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SUMMARY

Various U.S.A. fishing fleets harvest tuna and tuna-like species in the North Pacific Ocean (NPO) from coastal waters of North America to the archipelagoes of Hawaii, Guam and the Commonwealth of the Northern Mariana Islands (CNMI) and American Samoa in the central and western Pacific Ocean (WCPO). 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. Thousands of small-scale troll and handline vessels operate in waters around the tropical Pacific Islands; however, these fleets account for only a minor fraction of the total tuna catch.

The National Oceanic and Atmospheric Administration (NOAA) Fisheries continued to conduct research in 2018 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 2018, 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 international Regional Fisheries Management Organizations (RFMOs).

NOAA Fisheries successfully completed biological and oceanographic research on tunas, billfishes, and sharks. Reported research includes: using environmental data to inform spawner-recruit dynamics, using age at length data in integrated population dynamics models, determining the status of pelagic shark populations using simple fishery indicators, environmental associations of Pacific bluefin tuna (*Thunnus orientalis*) catch, determining bias in estimates of growth, using EcoCast to avoid non-target species in catch, incorporating electronic tagging and catch data into shark habitat models, aspects of multistage recruitment functions, size compositions and sex ratios of oceanic whitetip sharks and giant manta rays for longline fisheries, and nocturnal visual census of pelagic fauna.

1. INTRODUCTION

Various U.S.A. fleets harvest tuna and tuna-like species in the North Pacific Ocean. Large-scale purse seine, albacore troll, and longline fisheries operate both in coastal waters and on the high seas. Small-scale coastal purse seine, gillnet, harpoon, troll, handline and recreational hook 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) and American Samoa in the western Pacific Ocean and from the equatorial region to the upper reaches of the North Pacific Transition Zone.

In the U.S.A., the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries or federal agency) shares monitoring responsibilities for tunas and billfishes with partner fisheries agencies in the states of California, Oregon, Washington, Hawaii, and territories of American Samoa, Guam, and the CNMI. NOAA's West Coast Regional Office (WCRO) 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 conduct federal monitoring. 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 maintained in the Pacific Fisheries Information Network (PacFIN) system (http://pacfin.psmfc.org/). Some state agencies also collect logbook and size-composition data. In the WCPO, 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) system (http:// http://www.pifsc.noaa.gov/wpacfin/), a federally funded program managed by the PIFSC. The SWFSC, WCRO, PIFSC, and PIRO share management of data on U.S.A. Pacific fisheries for tuna and tuna-like species.

This report provides information on the number of active vessels by fleet and their catches of tunas and billfishes in the NPO based on the data available through 15 March 2019. Data for 2018 are considered preliminary and are subject to change. Although the report is focused on tunas and billfishes, many of the fisheries' catch includes 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 highlights of recent and ongoing scientific work by NOAA Fisheries of relevance to the ISC.

2. FISHERIES

2.1. Purse Seine

Currently, the U.S.A. purse seine fishery consists of two separate fleets, one composed of large purse-seine vessels that operate in the WCPO, and a small coastal purse-seine fleet that operates in the eastern Pacific Ocean (EPO). Figure 1 shows the spatial distribution of the U.S.A. Western Pacific purse-seine fishery. Historically, the purse-seine fishery started in the EPO in the mid-1900s and most catch came from that ocean area 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 (SPTT) in 1987. The WCPO fleet operates mainly in areas between 10°N and 10°S latitude and 130°E and 150°W longitude, with the majority of the fishing effort south of the equator. The EPO fleet operates off the coast of Southern California. The number of unique U.S.A. purse-seine vessels (WCPO and EPO) fishing north of the equator decreased from a high of 74 in 1988 to 11 in 2006 (Table 1) then increased to 46 in 2009. In 2018, there were 46 purse seine vessels fishing in the North Pacific. 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 and other floating objects in the WCPO. The California-based EPO purse-seine fishery targets mostly small coastal pelagics, such as sardine, mackerel and squid, and targets tunas opportunistically. Larger vessels from the WCPO occasionally fish in the EPO.

The Inter-American Tropical Tuna Commission (IATTC) monitors the purse-seine fleets fishing in the EPO. U.S.A. purse-seine vessels fishing in the WCPO have been monitored by NOAA Fisheries under the SPTT 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 SPC samplers in other ports (coverage approximately 1-2% of landings). The Forum Fisheries Agency (SPTT Treaty Manager) places observers on 100% of the vessel trips. In the EPO, logbooks are submitted by vessel operators to NOAA Fisheries or the IATTC, and landings are obtained for each vessel trip from canneries or fish buyers. IATTC observers are placed on all large purse-seine vessels in the EPO.

2.2. Longline

The U.S.A. longline fishery targeting tunas and tuna-like species in the NPO is made up of the Hawaii-based fleet, the California-based fleet, and the American Samoa-permitted fleet in the NPO. 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. The Hawaii-based shallow-set longline fishery also closed on November 18, 2011, as a result of reaching annual interaction limit of 16 leatherback turtles. 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. Leatherback and loggerhead sea turtle interactions have been less than their respective limits since the levels were revised, though the fishery was closed in 2018 due to a court order that lowered the turtle take limits back to the 2011 levels (17 loggerhead turtles) and the shallow set fishery reached the revised loggerhead turtle take limit.

The number of vessels in the California-based fishery has always been low compared to the Hawaii-based fishery, and composed mainly of vessels that target swordfish. Most vessels with landings to California also participated in the Hawaii-based fishery. The California-based shallow-set longline fishery for swordfish was closed in 2004, resulting in relocation of most of those vessels back to Hawaii. Only one California-based vessel fished between 2005 and 2018 using deep-set longline to target tunas. Additionally, over a dozen Hawaii-permitted vessels reported landings in California in 2018 and seven Hawaii-permitted deep-set longline vessels and at least five shallow-set vessels reported landings in California in 2018.

In the North Pacific, the longline fishery extended from 125°W, just outside the U.S.A. West Coast EEZ to 175°W longitude and from 10°N to almost 40°N latitude in 2018 (Figures 2 and 3). The total number of vessels participating in the longline fishery increased from 36 in 1985 to a relative high of 141 vessels in 1991 (Table 1). Since then, the number of vessels has varied from 114 to 145 with approximately 145 vessels participating in 2018. 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, 2011, and 2013-2018 (Table 2). Bigeye tuna (*Thunnus obesus*) dominates the tuna catch with landings over 4,000 t during the past sixteen years. The 2018 bigeye tuna catch was 7,572 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. 2018 swordfish catch by longline was

1,053 t.

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 fishermen 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%. DAR dealer data represent the majority of the fish kept by the longline fishery with individual fish weighed to the nearest pound (Figures 4-6). 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 fish caught in the Hawaii-based longline fishery indicate, that in general, a higher proportion of larger tuna and tuna-like fish species are captured in the shallow-set longline fishery compared to the deep-set fishery (Figures 4-6).

The California-based longline fishery is monitored by NOAA Fisheries and the California Department of Fish and Wildlife (CDFW). Data are collected for 100% of longline landings by the CDFW. Logbooks, developed by the fishing industry (similar to the federal logbooks used in Hawaii), were submitted voluntarily to NOAA Fisheries until 1994 when logbooks became mandatory. Landed swordfish were measured for cleithrum to fork length by CDFW port samplers until 1999. NOAA Fisheries has placed observers on all California-based and non-Hawaii permit longline trips since 2002. The observers collect data on fishing location, protected species interactions, fish catch, disposition of catch and bycatch, and size measurements of catch and bycatch (retained catch and discards).

2.3. Albacore troll and pole-and-line

The U.S.A. albacore troll and pole-and-line fishery in the NPO started in the early 1900s. The fishery currently operates in waters between the U.S.A. West Coast and 160°W longitude. Fishing usually starts in June and ends in October or November. In 2018, 452 vessels participated in the fishery, down from 518 in 2017 (Table 1).

The troll and pole-and-line fishery catches almost exclusively albacore with minor incidental catches of Pacific bluefin tuna (*Thunnus orientalis*), 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 2017 and 2018, 7,430 t and 7,737 t of albacore were caught, respectively.

U.S.A. troll and pole-and-line vessels operating within the U.S.A. EEZ voluntarily submitted logbook records to NOAA Fisheries from 1973 to 1995 when those vessels fishing on the high-seas were required to submit logbooks. In 2005, the Highly Migratory Species Fishery Management Plan required all U.S.A. troll and pole-and-line vessels to submit logbooks to

NOAA Fisheries. NOAA Fisheries and various state fisheries agencies monitor the fleet's landings through sales receipts (fish tickets) and landings reported in logbooks. Spatial distribution of albacore catch and effort for 2018 are shown in Figures 7 and 8, respectively.

Since 1961, a port sampling program has been in place for collecting size data from albacore landings along the U.S.A. Pacific coast. Generally sizes of albacore caught in the albacore troll and pole-and-line fishery range between 55 cm fork length (8.5 pounds) and 90 cm (32 pounds). Weight distribution of the catch for 2018 is shown in Figure 9. State fishery personnel collect the size data according to sampling instructions provided by NOAA Fisheries, who maintain the database. In recent years, cooperative fishermen have also collected size data on selected fishing trips to augment data collected through the port sampling program.

2.4. Tropical pole-and-line

The tropical pole-and-line fishery targets skipjack around the Hawaiian Islands. 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. The number of vessels participating declined from a high of 27 in 1985. Numbers in 2017 and 2018 were too low to report due to confidentiality rules.. 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. To protect confidentiality, no catch data for the tropical pole-and-line fishery are reported for recent years.

2.5. Tropical Troll and Tropical Handline

Tropical troll fishing fleets for tuna and tuna-like species operate in Hawaii, Guam, and the CNMI. Tropical handline fishing fleets also operate in Hawaii. The vessels in these fisheries are relatively small coastal vessels (typically around 8 m in length) and primarily make 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 1,786 troll vessels and 431 handline vessels in 2018 (Table 1). The operations range from recreational, subsistence, and part-time commercial to full-time commercial. The small vessel catches generally are landed fresh and whole, although some catches are gilled and gutted.

Weights of individual fish were obtained from Hawaii DAR dealer data. The size distributions of tunas (skipjack,yellowfin, and bigeye) and marlins (striped marlin and blue marlin, *Kajikia audax* and *Makaira nigricans*, respectively) caught in the Hawaii fishery in 2018 are summarized in Figures 10 and 11.

The total retained catch from these tropical troll and handline fisheries combined ranged from 1,162 t in 1992 to 2,326 t in 2012 (Table 2). The majority of the catch was made up of yellowfin and skipjack tuna in 2018 followed by blue marlin.

The Guam Division of Aquatic and Wildlife Resources (DAWR) monitors the troll fishery using a statistically designed creel survey and commercial landings data. 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 are compiled from Hawaii DAR Commercial Fish Catch reports and Commercial Marine Dealer reports. The CNMI Division of Fish and Wildlife (DFW) monitors the tropical troll fishery in the CNMI region using creel surveys and commercial landings, and 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.

