Pelagic Fishing Methods in the Pacific

Introduction

Fishing vessels from many nations target tunas, bill fish and other pelagic fish in the central and western Pacific Ocean. These fleets operate in international waters and within the exclusive economic zones (EEZs) of Pacific nations and territories, either as domestic fleets or foreign vessels under licensed access agreements. Most major pelagic fishes are widely distributed and highly migratory, and domestic and foreign fisheries based in Pacific island and mainland nations compete for common pelagic fishery resources.

Commercial pelagic fisheries in the central and western Pacific consist of a mixture of large industrialized fleets from the so-called distant water fishing nations (DWFNs), smaller domestic commercial fleets from Pacific island nations, and artisanal domestic fisheries. The main DWFNs operating in the region are the USA, Japan, Taiwan and Korea. Other DWFNs that operate on a large scale within this area include the People's Republic of China, the Philippines, Australia and New Zealand. Vessels from these nations use troll, pole and line, longline and purse seine gear to harvest pelagic species. These fisheries target widely ranging pelagic species such as tunas (skipjack, yellowfin, albacore, bigeye, northern blue fin) and billfish (broadbill swordfish, striped, blue and black marlin, spearfish), and all have the potential for a considerable bycatch of wahoo, dolphinfish (mahimahi), pelagic sharks and sailfish, depending on the fishing method used and area fished. For more information on the major pelagic species, please refer to the *Pacific Profile* entitled "Important Pelagic Fishes of the Pacific" (Western Pacific Regional Fishery Management Council, 1995).

Purse seine, longline and troll fleets all range widely throughout the tropical, subtropical and temperate Pacific, operating both in international waters and within the EEZs of Pacific island nations and US territories. In addition to the island fisheries, several pelagic fisheries are based on the west coast of the US mainland. All areas in the region have locally-based hook and line fisheries (mostly troll and handline) that concentrate on nearshore tuna resources, and the California-based drift gillnet fleet also operates within the 200-mile US EEZ.

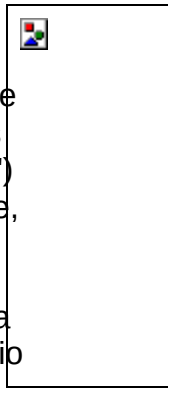
Pacific island nations have also begun industrial-scale pelagic fishing in an effort to increase benefits from their own marine resources, beyond the collection of access fees from DWFNs. In the past, these operations have typically been joint-venture pole and line and longline tuna fishing enterprises with DWFNs, but there is an increasing trend toward the island nations owning and operating their own purse seine and longline fleets.

Of the total tuna catch taken by the major gear types in the central and western Pacific, over 80% by weight is landed by purse seines, with pole and line and longline vessels each accounting for about 8-9% of the catch. Albacore trollers land less than 1% of the total, and local troll and handline fisheries make up the remaining 1% or so. The major Pacific pelagic fisheries are:

Purse seine gear targets surface-swimming tuna schools for canning. Most of the catch consists of skipjack and yellowfin tuna with a small proportion of bigeye tuna. The yellow fin and bigeye tuna taken by purse seines are mostly immature fish, while the

skipjack catch contains a mixture of size and age classes. There is an increasing trend for western Pacific purse seiners to target mature yellowfin, as is now the case in the eastern Pacific.
Longline gear targets large tunas suitable for the raw fish or *sashimi* markets, as well as for canning. Catch rates for longline gear are very low (fish caught on 2% of the hooks set is considered a good catch rate), but the catch is of higher value than that of other methods. Longlines catch tunas, swordfish, marlins, sharks and other pelagic species.
Pole and line, or baitboat, gear targets surface-schooling skipjack and juvenile yellowfin tuna. Pole and line fisheries concentrate on landing high quality skipjack for fresh fish markets, high grade canning, and processed products.
Troll gear is used throughout the region to target surface-swimming tuna and bill fish. Most regions have recreational and commercial troll fisheries. The albacore troll fishery catches smaller fish used mostly for canning.
Handline gear is set below the surface to catch relatively small quantities of large, deep-swimming tuna that are suitable for *sashimi* markets.
Drift gillnet gear was once widely used to target tuna, billfish, squid and salmon on the high seas, but this fishing method has been banned from the high seas areas of the South Pacific and central North Pacific due to its reputation for high levels of non-target bycatch. A coastal driftnet fishery is still viable in other areas such as Oregon, California and Mexico.
Harpoon gear targets swordfish that "bask" at the surface of the ocean in the waters off Southern California.

Purse Seine

A purse seine vessel uses a large net to surround a school of fish, and then closes off the bottom of the net with a cable that runs through steel rings along the bottom of the net (the term "purse seine" comes from a purse that is closed with a drawstring). This operation turns a huge panel of netting into an immense bowl that can trap an entire school of tuna. Variations of the purse seine method have been used for centuries to capture schooling fish. Large-scale tuna purse seining developed on the west coast of the USA, and evolved rapidly after the development of nylon netting and the Puretic power block used for efficient retrieval of the heavy nets. Purse seining quickly replaced most California pole and line tuna fishing during the 1960s as a means of landing large quantities of tuna for the canning industry.
eez_map.htm
eez_map.htm

The US purse seine fleet was originally based in San Pedro and San Diego, California, operating in the offshore tropical waters of. Mexico and Central America. The purse seine fishery of the eastern tropical Pacific (ETP) often operates on tuna schools associated with certain species of porpoise or drifting logs, and on unassociated ("free") schools. For reasons not well understood, yellow fin tuna in the ETP, but not elsewhere, often associate with porpoise schools and are vulnerable to purse seines if the porpoises are herded and encircled by the net. By concentrating on mature yellowfin associated with porpoises, the ETP fishery maintains a high ratio of large yellowfin tuna in the catch, usually about 75% yellowfin and 25% skipjack. This catch composition ratio is reversed for the western Pacific purse seine fishery which relies heavily on log-associated purse seine activity where juvenile yellowfin tunas predominate. The

