	2,124	42	5,936	339	471	100								10,119
1994	544	610	53	1,827	30	3,807	362	326	99	5							7,663
1995	882	984	101	2,099	29	2,981	570	543	182								8,371
1996	1,185	634	41	1,846	25	2,848	467	418	115	2							7,581
1997	1,653	1,143	106	2,526	26	3,393	487	352	143	2							9,831
1998	1,120	724	76	3,274	54	3,681	395	378	172	9							9,883
1999	1,542	477	99	2,820	54	4,329	357	364	242	10							10,294
2000	940	1,137	93	2,708	19	4,834	314	200	152								10,397
2001	1,295	1,029	211	2,418	6	1,969	399	351	136								7,814
2002	525	572	127	4,396	2	1,524	264	226	160								7,796
2003	524	809	207	3,618	1	1,958	363	538	248								8,266
2004	361	715	142	4,339	1	1,185	283	376	200	9							7,611
2005	296	712	91	4,999	1	1,622	337	511	216								8,785
2006	270	958	94	4,466	1	1,211	409	611	174								8,194
2007	250	844	93	5,822	0	1,735	262	276	160	0	44			128	8	7	9,629
2008	354	875	120	5,959	0	2,014	349	427	238	0	41			133	7	4	10,521
2009	203	527	136	4,628	1	1,817	360	258	124	0	30			120	9	6	8,219
2010	421	568	153	5,440	0	1,676	306	165	131	0	18			94	7	3	8,982
2011	708	937	207	5,701	0	1,623	373	362	249	0	19			68	13	2	10,262
2012	659	885	245	5,854		1,418	297	282	173		14			68	16	2	9,913

Table 2.
Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	SWO	BUM	MLS	BIL	TUN	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Albacore Troll and Pole-and-Line																	
1985	6,415	5															6,420
1986	4,708	1															4,709
1987	2,766	76															2,842
1988	4,212	7															4,219
1989	1,860	1															1,861
1990	2,718																2,718
1991	1,845																1,845
1992	4,572																4,572
1993	6,254	137	62							1							6,454
1994	10,978	769	352														12,099
1995	8,125	211	1,157														9,493
1996	16,962	606	393		2												17,963
1997	14,325	4	2		1												14,332
1998	14,489	1,246	2		128												15,865
1999	10,120	52	16		20												10,208
2000	9,714	3	4		1					1							9,723
2001	11,349	1	1		6												11,357
2002	10,768				1												10,769
2003	14,161		2														14,163
2004	13,473	1															13,474
2005	8,479																8,479
2006	12,547																12,547
2007	11,908																11,908
2008	11,761																11,761
2009	12,938																12,938
2010	12,634																12,634
2011	11,037																11,037
2012	14,137		0		0												14,137
Tropical Pole-and-Line																	
1985		472	1,328														1,800
1986		554	1,367							1							1,922
1987		1,861	2,087														3,948
1988		1,140	3,450	5													4,595
1989		1,318	2,456							3							3,777
1990		154	553							2							709
1991		942	1,840														2,782
1992		1,928	1,744							2							3,674
1993		2,636	2,850							5							5,491
1994		1,844	2,422							18							4,284
1995		394	2,393														2,787
1996		696	1,331							1							2,028
1997		468	1,755														2,223
1998		2,206	1,067														3,273
1999		57	601	4													662
2000		3	320	1													324
2001		4	448														452
2002		2	420							2							424
2003		35	587							4							626
2004		18	279						1								298
2005		68	353							1							422
2006		4	294							3							301
2007		23	272							1							296
2008		23	293							4							320
2009		17	214							1							232
2010																	-
2011																	-
2012																	-