2.6. Drift Gillnet

The U.S.A. large mesh drift gillnet fishery targets swordfish and common thresher sharks in areas within the EEZ in California waters and historically off the coast of Oregon. Other pelagic sharks, and small amounts of tunas and other pelagic species are also caught in the large mesh drift gillnet fishery. The number of vessels participating in this fishery has steadily decreased from a high of 220 in 1986 to a low of 17 in 2012. In 2018 there were 20 vessels that participated in the fishery (Table 1). Swordfish dominate the catch and peaked in 1985 at 2,990 t. Since then, swordfish catches have fluctuated while decreasing to a low of 62 t in 2010 (Table 2). The estimate of swordfish caught in the drift gillnet fishery for 2018 is 145 t, a decrease from 177 t caught in 2017.

Gillnet fishery landings data (100% coverage) are collected by state agencies in California and Oregon (no landings have occurred in Oregon since 2004). Logbook data for gillnet fisheries are required to be submitted to the CDFW for all trips. CDFW collected length data for swordfish landings between 1981 and 1999 from less than 1% of the landings. NOAA Fisheries observers on large mesh drift gillnet vessels have collected data on fishing location, protected species interactions, fish catch, disposition of catch and bycatch, and length since 1990; observer coverage is about 20% of effort. Figure 13 shows effort distribution for the fishery.

The U.S.A. fishing industry has been modifying a gear called “deep-set buoy gear” for targeting swordfish in the eastern Pacific Ocean as an alternative to gillnet gear and as part of an effort to maximize economic benefits while minimizing non-target catch. Fishermen are testing deep-set buoy gear under an exempted fishing permit from NOAA Fisheries. The deep-set buoy system uses heavy weights to rapidly lower baited hooks to target swordfish between 1,000 and 1,500 feet. The buoy gear’s strike detection system alerts fishermen when a fish is on the line and allows for its quick retrieval once hooked. It allows fishermen to avoid unmarketable or federally protected species that reside in shallower waters.

Deep-set buoy fishing takes advantage of the fact that different marine species feed at different depths at certain times of the day. Sea turtles, whales, and many fish are most commonly found in warm surface waters known as the upper mixed layer. Other fish, such as swordfish, opah, and bigeye thresher sharks, pursue food resources in deeper waters. The results of the exempted fishing permits gear tests will help U.S.A. fisheries managers determine if the method can be scaled up to become a viable commercial fishery. A decision is expected in 2019.

2.7. 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 greatly decreased from 113 in 1986 to 10 in 2012. Eighteen vessels participated in the fishery in 2018 (Table 1). Trends in swordfish catches have fluctuated from a high of 305 t in 1985 to 5 t in 2012, and 2015. Catch increased in 2016 and 2017 to 25 t and 28 t, respectively, before decreasing to 10 in 2018 (Table 2). Figure 13 shows effort distribution for the fishery.

Landings and logbook data for the harpoon fishery are collected by the CDFW. Length measurements were taken by CDFW between 1981 and 1999, covering less than 1% of swordfish landings.

2.8. Sport

Sport (recreational) catch and effort data are available from commercial passenger fishing vessels (CPFVs) and catch data are available from private vessels that target tunas and other pelagic fish. Logbook data for CPFVs are obtained from fisheries agencies in California while CPFV logbook data from vessels fishing out of Oregon and Washington are submitted to NOAA Fisheries. Estimates of catch for CPFV and private vessels are obtained through logbooks and surveys and maintained in the Recreational Fisheries Information Network (RecFIN) database (http://www.recfin.org/) for California, Oregon, and Washington. Total sport catches of tunas, sharks and billfish are estimated from data obtained from RecFIN and augmented by state and federal logbook data sets where available. The majority of the highly migratory species (HMS) catch is albacore, yellowfin and Pacific bluefin tuna. The albacore catch by sport vessels was 170 t in 2018 compared to 372 t in 2017 and 675 t in 2016. Figure 13 shows effort distribution for the fishery.

Sport catches of Pacific bluefin tuna are estimated differently from other species. From 1993 through 2012 the IATTC collected size samples from bluefin landed by CPFVs. In 2013 no sampling occurred and in 2014 NOAA Fisheries began collecting length samples from bluefin landed by CPFVs. A description of the size sampling and the procedure for estimating annual sport catches of Pacific bluefin are provided in working paper ISC/15/PBFWG-1/03. Catches vary and have ranged from a high of 809 t in 2013 to a low of 6 t in 1988. The 2018 catch was 484 t compared to 450 t in 2017. The size distribution of the Pacific bluefin tuna caught by the U.S.A. West Coast sportfishing industry is depicted in Figure 12.

3. RESEARCH

3.1. Good practices for including environmental data to inform spawner-recruit dynamics in integrated stock assessments: Small pelagic species case study

NOAA Fisheries evaluated two methods for incorporating environmental information in an integrated assessment model (Crone et al. 2019), based on: 1) including an environmental covariate as an additional component of the S-R function; or 2) using the covariate outside the S-

R relationship as a survey index of recruitment. The methods were implemented in a broadly employed stock assessment software package (Stock Synthesis) using population/fishery processes generally applicable to an exploited small pelagic fish species (Pacific sardine). Simulation analysis was used to examine how environment-recruitment considerations in the assessment influenced model performance. The quality (bias and precision) of estimates of abundance and derived quantities generated from the models were examined statistically. Findings indicated that both methods for including an environmental index in the model resulted in relatively high quality estimates for a diverse group of output variables, depending on assumptions regarding bias correction and penalties associated with the recruitment deviation estimates. Several estimated quantities were found to be generally unbiased and relatively precise (e.g., stock biomass and average recruitment), regardless of the method implemented in the model; whereas, the choice of the method did impact the quality of results associated with more sensitive quantities (e.g., virgin recruitment and depletion).

3.2. The use of conditional age at length data as a likelihood component in integrated population dynamics models

Integrated population dynamics models use a variety of data types, and all the data used impact modeled processes and estimated dynamics. Paired age-length data collected from the hard parts of fish treated as conditional age-at-length (CAAL) data are increasingly being used as a data component in stock assessment models. The original intent of the use of CAAL data was to directly estimate the length-at-age process (i.e., growth), including the associated variability in length-at-age. NOAA Fisheries analysts (Lee et al. 2019) show that using simulation, introduction of CAAL data that are not representative of the age-structure of the population can cause bias and imprecision in estimates of not only growth, but also dynamics and management quantities. Estimation of an appropriate age-based observations-modeled process (e.g., age-based selectivity) may improve model performance. Even the use of representative CAAL data in a model with misspecified age-based systems-modeled processes (natural mortality and time-varying growth) can lead to bias and imprecision in growth, dynamics, and management quantities. In these cases, estimation of an age-based observations-modeled process magnified the bias and imprecision. Greater consideration of this type of data is needed.

3.3. Can the status of pelagic shark populations be determined using simple fishery indicators?

Calls to develop alternative methods of assessing the population status of pelagic shark populations have increased substantially in recent years. An interim solution has been the development of more subjective evaluation of data series (indicator-based analysis) rather than predictions from complex stock assessment models. NOAA Fisheries examines the reliability of indicators for predicting population status (i.e., whether it has been overfished) and the fishing pressure (i.e., whether overfishing is occurring) of large pelagic sharks, based on these fishery indicator trends alone (Carvalho et al. 2018). Researchers simulate a variety of large pelagic shark populations under different exploitation scenarios using life history parameters, and measurable fishery indicators information (catch-per-unit of effort - CPUE; and average length - AL). Analysts simulation results, designed to be generalized (via sampling of realistic distributions) but based loosely on the shortfin mako shark, showed that the reliability of fishery indicators for establishing population status is dependent upon the length of the time series analyzed. These caveats are critical to the proper evaluation of population trajectories that underlie the most important conservation decisions being made for sharks today.

3.4. Environmental associations of Pacific bluefin tuna (*Thunnus orientalis*) catch in the California Current system

To examine how oceanographic and climate variability might change habitat suitability for Pacific bluefin off the West Coast, particularly in light of the recent marine heatwave (the "blob") NOAA Fisheries (Runcie et al. 2018) used fishery-dependent data from three different fisheries, which can encounter bluefin to define catch locations, and remotely sensed satellite data to define environmental conditions in fishing areas. The results of our multivariate models suggested that bluefin were mostly associated with warmer, low chlorophyll waters, but that the type of fishing gear used (drift gillnet, purse seine, or pole-and-line) was also important in determining occurrence. The predicted suitable habitat for bluefin moved northwards during the marine heatwave years. However, as this species is known to have broad thermal tolerances, it may be that these shifts were primarily due to them following particular prey species. IATTC and CDFW provided data for the analyses.

3.5. Bias in estimates of growth when selectivity in models includes effects of gear and availability of fish

Stock assessment models use data influenced by distribution patterns that are due to the non-random movement of fish, which can create bias in the assessment. For many stocks, length data are used to characterize the age structure of the population, and therefore there is a need for unbiased estimates of growth. Because of the influence of size-selective fishing gear, growth and length-based selectivity are often estimated as part of an assessment model to account for the size selection of gear. However, estimated selectivity can include not only length-based gear selection, but the biological aspects of the spatial availability of the target species. If availability to the fishing gear is a function of age, an approximation of an age-based process as a length-based one can bias growth estimates. The magnitude of the bias would be greater for fish with highly variable growth and for those with strong age-based distribution patterns. See Piner et al. 2018 for more information.

3.6. Electronic Tagging Studies and Habitat Modeling

Starting in 1999, NOAA Fisheries scientists have used satellite technology to study the movements and behaviors of large pelagic sharks; primarily blue, shortfin mako, and common thresher sharks, while other species are tagged opportunistically. Shark tag deployments have been carried out in collaboration with a number of partners in the U.S., Mexico, and Canada, including the Tagging of Pacific Predators (TOPP) program. The goals of these projects are to document and compare the movements and behaviors of these species in the eastern North Pacific and California Current and to link these data to physical and biological oceanography.

In recent years, NOAA scientists have incorporated electronic tagging data and catch data into habitat models. These models combine location information with environmental data from

ROMs models and satellite imagery to provide a quantitative estimate of habitat preferences across physical and biological oceanographic parameters. The modeling approach used, known as EcoCast, has a number of applications. The information on habitat preferences provides insight into abundance and distribution, and how these might shift seasonally and with climate variability. By combining habitat envelopes from target and non-target species, it is possible to create maps that allow fisheries to avoid bycatch species and maximize efficiency (Hazen et al. 2018).

3.7. Paulik revisited: Statistical framework and estimation performance of multistage recruitment functions.

Multiple processes act at different stages and different intensities within the timeline between spawning and the age designated as “recruitment”. However, common practice is to model only a single step between spawning stock and recruits. Reasons for this practice include lack of data on the intermediate stages, lack of understanding of the mechanisms and functional form governing intermediate stages, and lack of computational resources to model a multistage process in the appropriate statistical framework. NOAA scientists developed a state-space framework and, using a simulation study, explore the estimation of multistage stock-recruit functions (Brooks et al. 2018). They evaluated four different functions (Ricker, Beverton-Holt, Shepherd, and Generalized), and examined the effects on estimation of several factors, including the form of density dependence, the magnitude of measurement error associated with each stage, type of prior on measurement error, and the magnitude of process error between stages. Three-parameter stock-recruit functions (Shepherd, Generalized) correctly identified the form of density dependence in each stage, although the Shepherd model exhibited problems with convergence. Model misspecification resulted in bias, especially in parameters specifying measurement and process error; an informative prior on measurement error improved precision and bias. The Deviance Information Criterion selected the Ricker model too often, even when the true model was Beverton-Holt. Sequential density-dependent stages, even multiple overcompensatory stages, lead to an overall function that appears fairly flat, suggesting that a function capable of producing asymptotic dynamics is a practical default. The common practice of bypassing stages between the first (spawning stock) and the last (recruits) worked reasonably well. An application to data on North Sea herring illustrates that a multi-stage stock-recruit model can generate a stock-recruit function that is intermediate between Ricker and Beverton-Holt models, and that does not match existing three-parameter forms.

