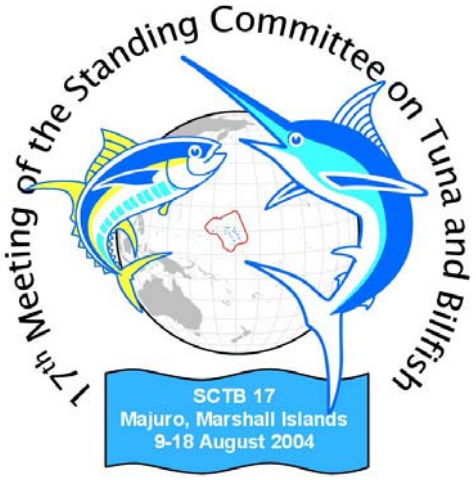
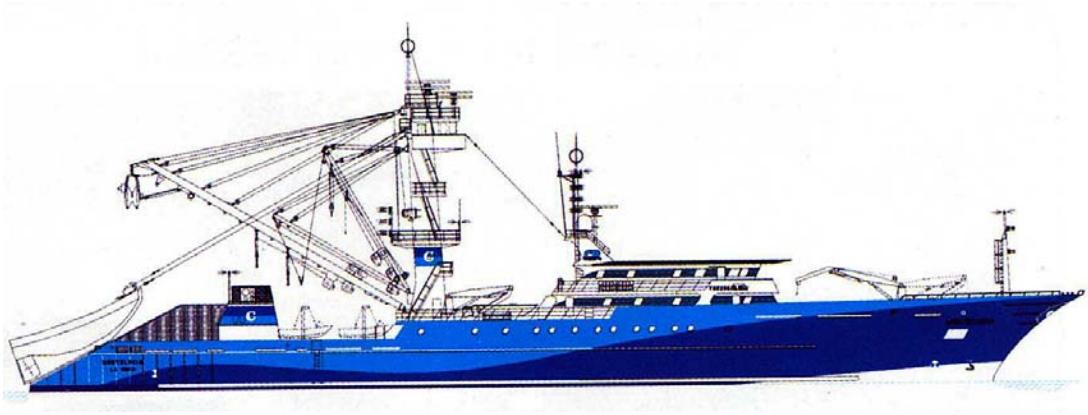


SCTB17 Working Paper

INF-FTWG-2

DOCUMENTATION AND CLASSIFICATION OF FISHING GEAR AND TECHNOLOGY ON BOARD PELAGIC LONGLINE VESSELS: HAWAII MODULE



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Documentation and classification of fishing gear and technology on board pelagic longline vessels – Hawaii module

Tom Swenarton and Steve Beverly

1. Introduction

At the 16th Sixteenth Meeting of the Standing Committee on Tuna and Billfish (SCTB16), held in Mooloolaba, Queensland, Australia (9–16 July 2003), a paper was presented documenting the variety and current status of tuna purse seine technology in a well illustrated format (Itano 2003). The purposes of the document were to inform the meeting of recent advances in purse seine technology influencing fishing power of vessels and to serve as a training aid for regional observers, port samplers and enforcement agencies. It was agreed that observer trainees benefit from graphic rich training aids. Additionally, inexperienced observers often fail to recognize new gear or innovative equipment due to a lack of experience with the history of gear development and use. The plenary recommended that similar work be conducted for longline gear and technology. The Fishing Technology Working Group was asked to complete the following task:

> ***3. Documentation and classification of fishing gears and practices of major DWFN[1] and PICT[2] fleets***
>
> ***e. Document the development, gear and current status of longline technology and fishing practices for major western and central Pacific Ocean (WCPO) longline fleets in a well illustrated format (SPC[3], FFA[4], regional and national observer programs, PICT and DWFN agencies).***

This paper is a preliminary attempt to document fishing gear and technology that has been or is currently used by the Hawaii-based pelagic longline fishery targeting tuna and swordfish (*Xiphias gladius*). Subsequent additions to this work will describe the important DWFN, joint venture and domestic longline fisheries of the WCPO.

2. The Hawaii longline fishery

Longline fishing was introduced to Hawaii by Japanese immigrants soon after the turn of the century, using wooden sampans-style boats and basket-style gear on tarred rope mainline. Large yellowfin (*Thunnus albacares*) and bigeye tuna (*T. obesus*) were landed for domestic markets, but during this period the fishery was second in importance to the skipjack (*Katsuwonus pelamis)* pole and line industry, referred to in Hawaii as "aku sampan" fishing. The early "flagline" fishery as it was then called declined steadily into the 1970s c.f. (Boggs and Ito 1993). June (1950) provides an interesting description of the early fishery.