Table 2.
Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	SWO	BUM	MLS	BIL	TUN	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Tropical Troll [3]																	
1985	7	967	101	8			145	18	12	2							1,260
1986	5	1,493	120	5			220	19	14	4							1,880
1987	6	1,616	137	8			261	29	20	11							2,088
1988	9	941	172	17			266	54	20	11							1,490
1989	36	828	153	14			326	24	23	11							1,415
1990	15	891	138	25			295	27	17	11							1,419
1991	72	802	237	25			346	41	25	9							1,557
1992	54	602	167	13			260	37	17	10							1,160
1993	71	861	157	3			311	67	20	6							1,496
1994	90	870	138	7			298	35	22	8							1,468
1995	177	978	152	20			315	52	29	7							1,730
1996	188	934	224	7			409	53	18	5							1,838
1997	133	770	196	26			378	37	17	4							1,561
1998	88	766	143	9			242	26	19	6							1,299
1999	331	1,019	181	24			293	27	33	4							1,912
2000	120	1,080	415	207			235	15	20	15							2,107
2001	194	878	523	226			291	44	32	13							2,201
2002	235	632	355	586			225	30	13	6							2,082
2003	85	735	268	213			210	29	18	25							1,583
2004	157	746	251	381			188	31	23	45							1,822
2005	175	679	259	295			187	20	15	14							1,644
2006	95	508	296	303			160	21	14	12							1,409
2007	3	501	266	63		1	127	13	12	8							994
2008	1	451	481	74			198	14	14	7							1,240
2009	3	471	412	59		0	15	10	8	12							990
2010	2	426	416	118			148	19	12	25						1	1,167
2011	4	496	385	110			199	16	18	16						1	1,245
2012	3	698	392	170		1	152	12	17	18						1	1,464
Tropical Handline																	
1985						4											4
1986						4											4
1987						4		1									5
1988						6											6
1989						7		0									7
1990						5		0									5
1991						6		0									6
1992						1		1									2
1993						4		1									5
1994						4		0									4
1995						6		0									6
1996						5		1									6
1997						7		1									8
1998						7		0									7
1999						9		1									10
2000																	-
2001																	-
2002								0									-
2003						10		0									10
2004						7		2									9
2005						5		0									5
2006						4		0									4
2007	94	254	7	324		5	1			1							686
2008	28	227	9	148		6	1			1							420
2009	97	317	11	136		5	1			3							570
2010	53	265	7	340		3	2			4	1			1			676
2011	84	357	9	296		5	2			1							754
2012	277	405	12	310		7	2			1	2			1			1,017

Table 2.
Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	SWO	BUM	MLS	BIL	TUN	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Gillnet																	
1985	2	12		2	8	2,990					856	0	90	129	0		4,089
1986	3	14		3	16	2,069				4	455	0	34	250	1		2,849
1987	5	3		6	2	1,529				5	354	2	18	208	1		2,133
1988	15	7		5	4	1,376				2	352	1	7	106	0		1,875
1989	4	1	5		3	1,243				3	430	0	16	117			1,822
1990	29	1	1	1	11	1,131				2	266	1	30	229	0		1,702
1991	17	1	3	3	4	944				3	542		31	125	0		1,673
1992		4	1	1	9	1,356				6	256	0	18	118	1		1,770
1993		7	2		32	1,412				9	243	1	41	87	0		1,834
1994	38				28	792				2	292	0	32	80	0		1,264
1995	52	2	70	1	20	771				1	234	5	30	79	0		1,265
1996	83	2	2		43	761					298	1	20	85	0		1,295
1997	60	3	2	5	58	708					291	35	29	118	0		1,309
1998	80	2	3	4	40	931				2	332	2	11	85	0		1,492
1999	149			2	22	606				1	285	10	5	52	0		1,132
2000	55	1		2	30	649					252	3	4	64	0		1,060
2001	94	5	1		35	375					319	1	1	30			861
2002	30	1			7	302					271	2		69			682
2003	16		9	6	14	216					280	4	6	57	0		608
2004	12	1			10	182					94	2	5	38			344
2005	20	2			5	220					167	0	10	25			449
2006	3	1	2		1	443				1	132	0	4	38			625
2007	4	0	0		2	490					184	2	5	37	9		733
2008	1	0	0		1	405					128		6	27			568
2009	4	1	0		4	251					81		7	25	1		374
2010	5				1	61					69		1	17	0		154
2011	5		0		19	118					54	0	1	8			205
2012	8		1		4	97					37			8		1	154
Harpoon																	
1985						305					0			1			306
1986						291							0	1			292
1987						235							0	3			238
1988						198					0			3			201
1989						62								1			63
1990						64					0			3			67
1991						20					0			1			21
1992						75					0			3			78
1993						168								1			169
1994						157					0			1			158
1995						97					0			1			98
1996						81					0			1			82
1997						84								3			87
1998						48					0		0	1			49
1999						81								0			81
2000						90								0			90
2001						52								1			53
2002						90					0			0			90
2003						107								0			107
2004						69								1			70
2005						77								1			78
2006						71					2			0			73
2007						59								0			59
2008						48								1			49
2009						50					0			1			51
2010						37					0			0			37
2011						24					0			0			24
2012						5					0			0			5