3.8. Size compositions and sex ratios of oceanic whitetip sharks and giant manta rays for longline fisheries in the Pacific Islands region.

NOAA Fisheries presents relevant life history, assessment, and summary plots of data available from Hawaii longline fishery observer data and the literature for oceanic whitetip shark (*Carcharhinus longimanus*) and giant manta ray (*Manta birostris*) catches by the longline (LL) fisheries in Hawaii and American Samoa from 2010 to 2016 (Kapur et al. 2018). This information is being provided as both species are currently proposed to be listed as threatened under the Endangered Species Act (ESA). The Hawaiian longline fishery is represented in two parts, the Shallow Set (SS) and Deep Set (DS). Deep sets are classified as containing 15 or more hooks per float and that fishery has a target of 20% observer coverage annually; shallow sets are any number of hooks below 15 and that fishery has mandated 100% observer coverage. The American Samoa longline fishery is presented as a single entity. For each fishery, scientists summarize the relevant life history and assessment information to aid the reader in interpreting the presented data. We provide summary tables and histograms describing the estimated (non-empirical) sex ratio and length composition of observed catch through the time period examined. There are far fewer observed catches of giant manta ray and thus those data are presented for each individual.

3.9. Nocturnal visual census of pelagic fauna using scuba near Kona, Hawaii.

Plankton and micronekton occupy the base and intermediate levels of oceanic food webs and are generally regarded as difficult to quantify. Gelatinous plankton are the most abundant functional group of macroplankton, yet they remain largely unstudied. What little is known of plankton communities has been largely deduced from plankton samplers, optical counters, nets, and towed cameras. This NOAA research (Milisen et al. 2018) introduces a survey methodology that used recreational scuba divers to evaluate pelagic community structure observed on popular “blackwater” dives. The most abundant organisms encountered were salps, siphonophores, and ctenophores. Over a 19-month period, environmental data were compared against nightly observed diversity to build a generalized additive model that accounted for 43% of the total observed deviation in biodiversity. The three most important predictors of pelagic diversity were water temperature, bathymetry, and El Niño–Southern Oscillation (ENSO) index.

3.10 Regional-scale surface temperature variability allows prediction of Pacific bluefin tuna recruitment

NOAA Fisheries examined relationships between sea surface temperature (SST) in the region between Taiwan and the Sea of Japan, and annual recruitment of Pacific bluefin tuna (*T. orientalis*) over the past 35 years (Muhling et al. In Press). Spatial correlation maps showed that warmer SSTs south of Shikoku, in the East China Sea and in the Sea of Japan from summer through late fall were associated with above average recruitment. SST anomalies near larval and juvenile habitats were most strongly correlated with local air temperatures. Generalized Additive Models predicting annual PBF recruitment from SST fields suggested that the influence of SST on recruitment was stronger than that of spawning stock biomass. Correlations between SST and recruitment likely reflect biological processes relevant to early juvenile habitat suitability. The influence of late fall SSTs could also be a result of varying availability of age-0 fish to the troll fishery, however the relative importance of these processes was not clear. Despite these knowledge gaps, the strong predictive power of SST on PBF recruitment can allow more proactive management of this species under varying environmental conditions.

3.11 Dynamic habitat use of albacore and their primary prey species in the California Current System

Juvenile north Pacific albacore (*T. alalunga*) forage in the California Current System (CCS), supporting fisheries between Baja California and British Columbia. Within the CCS, their distribution, abundance, and foraging behaviors are strongly variable interannually. In this study, NOAA Fisheries uses catch logbook data and trawl survey records to investigate how juvenile albacore in the CCS use their oceanographic environment, and how their distributions overlap with the habitats of four key forage species. We show that anchovy (*Engraulis mordax*) and hake (*Merluccius productus*) habitat is associated with productive coastal waters inshore of core juvenile albacore habitat, whereas sardine (*Sardinops sagax*) and boreal clubhook squid (*Onychoteuthis borealijaponica*) habitat overlaps more consistently with that of albacore. Our results can improve understanding of how albacore movements relate to foraging strategies, and why prey-switching behavior occurs. This has relevance for the development of ecosystem models for the CCS, and for the eventual implementation of ecosystem-based fishery management.

4. CITATIONS

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Chan, H.L., Pan, M. 2019. Tracking economic performance indicators for small boat fisheries in America Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-79, 76 p. https://doi.org/10.25923/8etp-x479.

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6. FIGURES

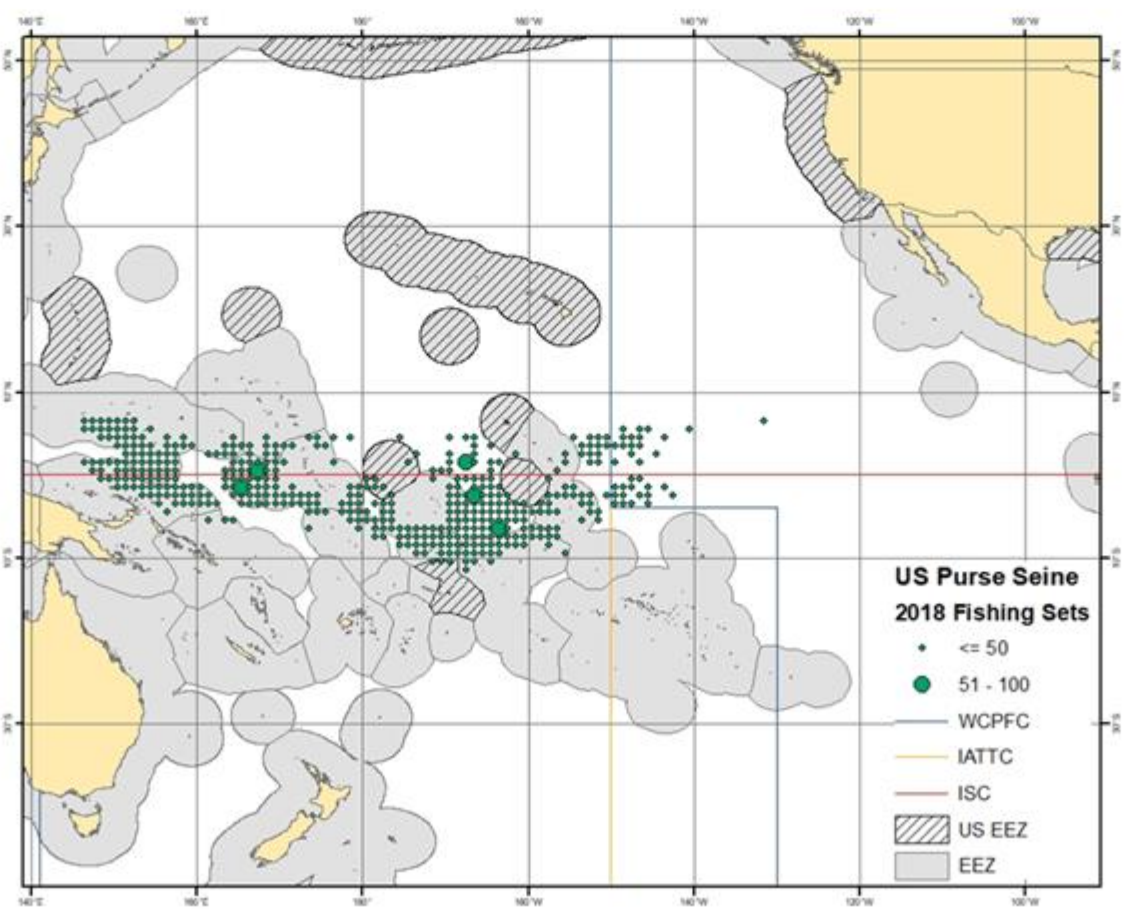

Figure 1. Spatial distribution of reported logbook fishing effort by the 2018 U.S. Western Pacific purse seine fishery in vessel-days. The size of circles is proportional to the amount of effort. Effort in some areas is not shown in order to preserve data confidentiality.

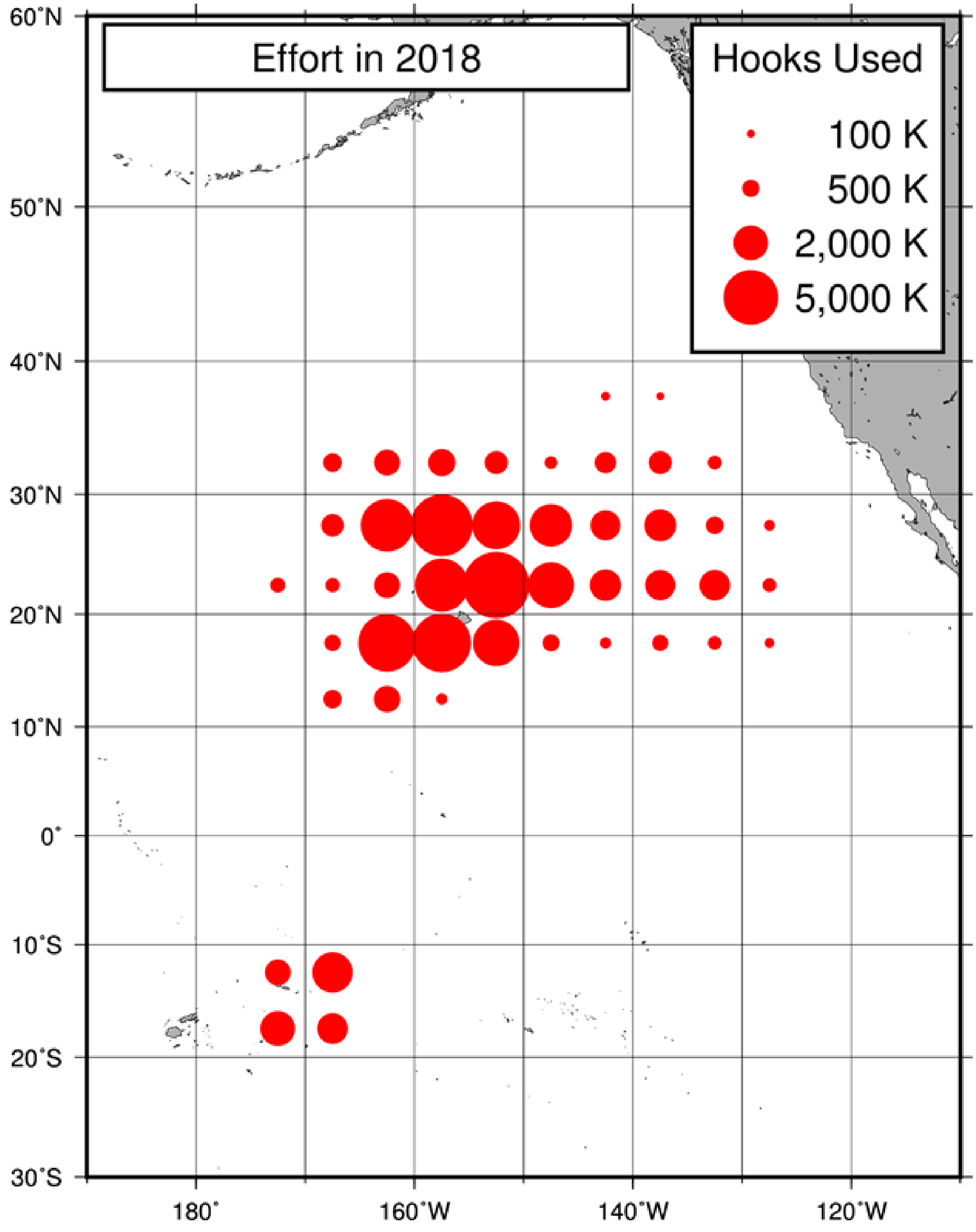

Figure 2. Spatial distribution of reported logbook fishing effort by the 2018 U.S. longline fishery in the North Pacific Ocean, in 1,000s of hooks. The size of circles is proportional to the amount of effort. Effort in some areas is not shown in order to preserve data confidentiality.

