U.S. National Report to the 5th ISC On Fisheries and Research for Tuna and Tuna-like Species in the North Pacific[1]

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Honolulu, Hawaii U.S.A.

and

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Introduction

A variety of U.S. fisheries harvest tuna and tuna-like species in the North Pacific. Large-scale purse seine, albacore troll, and longline fisheries operate both in coastal waters and on the high seas. Small-scale gill net, harpoon, and pole-and-line fisheries and commercial and recreational troll and handline fisheries operate generally in coastal waters. Overall, the range of U.S. fisheries in the Pacific is extensive, from coastal waters of North America to Guam and the Northern Mariana Islands in the western Pacific and from the equatorial region to the upper reaches of the North Pacific Transition Zone.

In U.S. Pacific fisheries for tunas and billfishes, fishery monitoring responsibilities are shared by the National Marine Fisheries Service (NMFS) and by partner fisheries agencies in the states and territories of California, Oregon, Washington, Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. On the federal side, monitoring is conduced by the Pacific Islands Regional Office (PIRO) and the Pacific Islands Fisheries Science Center (PIFSC) in Hawaii and by the Southwest Regional Office (SWRO) and the Southwest Fisheries Science Center (SWFSC) in California. NMFS fishery monitoring activities include collection of landings and sales records at markets and ports of landing, federally-mandated logbook statistics on fishing effort and catch, observer data, and biological sampling data. In the central and western Pacific, 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[1]. In California, Washington, and Oregon, landings receipts are collected by state agencies and placed in the Pacific Fisheries Information Network (PacFIN) system. State agencies are also mandated to collect logbook data and have also collected size composition data. The management of data on U.S. Pacific fisheries for tuna and tuna-like species is coordinated between the SWFSC, SWRO, PIFSC, and PIRO. Data catalogs, metadata, data summaries, reports, and related information are being assembled as part of a Web-based portal hosted at the SWFSC (still under construction).

[1] http://www/pifsc.noaa.gov/wpacfin/

This report provides information on the number of active vessels by fleet and their catches of tunas and billfishes in the North Pacific based on the data available through 2003, which are considered complete. Data for 2004 are incomplete but in some cases provisional estimates are given for 2004. Although the report is focused on tunas and billfishes, many of the fisheries described catch other pelagic fishes important to the fishing fleets and local economies; catch data for these species are not included.

NMFS 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. The report includes summaries of recent and ongoing scientific work at the PIFSC and SWFSC of primary relevance to the ISC.

Fisheries

Purse Seine Fishery

Western and Central Pacific

The U.S. purse seine fishery in the western and central Pacific Ocean (WCPO) started in a big way in 1976. The fishery operates mainly in areas between 10° N and 10° S latitude and 130° E and 150° W longitude (Figure 1). The number of U.S. vessels participating in the fishery and fishing north of the equator decreased from a high of 48 in 1994 to 22 in 2002 before increasing to 26 in 2003 (Table 1). Catches are primarily of skipjack tuna (73%) with smaller quantities of yellowfin tuna (22%) and bigeye tuna (5%) taken. Before 1995 the fleet fished mainly on free-swimming schools of tunas unassociated with floating objects such as logs and Fish Aggregating Devices (FADs). From 1995 to 2000 fishing on schools associated with floating objects became more prevalent. Since 2000, fishing has been about equally distributed between associated and unassociated schools.

U.S. catches of tunas north of the equator (most of the catch is south of the equator) are shown in Table 2. Skipjack tuna catches peaked in 1992 at 62,730 t (metric tons), then fluctuated but generally decreased, reaching 3,244 t in 2002 before increasing to 17,293 t in 2003. Yellowfin tuna catches decreased from a high of 21,845 t in 1998 to a low of 1,175 t in 2000 and then increased to 3,321 t in 2003. Preliminary estimates of the catches of skipjack and yellowfin tuna in 2004 are 972 t and 2,798 t, respectively. Skipjack tuna caught in 2003 generally ranged in fork length from 35 cm to 76 cm and averaged 52 cm, while yellowfin tuna ranged from 30 cm to 143 cm and averaged 67 cm (Figure 2). Tunas caught in associated sets are usually smaller than those caught in unassociated sets.

U.S. purse seine vessels fishing in the WCPO have been monitored by NMFS 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 measured for fork length by NMFS personnel as vessels land their catches in American Samoa (coverage approximately 1-2% of landings). Species composition samples are also taken and used to separate yellowfin tuna from

bigeye tuna in the reported landings. The Forum Fisheries Agency (which manages the Treaty) places observers on approximately 20% of the vessel trips.

Eastern Pacific

The U.S. purse seine fishery in the eastern Pacific Ocean (EPO) started in the late 1950's. The fishery currently operates mainly in areas between 20° N and 20° S latitude and between the Central American coastline and 150° W longitude (Figure 1). The number of U.S. vessels fishing north of the equator has decreased from 71 in 1985 to 4 in 2001-2003 (Table 1). Catches were mainly yellowfin tuna until 1995. For several years, the Inter-American Tropical Tuna Commission (IATTC) has managed the harvesting of yellowfin tuna using quotas and recently started setting quotas for bigeye tuna as well. Yellowfin tuna were caught mainly in association with schools of dolphins until the 1990s when a dolphin-free policy, adopted by canneries, forced the vessels to fish on free-swimming schools or schools associated with floating objects, including FADs deployed by the vessels. Skipjack tuna became more prevalent in the catch as fishing concentrated more on FADs, and the catches of bigeye tuna increased as well. Many U.S. vessels moved to the western and central Pacific Ocean because of the policy adopted by the canneries.

U.S. purse seine catches of yellowfin tuna north of the equator decreased from 88,031 t in 1987 to 295 t in 2003 (Table 2). Skipjack tuna catches decreased from 28,137 t in 1988 to 984 t in 2002 and then increased to 3,138 t in 2003. Preliminary data indicate that the 2004 yellowfin tuna and skipjack tuna catches north of the equator were 320 t and 1,500 t, respectively. Other tuna and tuna-like fishes are also caught and are shown in Table 2. Yellowfin tuna caught in 2003 ranged from 34 cm to 150 cm fork length, and skipjack tuna ranged from 33 cm to 85 cm fork length (Figure 3).

The IATTC monitors U.S. purse seine vessels fishing in the EPO. Logbooks (coverage 100%) are submitted by vessel operators, and landings (coverage 100%) are obtained from each vessel or from canneries or fish buyers. Fish are measured for fork length by port samplers (coverage unknown but probably less than 2% of the fish landed). IATTC observers are placed on all large purse seine vessels.

Albacore Troll Fishery

The U.S. troll fishery for albacore in the North Pacific Ocean started in the early 1900's. The fishery operates in waters between the U.S. west coast and 160° E longitude (Figure 4). 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 179 in 1991 to a high of 1,121 in 1997 (Table 1). In 2003, 718 vessels participated in the fishery. Historically, some pole-and-line vessels targeted albacore seasonally, but few pole-and-line vessels have operated in recent years.

The troll fishery catches mainly albacore. While transiting to and from the fishing grounds, minor amounts of skipjack, yellowfin and bluefin tunas, eastern Pacific bonito, yellowtail, and mahimahi are incidentally caught. Since 1985, the albacore catch has ranged between 1,845 t in 1991 and 16,938 t in 1996 (Table 2). In 2003, 17,237 t were caught. The

preliminary estimate of the 2004 catch is 13,200 t. Sampled albacore caught in 2003 ranged in fork length between 47 and 99 cm and averaged 75 cm (Figure 5).

U.S. troll vessels voluntarily submit logbook records to NMFS. Since 1995, however, those vessels fishing on the high-seas have been required to submit logbooks and beginning in 2005, all troll vessels will be required to do so. Logbook coverage rate in 2003 is approximately 30% of the landings. Landings are monitored by NMFS and various state fisheries agencies and coverage is 100% of the fleet. Landings are also measured for fork length by state agency port samplers along the U.S. west coast and by NMFS personnel in American Samoa. Coverage rate in 2002 is approximately 1% of the landings.

Longline Fishery

The U.S. longline fishery targeting tuna and tuna-like species in the North Pacific Ocean is made up of two components, the Hawaii-based fishery and the California-based fishery. Vessels transited between the two areas freely until 2000 when domestic regulations placed restrictions on moving between the two domestic management areas. The Hawaii-based component of the U.S. longline fishery comprises a majority of the vessels, fishing effort, and catch.

Hawaii-based fleet

The Hawaii-based domestic longline fishery started in the early 1900's with small, wooden sampan-style boats fishing in the coastal waters of Hawaii for large tunas. This fishery continued to target tunas up to the late 1980's, and the fishing grounds expanded into oceanic waters off Hawaii as larger, steel-hulled boats entered the fishery. The fishery started expanding rapidly in the late 1980's as new participants arrived from the Gulf of Mexico. Then, in the early 1990's, a second wave of longline vessels began arriving in Hawaii with experience targeting swordfish in the fishery off the U.S. Atlantic seacoast. The number of vessels increased more than four-fold from 37 in 1987 to 141 in 1991 (Table 1). During this time, the exportation of high quality bigeye tuna to Japan began, coinciding with an expansion of the Japanese economy. Also, with increased targeting of swordfish, Hawaii quickly became a major exporter of swordfish to the U.S. mainland. The number of vessels participating in the fishery decreased in 1992 and ranged between 100 and 125 vessels thereafter. Regulatory restrictions due to interactions with endangered sea turtles curtailed swordfish-directed effort in 2000 and 2001, though the number of vessels did not change much. Swordfish targeting was prohibited altogether in 2002 and 2003, after which the fishery targeted tunas exclusively. A seasonal area closure was also imposed on the tuna longline fishery to reduce interactions with sea turtles. Hawaii-based longline vessels that targeted swordfish were also active in the California longline fishery prior to the prohibition and many elected to stay in California to continue targeting swordfish. Other swordfish longliners converted from targeting swordfish to targeting tunas in order to stay in Hawaii. There were 110 vessels participating in the Hawaii longline fishery in 2003. The range of the fishery extended from 5^{o}N to 35^{o}N latitude and 145^{o}W to 175^{o}W longitude (Figure 6). The Hawaii-based longline vessels land their catches fresh. In Hawaii, swordfish are generally landed as trunks (headed, tailed, and gutted). Tunas and other bony fishes are usually landed whole. Sharks are landed headed and gutted.

Catch levels and catch species composition in the Hawaii-based longline fishery changed considerably over the past 17 years in response to fishery and regulatory changes. The annual catch of tunas and billfishes rose steadily from 1,619 t in 1987 to 10,087 t in 1993 due to expanding fleet size and increased targeting of swordfish. Catches of swordfish grew from 24 t to 5,909 t during this period while tuna catches increased to a lesser extent, rising from 2,705 t to 7,206 t. The total catch of tunas and billfishes dropped to 6,930 t in 1994 primarily to due poorer swordfish catches. In the following years, catches of tunas increased. The total catch of tunas and billfishes fell dramatically after 2000 due to regulatory changes including the prohibition of shallow-set longline gear. Catches of swordfish declined sharply while targeting of bigeye tuna increased.

The Hawaii-based longline fishery is monitored by the PIFSC and the State of Hawaii's Division of Aquatic Resources (DAR). PIFSC biologists collect mandatory logbooks of fishing effort, catch, and other information from longline fishers, generally at the docks in Honolulu. The coverage for this fishery was complete (100%) in 2003. DAR also requires fish dealers to submit market data, and coverage was nearly 100% in 2003. Observers contracted by NMFS's Pacific Islands Regional Office are placed on longline vessels to monitor protected species interactions, vessel operations, and catches. The coverage rate of the observer data is mandated by law to be no less than 20%, and 100% on vessels targeting swordfish.