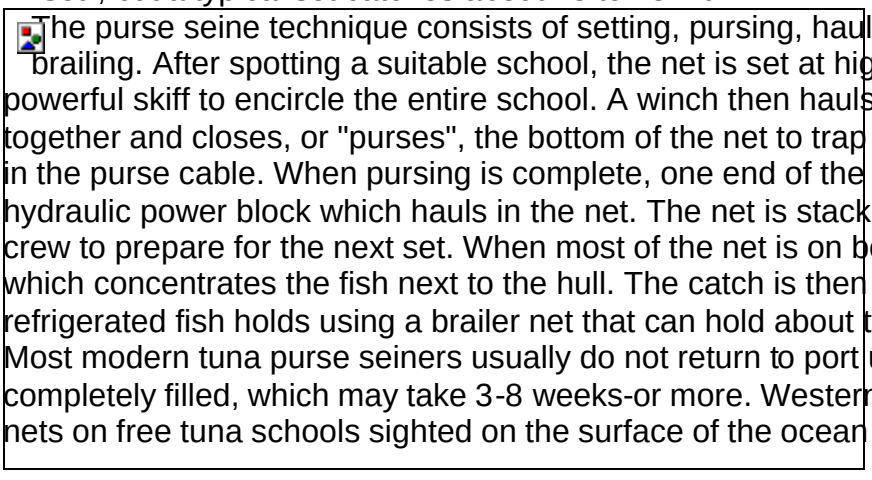
incidental mortality of porpoises in the eastern tropical Pacific was once so large that it inspired the Marine Mammal Protection Act of 1972 (MMPA).

The western Pacific purse seine fleet developed rapidly after productive Japanese surveys in Papua New Guinea and Micronesia during the mid-1970s. The USA currently has about 45-50 distant-water purse seiners, based mostly in American Samoa and Guam, and operating under conditions of a multilateral fishing agreement between the governments of the USA and several South Pacific island nations. There are still large purse seine fleets, e.g., from Mexico, Venezuela, Ecuador and Panama, that are not subject to the MMPA or other "dolphin safe" policies, and continue to fish in the ETP fishery, as do a few US vessels. These vessels carry scientific observers and use fishing practices that protect dolphins.

Other DWFN purse seine fleets from Taiwan, Korea, the Philippines, the former Soviet Republic and Australia followed the Japanese and US boats into the western Pacific, operating under bilateral agreements with individual South Pacific nations. Currently, the Solomon Islands, the Federated States of Micronesia and the Republic of the Marshall Islands operate domestic or joint-venture purse seine vessels. There are now about 200 large tuna purse seiners operating in the central and western tropical Pacific region, mostly in an area stretching from Palau, east to the Phoenix Islands of Kiribati, and from Micronesia south to the Solomon Islands (130° E to 170° W longitude and l0° N to 10° S latitude).

The most productive region for purse seining within this area stretches along the equator between Micronesia, Papua New Guinea and Kiribati, where eastward and westward flowing counter-currents create productive upwelling areas. Purse seine activity extends westward from the eastern tropical Pacific purse seine fisheries of Mexico and Central America, but these vessels seldom venture west of 145° W or north of 15° N. There is currently little to no purse seining within the EEZ of the US Pacific islands or in the north central Pacific, except for some seasonal activity by Japanese vessels relatively close to Japan.

Modern tuna purse seine vessels commonly measure 60-75 m (200 to 250 ft) in length and can carry 1,000-1,500 metric tons (mt) of fish catch in large freezer holds. Purse seine nets used in the western and central tropical Pacific typically measure 1.5 km (a mile) or more in length and 210L275 m (700-900 ft) in depth. These nets are capable of encircling an entire school and capturing over 200 mt of tuna in a single operation or "set", but a typical set catches about 15 to 45 mt.



The purse seine technique consists of setting, pursing, hauling net, "sacking up" and brailing. After spotting a suitable school, the net is set at high speed with the help of a powerful skiff to encircle the entire school. A winch then hauls the ends of the net together and closes, or "purses", the bottom of the net to trap the fish school by hauling in the purse cable. When pursing is complete, one end of the net is fed through the hydraulic power block which hauls in the net. The net is stacked on the deck by the crew to prepare for the next set. When most of the net is on board, the net is sacked up, which concentrates the fish next to the hull. The catch is then brailed from the net to refrigerated fish holds using a brailer net that can hold about two tons of fish per scoop. Most modern tuna purse seiners usually do not return to port until their fish holds are completely filled, which may take 3-8 weeks-or more. Western Pacific seiners set their nets on free tuna schools sighted on the surface of the ocean during daylight hours, or

before dawn on schools found associated with drifting logs or man-made rafts. Pre-dawn log sets are usually successful as the tuna are very close to the log, and setting and pursing can be completed before the fish can avoid the net. Daytime sets are often less successful, but are beginning to account for larger catches due to experience and improvements in fishing technology.

Because tunas are usually not associated with porpoises in the western Pacific region, seiners operating there do not have an associated porpoise bycatch. Some purse seine sets do have a large catch of non-target species, and these bycatch levels are higher when setting on schools that are associated with drifting logs and rafts due to the attraction of many fish species to drifting debris in the open ocean. Typical purse seine bycatch includes rainbow runner, dolphinfish, wahoo, marlin, pelagic sharks, mackerel scad, oceanic triggerfish and rudderfish. The reported bycatch from the US purse seine fleet in the western Pacific has consistently been less than 1% of the total catch.

Longline

Modern tuna longlining evolved from techniques developed in Japan several hundred years ago as a relatively simple method to harvest large yellowfin tuna and albacore. This technique is preferred for harvesting large tunas for *sashimi* markets, and swordfish. Longline gear consists of a mainline that is set horizontally near the surface, to which branch lines ("gangions") are clipped at regular intervals, each with a single baited hook. One set of longline gear can consist of thousands of hooks clipped to a single mainline extending across several miles of ocean, buoyed by plastic or glass floats. Longlining allows a single vessel to distribute effort over a large area to harvest fish that are not concentrated enough to be caught by fishing methods such as purse seines. Usual longline bycatch includes dolphinfish, wahoo, barracuda, moonfish, pomfrets and sharks, nearly all of which are kept and utilized. Typically, however, only the fins of sharks are kept and dried for shark fin soup, and usually only mako and thresher shark carcasses are landed whole.