Longline fishing in Hawaii underwent revitalization during the 1980s, fueled by demand for sashimi grade tuna and expanding markets. The fishery concentrated on bigeye tuna with substantial amounts of albacore, (*Thunnus alalunga*) and yellowfin tuna also landed. By 1985, longline landings surpassed those of the pole and line skipjack fishery and remains to

[1] Distant water fishing nations
[2] Pacific island countries and territories
[3] Secretariat of the Pacific Community
[4] Forum Fisheries Agency

this day Hawaii's largest and most economically important fishery (WPRFMC 2003). By the early 1990s, the fishery changed significantly with a rapid expansion of swordfish effort initiated by large steel vessels arriving from U.S. Atlantic swordfish and Gulf of Mexico fisheries. Tuna remained a primary target but a segment of the fishery targeted swordfish or landed both swordfish and tuna. Swordfish effort declined in importance following the mid-1990s, as swordfish boats began to leave Hawaii for a variety of reasons; including declining swordfish catches and high operational costs, increasing restrictions on fishing effort resulting from environmental issues, new fishing opportunities in the South Pacific, and to maintain fishing permits elsewhere in the U.S. (Ito pers. comm.). The fleet gradually shifted effort back to a fishery concentrating on tunas.

Hawaii-based longline vessels now operate under a federally managed limited access program allowing for 164 transferable longline permits, limited to vessels of less than 101 feet in overall length. The fishery is monitored by an at sea observer program and an electronic Vessel Monitoring System (VMS) administered by the National Marine Fisheries Service (NOAA Fisheries). Longline vessels are restricted from areas surrounding the Northwest Hawaiian Islands to avoid interactions with protected species and is further restricted from nearshore areas surrounding the main Hawaiian Islands to separate longline gear from small vessel fisheries using troll and handline gear. Shark finning was effectively eliminated in 2001 by federal and state regulations requiring the landing of the entire shark carcass if fins are to be taken.

Issues related to longline interactions with species protected by U.S. federal law, such as marine turtles, seabirds and marine mammals have significantly influenced the fishery in recent years. Swordfish directed effort was essentially eliminated in 2001 because of concerns over potential longline impacts on marine turtles. However, swordfish effort was re-opened in mid-2004 on a limited basis. Only 2,120 swordfish style "shallow sets" are currently allowed annually[5]. These measures were put in place to insure Hawaii based longline vessels operate in a way to limit interactions with sea turtles. Swordfish targeting boats are required to use size 18/0 circle hooks and mackerel type bait instead of squid that was found to be preferable to sea turtles. Other restrictions also apply. Swordfish effort generally takes place to the north of the Hawaiian Islands, centered on the Subtropical Convergence Zone (SCTZ), in a broad east/west band around 30 to 40 degrees North latitude.

Despite the re-opening of swordfish target longline effort in 2004, bigeye tuna is the mainstay of the fishery that operates in all directions and up to 1000 nautical miles from the home port of Honolulu. The fishery is active throughout the year, shifting north and south depending on the season and year. Although 164 permits are issued, active vessel participation in recent years has ranged from a high of 125 in 2000, dropping to 101 in 2000 and rising to 110 in 2003. Annual landings ranging from 11,000 mt in 2000, dropping to 7,000 mt in 2001 and then rising slightly to 8,000 mt in 2003. Generally, catches are kept whole and on ice, with limited or no mechanical refrigeration supplied. A detailed description of the Hawaii-based longline fishery is provided in NMFS (2001) and annual landings are summarized and reported by the Pacific Islands Fisheries Science Center, and compiled by the Western Pacific Regional Fisheries Management Council and NOAA Fisheries (WPRFMC 2003).

[5] "Deep sets" have been defined in the federal register based on four criteria: float lines must be 20 meters or longer, 15 or more branchlines used per basket, (10 per basket for basket gear), no lightsticks may be used, and no more than 10 swordfish may be possessed or landed at any time in the trip. If any one of these criteria are not met, the set is defined as shallow and the vessel must possess a certificate for that set and must have declared the intent to go swordfishing prior to departure.

3. **The longline**

Pelagic longline gear is composed of a long length of mainline deployed across ocean attached to numerous baited "branchlines" that are suspended in the water column between regularly spaced floats. Each branchline connects the mainline to a single, baited hook with anywhere from 4 to 30 or more branchlines (baited hooks) set between floats. The floats may be attached directly to the mainline for a shallower set or connected to "floatlines" to target deeper-dwelling species. Each section of mainline with its branchlines between two adjacent floats is defined as a "basket" of gear as traditional style "basket gear" was composed of mainline sections that were stored in baskets when not in use.

A combination of the number of hooks set per basket, setting speed, vessel speed, floatline length, branchline length, mainline material, bait type and other factors combine to influence the depth at which a longline will effectively "fish" or "target" most of its hooks. For example, longline gear can be set very shallow to concentrate on species that inhabit the upper mixed layer of the ocean or very deep to concentrate on deep dwelling species. **Figure 1** shows a longline vessel setting gear with short floatlines and six hooks per basket. The figure is not to scale as the length between hooks is much greater than depicted.