California-based fleet

The California-based domestic longline fishery began in 1991. The fishery extends from outside the U.S. west coast EEZ to waters near Hawaii (Figure 7). The longline fleet increased from 3 vessels in 1991 to 44 vessels in 2000, and decreased to 20 vessels in 2002 (Table 1). In 2003, an estimated 24 vessels participated in the fishery.

The California-based longline fleet targets primarily swordfish and catches tunas and other fishes incidentally (Table 2). Catches of swordfish reached their highest levels in 2000 at 1,908 t. Since then swordfish catches have fluctuated. The 2003 catch of swordfish was 1,811 t, while the preliminary estimate for 2004 is 900 t.

Landings data are collected from 100% of the fleet by the California Department of Fish and Game (CDFG). Logbooks developed by the fishing industry (similar to the federal logbooks used in Hawaii) were submitted voluntarily to NMFS until 1994. From 1995 to 1999, CDFG collected logbooks from 100% of the fleet, and NMFS has done so since 1999 as a requirement of the High Seas Fishing Compliance Act. When boats depart Hawaii and land in California, the CDFG collects federal logbooks and sends them to PIFSC in Hawaii. Landed swordfish were measured for fork length by CDFG port samplers until 1997. NMFS's Southwest Regional Office currently places observers on California longline vessels. The observers also collect length measurements.

Troll and Handline Fisheries, Pacific Islands

In Guam and the Northern Mariana Islands, only a troll fishery operates for tuna and tuna-like species. In Hawaii, a specialized tuna handline fishery operates as well as a troll fishery. In general, boats that participate in these fisheries are relatively small (typically around 8 m in length) and make day long trips fishing in coastal waters. Some multiple-day handline trips take place to seamounts and NOAA weather buoys off Hawaii. The operations range from recreational, subsistence, and part-time commercial to full-time commercial. Their catches generally are landed fresh and whole, although some catches are gilled and gutted.

The total catch from these U.S. Pacific Island fisheries ranged from 1,509 t to 2,525 t during 1985-2003. Yellowfin tuna made up about half of the troll and handline catch. The next largest components of the catch were blue marlin and skipjack tuna. Although bigeye tuna and albacore represented small components of the catch, Hawaii catches of these species have been increasing. The Hawaii troll and handline fisheries typically account for almost 90% of the total U.S. Pacific Island troll and handline landings.

The Guam Division of Aquatic and Wildlife Resources (DAWR) monitors the troll fishery using a statistically designed creel survey. The Guam DAWR, with the assistance of NMFS, extrapolates the creel survey data to produce total catch, fishing effort, and participation estimates. The Hawaii troll and handline fishery catch and effort summaries are compiled from Hawaii DAR commercial catch reports and fish dealer reports. The Commonwealth of the Northern Mariana Islands monitors the troll fishery using their Commercial Purchase database.

Other Fisheries

U.S.-flag vessels also harvest tunas and tuna-like fishes in the North Pacific Ocean using pole-and-line, gill net, and harpoon gear. A small number of U.S. pole-and-line vessels operate off the North American west coast and around Hawaii. These fleets have different origins and have operated independently. Both fleets have declined recently and are no longer significant contributors to the U.S. catch (Table 2).

Pole-and-line Fishery, Eastern Pacific Ocean

This pole-and-line fishery operates in waters along the U.S. west coast to areas off Central America and South America. The vessels usually target yellowfin tuna and skipjack tuna or albacore. The number of pole-and-line vessels operating north of the equator decreased from 9 in 1985 to 1 in 2003 (Table 1). The highest yellowfin tuna catch north of the equator was 1,897 t, recorded in 1987. The highest skipjack tuna catch was 1,012 t in 1989 (Table 2). The pole-and-line catches of yellowfin and skipjack tunas were less than 2 t in 2003 and 3 t in 2004 (preliminary data).

Logbook data (fishing effort and catch) for this fishery are collected by the IATTC and NMFS. Fork-length data for yellowfin and skipjack tunas are collected by the IATTC. Albacore fork-length data are collected by NMFS through a contract with state agencies of Oregon, Washington, and California. Landings data are collected by state agencies (coverage 100%).

Pole-and-Line Fishery, Hawaii

The Hawaii-based pole-and-line fishery, using mostly wooden sampan-style boats, was once the largest commercial fishery in Hawaii, targeting skipjack tuna. However, beginning in the mid-1960's, the fleet gradually declined and in 1989 the Honolulu tuna cannery that had provided a key outlet for the fleet's catch closed. By 2003, there were only 6 boats participating in the fishery (Table 1). The Hawaii pole-and-line fishery has operated exclusively in coastal waters of Hawaii. The fishery is markedly seasonal with the largest catches occurring in summer months.

Total annual catch by the Hawaii pole-and-line fishery was highest in the late 1980's and ranged from 959 t to 1,785 t during this period (Table 2). The catch then declined to an average of 704 t in the 1990s and 384 t in the 2000's with the 2003 catch equaling 458 t. The Hawaii pole-and-line catch is composed predominantly of skipjack tuna, with yellowfin tuna and mahimahi being minor components.

Hawaii DAR monitors the fishery using catch reports submitted by fishers and market reports submitted by fish dealers.

Drift Gill Net Fishery

The drift gill net fishery operates mainly in areas within the 200 mile EEZ of California and sometimes off Oregon (Figure 8). Tuna and tuna-like fishes are caught mainly by drift gill nets, with minor quantities caught incidentally in set gill nets. The number of vessels participating in the fishery decreased from 220 in 1986 to 37 in 2003 (Table 1). Swordfish catches were 2,368 t in 1985 and have fluctuated while decreasing to 216 t in 2003 (Table 2). The preliminary 2004 swordfish catch estimate is 170 t.

Gill net fishery landings data (100% coverage) are collected by state agencies in California, Washington and Oregon (only minor amounts of tuna and tuna-like fishes are landed in Oregon or Washington). Logbook data for gill net fisheries are collected from 100% of the fleet by the CDFG. CDFG also collected length data for swordfish landings until 1997; less than 1% of the landings were sampled. NMFS places observers on gill net vessels and also collect length data.

Harpoon Fishery

The harpoon fishery operates in areas within the 200-mile EEZ of California between 32°N and 34°N latitude (Figure 9). The number of vessels participating in the fishery decreased from 113 in 1986 to 23 in 2001 (Table 1). Swordfish are targeted. Swordfish catches decreased from 236 t in 1986 to 16 t in 1991 and then fluctuated, reaching 106 t in 2003 (Table 1). The 2004 estimated swordfish catch is 70 t.

Landings and logbook (catch and fishing effort) data for the harpoon fishery are collected by the CDFG and coverage is 100% of the fleet. Length measurements were taken until 1997, covering less than 1% of swordfish landings.

Research

U.S. government research on tunas and tuna-like species of the North Pacific Ocean is shared between the Southwest Fisheries Science Center (SWFSC) and the Pacific Island Fisheries Science Center (PIFSC) of the National Marine Fisheries Service. Studies are largely carried out from laboratories in La Jolla, California for the SWFSC and in Honolulu, Hawaii for the PIFSC and in collaboration with scientists of other government or university laboratories, both in the U.S. and abroad. Both Centers have studies devoted to stock assessment, biological and oceanographic research, and fishery management issues, but each Center concentrates largely on different species and fisheries in order to minimize duplication. In this section, studies that are underway are described, recent results are provided for some and the key investigators are identified. If the reader wishes to learn more about the studies, he/she should contact the investigators (SWFSC website: http://swfsc.nmfs.noaa.gov; PIFSC website: http://www.nmfs.hawaii.edu/)

Southwest Fisheries Science Center

The Southwest Fisheries Science Center has a long history of research on stocks and fisheries for highly migratory species (HMS). During the past few years, the SWFSC has focused increased resources on research of North Pacific HMS in order to address growing concerns about resource status and sustainability. Studies described in the following section are largely designed to address the growing concerns and are guided by NMFS strategic plan objectives of promoting resource stewardship and building sustainable fisheries. Included are research projects on North Pacific sharks, although not a current focus for the ISC, have relevance with respect to methodology being tested and information for an ecosystem-based approach for HMS.

Stock assessment studies − The SWFSC investment in stock assessment research is designed to deliver accurate information on stock status and for providing relevant advice for managers. During the past year, the focus has largely been on supporting tasks of the North Pacific Albacore Workshop (NPAW), building a time series of abundance indices for juvenile sharks in nursery grounds off Southern California, and continuing the Billfish Tagging Program.

- 2004 marked the end of a 4-year workplan for the North Pacific Albacore Workshop with objective of producing a comprehensive stock assessment at the end of the 4 years. A team lead by Ray Conser and consisting of Paul Crone, Al Coan, Suzie Kohin and Gary Sakagawa worked with international counterparts during the 4-year period. Tasks included developing catch-at-age matrices, estimating indices of relative abundance, reviewing appropriate maturity schedules, natural mortality rates, weight-at-age relations, etc. for use in the assessment models and assisting in organizing meetings leading up to the 19th Workshop. The 19th Workshop was held in December 2004 in Nanaimo, Canada and chaired by Max Stocker of Fisheries and

Oceans Canada. Participants evaluated available data and information, made decisions on appropriate ones for the assessment and carried out the stock assessment at the workshop using a VPA-2BOX model. The results and full report of the Workshop are being prepared for release by June 2005.

- A team of SWFSC scientists lead by Dave Holts and consisting of Suzy Kohin, Antonella Preti, Darlene Ramon, Rand Rasmussen, Marinas Som and Sean Suk contributed to a project that monitors juvenile shortfin mako (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*) abundance off Southern California. Results of juvenile shark abundance surveys for the years 1994 to 2004 resulted in an overall fishing effort of 380 longline sets that soaked 56,807 hooks for 1,298 hours. Total catch for the period included 1,186 shortfin mako, 2,861 blue, 102 common thresher shark (*Alopias vulpinus*) and 515 pelagic ray (*Dasyatis violacea*). Virtually all of this catch was landed alive and released. Catches of shortfin mako varied from 48 in the 2000 survey to 190 in the 2001 survey, and catches of blue sharks varied from 70 in the 2002 survey to 991 in the 2000 survey. CPUE (catch per 100 hook-hours) for shortfin mako has declined significantly ($\alpha = 0.05$) over the period. CPUE for blue sharks also is declining but not at a significant rate. Length frequencies of captured mako and blue sharks indicate interannual variability with neither an increasing nor decreasing trend. Analysis of capture rates and length frequencies with respect to environmental data, and habitat use patterns recorded by electronic tags will help to standardize these indices. Fishery independent surveys of this type are invaluable for stock assessments and their value increases with the increased duration of the time series. At 10 years, this survey is already the longest running fishery independent survey for any highly migratory fish stock within the US EEZ, and can only now be considered the start of a useful index for stock assessments.

  Research conducted concurrently with the surveys included conventional tagging for movement information, marking with oxytetracycline (OTC) for age and growth studies, blood sampling for condition factors caused by capture stress and/or injury, acoustic tracking and satellite archival tagging for movement and physical habitat pattern descriptions, and a variety of physiological studies addressing cardiac function, swimming performance, and condition factors. A summary of concurrent work performed on the surveys is as follows:

  - Conventional tags deployed: shortfin mako 524, blue 78, and common thresher 201.
  - Satellite pop-up/transmitter tags deployed: shortfin mako 48, blue 56, common thresher 20.
  - OTC for age and growth studies: total of 488 shortfin mako and common thresher; recapture rate to date is 5.7%.
  - Blood samples drawn: 74 shortfin mako, 68 blue shark and 57 thresher shark for studies on condition at capture and post-release survival studies.
  - DNA samples collected: 309 shortfin mako and thresher samples collected and archived.