DWFN Longline Fishery

Japan, Korea, Taiwan and China are the main high seas longline nations in the Pacific. A typical Asian high seas longliner may measure 150-300 gross tons and 24-46 m (80-150 ft), and carry a crew of 15-30. They make trips lasting several months and usually deliver their catch to ports in Japan and Southeast Asia, or transship their catch to freezer vessels in ports near the fishing grounds. These large vessels operate throughout the central and western Pacific region. In contrast, smaller longliners (less than 100 gross tons) from Japan, Korea, Taiwan and mainland China, air transship their fresh *sashimi* tuna catch from areas near the fishing grounds, such as Guam, Palau, Micronesia, Marshall Islands, Kiribati and Tahiti. Larger Japanese and Korean longliners concentrate on high-grade *sashimi* tunas such as blue fin, bigeye and large yellow fin tuna. Many older Taiwanese longliners continue to target albacore for canning. Some billfish such as striped and black marlin are valued by the Japanese and are sometimes targeted by longline vessels.

A typical Asian longline vessel may set 80-100 km (50-60 nm) of mainline with 1,5002,000 baited hooks each day. Only a small percentage of the hooks on a given longline catch fish; typical catch rates for 1,000 hooks set from an Asian longliner may average 10-13 albacore, and 5-15 yellowfin or bigeye tuna, and a few billfish. Albacore taken on longline gear are mostly large, mature fish over four years old, weighing over

16 kg (35 lb.). Yellowfin and bigeye tuna are also larger, older fish ranging to well over 90 kg (200 lb.). The large number of hooks set, long trips, lower operating expenses (compared to purse seine vessels), and high value of the catch maintain the economic viability of the fishery.

All longliners set and retrieve their gear once a day, with the time of setting and hauling determined by the fish being targeted and prevailing fishing conditions. A typical day aboard a Japanese *sashimi* tuna longline vessel might begin with baiting the hooks and setting the gear before sunrise. The mainline is set while the vessel steams across the prevailing current at about 15 km/hr (8 knots, kt) while the crew snaps baited branch lines, typically 18-27 m (60-90 ft) long, to the mainline about every 150 feet (46 m). The hooks are typically baited with Japanese sardine, scad, squid or saury, and a buoy is attached to the mainline about every 12 hooks. To set the mainline deeper where valuable bigeye tuna are found, more branch lines are attached between buoys, longer buoy lines are used, and a line shooter releases more of the mainline to create slack during setting. Marker flags, lighted buoys and radio beacons are attached at regular intervals to mark the line.

Once set, the vessel may drift nearby or steam slowly along the line looking for bobbing floats that signal the presence of a struggling fish, in which case that section of the line is hauled and hooks are re-baited. Otherwise, the line may be left to soak until noon, when the hauling process begins. The crew may retrieve line continuously for up to 12 hours, day in and day out, often until after midnight. When hauling the line, the vessel must be kept constantly underway at 3-6 km/hr (2-3 kt), with the ship at a 15° to 45° angle to the mainline, as the line is too heavy to haul from a stationary vessel. Retrieval of the line is assisted by a hydraulic line hauler mounted near the foredeck rail. As the mainline is retrieved, the crew removes branch lines, buoy lines, lights and radio buoys, which are readied for the next day's set. The only break in this monotonous operation occurs when a hooked fish is brought to the boat or the line is tangled. Tangles must be worked out immediately or cut away, as there is little time between the finish of the haul and the start of the next day's set. After the hauling is complete, damaged sections of the mainline are replaced, and all gear and bait are made ready for the next morning's set. Fish are carefully gaffed, brought aboard, and quickly killed to minimize struggling which could damage the meat and lower the value of the fish. Fish are gently handled to minimize bruising and other damage, immediately bled, gilled and gutted, pre-chilled in iced brine. The stomach cavities are typically filled with ice, and the fish are stored on ice (or in some cases flash/blast frozen).

US Longline Fishery

Newer vessels in the US mainland longline fleet average 25-50 m (80-165 ft) in length, and have a captain and crew of 4-6. Fishing trips last anywhere from three weeks to three months. They target swordfish and tunas, and utilize a bycatch of sharks, moonfish, and other species. General techniques are similar to those described above. Longlining for swordfish in the North Pacific is a relatively new fishery for the USA, and the introduction of chemical light sticks in the late 1970s revolutionized the industry. In addition to using squid or other bait (mackerel, saury, etc.) on the hooks, these lights are attached by rubber bands or line clips to the branch lines about 2 m (6 ft) above the hook. The light sticks produce a chemical luminescence for up to 24 hr. The lights are available in a variety of colors and are thought to attract either the bait upon which

swordfish prey, or the swordfish themselves. The light sticks are positively buoyant and of a shape and size that, if inadvertently lost from the branch line or discarded improperly, could create problems if ingested by marine mammals, seabirds or marine turtles.

The mainline is typically 30-100 km (18-60 nm) long, with 400-2,000 baited hooks set each day (with an average of 800 in the Hawaiian fishery, see below). The branch lines are typically 11-15 m (35-50 ft) long. When targeting swordfish, buoys are hooked to the mainline at about 500 m (1,650 ft) intervals, with 10-20 m (30-70 ft) of line to keep the mainline below the surface. Radar reflectors and radio beacons are used to keep track of the line. To target deeper-swimming bigeye tuna, line shooters are sometimes used to put slack into the mainline to make it sink deeper. These deeper sets use no light sticks and often have 67 branch lines between the floats, as compared to 2-3 gangions used when targeting swordfish.

Hawaii Longline Fleet

The Hawaii longline fleet includes several older wooden longliners, a few wood and fiberglass vessels, and many newer steel longliners that were previously engaged in the fishery off the US mainland. Some Hawaii vessels target primarily swordfish, some target yellowfin and bigeye tunas, and some switch between fisheries. Some longliners engage in the longline fishery throughout the year, and others may switch to different fisheries in Hawaii or the US mainland during part of the year.