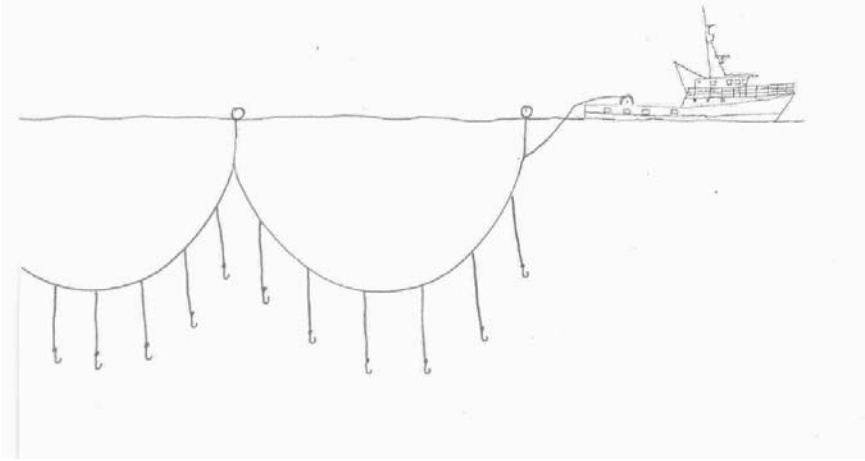


Figure 1. Hypothetical longline vessel setting six hooks per basket (not to scale)

Until recently, one vessel continued to use the traditional style "basket gear" in the Hawaii-based fishery. Currently, longline fishing in Hawaii is conducted with the newer style monofilament mainline gear. Monofilament longlining employs a large hydraulic reel that stores many miles of continuous heavy monofilament. Baited branchlines are quickly snapped to the mainline as the boat moves forward interspersed with floats at regular intervals. At the end of the set, the mainline is cut allowed to drift free, attached to marker buoys. The end result is the same as for basket style gear: many miles of baited hooks are deployed across the ocean, suspended from the surface at a desired target depth. Monofilament style longlining is considered more time efficient allowing for more fishing effort per day. However, basket style gear tends to "fish" deeper than monofilament gear due to the greater density of the mainline material.

Swordfish targeted longline gear, categorized in the Hawaii-based fishery as "shallow set" fishing deploys surface gear by using only three to five hooks per basket, no weight on the branchlines and the absence of a line shooter; a hydraulic device used in tuna targeted longlining that throws the mainline off the vessel at a higher rate than the vessel speed to

ensure greater mainline depths between floats. Swordfish vessels make ample use of light emitting devices to attract fish. Chemical lightsticks, battery powered light emitting diodes (LED's) and luminescent plastic chafing gear such as line tubes, thimbles and beads are placed near the hooks. Currently, lighted devices are prohibited on Hawaii longline gear due to sea turtle interaction concerns as it is believed that glowing items may attract the turtles.

To target deep-dwelling species such as bigeye tuna, more hooks are set per basket, a small weight may be attached to each branchline, longer floatlines are used and the boat is slowed down during the set while the mainline is expelled from the boat at a high rate using the line shooter. This gear configuration essentially defines Hawaiian "deep set" tuna targeted gear, with hooks reaching depths of 300 m or more. The shallow set swordfish style gear is set at night to catch the swordfish as they rise to surface waters to feed at night with the gear hauled in the day. Deep set tuna gear normally sets in the day and hauls gear at night.

All Hawaii-based longline boats use radio buoys, with four or five attached to the mainline in place of floats at regular intervals, usually one at each end and a few in the middle. A radio direction finder in the wheelhouse is used to track down the gear when it is time to haul and if sections of the gear break away. **Figure 2** depicts setting and hauling of the gear (not to scale).

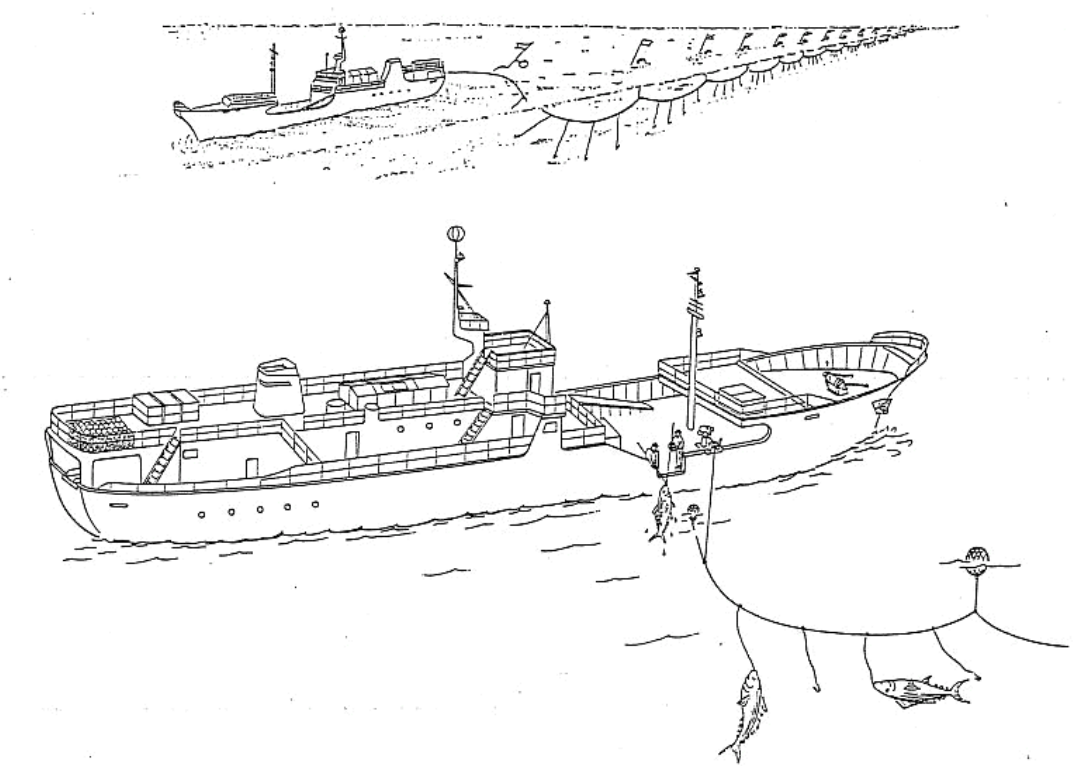


Figure 2. "Shallow set" gear with four hooks per basket. This picture is also not to scale, as the hooks are spread out over much greater distances than depicted here. (Source: FAO/UN)