- Heart, liver, gonad and muscle tissue collected: specimens collected for a variety of ongoing studies including reproductive condition, heavy metal and DDT concentrations, and biochemical analyses.
- Stomachs collected: taken from moribund sharks for feeding pattern studies and to supplement ongoing food habitat studies.
- Physiological studies: measurements of swimming energetics were made using a self-contained, variable speed, water tunnel on 4 shortfin mako sharks and 6 pelagic rays.
- Live specimens collected: pelagic rays were collected by personnel from Monterey Bay Aquarium and are currently on display in the Aquarium's Outer Bay exhibit.

- In 2004 another project to monitor shark abundance was developed. This one was for indexing abundance of the common thresher shark for the West Coast population. The research design calls for defining the nursery area for common thresher shark, and to select a representative core area (or areas) within the nursery for sampling juveniles annually. The resulting 0-age pup, or neonate index of abundance should mirror adult abundance since adult populations and recruitment are tightly linked in K-selected sharks. This study will complement the fishery dependent data available through other sources.

  In this first year of the study, 16 survey trips were completed (6 gillnet and 10 longline). In 124 longline sets, 103 common thresher were captured, 34 of which were neonates. In 29 gillnet sets, 83 common thresher were captured, 37 of which were neonates. Neonates were captured in most sampled areas including off San Diego, Carlsbad, Gaviota and Santa Barbara, California. Depth-stratified sampling revealed that over half the neonates were caught in shallow waters of 0-25 fm. During this first year, various longline gears (e.g. hook size, bait, hooks/set) were utilized in order to determine the most effective gear for sampling neonates. Gillnet sampling was conducted only in areas north of Laguna Beach and not over the entire distribution range off southern California. During the second year of the study, 2005, longline sets will be conducted using a standardized gear that targets neonates. Plans also include gillnet sampling in southern areas between Laguna Beach, California and the Mexican border, and close to the Channel Islands. This thresher pre-recruit survey project provides the opportunity to enhance other ongoing studies of SWFSC shark researchers, including:

  - Conventional tagging
  - Satellite tagging
  - DNA collection
  - OTC injections for ageing studies
  - Stomach and reproductive tract collection from moribund sharks

- SWFSC billfish studies are on-going under the leadership of Dave Holts and includes an annual billfish angler survey and conventional tagging by anglers. In 2003, 832 billfish anglers reported catching 5,845 billfish during 6,732 fishing days in the Pacific

Ocean. The annual mean catch-per-effort for all billfish was 0.87 billfish per day in 2003, up from, 0.50 in 2002. The current mean catch rate of 0.87 is a new record high and well above the prior five-year average of 0.58 (1999 - 2003). The second highest rate in CPUE occurred in 2000. The lowest catch rates (0.33) in the late 1970s coincided with the period of intense commercial fishing for billfishes in the eastern Pacific Ocean.

The SWFSC's constituent-based Billfish Tagging Program began in 1963 and has provided tagging supplies to billfish anglers for 40 continuous years. Tag release and recapture data are used to determine movement and migration patterns, species distribution, and age and growth patterns of billfish. This volunteer tagging program depends on the participation and cooperation of recreational anglers, sport fishing organizations, and commercial fishers. Since inception nearly 52,000 fish of 75 different species have been tagged and released. Emphasis continues to be on the skillful tagging of billfish and bluefin tuna only. The tagging of other sport fish is not encouraged by this program.

Billfish Tagging Report cards received for 2003 indicate a total of 1,369 billfish and 91 other fish were tagged and released by 1,297 anglers and 265 fishing captains. In all, 534 blue marlin, 363 striped marlin, 696 sailfish, 151 spearfish, 7 black marlin, 2 swordfish and 16 unknown billfish were reported tagged and released in 2003.

Biological and Oceanographic Research − SWFSC research projects involving biology range from behavior and movement of North Pacific albacore to food habits of sharks. A few of the projects are described below.

- Since 1971, the SWFSC has had an ongoing partnership with the West-Coast based U.S. albacore fishing industry. Research is conducted in cooperation with the American Fisherman's Research Foundation (AFRF), a private foundation established by the Western Fishboat Owner's Association to promote research on albacore and related fish. Past projects have included exploratory fishing with simultaneous collection of oceanographic data, development of a standard logbook, research into the impact of high seas driftnetting, onboard and port sampling for size frequencies, and conventional tagging to study movements, growth, and longevity. Since 2001, SWFSC and AFRF have been conducting an archival tagging project to study migratory patterns, and depth and temperature preferences of north Pacific albacore. To date, 277 tags have been deployed. The goal is to deploy ≈500 tags by 2006. Sixteen tags have so far been recovered (6% recovery rate), and the data demonstrate extensive movement and diurnal vertical excursions to beyond 200 m during daytime with fish remaining in the upper 50 m at night. This project is being managed by Suzy Kohin and John Childers.

- A team of SWFSC scientists including Dave Holts, Suzy Kohin, Antonella Preti and Darlene Ramon is conducted a number of biological studies on sharks. One study involves age and growth of shortfin mako and common thresher shark with vertebrae

and OTC (oxytetrachcline) marked animals. A total of 488 OTC marked individuals have been released off southern California and 28 have been recovered (5.7%). Of those 28, vertebrae were collected from 18 of the sharks. Time at liberty ranged from 7 to 1,594 days with net movements of individual sharks as far as 2,648 nautical miles. Preliminary results indicate that juvenile and sub-adult shortfin makos lay down bands of unequal size each year; however, as they mature and transition from a coastal distribution to a more oceanic distribution, the calcification pattern in the vertebrae appears to change with hyaline and calcified zones becoming narrower and more equal in relative size. This is an extremely interesting finding since the question of whether the shortfin mako lays down one band or two per year has been an ongoing uncertainty, with 2 independent labs reporting conflicting results. Preliminary results from common threshers indicate that they lay down one band per year.

- Another study being conducted involves behavior and habitat use patterns of common thresher sharks. Satellite telemetry tags (pop-up tags, PSAT) are being used for this study. Seven common thresher sharks were tagged during spring and summer 2004. To date, 4 of the 5 pop-off tags have provided 18 months of behavioral data. One tag was recovered and the entire archived record has been downloaded providing a high resolution record of the shark's movements over a 4-month period. The fin mounted near real-time satellite transmitting tags, which have been a huge success on mako and blue sharks in earlier studies, prove not to be a useful tool for studying threshers as these animals apparently seldom swim with their fins exposed above the surface. Overall, the data demonstrated that thresher sharks have a diurnal pattern of swimming behavior foraying into deeper depths of up to 200 m during the daytime, while staying closer to the surface at night. The data are being examined with respect to oceanographic features (bathymetry, surface temperature, water column profile, and surface chlorophyll) in order to quantify the essential habitat of these sharks.

- A food habits study for common thresher shark is also underway. This study is investigating dietary differences during 1998-2000 when there was a transition between a warm-water regime to a cool-water regime off California-Oregon. The stomach contents of 165 thresher sharks collected during the warm water period August 1998 thru January 1999 and the contents of 87 thresher sharks collected during the cool water period, July 1999 thru May 2000, have so far been analyzed. During both periods, northern anchovy was the dominant prey item in the diet, however during the warm water period the diet was much more varied with more prey items encountered in the diets, and less specialization on northern anchovy as compared to the cool water period.

Fishery Management Research − A limited but important number of studies at the SWFSC falls into this category of fishery management research. One group of studies is being managed by Dale Squires and involves several researchers, including at the PIFSC. The researchers are applying different economic models to evaluate factors contributing to overcapacity in tuna fisheries, cost-effectiveness of mitigation measures for sea turtle-HMS

fishery interaction and factors for developing a limited entry scheme for fisheries included in the HMS fishery management plan of the U.S. Pacific Fishery Management Council.

Pacific Islands Fisheries Science Center

Scientists at the Pacific Islands Fisheries Science Center are actively engaged in research on tuna and tuna-like species and the fisheries that pursue them in the North Pacific. Studies are underway on stock assessment, biology, oceanography, and methods to reduce the incidental catch and mortality of protected species in longline fisheries. The work is conducted by PIFSC staff and affiliated scientists employed by the NOAA-University of Hawaii Joint Institute for Marine and Atmospheric Research (JIMAR) and co-located at the PIFSC. Many of the studies are funded by JIMAR's Pelagic Fisheries Research Program (PFRP).

Stock assessment studies – PIFSC stock assessment scientists routinely collaborate with colleagues in several Pacific nations to conduct stock assessments and related analyses. Last year, they contributed to several important analyses reported to the 17th meeting of the Standing Committee on Tuna and Billfish. One was a study of relative abundance indices for bigeye and yellowfin tuna in the western and central Pacific using Japanese longline data co-authored by PIFSC scientist Keith Bigelow and collaborators Adam Langley of the Secretariat of the Pacific Community's Oceanic Fisheries Program (SPC/OFP) and Toby Patterson of CSIRO. The others were stock assessments of yellowfin tuna and bigeye tuna in the western and central Pacific co-authored by John Hampton of SPC/OFP, Langley, Kleiber, and Kazuhiko Hiramatsu of Japan's National Research Institute for Far Seas Fisheries (NRIFSF). Bigelow and Kleiber will continue such collaboration this year as stock assessments for yellowfin tuna, bigeye tuna, and other species are prepared for the Western and Central Pacific Fisheries Commission.

- Research continues on the factors affecting the catch-per-unit-of-effort (CPUE) statistics used in stock assessments of tunas and billfishes. The fishing depth of longline gear affects its selectivity for various species, depending on the depth of their preferred habitat, the gear's soak time, and the species' diel migration. Understanding gear depth is important to interpreting and standardizing longline CPUE trends. Keith Bigelow, Mike Musyl (PIFSC/JIMAR), Francois Poisson (Indian Ocean Tuna Commission), and Pierre Kleiber have submitted for publication a manuscript on the subject: "Pelagic longline gear depth and shoaling: how deep is deep?" The manuscript provides details on 599 longline sets monitored with temperature-depth recorders (TDRs) and develops a model of longline shoaling based on mesoscale oceanographic factors.

- Work is underway on an updated Pacific-wide bigeye tuna stock assessment. This is a collaboration involving scientists from the IATTC, NRIFSF, SPC/OFP, and PIFSC. In support of the assessment, PIFSC scientists have produced bigeye tuna relative abundance indices for the Hawaii-based tuna longline fleet, Japanese tuna longline fleet, and Hawaii handline fleet and summarized bigeye size data for the Hawaii-base longline and handline fleets.

- In another collaborative project, Kleiber, John Sibert (PFRP), John Hampton (SPC/OFP), George Watters (SWFSC, formerly of IATTC), and Carl Walters (University of British Columbia) have co-authored an article for publication in the journal Nature. Their article challenges recent, highly publicized claims by Ransom Myers and Boris Worm (Dalhousie University) that pelagic fish abundance has declined drastically due to fishing. In the Kleiber et al. article, the authors show that the Myers and Worm findings were based on misleading use of "community CPUE", a statistic Myers and Worm computed using the catch rate of all species combined in the Japanese longline fishery. Kleiber et al. point out that high CPUE levels during the early years of the time series were associated with a longline fishery targeting albacore for canning, whereas lower CPUEs observed in later years were for a fishery that had switched to targeting higher valued bigeye tuna for the sashimi market. Although the authors agree that biomass of both species has declined, they assert that the reductions are not as drastic as indicated in the Myers and Worm paper.