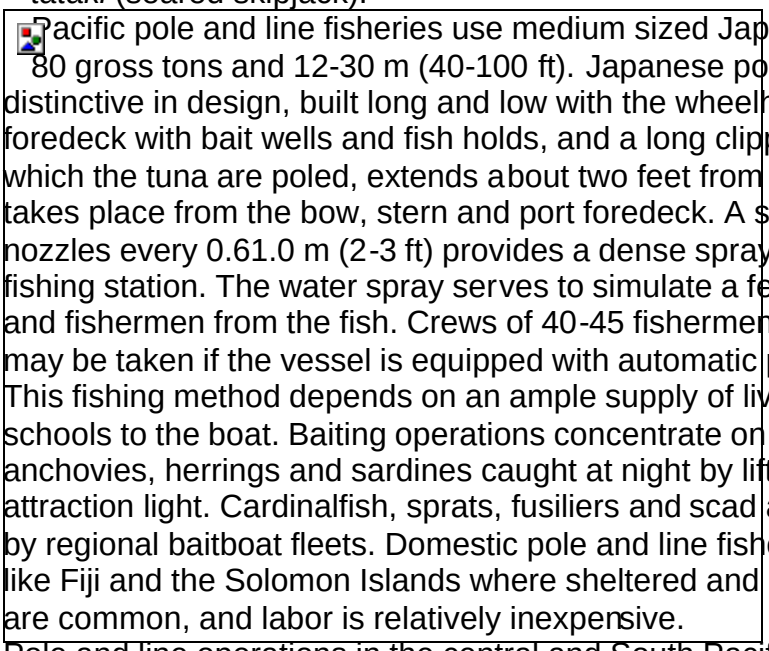
The older vessels measure 13-21 m (4370 ft) and are capable of taking two-week trips, while the more modern longliners average 2130 m (70-100 ft) and can travel for 2-3 months. These newer vessels are often outfitted with water and ice-making machines and modern electronic equipment for navigation, communications and locating fish. Most longliners now use monofilament mainline gear and can operate with a captain and crew of three when fishing for tuna, and a captain and crew of four when fishing for swordfish (the extra crew member is needed for more complete processing of the swordfish carcasses).

To catch tunas, a vessel may travel one to two days from port and a few hundred kilometers. To catch swordfish, a vessel may travel from two to 10 days and up to 3,200 km (2,000 mi), depending on the season. The techniques for tuna and swordfish longlining by Hawaii based vessels is similar to 'those described above. Longline trips typically last about 14-21 days when yellowfin and bigeye tunas are targeted, and about 30-45 days when swordfish are pursued. Hawaii longliners often sell their fresh tunas at the auction, where they are purchased by both local and export wholesalers. The swordfish catch, on the other hand, is typically sold directly to export wholesalers who ship the catch by air to the US mainland, Japan and Europe. The Hawaii-based longline fleet landed approximately 6,000 mt of swordfish in 1993, nearly 15% of the total Pacific swordfish catch. For more information on the Hawaii seafood market, please refer to the *Pacific Profile* entitled "Hawaii Seafood Market for Pelagic Fish" (Western Pacific Fishery Management Council, 1995).

Pole and line

Pole and line, or baitboat, is the term used to describe a tuna fishing method where fish are caught with a bamboo or fiberglass pole and a barbless, leathered lure. This fishing method was probably developed by Polynesians to catch skipjack tuna, using pearl shell lures rigged with hooks of hawksbill turtle shell. Poles are mostly used singly, but

two or three poles can be connected to a single lure to boat larger fish. The poles are usually handled by sturdy fishermen, but automated poling machines are also used. Modern commercial pole and line fishing for tuna began in southern Japan and later spread to many locations, including Hawaii, southern California, south Australia, and parts of the Atlantic. Larger domestic pole and line fisheries based in Fiji, Kiribati, Indonesia and the Solomon Islands catch skipjack and small yellowfin to supply canneries or specialty markets, such as for Japanese *katsuoboshi* (dried skipjack) or *tataki* (seared skipjack).



Pacific pole and line fisheries use medium sized Japanese-style vessels of about 20-80 gross tons and 12-30 m (40-100 ft). Japanese pole and line vessels are very distinctive in design, built long and low with the wheelhouse and engine room aft, a long foredeck with bait wells and fish holds, and a long clipper bow. A rail, or sponson, from which the tuna are poled, extends about two feet from the hull, and most of the fishing takes place from the bow, stern and port foredeck. A seawater spray system with nozzles every 0.61.0 m (2-3 ft) provides a dense spray directed to the area below each fishing station. The water spray serves to simulate a feeding frenzy and mask the vessel and fishermen from the fish. Crews of 40-45 fishermen sail on these vessels, but fewer may be taken if the vessel is equipped with automatic poling machines.

This fishing method depends on an ample supply of live bait used to attract tuna schools to the boat. Baiting operations concentrate on several species of tropical anchovies, herrings and sardines caught at night by lift nets and underwater bait attraction light. Cardinalfish, sprats, fusiliers and scad are also important baitfish used by regional baitboat fleets. Domestic pole and line fisheries are viable only in nations like Fiji and the Solomon Islands where sheltered and productive bait fishing grounds are common, and labor is relatively inexpensive.

Pole and line operations in the central and South Pacific consist of large boats from Japan taking their catch to Japanese markets, domestic fleets unloading their catch within the region for export, local processing or fresh consumption, and small-scale fisheries that supply domestic fresh fish markets. Japan is currently the only DWFN operating pole and line vessels in the central and western Pacific. The fleet works east and south of southern Japan toward Wake Island and in the tropical waters of Micronesia, the Marshall Islands and Kiribati. This fleet consists of sophisticated vessels of 300-500 gross metric tons and concentrates on catching mature, high-grade skipjack weighing 4-7 kg (10-15 lb). Juvenile yellowfin, bigeye and albacore are also caught and retained for sale. These vessels carry their live bait from Japan, eliminating dependency on successful baiting during their fishing trips, which can last five weeks or more. The baitfish are usually temperate water anchovies that have been kept in floating pens in Japan prior to the fishing trip. This culls weak fish and accustoms the survivors to life in captivity. The bait fish are kept in temperature controlled bait wells and fed daily. Every effort is made to keep the baitfish in top condition because tuna pole and line fishing depends on a good supply of lively chum.