3.1 Basket-style and monofilament mainline gear descriptions

Basket-style gear is not currently in use in Hawaii; the last boat using it left the fishery in 2003. Beverly (2001) provides a detailed description of basket and monofilament gear that is not specific to the Hawaii fishery but clearly explains the different gear configurations:

> ***Basket gear*** *is made from tarred rope. The mainline for basket gear can range from 4 to 8 mm dia, but 6.4 mm (1/4 in) is about average. Branchlines range from 15 to 30 m in length, and baskets can contain from 5 to 15 branchlines. Branchlines are usually spaced about 50 m apart on the mainline, and are attached at specific joints made with two eye splices and a sheet bend. Branchlines are made from tarred rope, a sekiyama or middle wire, a leaded swivel, a tsurimoto (galvanized trace wire) and a hook. Floatlines with floats are attached between the baskets, also on joints. The floatlines are usually made from the same tarred rope as the mainline and can range from 10 to 30 m in length.*
>
> *Traditional basket gear is set manually. The three main crewmen during setting operation are the baiter, the line thrower, and the float man. The baiter baits the hooks and throws the baited branchlines at regular intervals. The line thrower throws the coils of mainline off the stern from a setting table at a regular pace. The float man throws the floats and floatlines. The other men pass coils of mainline back to the thrower, tie baskets of mainline together, pass floats and bait, etc. The depth of set is regulated by how fast the thrower tosses out the coils of line. There can be a lot of uncertainty and variation in manually set basket gear.*
>
> *Basket gear is usually hauled with a hydraulic line hauler, and the branchlines are coiled by hand. The baskets are either coiled into some type of basket or tub or are tied up into a bundle, and then stowed in a cage or in bins. Branchlines are usually left connected to the mainline and are placed on top of each successive coil of mainline.*
>
> ***Monofilament gear*** *is similar to basket gear, but there are some fundamental differences. Basket gear uses short floatlines and long branchlines to achieve a deep set. Monofilament gear uses long floatlines and short branchlines to achieve the same depth of set. This can be done because monofilament mainline is easier to haul from deep water as it gives less resistance in the water than tarred mainline. The result is that monofilament gear can get more hooks in the water over a given length of mainline. Another advantage that monofilament gear has over basket gear is that monofilament gear is less labour intensive. Monofilament gear is also easier for the crew to learn. The techniques can be mastered in a few trips, while basket gear may take several seasons to master. Monofilament gear is also easier to maintain. New branchlines can be made up, and branchlines and mainline can be repaired easily during hauling operations.*
>
> *Monofilament gear is set from the stern of the boat usually with the aid of a line setter, although it can be set without a line setter. As the line is paid out over the stern during setting, baited branchlines and floatlines with floats are attached at intervals usually controlled by an audible signal from a hook timer. If the line is*

set without a line setter-this is called towing the line-then the length of mainline set is equal to the distance that the vessel travels, and the baited branchlines do not reach into very deep water. With a line setter the depth of the set can be increased, because the length of mainline paid out is greater than the distance traveled by the boat.

The line setter throws out the mainline at a greater speed than the vessel is traveling so that a catenary will be formed in the line and the set will be deep. Depths of 200 to 300 m or more can be reached. This is important when bigeye and albacore are the target species. Some fisheries scientists have described the ratio of boat speed to line speed as "sagging rate", or SR. Towing the line would correspond to an SR of 1.0 while a very deep set would have an SR of 0.5. An average SR would be about 0.75. There are many ways a fisherman can calculate the SR, some using sophisticated hook timers and tachometers on the line setter, others using more intuitive methods such as grabbing the line and counting seconds until it becomes too tight to hold.