Biological and Oceanographic Research – PIFSC staff and affiliated JIMAR scientists are engaged in several biological studies on billfish and other important pelagic species in Hawaii. These studies provide a basis for improved stock assessment and resource management.

- JIMAR scientists Mike Musyl and Lianne McNaughton are conducting studies to improve understanding of factors affecting the survival of marlin caught and released by recreational fishers. The project involves close cooperation with anglers and organizers of the Hawaiian International Billfish Tournament and builds on the recent work of fellow scientists including Chris Moves of Queens University in Canada. Musyl and McNaughton collect samples of blood and muscle tissue from marlin killed during capture or released alive and analyze them for heat shock proteins (HSPs). They also deploy pop-up archival satellite tags (PSATs) when opportunities arise. The HSPs are being evaluated as predictors of long-term post-release survival in billfishes. Such biochemical predictors may provide additional predictive capability to the information generated by PSATs. The PSAT results provide important information for management, such as movement of marlin between geographic areas and residence time in areas visited. Results to date indicate that some marlin remain in Hawaiian waters, some move south to equatorial waters, and others move eastward off Central America.

- Research on the early life history of billfish, swordfish stock identification, and swordfish age and growth continues within the PIFSC Life History Program. Regarding early life history, a multiplex PCR assay was developed by colleagues at Scripps Institute of Oceanography (SIO) and the SWFSC and designed to amplify a unique mtDNA size fragment of the cytochrome *b* gene that distinguishes between all six species of Indo-Pacific billfishes, wahoo *Acanthocybium solandri*, and two species of dolphinfishes (*Coryphaena hippurus and C. equiselis*). This PCR assay has been tested at sea on PIFSC research cruises off Kona, Hawaii and has identified egg collections of swordfish *Xiphias gladius*, shortbill spearfish *Tetrapterus angustirostris*, blue marlin *Makaira nigricans*, wahoo *Acanthocybium solandri*, and pompano dolphinfish *Coryphaena equiselis*. This is the first time that the eggs of

blue marlin, shortbill spearfish, and wahoo have been identified and described. The results of this collaboration between SIO, SWFSC, and PIFSC have recently been published. A preliminary study of the otolith microchemistry of young-of-year (YOY) swordfish collected from the Hawaii and central equatorial region has shown unique elemental signatures among the two sites. Currently, a collaboration between Robert Humphreys (PIFSC), Kotaro Yokawa (NRIFSF), and Michael Hinton (IATTC) is ongoing to collect additional YOY swordfish otoliths from the central, western, and eastern Pacific, respectively. These samples will be used for further otolith microchemistry analysis to ascertain whether YOY swordfish have a unique elemental signature that can distinguish swordfish in these regions. The ultimate goal of this work is to establish a technique that could identify the nursery ground origin of adult swordfish by analyzing the elemental signature contained within the YOY portion of the adult otolith. With respect to current age and growth studies, Edward DeMartini (PIFSC) is completing the analysis of swordfish age and growth in Hawaii based on annual age estimates from anal fin ray sections. Humphreys is completing the analysis of juvenile swordfish age and growth based on counts of presumed daily growth increments contained within the sagittal otolith.

- With funding from PFRP, JIMAR biologist Donald Hawn continues working with Hawaii longline vessel captains to gather information on biology of tunas, billfishes, and other commercially valuable pelagic species. He regularly accompanies longline vessels on fishing trips and with the cooperation of the crew he applies PSATs to selected fish to learn about their subsequent movements. He also collects specimens for laboratory work on age and growth and other life history studies. Particular emphasis is placed on collecting biological data for poorly understood non-target species important to many Hawaii consumers, such as opah (*Lampris guttatus*) and monchong (*Taractichthys steindachneri*)

Fishery Management Research – For several years, PIFSC scientists have actively studied the life history and ecology of sea turtles and other protected species caught incidentally during longline fishing operations and ways to reduce such interactions and their impacts on the affected populations. Interactions with protected species have had major impacts on the U.S. longline fleets based in Hawaii and California. The research is critical to finding ways to foster the recovery of the protected species while maintaining viability of the valuable longline fisheries

- PIFSC scientists have been studying the pelagic ecology of Japanese loggerhead sea turtles in the central and western North Pacific. Loggerheads are a protected species caught incidentally by several fishing fleets, including longline vessels fishing for swordfish and other species in North Pacific waters. Understanding the pelagic distribution of loggerheads is important to developing longline fishing strategies that minimize interactions between longline gear and the turtles. Jeff Polovina, George Balazs, and Evan Howell of PIFSC, Denise Parker of JIMAR, Peter Dutton of SWFSC, and Itaru Uchida of the Port of Nagoya Public Aquarium have followed the oceanic movements of satellite-tracked loggerheads released from the Nagoya Aquarium and turtles caught and released by U.S. longline vessels on the central

Pacific fishing grounds north of Hawaii. They also studied concurrent oceanographic data from satellite-borne remote sensors to determine surface circulation features (currents, eddies, and meanders) and ocean productivity (surface chlorophyll concentration) in the region. Combining the two kinds of data they found that the Kuroshio Extension Current Bifurcation Region (KECBR) is a key foraging ground for pelagic loggerheads. This work and similar studies of the Transition Zone Chlorophyll Front (TZCF) show that foraging juvenile loggerheads favor waters that are important fishing grounds for longline vessels. Such knowledge is valuable for finding ways to reduce the frequency of interactions and minimize effects of hooking on the loggerhead population. A manuscript describing the study is being submitted for publication in Deep-Sea Research.

- PIFSC biologists Chris Boggs and Yonat Swimmer are also engaged in international collaborative projects to study longline gear interactions with sea turtles and to find ways to modify gear and fishing practices to reduce the frequency and severity of interactions. These studies include attaching archival satellite transmitters to sea turtles caught by longline gear and monitoring their post-release movements and survival, international collaborative experiments with longline gear designed to reduce turtle interactions and mortality (including cooperation with Japan), and technical assistance to other countries throughout the Pacific interested in developing turtle bycatch reduction projects.

Table 1. Number of vessels operating in U.S. fisheries for tuna and tuna-like species in the North Pacific Ocean. Statistics for the purse seine fishery, longline fishery, and pole-and-line fishery are divided into western and central Pacific (WCPO) or Hawaii-based components and eastern Pacific Ocean (EPO) or California-based components. Data for 2003 are preliminary. Dashes indicate missing data.

	Purse Seine		Albacore	Longline		Pole-and-Line			
Year	WCPO	EPO	Troll	Hawaii	California	Hawaii	EPO	Gill Net	Harpoon
1985	39	71	824	--	0	18	9	210	99
1986	32	53	462	--	0	16	3	220	113
1987	33	52	518	37	0	13	5	210	98
1988	31	56	547	50	0	13	4	192	83
1989	35	49	346	88	0	10	8	158	44
1990	39	46	371	138	0	8	4	146	49
1991	43	22	179	141	3	7	5	123	32
1992	44	18	603	123	2	7	4	113	48
1993	42	20	518	122	7	9	4	105	44
1994	48	14	686	125	31	7	4	112	49
1995	44	11	464	110	22	7	4	127	39
1996	35	8	640	103	15	8	1	100	30
1997	34	8	1121	105	25	8	1	104	31
1998	36	7	755	114	33	7	2	87	26
1999	22	6	705	119	37	8	1	78	30
2000	22	8	649	125	44	6	1	77	26
2001	28	4	870	101	38	6	3	64	23
2002	22	4	641	100	20	6	7	45	29
2003	26	4	718	110	24	6	1	37	34

Table 2. Catches of tuna and tuna-like species for U.S. fisheries in the North Pacific Ocean (metric tons). The purse seine, longline, and pole-and-line fisheries are divided into western and central Pacific or Hawaii-based components and eastern Pacific Ocean or California-based components. Catches for 2003 are preliminary. Catches indicated by "-" are less than 0.5 t.

YEAR	ALB	YFT	SKJ	BET	PBT	BKJ	BEP	SWO	BLZ	MLS	UNPSEC. BILLFISH	UNSPEC. TUNA	TOTAL
Purse Seine Fishery, Western and Central Pacific Ocean													
1985	0	10,814	38,027	0	0	0	0	0	0	0	0	0	48,841
1986	0	14,828	39,943	0	0	0	0	0	0	0	0	0	54,770
1987	0	28,444	35,218	0	0	0	0	0	0	0	0	0	63,662
1988	0	8,419	42,509	871	0	0	0	0	0	0	0	0	51,799
1989	0	6,175	15,163	349	0	0	0	0	0	0	0	0	21,687
1990	0	13,872	40,269	469	0	0	0	0	0	0	0	0	54,610
1991	0	8,846	37,512	367	0	0	0	0	0	0	0	0	46,725
1992	0	15,838	62,730	1,261	0	0	0	0	0	0	0	0	79,829
1993	0	16,697	51,456	1,354	0	0	0	0	0	0	0	0	69,507
1994	0	7,957	27,349	241	0	0	0	0	0	0	0	0	35,548
1995	0	14,958	54,565	1,498	0	0	0	0	0	0	0	0	71,021
1996	0	3,328	10,622	1,690	0	0	0	0	0	0	0	0	15,641
1997	0	19,512	26,302	3,592	0	0	0	0	0	0	0	0	49,406
1998	0	21,845	22,861	3,216	0	0	0	0	0	0	0	0	47,922
1999	0	2,665	7,944	1,295	0	0	0	0	0	0	0	0	11,903
2000	0	1,175	3,578	474	0	0	0	0	0	0	0	0	5,227
2001	0	4,004	14,672	1,138	0	0	0	0	0	0	0	0	19,814
2002	0	4,980	3,244	1,065	0	0	0	0	0	0	0	0	9,289
2003	0	3,321	17,293	572	0	0	0	0	0	0	0	0	21,187
Purse Seine Fishery, Eastern Pacific Ocean													
1985	24	81,228	8,232	970	3,249	0	2,876	0	0	0	0	0	96,579
1986	32	83,517	7,025	43	4,462	0	61	0	0	0	0	132	95,272
1987	1	88,031	10,490	95	821	12	1,654	0	0	0	0	56	101,160
1988	12	78,867	28,137	182	792	6	2,951	0	0	0	0	9	110,955
1989	1	68,822	15,917	37	993	53	653	0	0	0	0	70	86,546
1990	14	50,503	11,127	252	1,289	262	2,060	0	0	0	0	39	65,545
1991	0	18,918	9,479	542	306	20	146	0	0	0	0	7	29,417
1992	0	17,479	8,445	1,574	1,226	1	146	0	0	0	0	-	28,871
1993	0	13,189	10,637	2,965	300	21	100	0	0	0	0	-	27,212
1994	0	2,834	1,291	2,220	497	59	0	0	0	0	0	8	6,909
1995	0	2,212	5,519	1,376	564	36	13	0	0	0	0	0	9,720
1996	0	4,364	6,944	2,480	1,688	45	129	0	0	0	0	0	15,650
1997	3	2,748	6,139	2,231	1,012	0	0	0	0	0	0	7	12,140
1998	6	2,663	3,695	974	482	0	193	0	0	0	0	0	8,013
1999	0	2,364	9,084	1,651	18	78	0	0	0	0	0	0	13,195
2000	2	575	1,403	392	98	0	125	0	0	0	0	0	2,595
2001	3	837	1,247	359	31	70	0	0	0	0	0	0	2,548
2002	3	562	984	84	0	188	0	0	0	0	0	0	1,821
2003	44	295	3,138	460	22	162	0	0	0	0	0	0	4,120

Table 2. Continued.