A typical day of fishing begins at dawn when the fishing master and other crewmen use binoculars to search for bird flocks from the observation deck while the vessel steams ahead at about 18 km/hr (10 kt). Feeding seabirds often indicate the presence of tuna schools, and bird-detecting radar units may also be used to locate fish. When a school is located, fresh bait is transferred to small chumming tanks located at the bow,

amidships and stern while the fishermen arrive at their poling stations along the rails and stern sponson. Automatic poling machines are also readied as the vessel coasts into position ahead of the moving school. As the vessel intercepts the path of the school, live baitfish are broadcast to attract and hold a school around the boat. At the same time, seawater sprayers are activated.

The fishing strategy is based on enticing a tuna school to abandon its previous activity and begin feeding actively on live .bait thrown from the vessel. Each fisherman uses a 2-5 m (7-16 ft) pole with a 2-4 m (7-13 ft) line, a 0.5 m (1.6 ft) wire leader, a jig of chrome, feathers and soft plastic, and a barbless hook. As the fish enter a feeding frenzy, they will snap at anything resembling bait and readily attack the jigs. Hooked fish are jerked cleanly from the water in one motion, and the fishermen can usually flick the barbless jigs from the fish in mid-air. The action is fast and furious on a biting school, and a typical 10-20 minute fishing period may result in 1-4 tons of tuna on the deck. When the school dives or stops biting, the caught fish are stored in refrigerated wells (whole, not processed), the vessel is cleaned, and the search for fish resumes. Spare time between fishing periods is also occupied with cleaning the bait wells, rigging gear, or transferring catch between wells.

Japanese baitboats can catch about 814 tons of tuna per day, while the smaller domestic pole and line boats like those from Fiji and the Solomon Islands harvest closer to 2-5 tons/day. Pole and line fishing is highly selective and most of the catch consists of skipjack, with relatively small quantities of juvenile yellowfin, bigeye and albacore. The limited bycatch typically consists of kawakawa, frigate tuna, dolphinfish and rainbow runner that are often found mixed with skipjack tuna schools near reefs, seamounts, fish aggregation devices (FADs), drifting logs and flotsam.

Pole and line fishing in Hawaii

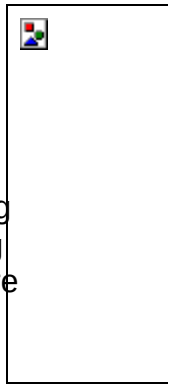
Fewer than six wooden sampans (or *"aku* boats" after the Hawaiian name for skipjack tuna) based in Honolulu are active in the pole and line fishery. These vessels, built in the 1940s and 1950s, average about 23-30 m (76-100 ft) in length and are equipped with live bait wells and sea water sprayers. The fishing techniques are similar to those described above for the distant water pole and line boats, but the Hawaii vessels operate with a much smaller crew, about 5-7. The baitfish, anchovies, silversides and sardines, are found in the sheltered waters of Kaneohe Bay, Pearl Harbor and Keehi Lagoon. To catch baitfish at night, a net measuring about 30-50 m (100-165 ft) long and 24 m (80 ft) deep is set by the vessel and a skiff, and a light is immersed in the water to attract the fish. To catch baitfish during the day, a net measuring about 160 m (530 ft) long and just over a meter deep is laid by the skiff to encircle schools found in waters about 2-4 m (713 ft) deep. Because the baitfish are easily injured, both the day and night nets are "dried up," or closed up tightly, before a fisherman carefully brails the fish from the water into the vessel.

The vessel leaves port in time to arrive at the fishing area by daybreak. Most fishing is conducted within about 30 km (20 mi) of shore. At daybreak, the crew begins searching for seabirds that might be associated with skipjack tuna schools. The vessel will stay with a school for as long as the fish are biting, after which the catch is stored in the empty bait wells, the decks are scrubbed and the vessel moves off in search of another school. Scouting ends around 5-7 pm, and the vessel arrives in port around 6-11 pm. The fish are manually off-loaded to refrigerated containers and are marketed by

Honolulu fish brokers. The fish are marketed locally in fresh condition or processed into a variety of raw *"poke"* dishes. Skipjack are available in Hawaiian waters throughout the year but are most abundant in summer. Market prices are highest in winter. Closure of the Hawaiian cannery in 1984 eliminated the most important market for the pole and line boats.

Troll

Trolling refers to the towing of artificial lures or natural baits near the surface from a moving boat ("trolling" and "trawling" are' sometimes confused, but trawling refers to a vessel towing a net along the bottom or in the water column to harvest fish, shrimp or shellfish). Most areas of the Pacific have a relatively large number of small recreational and commercial trolling vessels, and trolling from chartered boats is popular in some areas. In addition, a fleet of high seas albacore trollers is also active throughout the Pacific.



Commercial albacore trollers tow 12-18 lines simultaneously from the vessels's stern and from long outrigger poles mounted amidships. The line lengths or depths are adjusted or to permit hauling of any one line without tangling or interfering with the others. The lines are either braided polypropylene, dacron or monofilament nylon and are pulled by hand or hydraulic haulers. Lures have metal heads and feather or plastic skirts, and are rigged with barbless double hooks. Troll vessels never stop when fishing during the day, but may slow and make tight circles or short, straight runs when fishing on an albacore school. Fish are hauled directly to the stern of the vessel where they are quickly taken from the water and unhooked before being stored whole in blast or spray brine freezer holds.

'Albacore vessels usually drift at night or steam toward promising fishing grounds as determined by recent fishing activity, sea surface temperatures, or observations of baitfish and albacore on sonar or depth sounding equipment. The use of cooperative, or "code", groups also increases efficiency of the fleet. At dawn, the jigs are deployed and the rest of the day is a continuous cycle of pulling fish, changing lures, storing the catch, and searching for birds, water temperature fronts or other vessels that might indicate productive fishing areas. At dusk, the jigs are retrieved and stored for the next day of fishing.

US albacore trollers, many of which are combination salmon/albacore trollers, have fished in the offshore waters of California, Oregon, Washington and British Colombia for decades. Gradually, vessels ventured farther offshore and began to target surface albacore found north of Midway Island in the Northwestern Hawaiian Islands. This fishery operated in the north-central Pacific, starting in May or June, and followed the fish eastward toward North America, sometimes fishing until October or early November. The Midway fishery has not been active in recent years.