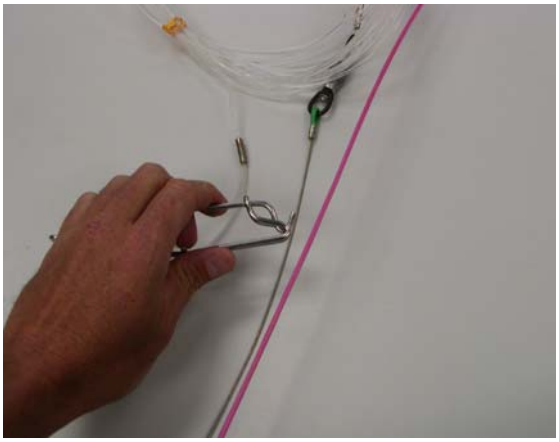
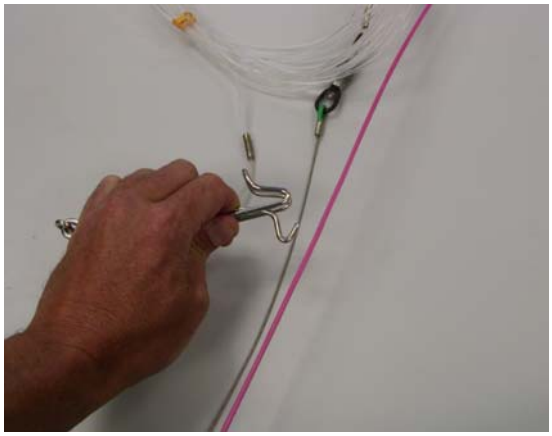
The branchlines, also called snoods or gangions, can be made from monofilament or tarred line, or a combination of these materials. Branchlines are suspended from the mainline with swivel snaps, also called clips. Branchlines can also have a lead swivel near the hook end and a trace, or leader made of monofilament or wire. Hooks can be Japan tuna hooks with brazed rings, tuna circle hooks, or big game style "J" hooks. Connections on branchlines are usually made with crimped sleeves, but sometimes knots are used. Eye loops are protected from chafing with thimbles, green springs, or plastic tubes. Floatlines are usually made with tarred rope; either polyvinyl chloride or polyester-polypropylene is not as good for floatlines as it is a floating rope and will float the mainline up towards the surface. Floats are usually hard plastic balls. As the mainline is hauled it is stored directly back onto the reel. Branchline are unsnapped as the mainline is moving and are coiled into branchline bins or tubs. Floats and floatlines are also detached. Floats are usually stowed in a cage or bin and coiled floatlines are stored in tubs.

Length of floatlines can range from 10 m to as much as 60 m. A typical monofilament tuna longline has 30 to 40 m floatlines and 20 to 30 branchlines in a basket. The branchlines are 10 to 12 m long. A typical broadbill swordfish longline has 10 m floatlines and 5 to 10 branchlines in each basket. The branchlines are the same length as the tuna branchlines and the basket length is usually the same too. This means that there is a greater interval between swordfish branchlines than tuna branchlines.

Monofilament systems do not usually use fair-lead rollers at the rail during hauling like basket gear systems do. The line is guided to the reel by a longline block hanging from a davit. This is usually an open block made of aluminum with a stainless steel sheave and roller bearings. The block is usually hung at about head level so that the operator can position one hand on the mainline before they reach the block. The line isn't stopped-the snaps are made so that they slide on the moving line. They are stopped as they strike the rollerman's hand, unsnapped, and pulled down, away from the mainline. The reel is stopped only for fish or for problems such as tangles.

3.2 Th longline clip

The longline clip allows easy attachment and removal of branchlines, floatlines, radio buoys and other gear from the mainline. When setting, branchlines and floats are attached as the line travels off the vessel. When hauling, the clip permits easy removal of gear and catch. **Figure 3** showing the attachment of the longline clip to the mainline

NOAA FISHERIES, PIR (Pacific Islands Region)

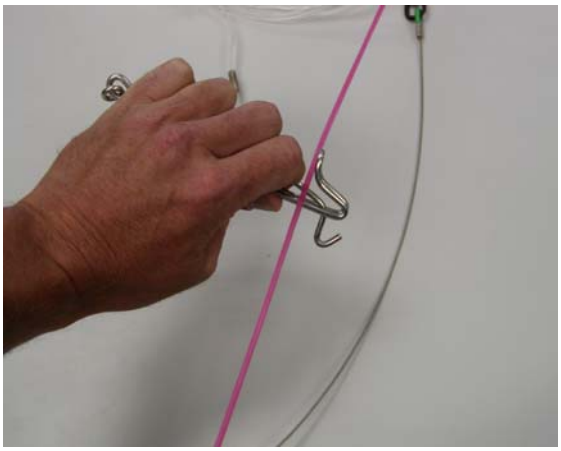
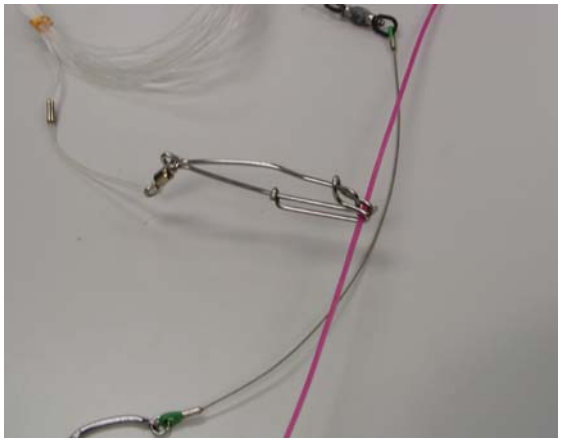



Figure 3. Attachment of a branchline clip to monofilament mainline. (NOAA FISHERIES, PIR)

3.3 The branchline

Figure 4 shows a typical tuna branchline: this one employs a wire leader, ring eye tuna hook and a weighted swivel. Swordfish gear is usually rigged without the weight and wire leader and a "J" style hook is employed. However, by law Hawaii vessels targeting swordfish must now use 18/0 circle hooks as they are believed to reduce chances of deep hooking sea turtles.