YEAR	ALB	YFT	SKJ	BET	PBF	BKJ	BEP	SWO	BLZ	MLS	UNSPEC. BILLFISH	UNSPEC. TUNA	TOTAL
Longline Fishery, Hawaii-based													
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	150	261	1	815	0	0	0	24	51	272	45	0	1,619
1988	307	594	4	1,239	0	0	0	24	102	503	68	0	2,841
1989	248	986	10	1,442	0	0	0	281	356	612	132	0	4,067
1990	177	1,098	5	1,514	0	0	0	2,437	378	538	58	0	6,205
1991	312	733	30	1,553	2	0	0	4,508	297	663	69	0	8,167
1992	333	346	22	1,486	38	0	0	5,700	347	459	142	0	8,873
1993	438	631	36	2,121	42	0	0	5,909	339	471	100	0	10,087
1994	497	606	53	1,787	24	0	0	3,176	362	326	99	0	6,930
1995	879	979	101	2,051	25	0	0	2,713	570	543	182	0	8,043
1996	1,182	630	41	1,787	22	0	0	2,502	467	419	115	0	7,165
1997	1,645	1,141	106	2,449	24	0	0	2,881	487	352	143	0	9,228
1998	1,111	722	76	3,226	16	0	0	3,263	395	378	172	0	9,359
1999	1,474	473	99	2,719	10	0	0	3,100	357	364	242	0	8,838
2000	919	1,137	93	2,625	4	0	0	2,949	314	200	152	0	8,393
2001	1,271	1,013	211	2,366	1	0	0	220	399	352	136	0	5,969
2002	524	570	127	4,386	1	0	0	204	264	226	160	1	6,463
2003	522	809	207	3,589	0	0		147	363	538	252	0	6,427
Longline Fishery, California-based													
1985	0	0	0	0	0	0	0	46	0	0	0	0	46
1986	0	0	0	0	0	0	-	4	0	0	0	0	4
1987	0	0	0	0	0	0	-	4	0	0	0	0	4
1988	0	0	0	0	0	0	0	19	0	0	0	0	20
1989	0	0	0	0	0	0	0	29	0	0	0	0	29
1990	0	0	0	0	0	0	-	18	0	0	0	-	18
1991	0	-	0	2	0	0	0	39	0	0	0	-	41
1992	1	0	-	0	0	0	-	95	0	0	0	0	96
1993	0	2	0	3	0	0	0	165	0	0	0	0	171
1994	47	4	-	40	6	0	-	740	0	0	0	5	842
1995	3	5	0	48	4	0	1	279	0	0	0	0	340
1996	3	4	-	59	3	0	0	347	0	0	0	2	417
1997	8	2	-	77	2	0	-	664	0	0	0	2	754
1998	9	2	-	48	38	0	-	422	0	0	0	9	528
1999	68	4	-	101	44	0	-	1,333	0	0	0	10	1,560
2000	21	-	0	83	15	0	-	1,908	0	0	0	0	2,027
2001	24	16	0	52	5	0	0	1,763	0	0	0	-	1,860
2002	1	2	0	10	1	0	0	1,320	0	0	0	0	1,334
2003	2	-	-	29	-	0	0	1,811	0	0	0	0	1,842

Table 2. Continued.

YEAR	ALB	YFT	SKJ	BET	PBF	BKJ	BEP	SWO	BLZ	MLS	UNSPEC. BILLFISH	UNSPEC. TUNA	TOTAL
Albacore Troll Fishery													
1985	6,415	5	0	0	0	0	-	0	0	0	0	-	6,420
1986	4,708	1	-	0	0	0	-	0	0	0	0	0	4,709
1987	2,766	76	0	-	0	0	33	0	0	0	0	0	2,875
1988	4,212	7	-	0	0	-	0	0	0	0	0	-	4,219
1989	1,860	1	-	0	0	0	-	0	0	0	0	0	1,861
1990	2,603	0	0	0	0	0	55	0	0	0	0	-	2,658
1991	1,845	-	0	0	0	0	0	0	0	0	0	0	1,845
1992	4,572	-	-	0	0	0	-	0	0	0	0	0	4,572
1993	6,254	137	62	0	0	0	0	0	0	0	0	1	6,454
1994	10,978	769	352	0	0	0	0	0	0	0	0	-	12,099
1995	8,045	211	1,157	0	0	0	0	0	0	0	0	0	9,413
1996	16,938	606	393	0	2	0	0	0	0	0	0	0	17,939
1997	14,252	4	2	-	1	0	-	0	0	0	0	-	14,259
1998	14,410	1,246	2	-	172	0	10	0	0	0	0	-	15,840
1999	10,060	52	16	0	20	0	-	0	0	0	0	-	10,148
2000	9,645	3	4	0	1	0	-	0	0	0	0	1	9,654
2001	11,210	1	1	-	6	0	-	0	0	0	0	-	11,218
2002	10,387	0	-	0	1	0	-	2	0	0	0	-	10,390
2003	17,237	-	2	0	-	0	-	-	0	0	0	0	17,239
Troll and Handline, Pacific Islands													
1985	7	1104	230	8	-	-	-	4	170	18	12	2	1,555
1986	5	1526	270	15	-	-	-	4	246	19	14	4	2,103
1987	6	1639	237	8	-	-	-	4	282	31	20	11	2,238
1988	9	985	389	17	-	-	-	6	295	55	20	11	1,787
1989	36	851	326	14	-	-	-	7	366	24	22	11	1,657
1990	15	944	272	39	-	-	-	5	337	28	17	11	1,668
1991	72	934	343	68	-	-	-	6	387	41	25	9	1,885
1992	54	1045	260	81	-	-	-	1	302	38	17	10	1,808
1993	71	1050	250	41	-	-	-	4	339	69	21	6	1,851
1994	90	1286	265	154	-	-	-	4	333	35	22	8	2,197
1995	177	1298	292	66	-	-	-	6	353	52	29	7	2,280
1996	188	1182	407	177	-	-	-	5	442	55	18	4	2,478
1997	133	1010	352	89	-	-	-	7	423	39	17	4	2,074
1998	88	1113	306	239	-	-	-	7	264	26	19	6	2,068
1999	331	1406	284	99	-	-	-	9	331	29	32	4	2,525
2000	120	1085	273	206	-	-	-	8	235	14	16	4	1,961
2001	194	898	322	297	-	-	-	7	295	45	24	4	2,086
2002	234	649	262	585	-	-	-	12	228	29	12	3	2,014
2003	85	735	243	185	-	-	-	10	208	28	13	2	1,509

Table 2. Continued.

YEAR	ALB	YFT	SKJ	BET	PBF	BKJ	BEP	SWO	BLZ	MLS	UNSPEC. BILLFISH	UNSPEC. TUNA	TOTAL
Pole-and-Line Fishery, Hawaii-based													
1985	0	103	853	0	0	0	0	0	0	0	0	3	959
1986	0	114	941	0	0	0	0	0	0	0	0	8	1,063
1987	0	78	1510	0	0	0	0	0	0	0	0	0	1,588
1988	0	76	1709	0	0	0	0	0	0	0	0	0	1,785
1989	0	10	1333	0	0	0	0	0	0	0	0	0	1,343
1990	0	18	487	0	0	0	0	0	0	0	0	2	507
1991	0	20	953	0	0	0	0	0	0	0	0	0	973
1992	0	16	763	0	0	0	0	0	0	0	0	1	780
1993	0	5	962	0	0	0	0	0	0	0	0	3	970
1994	0	9	514	0	0	0	0	0	0	0	0	0	523
1995	0	15	570	0	0	0	0	0	0	0	0	0	585
1996	0	1	835	0	0	0	0	0	0	0	0	0	836
1997	0	0	881	0	0	0	0	0	0	0	0	0	881
1998	0	1	382	0	0	0	0	0	0	0	0	0	383
1999	0	10	586	0	0	0	0	0	0	0	0	0	596
2000	0	1	320	0	0	0	0	0	0	0	0	0	321
2001	0	2	447	0	0	0	0	0	0	0	0	0	449
2002	0	2	305	0	0	0	0	0	0	0	0	0	307
2003	0	23	435	0	0	0	0	0	0	0	0	0	458
Pole and Line Fishery, Eastern Pacific Ocean													
1985	1,498	256	396	3	3	0	1	0	0	0	0	-	2,157
1986	432	515	351	15	1	0	2	0	0	0	0	1	1,318
1987	158	1,897	363	2	0	0	281	0	0	0	0	-	2,702
1988	598	239	454	-	5	0	27	0	0	0	0	-	1,323
1989	54	1,436	1,012	-	8	0	2	0	0	0	0	3	2,515
1990	115	154	64	1	62	0	16	0	0	0	0	2	414
1991	0	925	619	2	0	0	16	0	0	0	0	-	1,563
1992	0	1,763	494	4	1	0	13	0	0	0	0	2	2,278
1993	0	1,509	998	20	4	0	1	0	0	0	0	5	2,537
1994	0	853	785	6	1	0	155	0	0	0	0	18	1,819
1995	80	239	649	0	0	0	-	0	0	0	0	0	969
1996	24	0	0	0	0	0	-	0	0	0	0	1	25
1997	73	141	281	-	1	0	1	0	0	0	0	-	497
1998	79	165	12	1	3	0	4	0	0	0	0	-	264
1999	60	47	15	4	2	0	-	0	0	0	0	-	129
2000	69	12	0	1	12	0	-	0	0	0	0	-	95
2001	139	2	-	-	1	0	-	0	0	0	0	-	142
2002	378	0	-	0	2	0	-	0	0	0	0	2	382
2003	59	2	1	-	3	0	1	1	0	0	0	0	67

Table 2. Continued.

YEAR	ALB	YFT	SKJ	BET	PBF	BKJ	BEP	SWO	BLZ	MLS	UNSPEC. BILLFISH	UNSPEC. TUNA	TOTAL
Gill Net Fishery													
1985	2	12	0	2	6	0	289	2,368	0	0	0	-	2,679
1986	3	14	0	3	15	0	58	1,594	0	0	0	4	1,691
1987	5	3	-	6	2	0	95	1,287	0	0	0	5	1,403
1988	15	7	-	5	4	0	33	1,092	0	0	0	2	1,158
1989	4	1	5	-	3	0	12	1,050	0	0	0	3	1,078
1990	29	1	1	1	9	0	35	1,028	0	0	0	2	1,106
1991	17	1	3	3	3	0	14	836	0	0	0	3	880
1992	0	4	1	1	8	0	7	1,332	0	0	0	6	1,359
1993	0	7	2	-	32	0	8	1,400	0	0	0	9	1,458
1994	38	-	-	-	28	0	1	799	0	0	0	2	868
1995	52	2	70	1	19	0	2	755	0	0	0	1	902
1996	83	2	2	-	43	0	2	752	0	0	0	-	884
1997	60	3	2	5	57	0	6	707	0	0	0	-	840
1998	80	2	3	4	40	0	4	924	0	0	0	2	1,059
1999	149	-	-	2	19	0	1	606	0	0	0	1	778
2000	55	1	-	2	30	0	1	646	0	0	0	-	735
2001	94	5	1	-	34	0	-	375	0	0	0	-	509
2002	30	1	-	0	6	0	1	302	0	0	0	-	340
2003	16	-	9	6	14	0	1	216	0	0	0	0	262
Harpoon Fishery													
1985	0	0	0	0	0	0	0	211	0	0	0	0	211
1986	0	0	0	0	0	0	0	236	0	0	0	0	236
1987	0	0	0	0	0	0	0	211	0	0	0	0	211
1988	0	0	0	0	0	0	0	180	0	0	0	0	180
1989	0	0	0	0	0	0	0	54	0	0	0	0	54
1990	0	0	0	0	0	0	0	50	0	0	0	0	50
1991	0	0	0	0	0	0	0	16	0	0	0	0	16
1992	0	0	0	0	0	0	0	74	0	0	0	0	74
1993	0	0	0	0	0	0	0	169	0	0	0	0	169
1994	0	0	0	0	0	0	0	153	0	0	0	0	153
1995	0	0	0	0	0	0	0	96	0	0	0	0	96
1996	0	0	0	0	0	0	0	81	0	0	0	0	81
1997	0	0	0	0	0	0	0	84	0	0	0	0	84
1998	0	0	0	0	0	0	0	48	0	0	0	0	48
1999	0	0	0	0	0	0	0	81	0	0	0	0	81
2000	0	0	0	0	0	0	0	90	0	0	0	0	90
2001	0	0	0	0	0	0	0	52	0	0	0	0	52
2002	0	0	0	0	0	0	0	90	0	0	0	0	90
2003	0	0	0	0	0	0	0	106	0	0	0	0	106

Table 2. Continued.