The South Pacific albacore fishery, which began in 1986, operates from December through early April, with 40-60 US vessels joining an international fleet. This relatively large commercial troll fishery in the South Pacific fishes on surface albacore schools found around New Zealand, and in international waters far to the east of New Zealand and south of French Polynesia. The high seas fishery operates on dense concentrations of albacore that form along the Subtropical Convergence Zone (STCZ), a highly productive region of the South Pacific (35-47° S and 170-130° W) that forms between different water masses during the southern summer. Fishing reaches a peak in January

and February when surface water temperatures are highest and the STCZ is well developed. Most of the troll vessels travel to these fishing grounds from home ports in the northwestern USA where they join vessels from New Zealand, French Polynesia and Fiji. Some of these vessels move north after their southern fishing season (May/June) to reprovision in Hawaii before heading to the North Pacific grounds or the west coast.

Vessels in the STCZ fishery are typically larger than those of the coastal New Zealand fleet, being at least 18-24 m (60-80 ft) in length, operating with crews of 3-5, and capable of freezing 45-90 tons of fish. Vessels use the same gear and methods used by the surface albacore troll fisheries of the northwestern USA and the central Pacific fisheries. Catch rates in the STCZ fishery have been relatively high, ranging from 100-500 or more fish/boat/day, and averaging about 150 fish/ day. The albacore caught by surface trolling are less than four years old, averaging 5-11 kg (12-24 lb). The fishery is highly specialized, meaning that almost all the catch consists of the target catch (albacore) with very little bycatch of other species. The main bycatch species include skipjack and yellowfin tuna, shortbilled spearfish, striped marlin, rainbow runner and dolphin fish.

Trolling in Hawaii

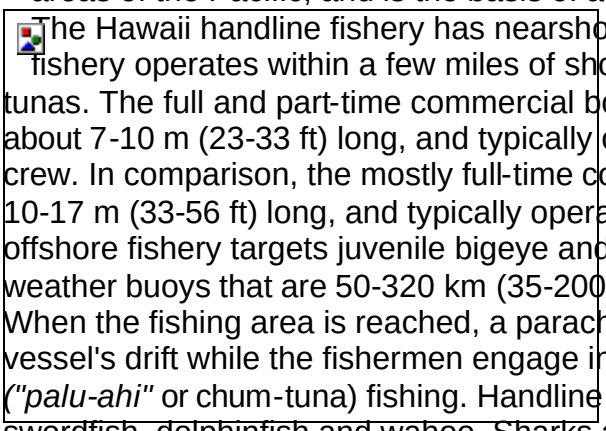
Trolling is the most popular pelagic fishing method in Hawaii, and includes full and part-time commercial (including charterboats), and recreational participants. The Hawaii troll fishery targets blue marlin, yellowfin tuna, dolphin fish, wahoo and skipjack tuna, and also lands bycatch of sail fish, spearfish, kawakawa, albacore, rainbow runner and sharks. Up to six lines rigged with artificial lures may be trolled when outrigger poles are used to keep the lines from tangling. Trolling gear usually consists of short, stout fiberglass poles and lever-drag hand-cranked reels. In addition to lures, trollers occasionally use live or dead bait. For example, small tuna are used to attract marlin, which is the prized catch for chartered vessels. Bigeye scad, mackerel scad, or strips of skipjack tuna are often used when a school of dolphinfish is encountered. When using live bait, the vessel slows to allow the bait to swim naturally.

Trollers fish in areas where water masses converge and where the underwater topography changes dramatically, such as near submarine cliffs or oceanic seamounts. Trollers also frequent fish aggregation devices (FADs), or search for drifting logs or flotsam that aggregate tunas, dolphinfish and wahoo. The various segments of the fishery use the same gear and techniques, but differ in catch composition, vessel size, fishing effort and catch disposition. Charterboats target and catch more marlin (40-50% by weight) while non-charter commercial trollers target and catch more yellowfin (about 80% by weight). Charterboats typically measure 10-13 m (33-43 ft) whereas non-chartered trolling vessels are usually trailered boats ranging from 5-8 m (1626 ft) in length. Full-time commercial vessels that are not engaged in charters expend the most effort, with an average trip lasting more than eight hours, whereas charterboats stay out 4-8 hr/trip. Part-time commercial and recreational vessels typically fish about 6 hr/trip. In Hawaii, about 70% of the charterboat catch, and 60% of the "recreational" and part-time commercial catch, is sold for food.

Handline

Handline fishing is an ancient technique used to catch tunas with simple gear and small boats. This technique was developed by Polynesians and Micronesians living on atolls

and small islands to catch yellowfin and bigeye tuna. This fishery continues in isolated areas of the Pacific, and is the basis of an important commercial fishery in Hawaii.



The Hawaii handline fishery has nearshore and offshore components. The nearshore fishery operates within a few miles of shore, and targets large yellow fin and bigeye tunas. The full and part-time commercial boats engaged in the nearshore fishery are about 7-10 m (23-33 ft) long, and typically operate with a captain and sometimes one crew. In comparison, the mostly full-time commercial offshore handline boats are about 10-17 m (33-56 ft) long, and typically operate with a captain and one or two crew. The offshore fishery targets juvenile bigeye and yellowfin tuna around seamounts and weather buoys that are 50-320 km (35-200 nm) from shore.

When the fishing area is reached, a parachute sea anchor is deployed to slow the vessel's drift while the fishermen engage in either night *("ika-shibi"* or squid-tuna) or day *("palu-ahi"* or chum-tuna) fishing. Handline bycatch is mostly utilized, and includes swordfish, dolphinfish and wahoo. Sharks are also caught, but usually not kept. The handline fishery is active year-round, and many handliners also participate in the bottomfish and troll fisheries.