Table 2.
Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	SWO	BUM	MLS	BIL	TUN	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Sport																	
1985	1,176				89			42									1,307
1986	196				12			19									227
1987	74				34			28									136
1988	64				6			30									100
1989	160				112			52									324
1990	24				65			23									112
1991	6				92			12									110
1992	2				110			25									137
1993	25				298			11									334
1994	106				89			17									212
1995	102				258			14									374
1996	88				40			20									148
1997	1,018				156			21									1,195
1998	1,208				413			23									1,644
1999	3,621				441			12									4,074
2000	1,798				342			10									2,150
2001	1,635				356			0									1,991
2002	2,357				654			0									3,011
2003	2,214				394			0									2,608
2004	1,506				49			0									1,555
2005	1,719				79			0									1,798
2006	385				96			0									481
2007	461				14			0									475
2008	418				93												511
2009	677				176												853
2010	704				122												826
2011	424				499												923
2012	902				617												1,519
Other [4]																	
1985	118	58	5	1	20	104				468	332		5	19	1		1,131
1986	66	227		6	41	109				6	93		14	59	1		622
1987	139	2,159	633	1	18	31				67	116		1	188	1		3,354
1988	76	936	372	1	46	64				2	67		2	214	3		1,783
1989	10	849	103		18	56					65		1	137	6		1,245
1990	20	508	147		81	43				1	90		0	141	20		1,051
1991	20	235	137		0	44					42		0	91	1		570
1992	40	1,119	1,014		14	47				2	35		3	19	1		2,294
1993	194	2,031	2,279		29	161					25		2	32	0		4,753
1994	66	3			1	24					37		4	46	12		193
1995	4	5	263		0	29					34		1	14	5		355
1996	10			4	0	15					21		0	9	0		59
1997	12		83		48	11					27	0	3	11	0		195
1998	15	43			59	19				1	22	0	0	12	1		172
1999	61				88	27					32	1	0	9	0		218
2000	24	1			11	33					44	0	0	12	0		125
2001	39				1	19					40	1	0	10	0		110
2002	13	27	1		2	3	1			1	30			12	0		90
2003	8	8	2	3	3	11					21		0	9	0		65
2004	3	27	2	132	0	44	5				21		0	13	0		247
2005	1				1	5					11	0		8	0		26
2006	0	349	12		0	5					24	0	0	7	0		397
2007	0	0	0		0						20	0	0	6	0		26
2008	0	2	0	5	0	19					19	0	0	5			50
2009	0	7	1		1	0					26	0		3	0		38
2010	19	0	0		0	18					26	0		3	0		66
2011	37	1	0	1	100	90					12			2	0		243
2012	6	0	0		38	0					28	1		10	0		84

[1] Purse Seine catches include EPO and WCPO fisheries, except where less than three vessels fished in the EPO. Purse seine estimates for 2010 through 2011 use calculated proportion of North Pacific Ocean catch from logbooks applied to total catches that were reported to WCPFC. For 2012, it is assumed that 19% of the catch is from north of the equator (based on 2011 estimate).

[2] Longline includes American Samoa, Hawaii, and California fisheries. Thresher and mako sharks are not recorded by species in longline but are included here under common thresher and shortfin mako, respectively.

[3] Tropical troll 1985-2006 includes tropical handline catches

[4] Other catches may include commercial and sport catches

[5] BIL catches for Tropical Troll and Longline include Black Marlin, Sailfish, Spearfish, and other billfishes