YEAR	ALB	YFT	SKJ	BET	PBF	BKJ	BEP	SWO	BLZ	MLS	UNSPEC. BILLFISH	UNSPEC. TUNA	TOTAL
Unclassified, Other, or Recreational													
1985	1,176	58	5	1	56	0	426	792	0	0	0	468	2,982
1986	196	227	0	6	7	0	28	696	0	0	0	6	1,166
1987	74	2,159	633	1	21	0	266	300	0	0	0	67	3,521
1988	74	936	372	1	4	0	335	344	0	0	0	2	2,068
1989	183	849	103	-	70	0	137	224	0	0	0	-	1,566
1990	28	508	147	-	134	0	227	137	0	0	0	1	1,182
1991	77	235	137	-	62	0	69	137	0	0	0	-	717
1992	74	1,119	1,014	0	174	0	78	44	0	0	0	2	2,505
1993	25	2,031	2,279	0	139	0	140	36	0	0	0	0	4,650
1994	319	3	-	0	125	0	12	8	0	0	0	-	467
1995	102	5	263	0	166	0	-	31	0	0	0	-	567
1996	88	-	-	4	30	0	-	10	0	0	0	0	132
1997	1,019	-	83	0	90	0	-	3	0	0	0	0	1,195
1998	1,209	43	-	0	214	0	-	13	0	0	0	1	1,480
1999	3,622	-	-	0	399	0	-	2	0	0	0	-	4,023
2000	1,801	1	0	0	220	0	-	9	0	0	0	0	2,030
2001	1,636	0	0	0	226	0	0	5	0	0	0	0	1,867
2002	2,358	0	0	0	348	0	0	3	0	0	0	0	2,710
2003	2,214	0	-	0	226	0	0	-	0	0	0	0	2,440

ALB - albacore, YFT - yellowfin tuna, SKJ - skipjack tuna, BET - bigeye tuna, PBF - Pacific bluefin tuna, BKJ - black skipjack, BEP - Pacific Bonito, SWO - swordfish, BLZ - blue marlin, MLS - striped marlin

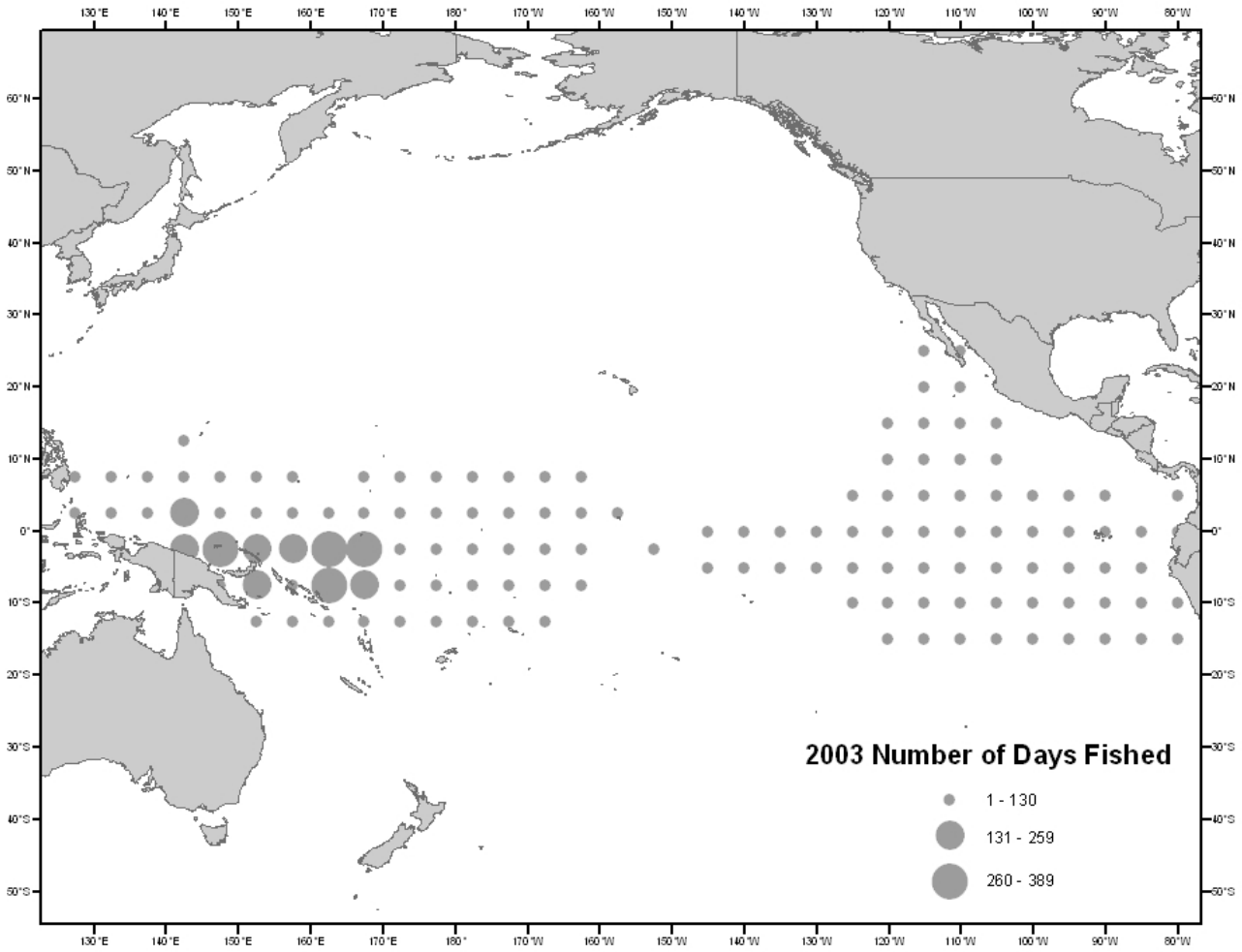

Figure 1. Distribution of nominal fishing effort (days fished) for the U.S. purse seine fishery in the Pacific Ocean, 2003.

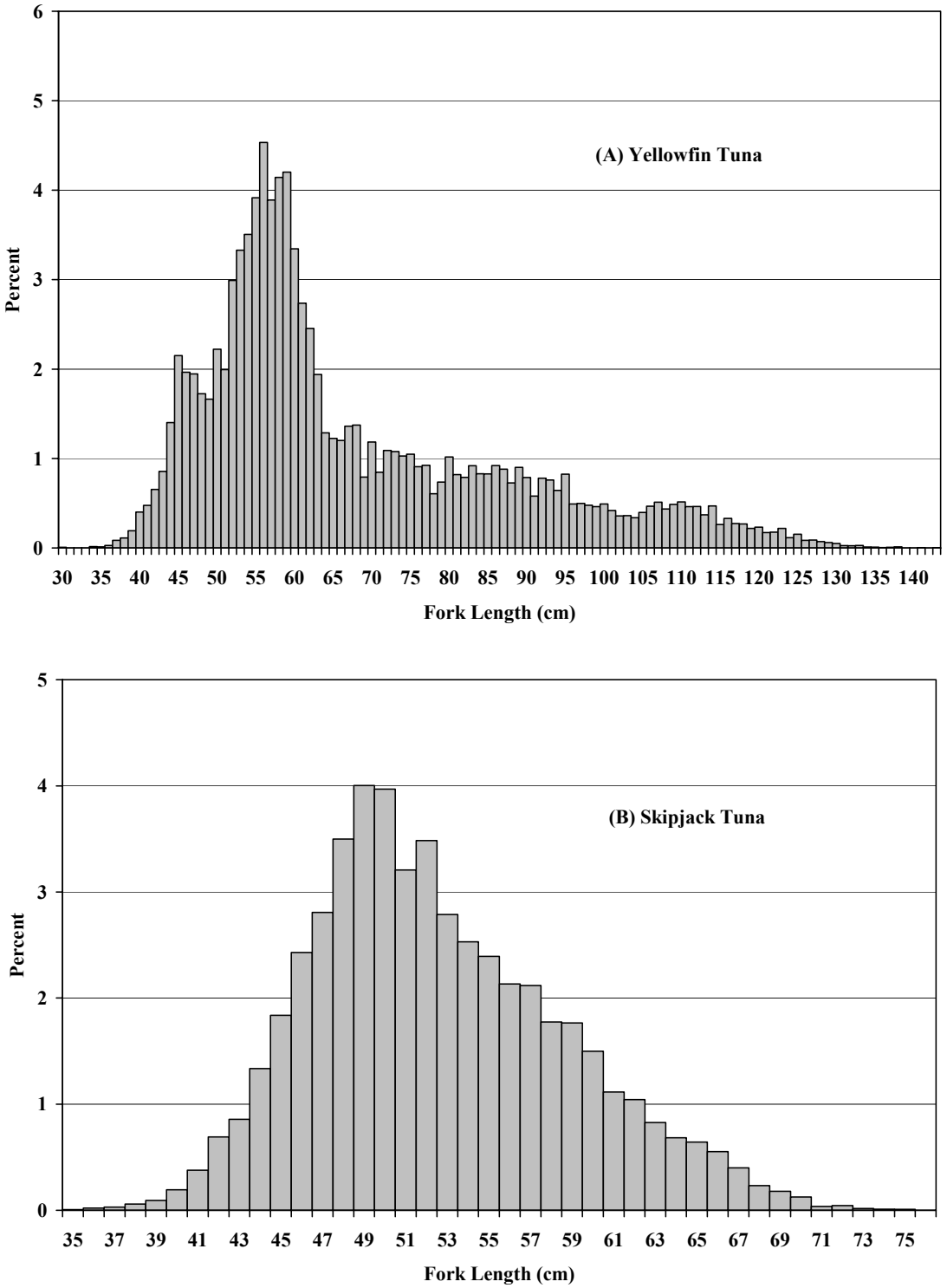

Figure 2. Size distribution of (A) yellowfin tuna and (B) skipjack tuna caught by U.S. purse seiners fishing in the western-central Pacific Ocean, 2003.