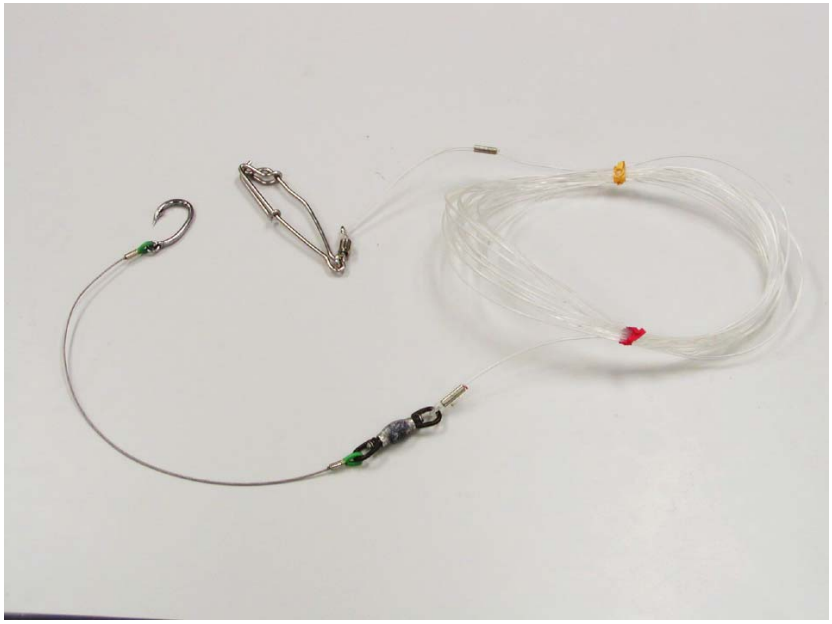


Figure 4. Typical tuna branchline. ((NOAA FISHERIES, PIR)

3.4 The hooks:

Figure 5 shows the common hooks used by Hawaii-based longliners:

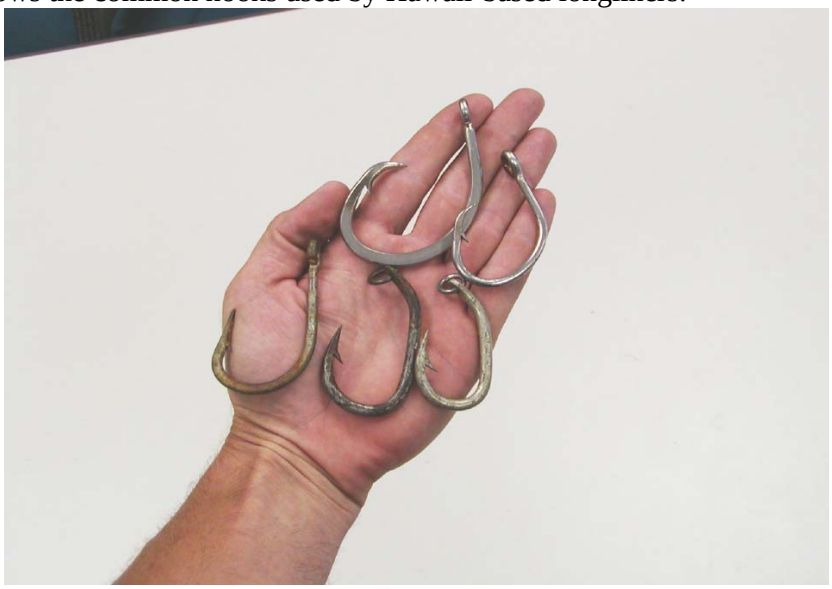


Figure 5. Clockwise from tip: 18/0 stainles circle, 14/0 circle hook, 8/0 "J" style hook, 3.8 ringed tuna, 3.6 ringed tuna hook. (NOAA FISHERIES PIR (Pacific Islands Region)

4. Gear storage

Floats are typically stored as close as possible to the setting and hauling areas. For monofilament gear as many as 90 floats may need to be attached and removed from the mainline each day. The branchlines are stored in special bins pictured below. Approximately 500 or more branchlines can be neatly stored and deployed with each bin. **Figure 6** shows typical storage of gear. Note the radio buoys at center and the rack for storing floats on the right.

Figure 6. Back deck of a Hawaii longline vessel with hook bin and floats **(**NOAA FISHERIES, PIR)

Figure 7 shows a typical hook bin.

Figure 7. Hook bin **(**NOAA FISHERIES, PIR)

Figure 8 shows the hook bin in detail. Each hook is stored in its longline clip. This bin is rigged with tuna style hooks and a mix of straight monofilament and wire leaders.