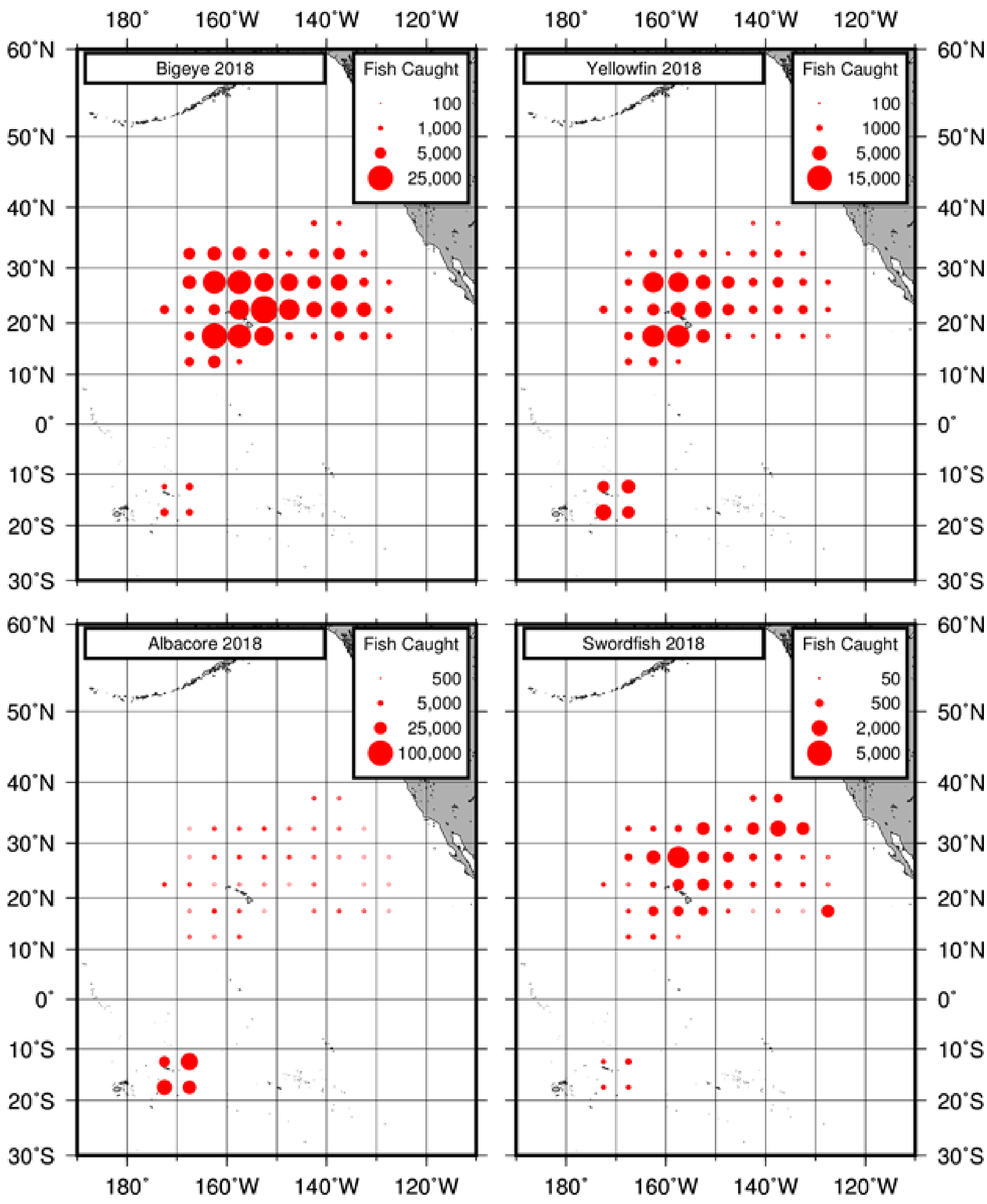

Figure 3. Spatial distribution of reported logbook fishing catch by the U.S. longline fishery in the North Pacific Ocean, in numbers of fish, in 2018 for bigeye (*Thunnus obesus*), albacore (*Thunnus alalunga*), yellowfin (*Thunnus albacares*), and swordfish (*Xiphias gladius*). The size of circles is proportional to the amount of effort. Effort in some areas is not shown in order to preserve data confidentiality.

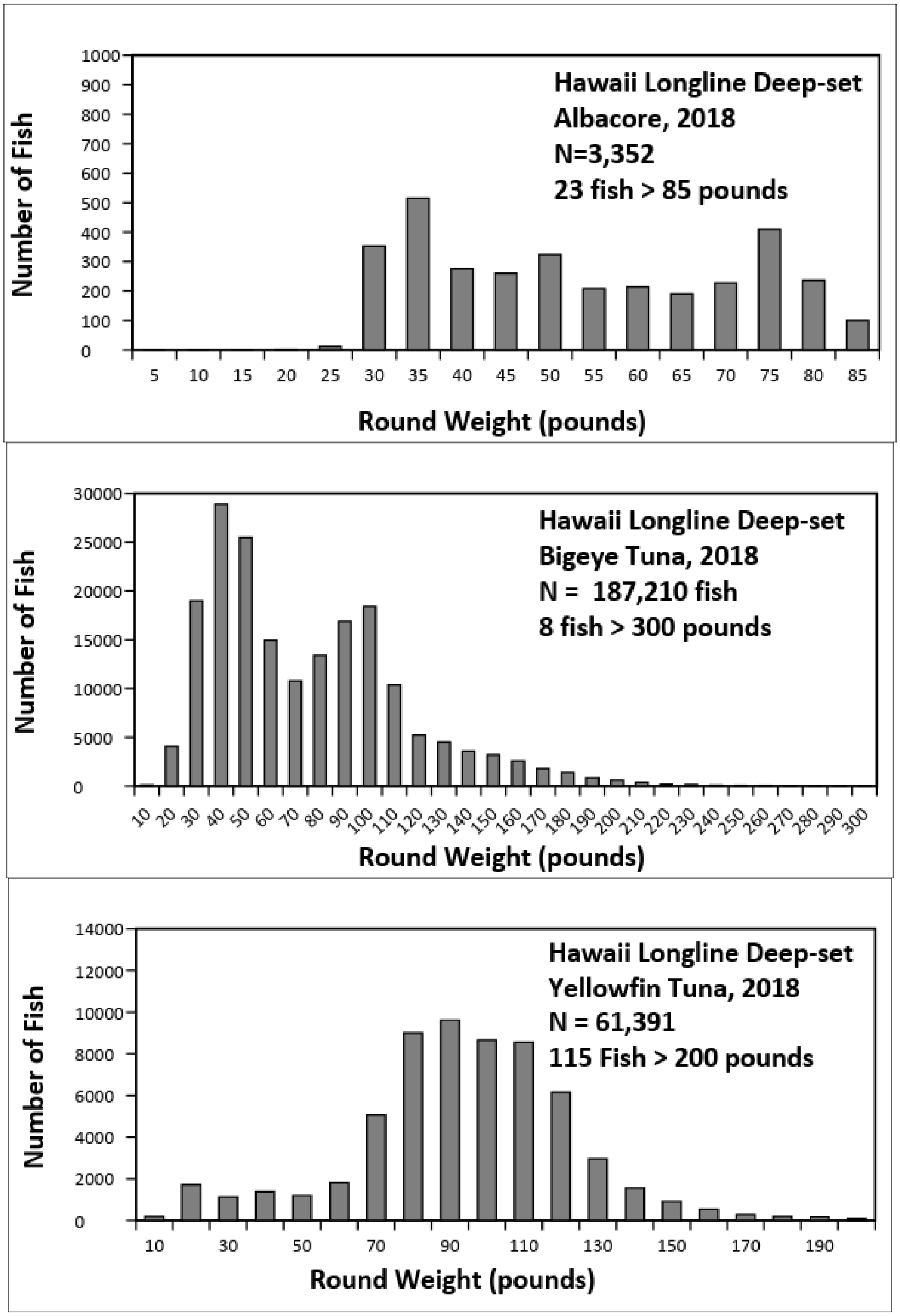

Figure 4. Size distribution of (A) albacore (*Thunnus alalunga*), (B) bigeye tuna (*Thunnus obesus*), and (C) yellowfin tuna (*Thunnus albacares*) caught by the Hawaii-based deep-set longline fishery in the north Pacific Ocean, 2018.