In the nighttime *ika-shibi* fishery, three .to four handlines are set, each consisting of a long nylon rope connected to dacron or polypropylene mainline, which is attached to a monofilament nylon leader. The hook is usually baited with mackerel scad, and is lowered with the help of a lead weight. To attract baitfish and tuna to the area, a low wattage light bulb is placed in the water, and the surface is chummed with chopped squid and/or whole or chopped anchovies. The daytime *palu-ahi* technique adds a weighted, retrievable bag stuffed with chum that is released at a depth of 120-140 m (400-460 ft) to attract tunas to the baited hook. When a fish is hooked, it is manually hauled in, gaffed and then killed by a hit to the head with a bullet or wooden bat. Once the fish is on board, fishermen may bleed it and remove its head and viscera, and then place the fish in a mixture of ice and saltwater. These handling methods help to quickly cool the flesh so it will not become "burnt" (discolored and/or soft).

A nearshore handline trip usually lasts 1-2 days, while an offshore trip may last 1-5 days. Individual fish caught in the nearshore fishery typically weigh 18-90 kg (40-200 lb), and a good trip might land 130-180 kg (300-400 lb). Individual fish caught in the offshore fishery range from 4-32 kg (10-70 lb), and a good offshore trip might land 1,300-1,800 kg (3,000-4,000 lb). Much of the handline fish is sold directly to grocery stores and restaurants, or peddled along the roadside, and some is shipped fresh by brokers to the various islands.

In the South Pacific, the introduction of modern materials and techniques has revitalized traditional handline fisheries, where small-scale commercial operations use handlines or vertical longlines to catch yellow fin, bigeye and albacore. Vertical longlines consist of a mainline suspended from a float or small boat that is oriented vertically in the water column and reaches depths in excess of 270 m (900 ft). Baited branch lines are snapped to the mainline at regular intervals. Vertical longlining is often practiced close to floating FADs to increase catch rates or in areas where large tuna are known to congregate during the day.

Drift Gillnet

High Seas Drift Gillnet

High seas driftnet fishing was a widespread pelagic fishing method used from the mid-1980s to the early 1990s by Japanese, Taiwanese and Korean fleets to harvest tuna, billfish, squid and salmon. The long monofilament gillnets had stretched meshes of about 18-20 cm (7-8 in) when targeting tunas and billfish, and about 8.5-11.5 cm (3.4-4.5 in) for squid and salmon. These nets also harvested large quantities of non-target species and wasted much of the target catch which dropped out of the net while it was hauled onto the vessel. The nets also entangled marine mammals, seabirds and marine turtles, many of which are considered threatened or endangered species. This fishing method has been banned from the South Pacific and central North Pacific, but continues in other areas.

California Swordfish/Shark Drift Gillnet

Since about 1984, fewer than 100 vessels have been active during any given fishing season. Environmental lobbying led to a ban on gillnetting within California state waters (0-3 miles from shore), which effectively eliminated the set net fishery for angel sharks and halibut. The driftnet fishery for swordfish was largely unaffected, and still operates within the EEZ from Mexico to Washington. As the fishery evolved, the original smaller (ca. 9 m or 30 ft) wooden or fiberglass boats were gradually replaced by larger (about 22 m or 72 ft) steel or aluminum ones, with the larger boats having increased range and greater fish holding and refrigeration capacities.

The basic gear for drift gillnet operations includes a hydraulic drum for setting and retrieving the net, and a winch and boom for lifting the catch. The net is set and retrieved over the stern. A metal railing guards the net from the propeller. The net is usually constructed of three-strand, twisted nylon twine knotted to form meshes, and is 1.41.8 m (0.9-1.1 mi) long and 18-36 m (60-120 ft) deep. The net is attached to the float line by means of a hanging line laced through two to four meshes at the top of the net and tied at intervals of 3-10.5 cm (1-4 in) along the float line. The mesh sizes of swordfish nets average about 46-56 cm (18-22 in) when stretched.

Drift gillnets are set with the float line 6-9 m (20-30 ft) below the surface. This depth is maintained by buoys attached to the float line at intervals of about 20 m (66 ft). The buoy lines can be lengthened to as much as 30 m (100 ft) when targeting fish at greater depths. A radar reflector and strobe light on a 2-meter (6 ft) pole is required at the end of the net. The nets are usually set each evening, and usually only one or two crew are needed. To attract swordfish and/or their prey, many fishermen also attach chemical light sticks to the net. Nets are often set perpendicular to currents or across temperature, salinity, or turbidity fronts, because fish tend to swim along these fronts. The vessel usually remains attached to one end of the net. The nets are allowed to fish for about nine hours, and are then retrieved each morning starting about 3:00 am and ending around sunrise. Once on board, swordfish are dressed by sawing off the bill and removing the fins. Usable shark fins are cut off to be dried and sold. Thresher shark tails are also removed, but most shark carcasses are not kept.

Gillnet trips last from two days to 2-3 weeks or more. Crews range from one to six. Catches vary by species, season and year. One set may yield up to 15 swordfish, 20 shortfin mako and 20 thresher sharks and 20 moonfish, although many sets produce no marketable fish. Over the last ten years, annual landings have averaged 910 mt (2 million lb) of swordfish, 455 mt (1 million lb) of common thresher shark, 120 mt (262,000 lb) of shortfin mako, 18 mt (40,000 lb) of bigeye thresher, and 1.4 mt (3,000 lb) of

pelagic thresher shark. Moonfish are an important bycatch, and there are occasional large catches of albacore, skipjack, bigeye and yellowfin tunas. Other bycatch may include striped marlin, marine mammals and turtles. There is a growing concern about the impact of this fishery on blue sharks, which are discarded when caught.
Fishing effort has recently decreased 50-60% due, in part, to seasonal closures. Landings of common thresher sharks have declined over 80%, and swordfish and shortfin mako landings have declined 60% and 40%, respectively. The average size of swordfish landed shows no trend, but the average size of common thresher shark has decreased 21%.