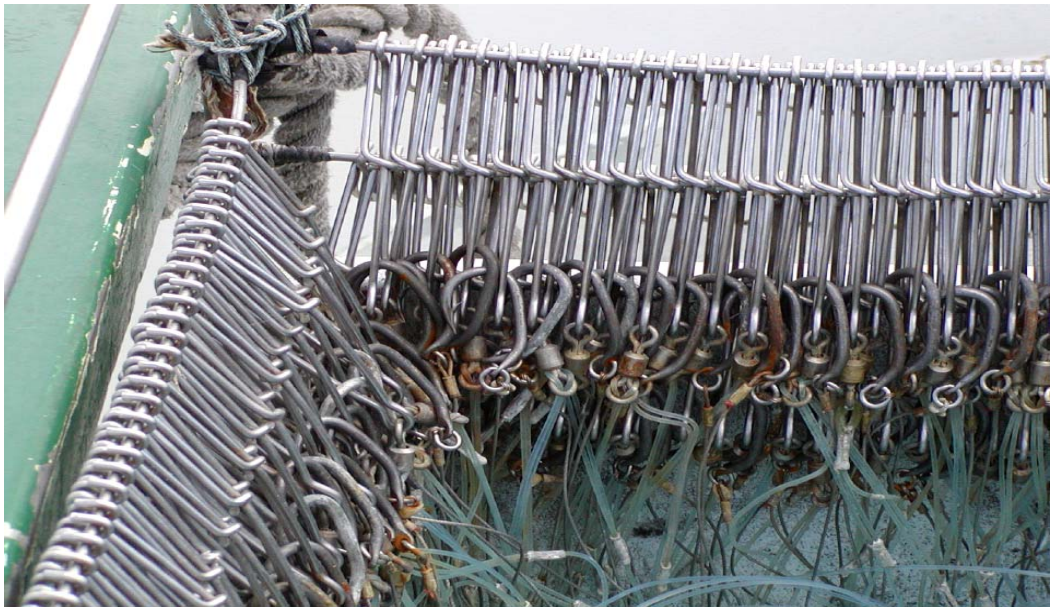


Figure 8. Hook bin detail **(**NOAA FISHERIES, PIR)

4.1 The hydraulic reel or spool

The hydraulically operated longline reel hauls and stores the nylon monofilament mainline. Hawaii-based boats typically use longline reels that hold about 40 to 50 miles of mainline. Depending on the size of the boat, smaller or larger spools are used with some boats using two spools. A traveling block runs the length of the spool slowly guiding the line from one end of the spool to the other when hauling to ensure a level wind. **Figure 9** shows a typical monofilament longline reel.

Figure 9. Monofilament mainline reel. (NOAA FISHERIES PIR (Pacific Islands Region)

4.2 The line shooter

The monofilament mainline is fed through the line shooter that pushes the line off the boat for deeper sets. The mainline is paid out from the back of the boat normally, although some boats are now setting from the side in an effort to reduce seabird interactions. It has been demonstrated by Hawaii-based vessels that side setting gives the bait time to sink out of the reach of birds before leaving the vicinity of the boat (Gilman et al. in review). **Figure 10** shows a typical line shooter.

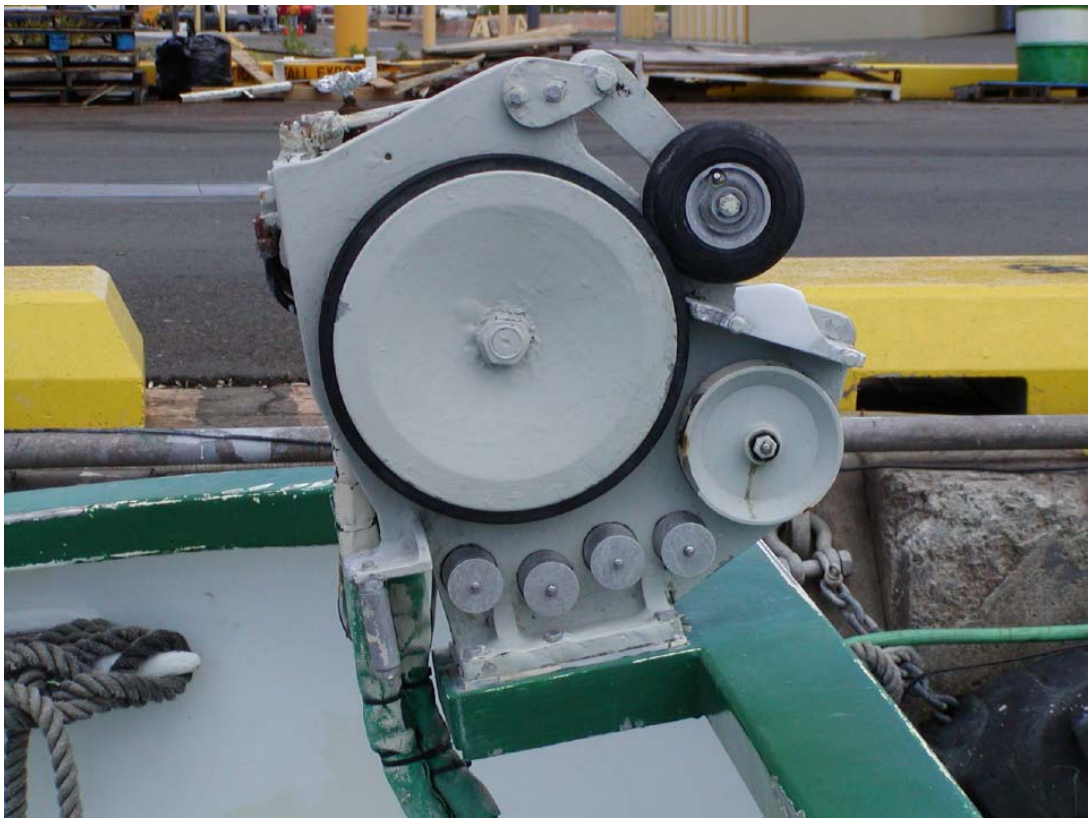


Figure 10. A typical line shooter on the stern of a Hawaii-based longline vessel **(**NOAA FISHERIES, PIR)