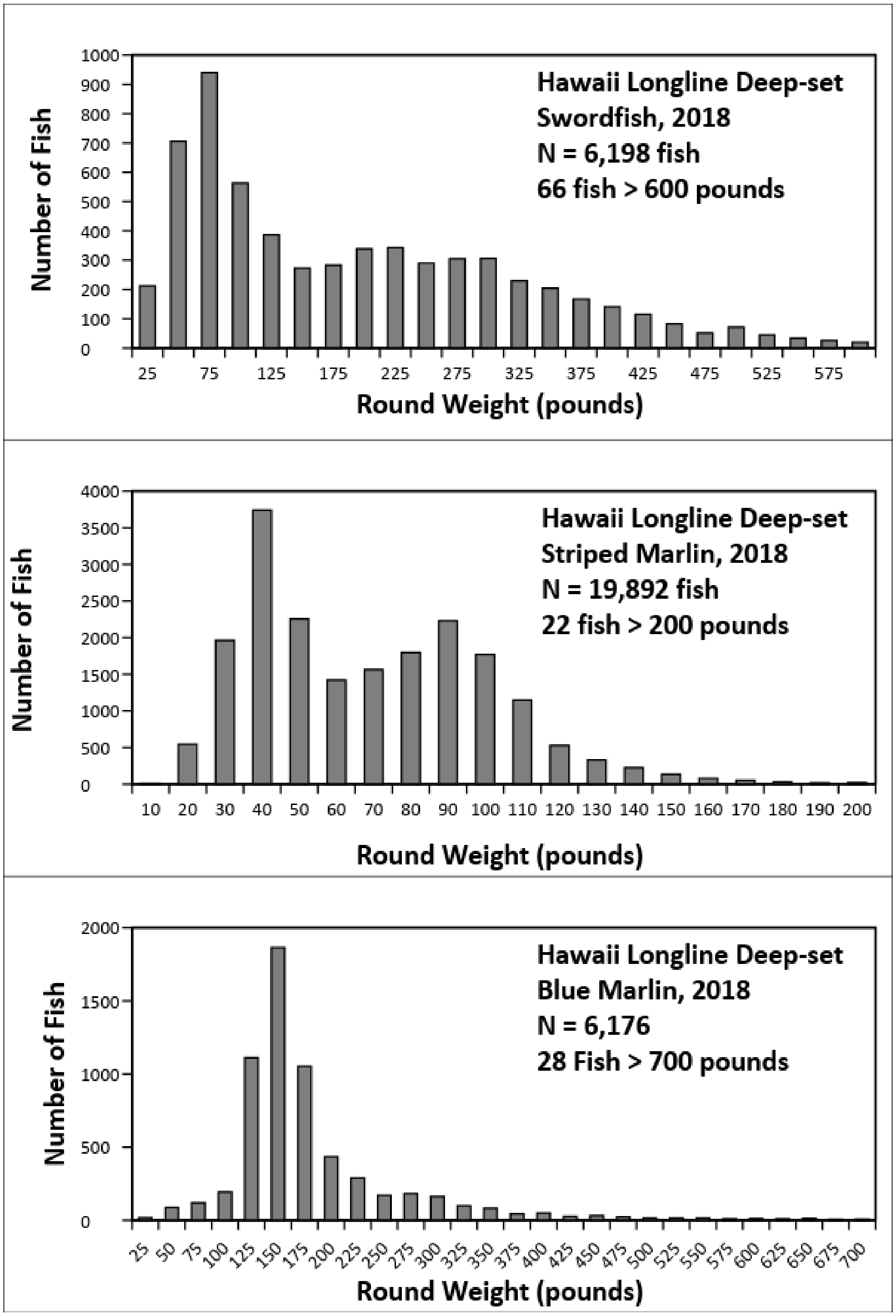

Figure 5. Size distribution of (A) swordfish (*Xiphias gladius*), (B) striped marlin (*Tetrapturus audax*), and (C) blue marlin (*Makaira nigricans*) caught by the Hawaii-based deep-set longline fishery in the north Pacific Ocean, 2018.

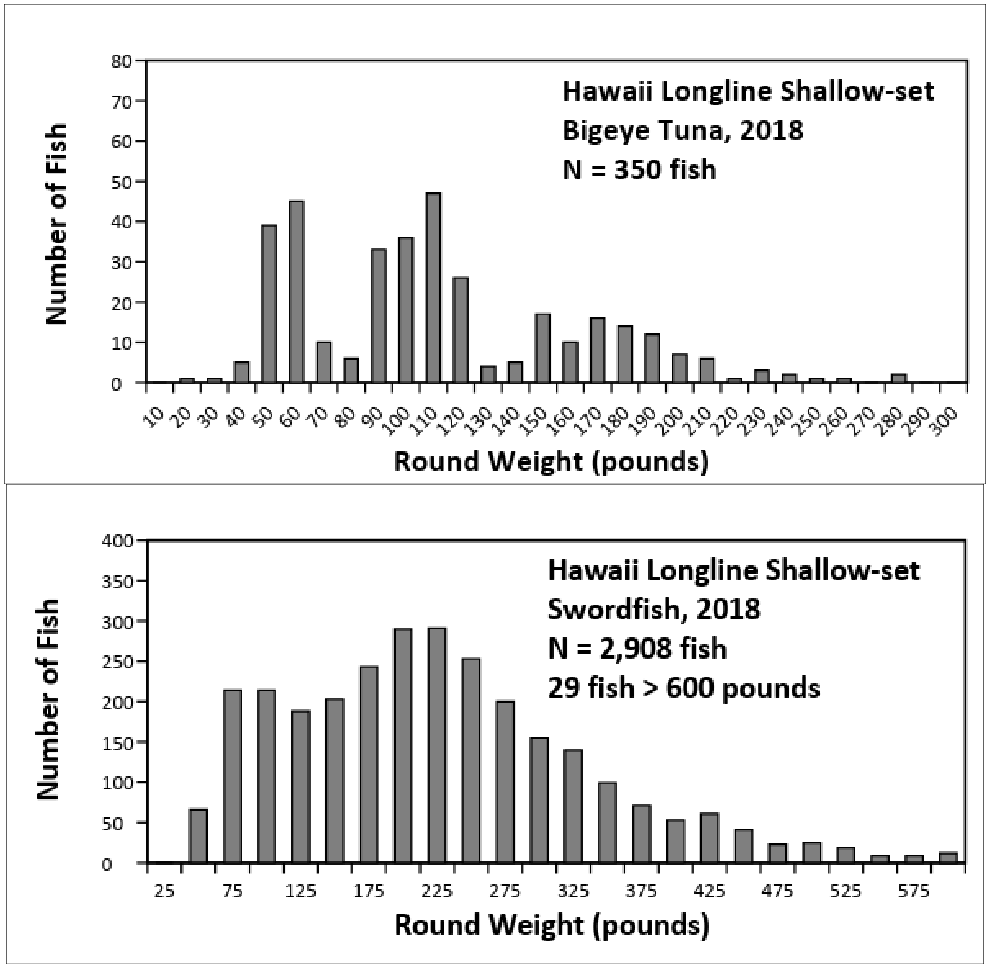

Figure 6. Size distribution of (A) bigeye tuna (*Thunnus obesus*), and (B) swordfish (*Xiphias gladius*) caught by the Hawaii-based shallow-set longline fishery in the north Pacific Ocean, 2018.

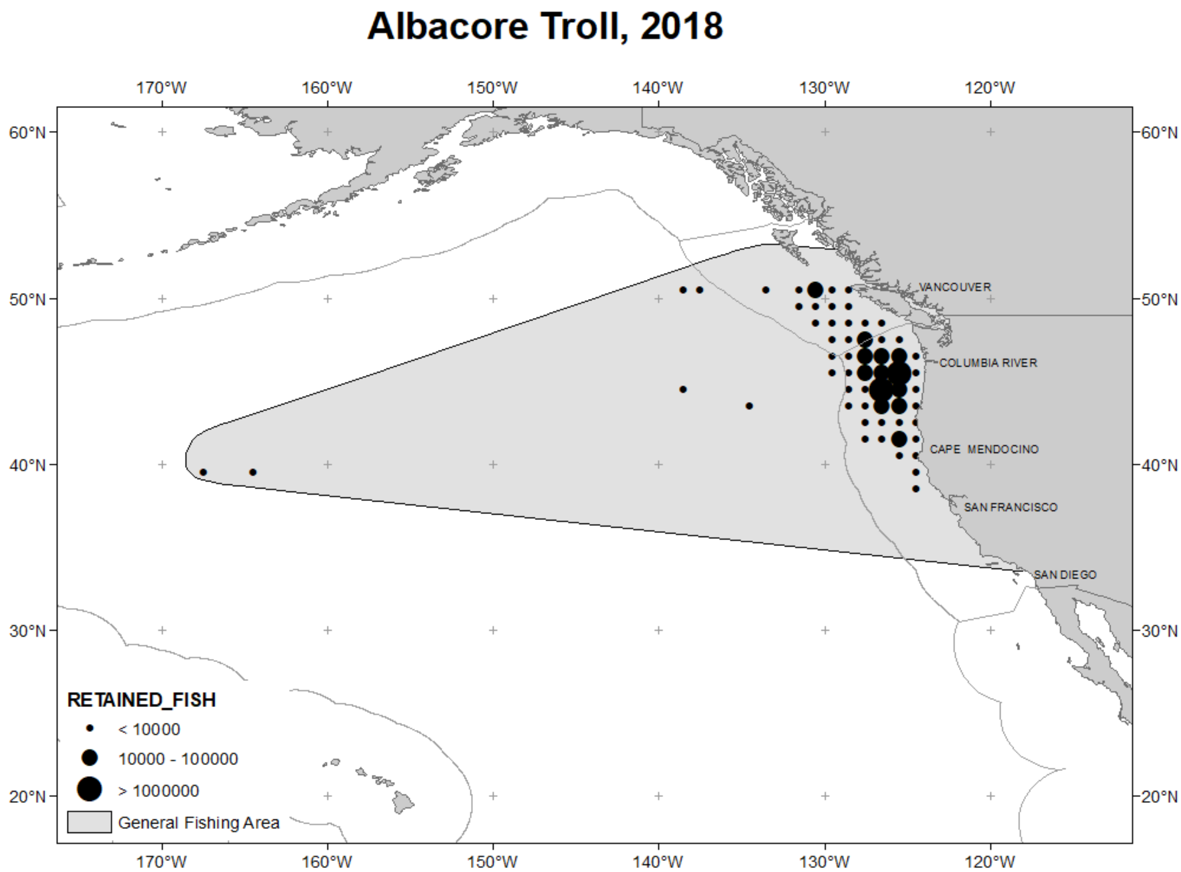

Figure 7. Spatial distribution of reported logbook fishing catch by the 2018 U.S. albacore troll and pole-and-line fishery in number of fish. The size of circles is proportional to the amount of catch. Catch in some areas is not shown in order to preserve data confidentiality.

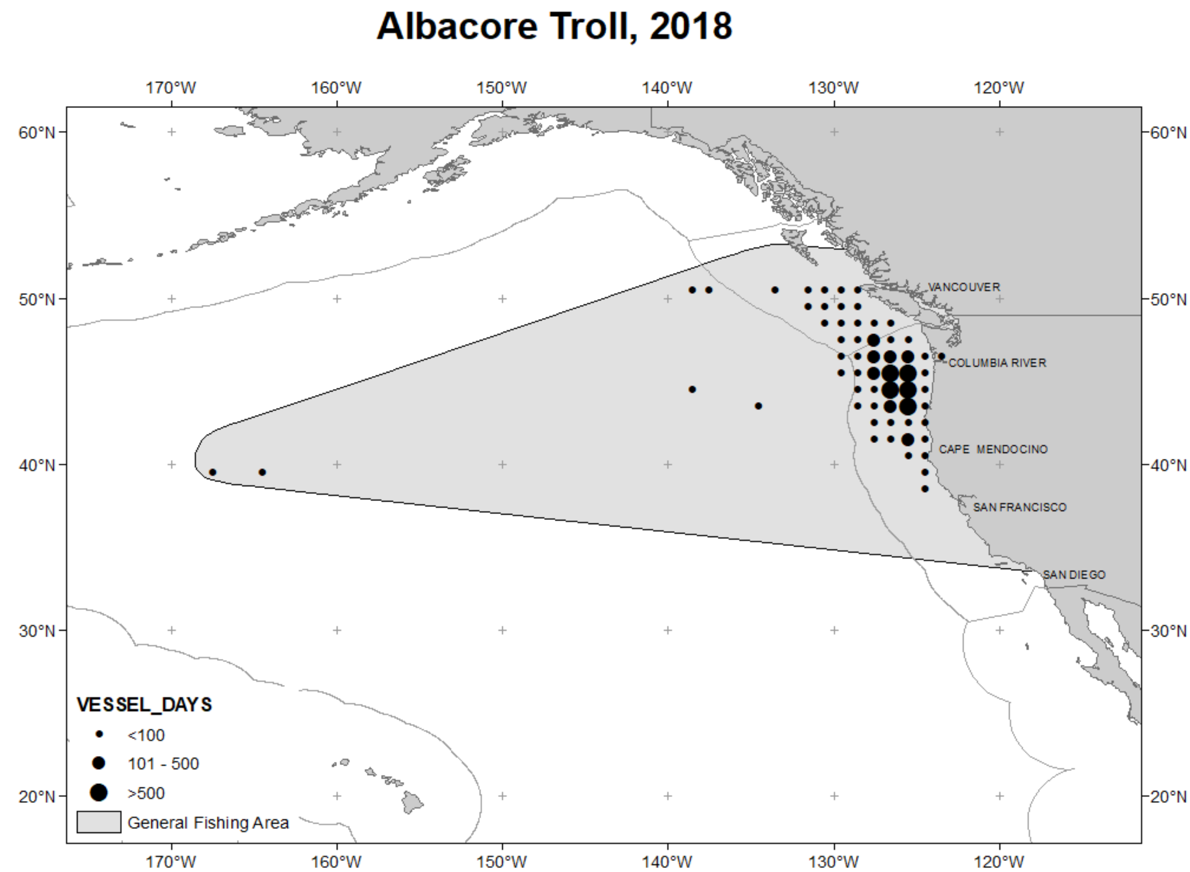

Figure 8. Spatial distribution of reported logbook fishing effort by the 2018 U.S. albacore troll and pole-and-line fishery in vessel days. The size of circles is proportional to the amount of effort. Effort in some areas is not shown in order to preserve data confidentiality.