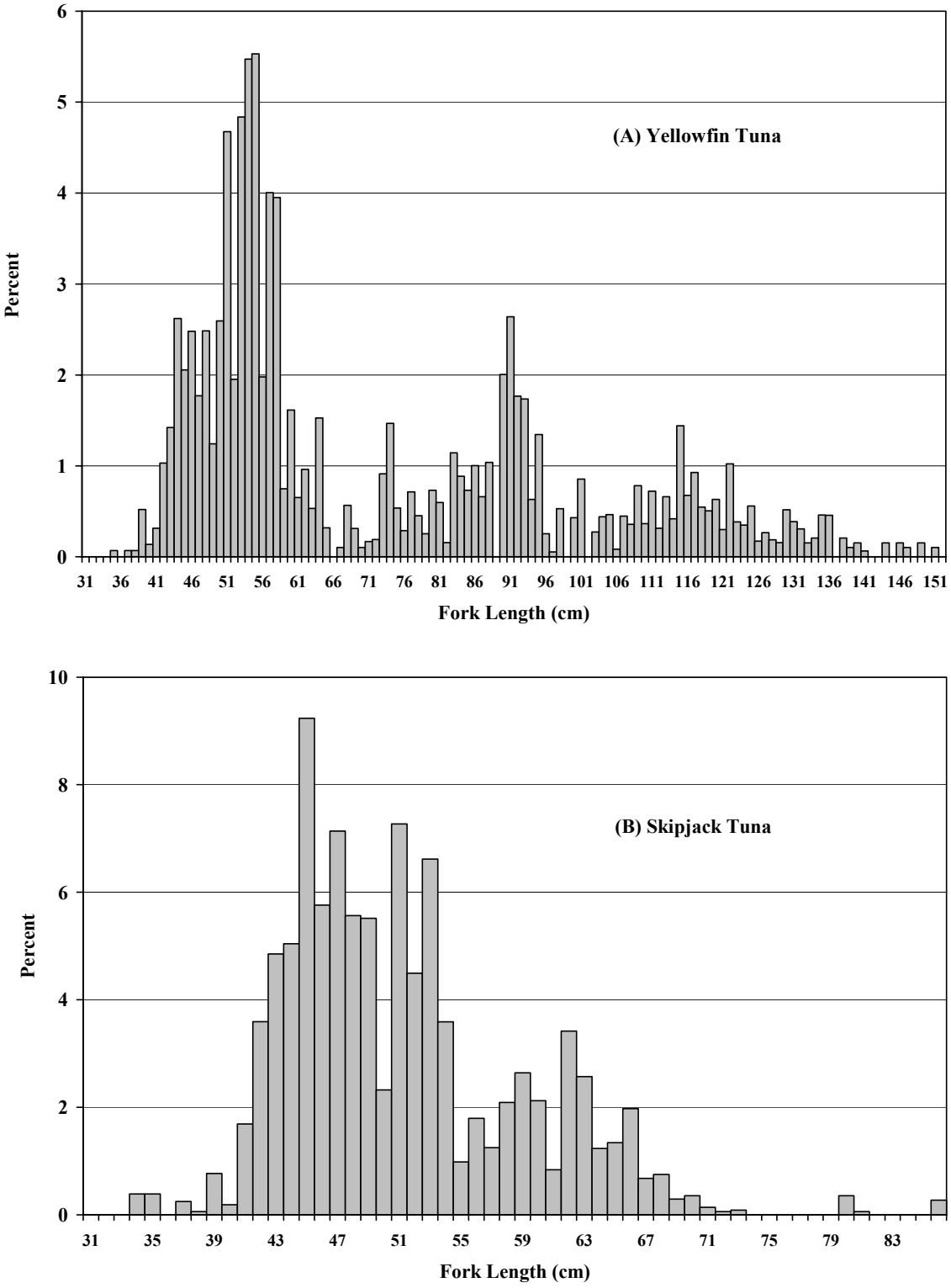

Figure 3. Size distribution of (A) yellowfin tuna and (B) skipjack tuna caught by U.S. purse seine fishery in the eastern Pacific Ocean, 2003.

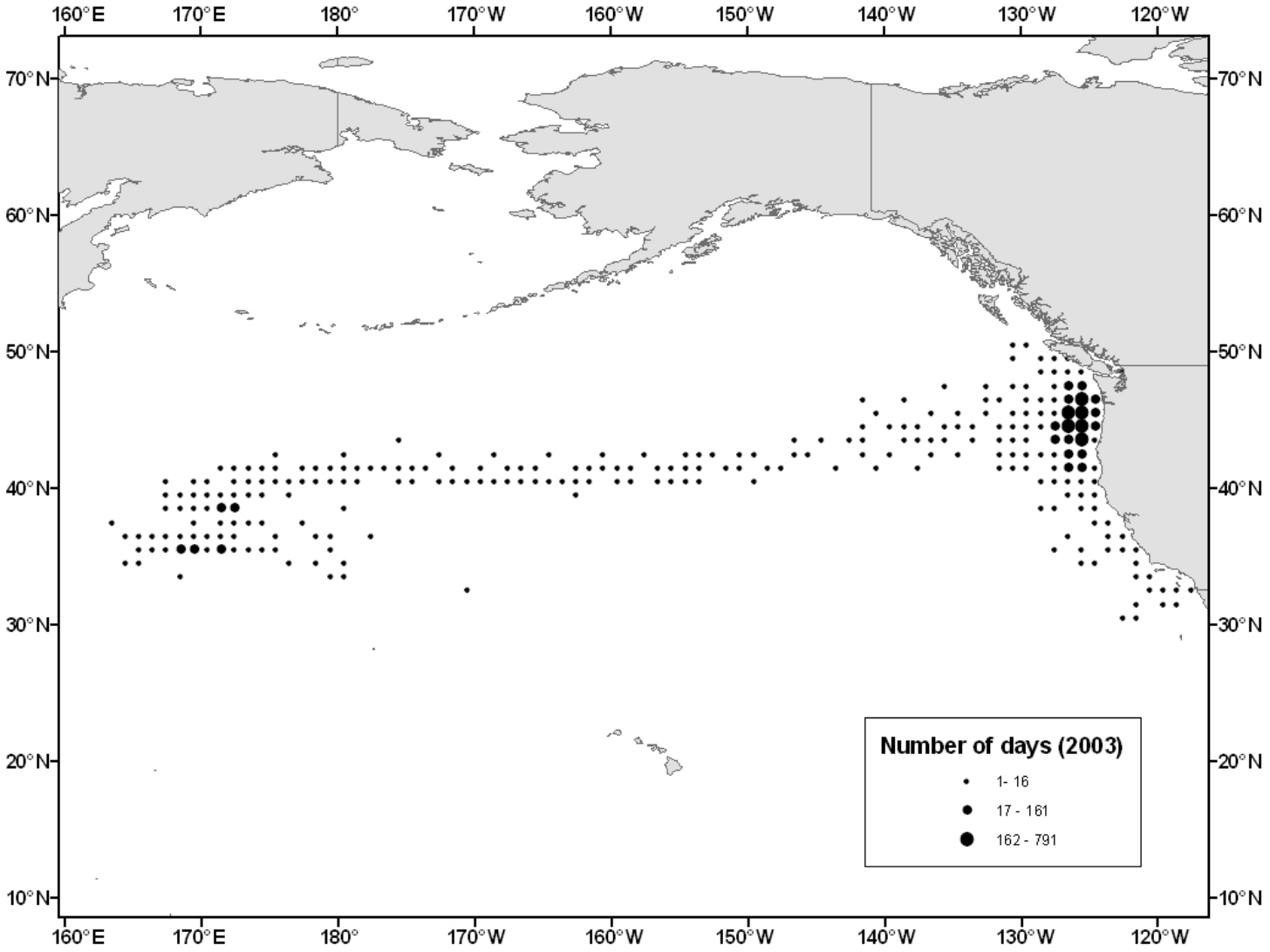

Figure 4. Distribution of nominal fishing effort (days fished) for the U.S. North Pacific albacore troll fishery, 2003.

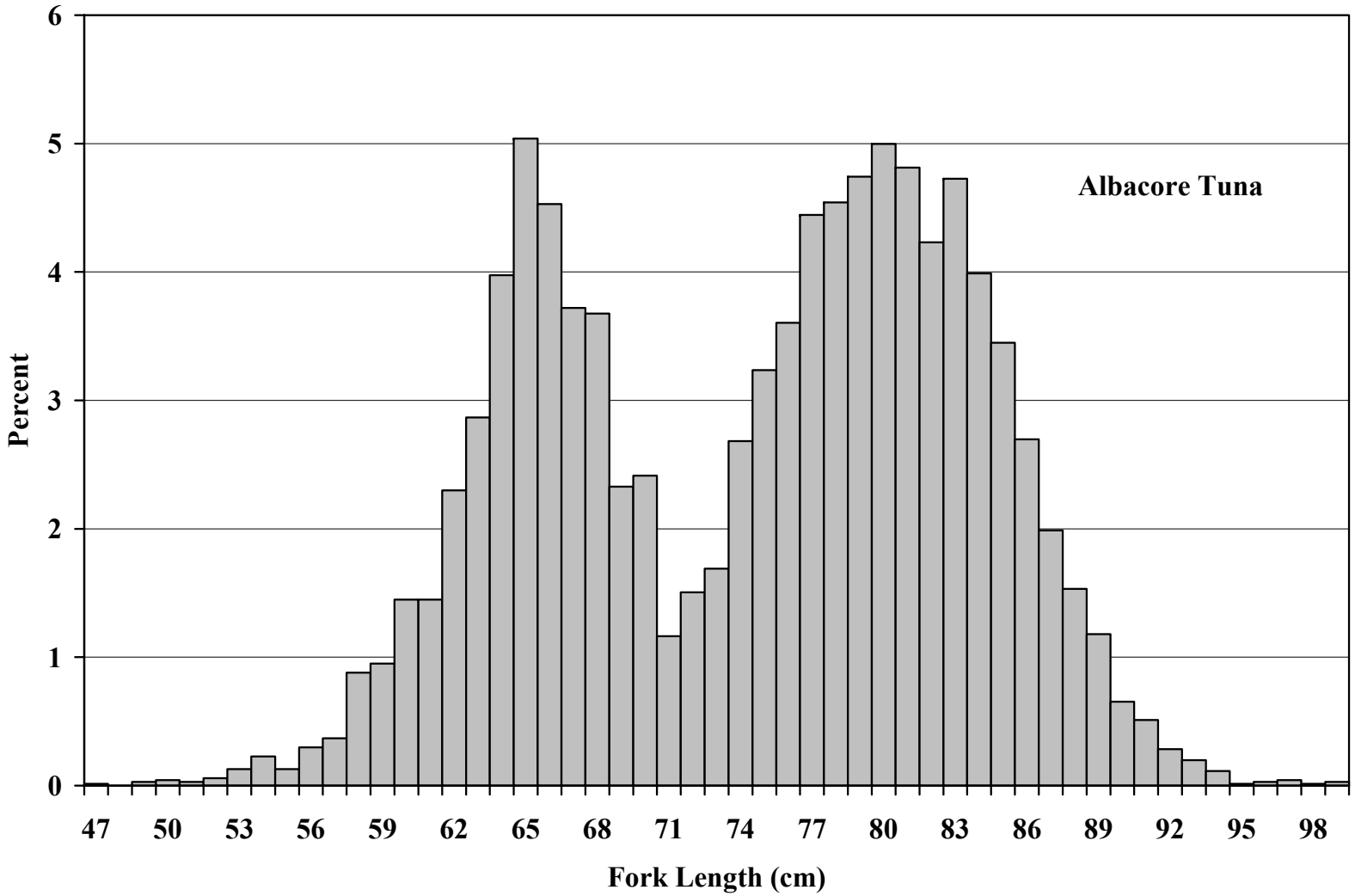

Figure 5. Size distribution of albacore caught by the U.S. North Pacific albacore troll fishery, 2003.