California Harpoon Fishery

The California drift gillnet fishery developed when boats from the swordfish harpoon fishery were refitted. The California harpoon fishery began before 1908, and similar harpoon fisheries for swordfish and bluefin tuna have operated in the Atlantic Ocean since the 1800s. This fishery takes advantage of the habit of swordfish to "bask" at the surface of the ocean in the waters off Southern California, making them vulnerable to an accurately thrown harpoon. There are still a few practitioners of this method landing swordfish mostly in California, but the high cost of fuel and search aircraft, and poor weather conditions have limited activity in the fishery.
The harpoon fishery is active mostly from June to November. A typical day is spent searching for fish at the surface, aided on most boats by a spotter in the crow's nest above the deck. Spotter planes were also used to assist in locating tinning fish and, by 1975, there were at least 79 aircraft-assisted boats. At that time there were more than 1,200 permit holders. The vessels have plank, or scaffolding, about 612 m (20-40 ft) long extending from the bow. The harpooner stands at the end of the plank in a small platform ("pulpit") when the vessel nears a basking swordfish. Once the fish is harpooned with a metal dart ("lily iron") designed to detach from the harpoon shaft after impalement, a line, buoys, and marker flag are thrown into the water, and the fish is allowed to become exhausted for several hours while the vessel searches for more fish. The fish is later hauled on board, dressed, and marketed with fins and head removed.

Pelagic Fisheries in the Future

Many US purse seine vessels moved to the western Pacific at about the time when most of the US west coast canneries moved to American Samoa and Puerto Rico. When dolphin-safe requirements for tuna fisheries were enacted in 1991, most of the remaining US purse seiners moved out of the eastern tropical Pacific. Several US seiners still operate in the ETP, however, fishing on logs and free tuna schools, and this fishery will remain viable if skipjack and yellowfin tuna stocks remain stable, fish prices remain strong, fuel prices remain affordable, and improvements in fishing technique and gear technology develop in a timely manner to keep abreast of the continually increasing world demand for top quality tuna products (mostly in cans). Because this is a surface fishery that targets small and immature tunas, there is growing concern about the potential for overfishing. Purse seine fishing accounts for over 80% of total pelagic fish landings, and there is little doubt that the efficiency of tuna purse seine vessels will increase with further improvements in searching and fishing technology, and additional experience gained by vessel operators. There is no compelling evidence at this time, however, at least for Skipjack and yellowfin tunas, to suggest that present harvest levels are a problem for stock replenishment. Monitoring of catch levels and gear efficiency

should be improved to obtain accurate catch and effort data for assessing the impacts on fish stocks.

In recent years, there has been a shift away from large *sashimi* longliners that deliver high grade frozen fish to Japan, towards much smaller vessels working out of South Pacific ports. These small boats can operate with a lower overhead, shorter transit time to the fishing grounds, and less expensive crews, and still transship fresh *sashimi* directly to Japan or Hawaii from any convenient port that has air cargo service. New developments in longline technology and methods are also likely. For example, longliners in Indonesia have dramatically increased their catch rates using live milkfish for bait. If this practice spreads widely, it may significantly increase the productivity of longline fisheries.

The status of the swordfish stock(s) in the Pacific is uncertain, so it is difficult to comment on future prospects for this fishery. There do not appear to be direct interactions or competition with foreign fishing vessels for swordfish, but there is a considerable amount of competition from foreign firms marketing swordfish in the USA, so the domestic fishery 'is no longer as lucrative as it was previously. Although the links between human health and mercury from swordfish are still ,unclear, the incidence of higher methyl mercury content (above the FDA action level of 1.0 ppm) in recent catches of. swordfish have prompted closer inspection and monitoring of catches, which adds a further regulatory burden on this industry. Longline interactions with endangered and protected species are also a concern.

The Japanese southern water pole and line fleet continues to shrink as a result of increased operating expenses, exclusion from 200 mile EEZs, and a rapid shift toward purse seine gear by the Japanese fishing industry during the 1980s. As freezing and storage technologies improve, the ability of Japanese purse seine vessels to compete with the pole and line fleet will also improve and may spell the end of the labor-intensive Japanese distant water pole and line fishery. The regional pole and line fisheries of the Solomon Islands and Fiji are in a better position because operating costs remain low there, and they supply canneries that specialize in packing very high grade tuna that are caught near those islands.

The Hawaiian pole and line skipjack tuna fishery has been faced with a limited market since the product changed from canned to fresh tuna after the closing of the Honolulu fish cannery in 9984. Low profit margins inhibit new vessels from entering the fishery, even though the few remaining vessels have a ready market for their fresh skipjack tuna, and fishing can be profitable at times. Alternatives for procuring baitfish and extending the shelf life of fresh skipjack tuna (now about two days) have been resisted by fishermen who prefer traditional methods of baiting and fish handling.

Albacore trolling in the South Pacific will most likely continue at current or slightly increasing levels, with more vessels from French Polynesia entering the fishery. Whether or not US trollers continue to make the long trip from the US west coast will depend on the relative price of fuel and availability of albacore. The North Pacific albacore troll fishery could be rejuvenated, but this is hampered by the lack of fuel and transshipment facilities that were formerly available at Midway Island. In any event, the future of albacore trolling is better now that high seas gillnetting has been prohibited.

The Hawaii troll fishery suffers from increased fuel and insurance costs, limited launching and berthing facilities, restricted markets, and ever-increasing competition for

nearshore tunas and billfishes. As more fishermen continue to enter the recreational and commercial troll fishery, an efficient data collection system for the recreational and part-time commercial components of the pelagic fishery is needed to obtain missing information. The allocation of blue marlin and other species among gear types is a growing issue.

Profitability of the handline fishery suffers from periodic over-supply in local markets due to limited air export, and from "burnt tuna syndrome" that decreases prices. Increased costs of vessel insurance and other expenses, as well as limited launching and berthing facilities, are also concerns. Offshore handliners are concerned about the relatively small size of the fish they catch, and the number of fishermen entering the fishery.

Concerns about the California swordfish and shark drift gillnet fishery are similar to those expressed for other gillnet and shark fisheries throughout the world, partly due to the slow growth and low reproductive rates of sharks relative to most other pelagic species. Pacific island nations have banned drift gillnetting from their EEZs and adjacent high seas areas. Since then, steps have been made toward limiting purse seine activity in the western Pacific and establishing guidelines and controls on DWFN transshipment procedures.

Further work is necessary to improve catch monitoring and reporting mechanisms for all pelagic fishing fleets, in order to provide accurate data to support stock assessment and management efforts.

Pacific pelagic fisheries are dynamic, and the information in this document is subject to change.