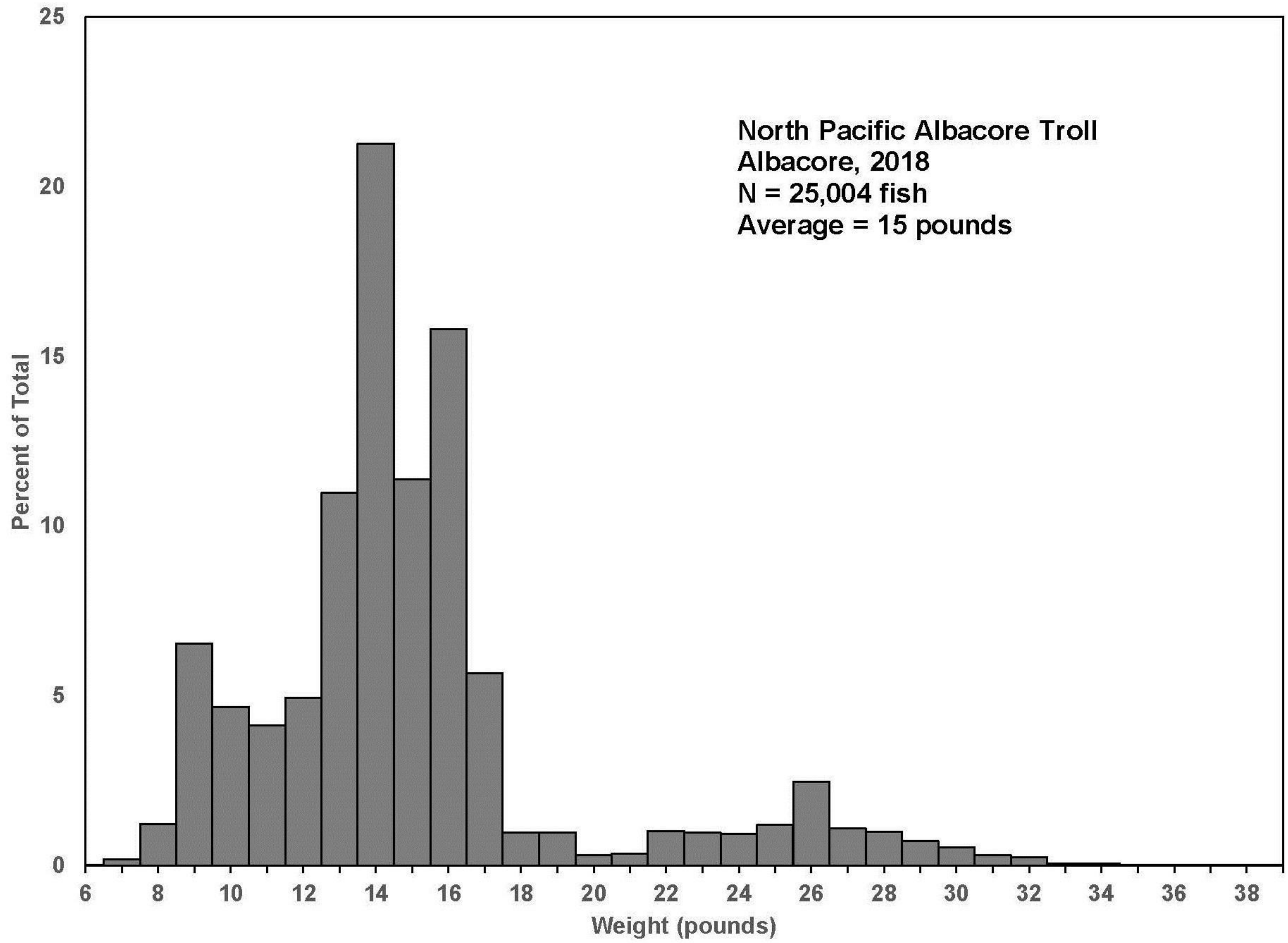

Figure 9. Size distribution of albacore (*Thunnus alalunga*) caught by the 2018 U.S. albacore troll and pole-and-line fishery.

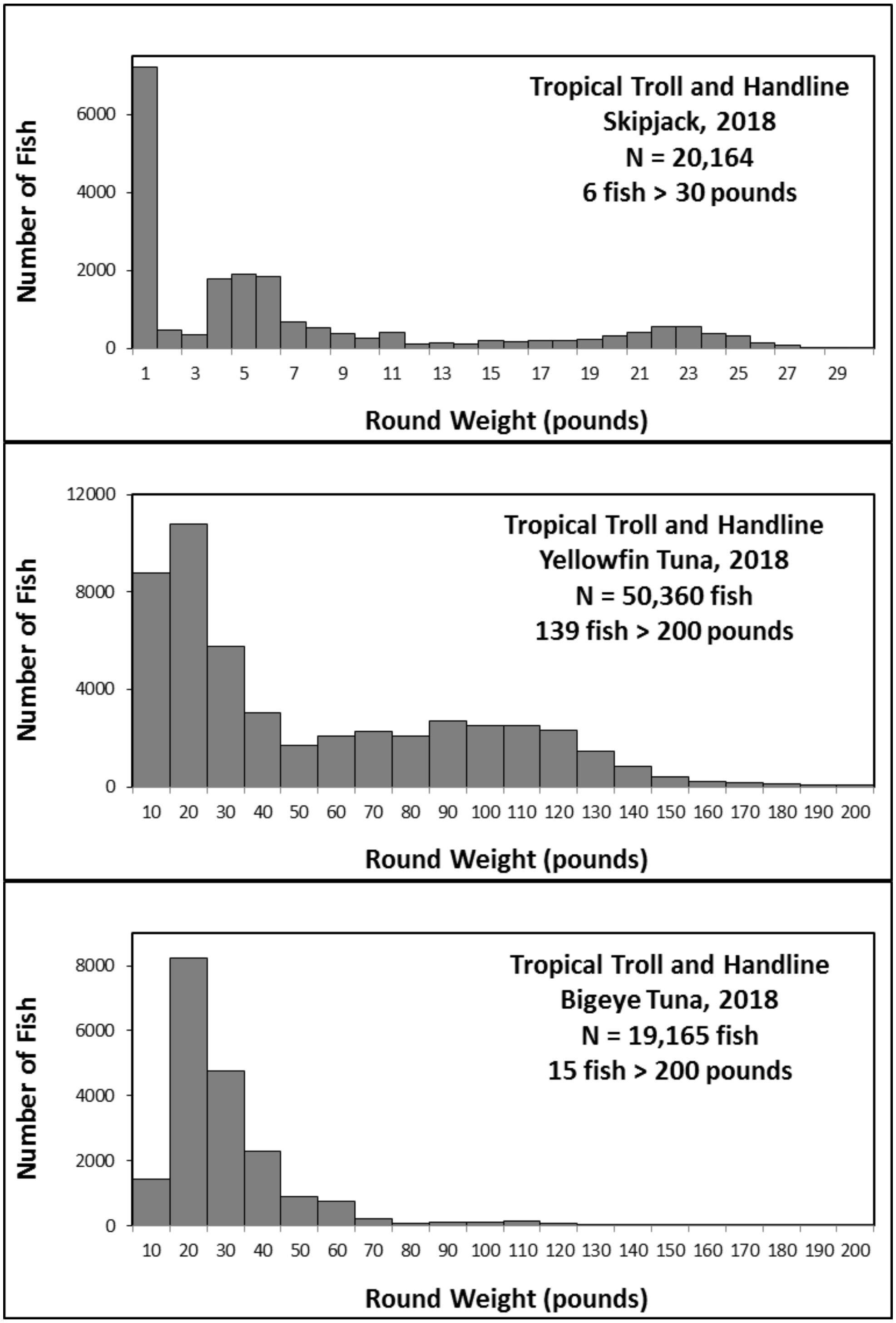

Figure 10. Size distribution of (A) skipjack tuna (*Katsuwonus pelamis*), (B) yellowfin tuna (*Thunnus albacares*), and (C) bigeye tuna (*Thunnus obesus*) caught by the Hawaii troll and handline fisheries, 2018.