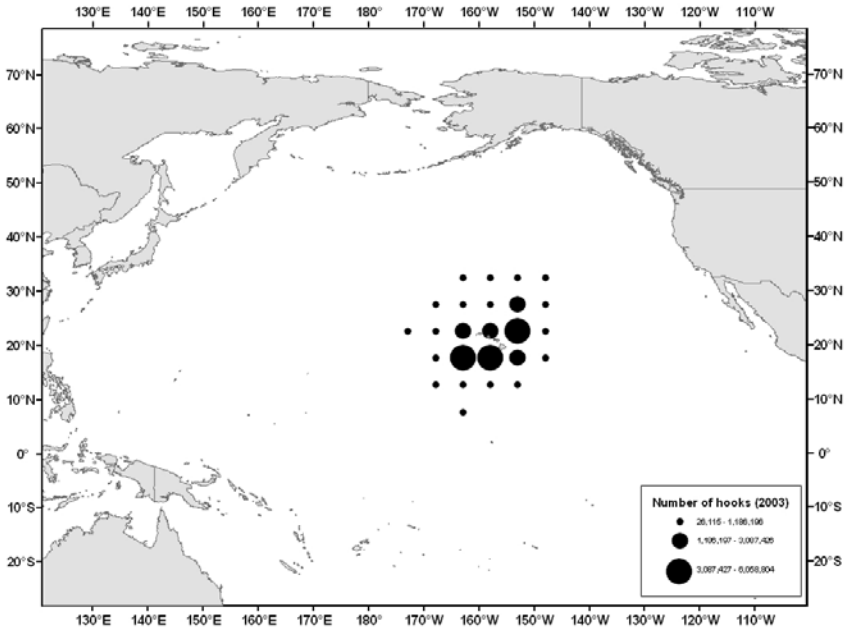

Figure 6. Distribution of nominal fishing effort by Hawaii-based longline vessels, 2003.

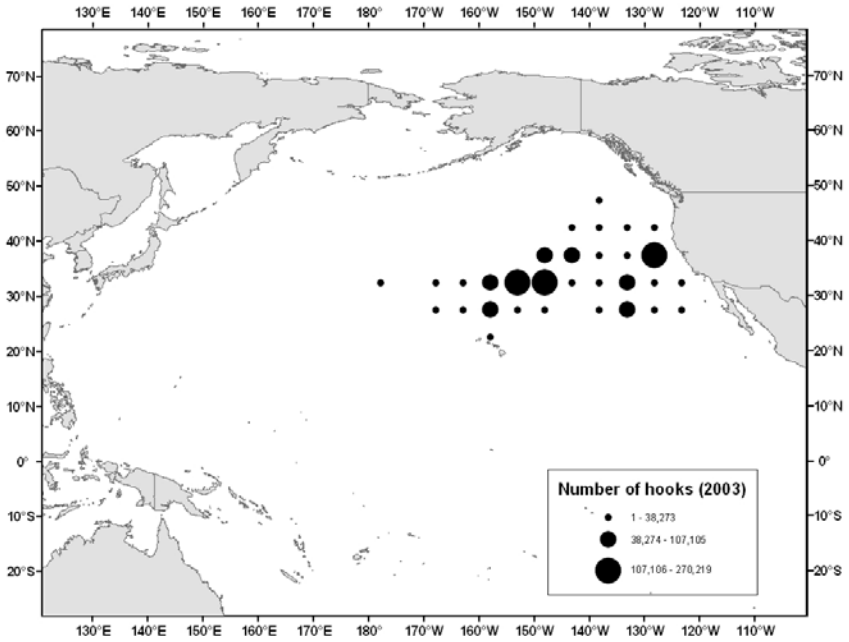

Figure 7. Distribution of nominal fishing effort by California-based longline vessels, 2003.

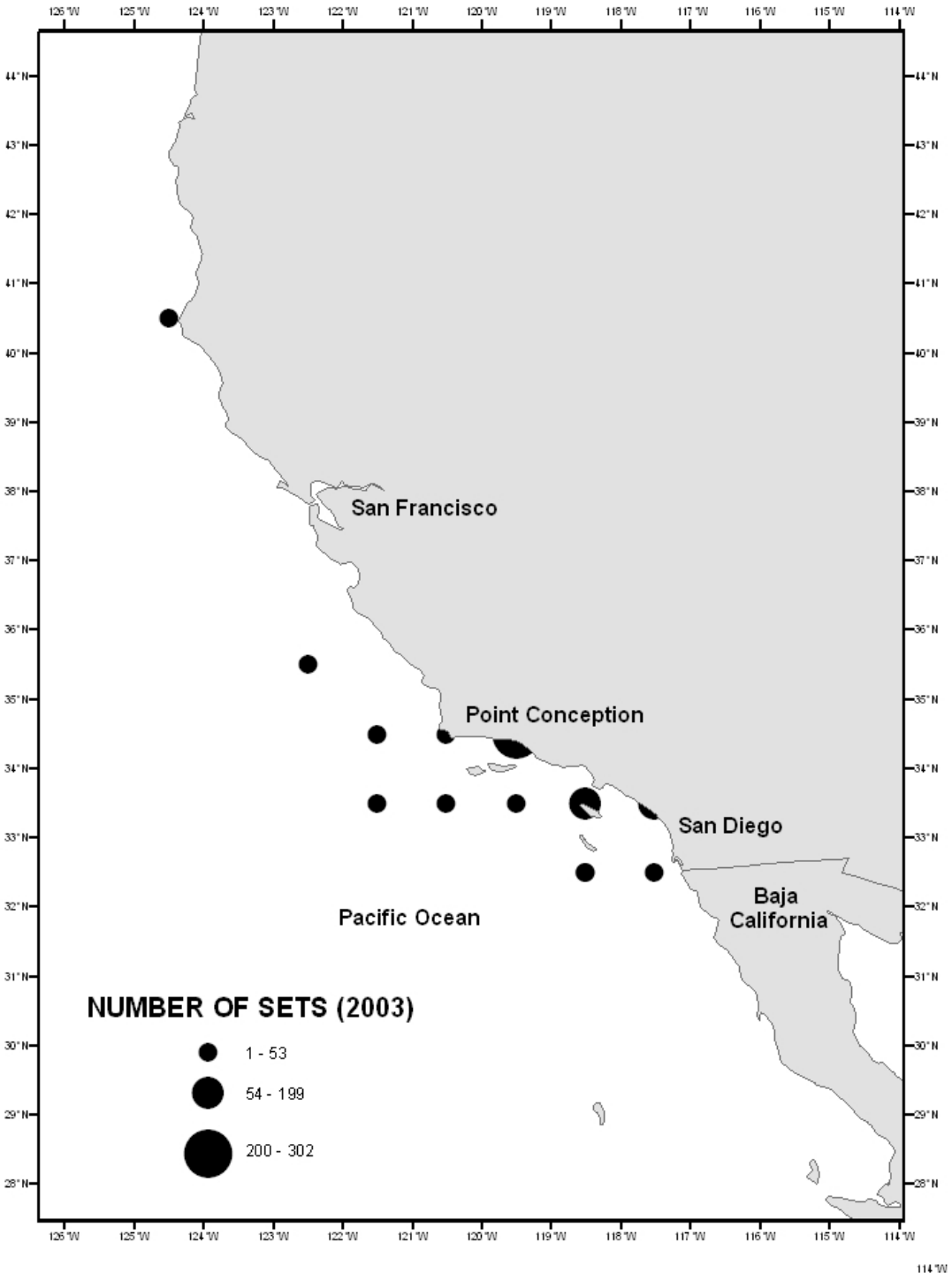

Figure 8. Distribution of fishing effort for the U.S. drift gill net fishery, 2003.

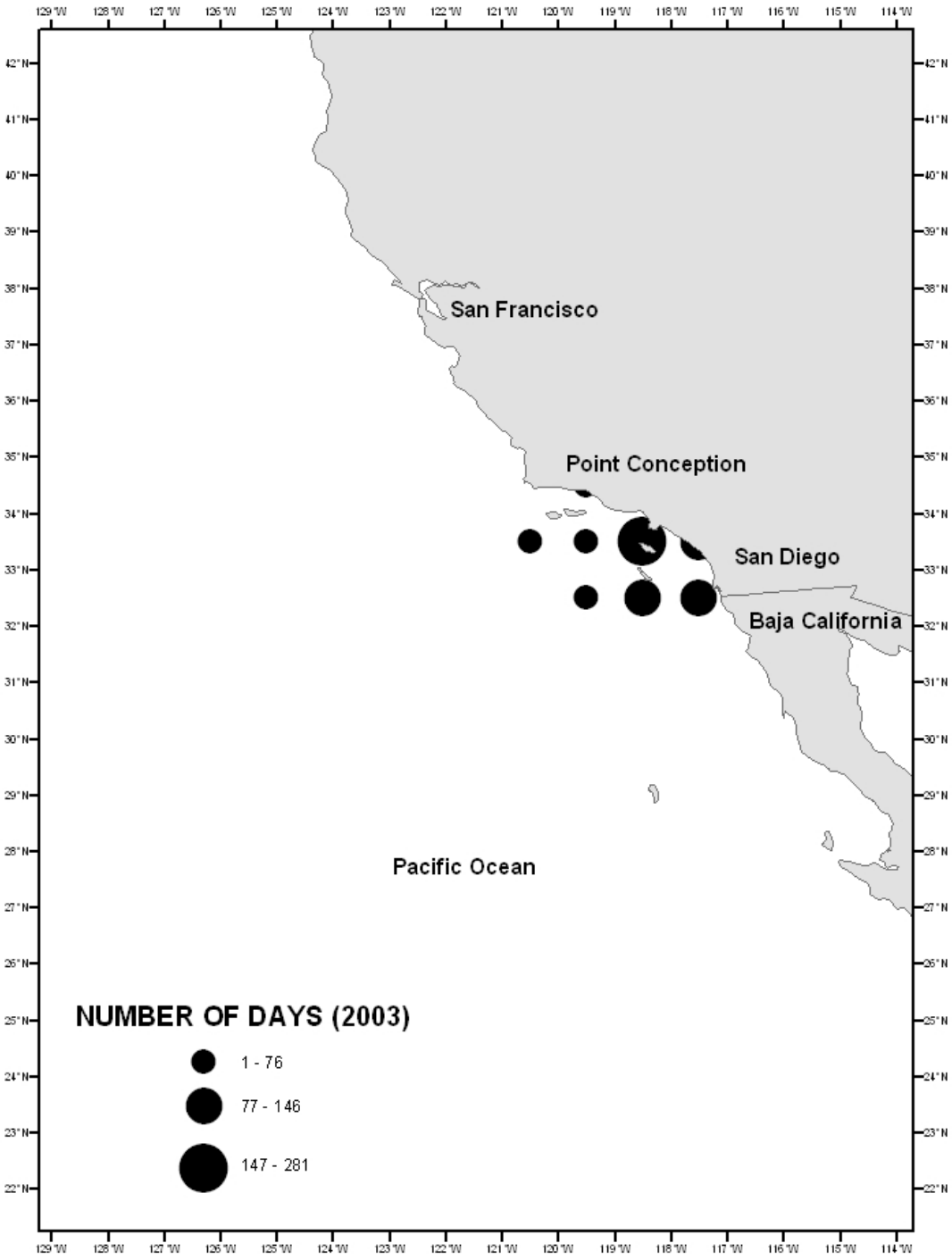

Figure 9. Distribution of fishing effort for the U.S. harpoon fishery, 2003.