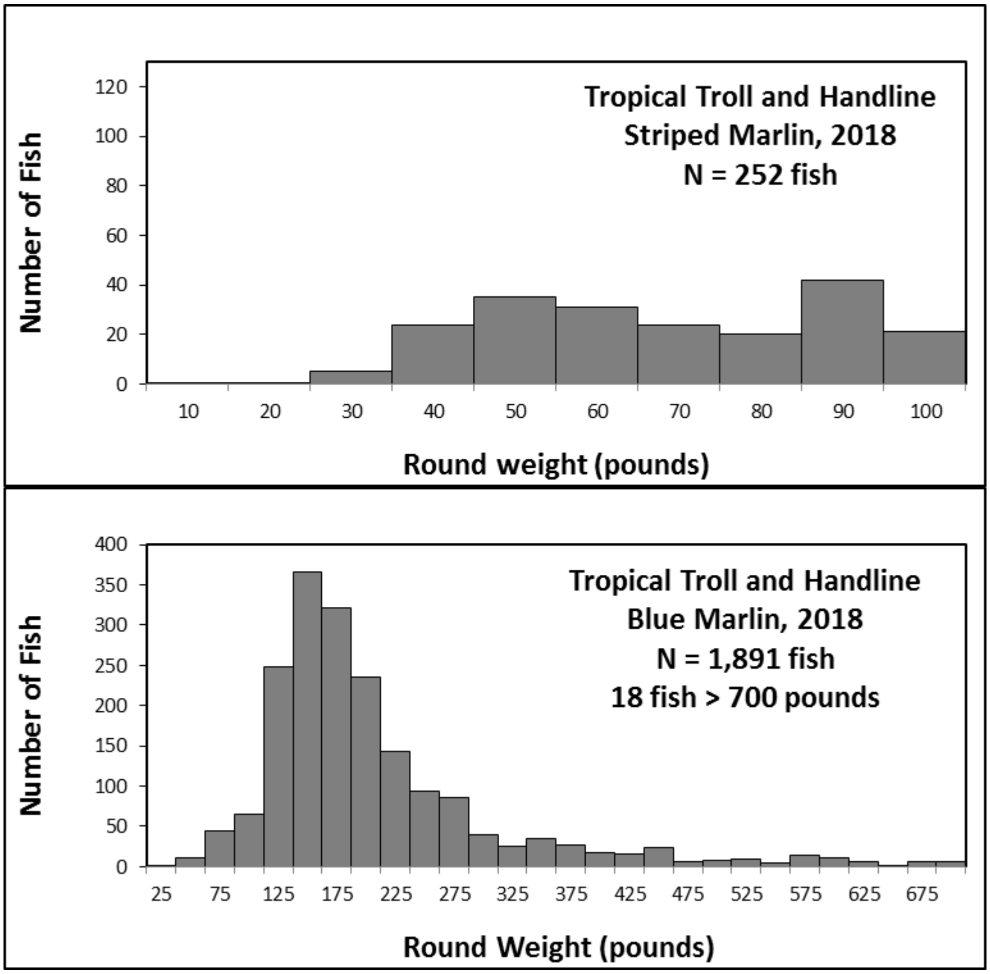

Figure 11. Size distribution of (A) striped marlin (*Kajikia audax*) and (B) blue marlin (*Makaira nigricans*) caught by the Hawaii troll and handline fisheries, 2018.

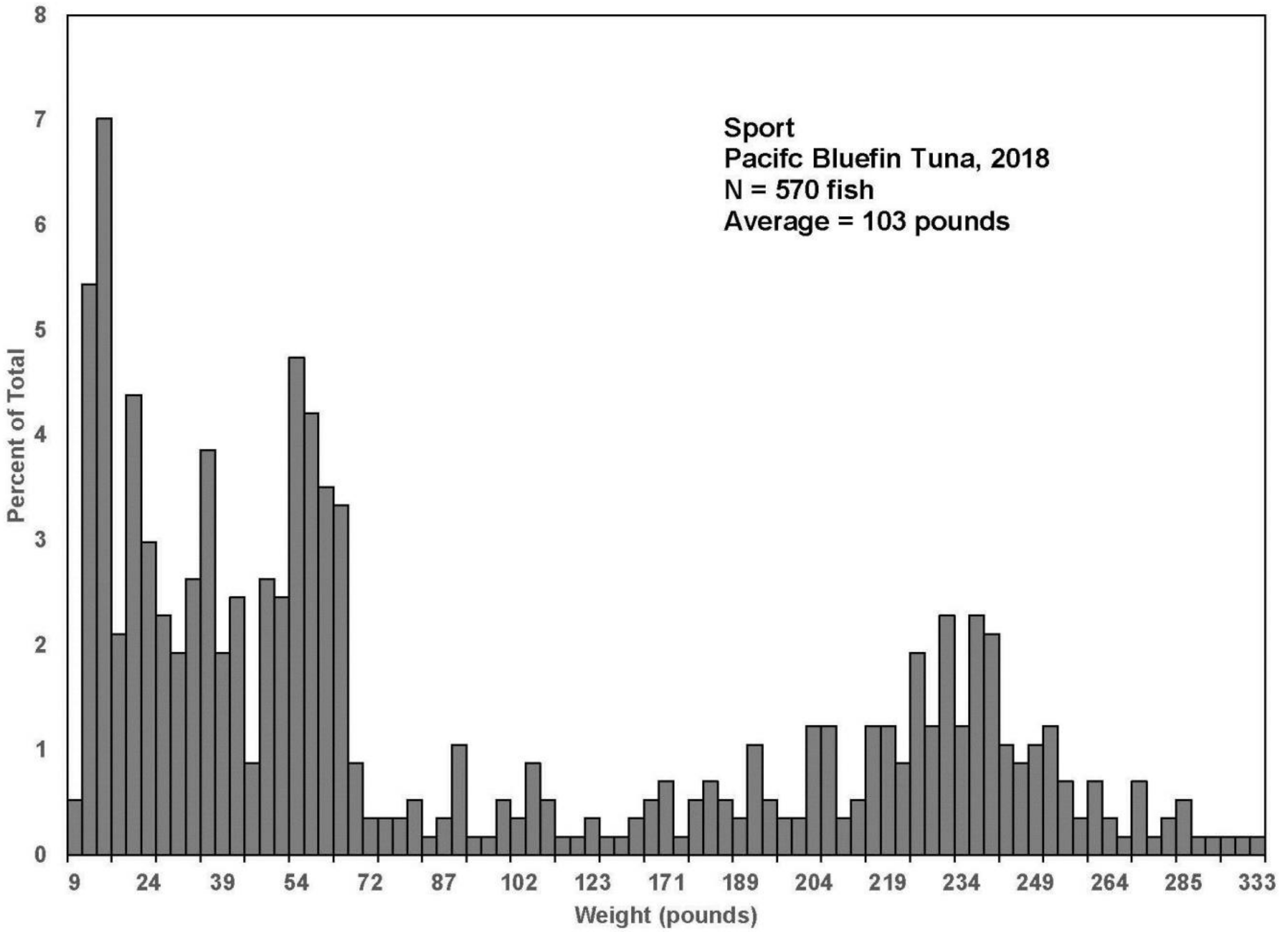

Figure 12. Size distribution of Pacific bluefin tuna (*Thunnus orientalis*) caught by the U.S. West Coast sport fishery in 2018.

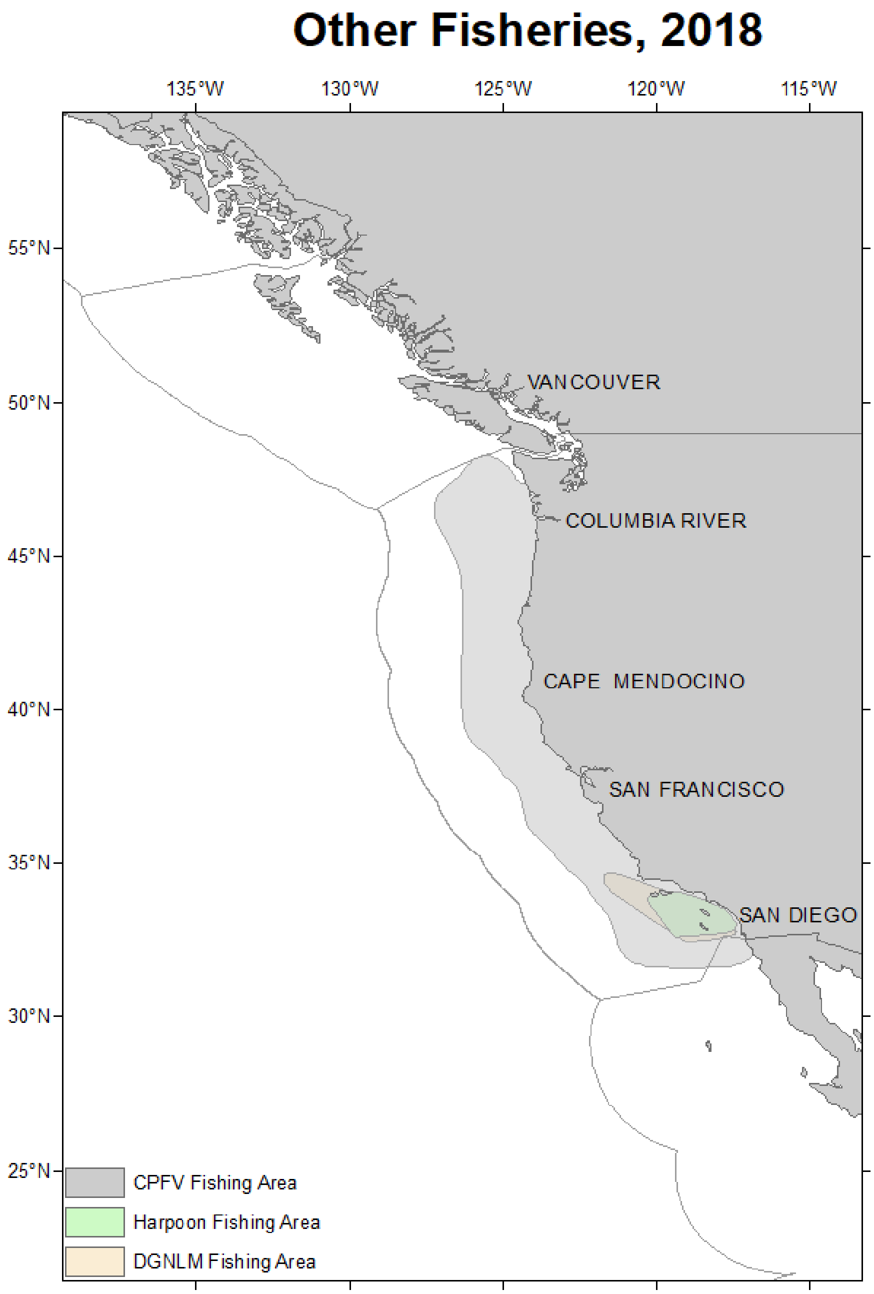

Figure 13. Spatial distribution of reported logbook fishing effort by the 2018 U.S. harpoon, large mesh drift gillnet, and west coast sport fishery in the North Pacific Ocean. Effort is not shown in order to preserve data confidentiality.

Table 1. Number of vessels fishing in the North Pacific Ocean in various U.S. fisheries. Data for 2018 are preliminary. -- indicates data are not available.

Year	Purse Seine [1]	Longline	Albacore Troll and Pole-and-Line	Tropical Pole and Line	Tropical Troll [2]	Tropical Handline	Gillnet	Harpoon	Surface Hook and Line
1985	53	36	792	27			210	99	
1986	51	39	419	19			220	113	
1987	47	37	486	18	1,899		210	98	
1988	74	50	531	17	1,878		192	83	
1989	73	88	338	18	2,002		158	44	
1990	71	138	368	12	2,042		146	49	
1991	59	141	172	12	2,117		123	32	
1992	72	124	602	11	2,160		113	48	
1993	68	122	608	13	2,132		105	44	
1994	72	127	721	11	2,210		112	49	
1995	65	116	471	11	2,387		127	39	
1996	61	114	676	9	2,411		100	30	
1997	68	117	1,172	9	2,400		104	31	
1998	68	122	841	9	2,370		87	26	
1999	42	140	776	9	2,502		78	30	
2000	40	130	645	7	2,229		77	26	
2001	43	125	860	9	2,208		64	23	
2002	31	123	644	13	2,045		45	29	
2003	29	128	729	14	1,960		37	34	
2004	28	126	695	11	2,012		33	29	
2005	23	126	541	10	1,917		37	24	
2006	11	128	601	11	1,916		45	24	
2007	22	130	676	3	1,869	424	49	28	
2008	36	130	525	3	1,978	475	51	32	
2009	46	128	687	6	2,083	552	35	28	
2010	37	125	635	2	2,042	480	26	26	
2011	39	129	656	2	2,100	508	22	17	
2012	40	129	841	1	2,084	576	17	10	
2013	40	136	703	2	2,185	534	18	13	
2014	46	141	615	2	2,115	499	20	15	81
2015	44	143	574	2	1,957	478	19	15	123
2016	41	141	568	2	1,915	475	21	23	89
2017	41	145	518	2	1,826	487	18	25	82
2018	46	145	452		1,786	431	20	18	99

[1] Number of Purse Seine vessels include vessels from the WCPO and EPO fleets

[2] Number of tropical troll vessels for 1987-2006 include tropical handline vessels

Table 2. U.S. catches (metric tons) of tunas and tuna-like species by fishery in the North Pacific Ocean, north of the equator. Data for 2018 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	TUN	SWO	BUM	MLS	BIL [5]	ALV [6]	PTH	BTH	SMA [6]	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	31	3,694	14,378	512	410												19,025
2010		7,136	41,523	1,557			0	1	1	15						34	50,267
2011		3,996	30,348	1,893		65		6	0	10				0		30	36,348
2012		5,837	42,479	1,038													49,354
2013		4,658	62,904	1,988													69,550
2014	0	6,624	57,474	855	401		0	1		0							65,355
2015		10,501	42,658	752	86			0		2							53,999
2016		6,462	52,859	1,663	316			0		1							61,301
2017		10,672	45,964	3,435	466			3		2							60,542
2018		10,105	55,629	5,269	12			2	0	0							71,017
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	5	3,807	362	326	99							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	2,848	467	418	115							7,581
1997	1,653	1,143	106	2,526	26	2	3,393	487	352	143							9,831
1998	1,120	724	76	3,274	54	9	3,681	395	378	172							9,883
1999	1,542	477	99	2,820	54	10	4,329	357	364	242							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	9	1,185	283	376	200							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	0	1,735	262	276	160	44			128	8	7	9,629
2008	354	875	120	5,959	0	0	2,014	349	427	238	41			133	7	4	10,521
2009	203	527	136	4,628	1	0	1,817	360	258	124	30			120	9	6	8,219
2010	421	568	153	5,440	0	0	1,676	306	165	131	18			94	7	3	8,982
2011	708	937	207	5,701	0	0	1,623	373	362	249	19			68	13	2	10,262
2012	660	887	245	5,873	0	0	1,395	298	282	173	14			68	16	1	9,912
2013	317	736	233	6,493	1	0	1,270	406	398	227	6			52	1	0	10,141
2014	208	658	187	7,131	0		1,665	535	426	238	7			53			11,108
2015	243	921	212	8,774	0	0	1,516	631	493	279	7			59			13,135
2016	248	1,512	240	8,229	0	0	1,092	554	390	361	4			70	0	0	12,701
2017	95	2,593	221	7,993	1		1,618	687	406	320	4			71			14,009
2018	86	2,496	149	7,572	1		1,053	663	465	233	2			60			12,779

Table 2. Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	TUN	SWO	BUM	MLS	BIL	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	12,340		0		0									0			12,340
2010	11,689		0														11,690
2011	10,143		0		0												10,143
2012	14,149		0		0												14,149
2013	12,310		0		0										0		12,310
2014	13,398	0			0												13,398
2015	11,595		0											0		0	11,595
2016	10,777				0												10,777
2017	7,430				0												7,430
2018	7,737																7,737
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																	-
2013																	-
2014																	-
2015																	-
2016																	-
2017																	-
2018																	-

Table 2. Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	TUN	SWO	BUM	MLS	BIL [5]	ALV [6]	PTH	BTH	SMA [6]	BSH	SKH	TOTAL
Tropical Troll																	
1985	7	967	101	8		2		145	18	12							1,260
1986	5	1,493	120	5		4		220	19	14							1,880
1987	6	1,616	137	8		11		261	29	20							2,088
1988	9	941	172	17		11		266	54	20							1,490
1989	36	828	153	14		11		326	24	23							1,415
1990	15	891	138	25		11		295	27	17							1,419
1991	72	802	237	25		9		346	41	25							1,557
1992	54	602	167	13		10		260	37	17							1,160
1993	71	861	157	3		6		311	67	20							1,496
1994	90	870	138	7		8		298	35	22							1,468
1995	177	978	152	20		7		315	52	29							1,730
1996	188	934	224	7		5		409	53	18							1,838
1997	133	770	196	26		4		378	37	17							1,561
1998	88	766	143	9		6		242	26	19							1,299
1999	331	1,019	181	24		4		293	27	33							1,912
2000	120	1,080	415	207		15		235	15	20							2,107
2001	194	878	523	226		13		291	44	32							2,201
2002	235	632	355	586		6		225	30	13							2,082
2003	85	735	268	213		25		210	29	18							1,583
2004	157	746	251	381		45		188	31	23							1,822
2005	175	679	259	295		14		187	20	15							1,644
2006	95	508	296	303		12		160	21	14							1,409
2007	3	501	266	63		8	1	127	13	12							994
2008	1	451	481	74		7		198	14	14							1,240
2009	3	471	412	59		12	0	15	10	8							990
2010	2	426	416	118		25		148	19	12						1	1,167
2011	4	496	385	110		16		199	16	18						1	1,245
2012	3	644	381	155		18	1	141	11	16						1	1,371
2013	2	528	535	148		5	1	137	8	16						1	1,381
2014	3	579	364	143		14	1	159	12	12	1					1	1,289
2015	2	556	398	59		15	1	196	11	17						1	1,256
2016	1	531	402	34		5		161	12	20						1	1,167
2017		466	389	37		16		155	6	13						1	1,082
2018	1	582	491	27		4	1	164	11	16							1,298
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		1	5	1									686
2008	28	227	9	148		1	6	1									420
2009	97	317	11	136		3	5	1									570
2010	53	265	7	340		4	3	2			1			1			676
2011	84	357	9	296		1	5	2									754
2012	253	381	12	298		1	6	2			1			1			955
2013	46	442	14	393		1	6	3			1						906
2014	49	385	8	206		2	7	4									661
2015	62	401	5	202		1	5	3			1						680
2016	24	269	5	183		2	4	2						1			490
2017	35	400	6	106		2	6	4									559
2018	20	337	5	124		1	3	3									493

Table 2. Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	TUN	SWO	BUM	MLS	BIL	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	4	2,069				455	0	34	250	1		2,849
1987	5	3		6	2	5	1,529				354	2	18	208	1		2,133
1988	15	7		5	4	2	1,376				352	1	7	106	0		1,875
1989	4	1	5		3	3	1,243				430	0	16	117			1,822
1990	29	1	1	1	11	2	1,131				266	1	30	229	0		1,702
1991	17	1	3	3	4	3	944				542		31	125	0		1,673
1992		4	1	1	9	6	1,356				256	0	18	118	1		1,770
1993		7	2		32	9	1,412				243	1	41	87	0		1,834
1994	38				28	2	792				292	0	32	80	0		1,264
1995	52	2	70	1	20	1	771				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	2	931				332	2	11	85	0		1,492
1999	149			2	22	1	606				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	1	443				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		3		253				38		7	21			326
2010	5				1		62				41		1	10			120
2011	5		0		18		119				55	0	1	8			206
2012	8		1	0	4		118				37			9		1	177
2013	5		0		7		95				48		1	16		0	172
2014	0		0	0	5		127				26	6	1	7			171
2015	1	1	0		4		99				31	2	0	7			145
2016	1	0	0		9	0	173				28	0	1	12		0	225
2017		1	0	0	1		177				39	4	0	12			235
2018		0	1		19		145				26	0	1	11			204
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
2013							6							0			6
2014							6							0			7
2015							5				0						5
2016							25							0			26
2017							28							0			28
2018							10										10

Table 2. Continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	TUN	SWO	BUM	MLS	BIL	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Surface Hook and Line [3]																	
1985																	-
1986																	-
1987																	-
1988																	-
1989																	-
1990																	-
1991																	-
1992																	-
1993																	-
1994																	-
1995																	-
1996																	-
1997																	-
1998																	-
1999																	-
2000																	-
2001																	-
2002																	-
2003																	-
2004																	-
2005																	-
2006																	-
2007																	-
2008																	-
2009																	-
2010																	-
2011																	-
2012																	-
2013																	-
2014		8	0		2	0	0				2			3			16
2015		15	1		7	0	1				2			1			27
2016		5	0		31		11				5			1			52
2017		4	0		18	0	3				5			1			31
2018		5	1		30		1				0			1			38
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				283				11								319
1994	106				86				17								209
1995	102				245				14								361
1996	88				40				20								148
1997	1,018				131				21								1,170
1998	1,208				422				23								1,653
1999	3,621				408				12								4,041
2000	1,798				319				10								2,127
2001	1,635				344				0								1,979
2002	2,357				613				0								2,970
2003	2,214				355				0								2,569
2004	1,506				50				0								1,556
2005	1,719				73				0								1,792
2006	385				94				0								479
2007	461				12				0								473
2008	418				63												481
2009	944	766	2		156												1,868
2010	862	276			88												1,226
2011	421	324			225												970
2012	1,212	708			400												2,320
2013	839	433	4		809												2,085
2014	1,042				420						1				0		1,463
2015	932				399						1				0		1,331
2016	675				368						2			0	0		1,045
2017	372				450						1				0		824
2018	170				484						1				0		655

Table 2 continued.

FISHERY/YEAR	ALB	YFT	SKJ	BET	PBF	TUN	SWO	BUM	MLS	BIL	ALV	PTH	BTH	SMA	BSH	SKH	TOTAL
Other [4]																	
1985	118	58	5	1	20	468	104				332		5	19	1		1,131
1986	66	227		6	41	6	109				93		14	59	1		622
1987	139	2,159	633	1	18	67	31				116		1	188	1		3,354
1988	76	936	372	1	46	2	64				67		2	214	3		1,783
1989	10	849	103		18		56				65		1	137	6		1,245
1990	20	508	147		81	1	43				90		0	141	20		1,051
1991	20	235	137		0		44				42		0	91	1		570
1992	40	1,119	1,014		14	2	47				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	1	19				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	1	3	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		7	1		2		0				66	0	1	7	1		85
2010	0	0			0						55		0	10	0		65
2011	0	1			100	0					20		0	8	0		130
2012	2	0	0		38		1				30	1		11	0		84
2013	0	2	1		3		7				18	6	0	12	0		49
2014		0	0		0		4				12			6	0		22
2015	2	1	0		0		13		0		24	0	1	4	0		46
2016	0	2	0	1	0	0	42				16	0	1	4	0		68
2017	14	0		5	0		44				21		1	6	0		91
2018		0	5	0			69				18			5	1		98

1 Purse Seine catches include EPO and WCPO fisheries. Bluefin catches are from EPO only.
2 Longline includes American Samoa, Hawaii, and California fisheries.
3 Tropical troll 1985-2006 includes tropical handline catches
4 Other catches include incidental catches from non-HMS fisheries
5 BIL catches for Tropical Troll, Purse Seine, and Longline include Black Marlin, Sailfish, Spearfish, and other billfish
6 Thresher and mako shark catches are not reported at the species level in the Longline, Tropical Troll and Tropical Handline fisheries but are listed under ALV and SMA, respectively.