5. Electronics and wheelhouse equipment

A typical Hawaii-based based longliner is equipped with standard marine electronics such as Global Positioning System (GPS) chart plotters, radio direction finder, autopilot, VHF radio and single side band radios. Some boats also employ computers, weather facsimile receivers, radar, and satellite phones. Satellite imagery (for sea surface temperature and altimetry) was utilized by some segments of the fleet, (typical for swordfish targeting vessels). **Figure 11** shows a typical pilothouse with marine electronics mounted to the bulkhead. Pictured top to bottom on shelves: radio direction finder, single side band radio, weather fax:

F**igure 11.** Marine electronics in wheelhouse. **(**NOAA FISHERIES, PIR)

Figure 12 of a typical pilothouse showing radar, GPS chartplotter, VHF radio, sounder, and engine controls, and auto pilot.

Figure 12. Wheelhouse controls and instruments. (NOAA FISHERIES, PIR)

6. The boats

In 2003, there were 110 vessels active in the fishery ranging in size from 46 to 98 feet. Most are of steel construction with some fiberglass and older wooden boats in the smaller sizes. There is a wide range of vessel types with some purpose built tuna or swordfish longline vessels and many boats adapted from other fisheries, such as the US Gulf of Mexico shrimp fleet. **Figure 12** shows some typical Hawaii-based longliners:

Figure 12. Hawaii-based longline vessels in Kewalo Basin, Honolulu. **(**NOAA FISHERIES, PIR)

7. Bait

Hawaii-based longliners rely primarily on saury bait *Cololabis saira*, although sardine species (primarily California sardine, *Sardinops sagax*) have seen an increase in use recently. Large *Illex* sp squid was formerly used for swordfish bait. Currently, squid is no longer to be longline bait on any Hawaii-based vessels as part of regulations put in place to reduce interactions with protected sea turtles. For the model swordfish targeted fishery currently underway (2004), only mackerel or mackerel-like baits may be used.

8. Catch

Tuna vessels target bigeye, yellowfin and albacore tuna with deep-set gear,and swordfish vessels target broadbill swordfish with shallow-gear, but a variety of fish are retained by all vessels. Dolphinfish (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), pomfrets (FAMILY BRAMIDAE), opah (*Lampris regius*), shark, billfish, escolar (*Lepidocybium flavobrunneum*), and oilfish (*Ruvettus pretiosus*) are also retained. Hawaii seafood consumers represent many diverse ethnic groups creating demand for many species that would be discarded elsewhere. Almost all of the longline landings are auctioned to seafood

wholesalers through the United Fishing Agency, now the only fish auction in Hawaii. Most of the seafood retailers, supermarket buyers and distributors to Hawaii restaurants purchase their fish through the UFA auction or from a wholesaler who buys there. A great deal of the catch is also exported to the US mainland where it ends up in fine restaurants and retail markets.

9. The fishing operation

The setting of the gear typically starts in the early morning for tuna fishermen, and the early evening for swordfish targeting boats. A radio buoy is clipped to the bitter end of the mainline and lowered over the side. The boat moves forward at about seven knots and the mainline is pulled off the reel by the forward motion of the boat. Deep-set tuna fishermen use the line shooter to "push" the mainline out faster than the boat speed to achieve a deep sag between the floats

Mainline is normally paid out from the stern of the vessel, although some are now setting from the side to reduce seabird interactions. The side set allows the bait to sink before leaving the vicinity of the boat, inhibiting interactions and lost baits. Branchlines with baited hooks are clipped onto the mainline at regular intervals and interspersed with floats to fish a targeted depth. Swordfish gear uses four to six hooks per basket. Tuna fishermen will use up to 30 hooks or more per basket. Some vessels use adjustable timers that alert the crew to clip on gear, helping to space the hooks at regular intervals. Additional radio buoys are attached in place of floats along the mainline and one is attached at the very end. The longline is then detached from the vessel and allowed to drift free, with the boat moving a distance away to let the gear soak. The vessel operator and crew take a break for a few hours and prepare for the haul.

When the "haulback", or retrieval of the line begins, the radio direction finder is used to find the last radio buoy set, and the haulback is started where the set was ended. Occasionally a vessel will steam back to the beginning set position and start hauling there. The mainline is run through a block or series of blocks back to the spool. The vessel operator drives along the mainline while carefully controlling the speed of the vessel and mainline reel, while unclipping the gear as it comes up and handing it to the crew to be dealt with. The hauling station is located close to the middle of the boat on the side. The vessel operator has controls to operate the boat and control the reel, and is positioned next to the first block through which the mainline passes. **Figure 13** shows the hauling station, note the vessel controls and block where the vessel operator unclips the gear. Usually the operator will leave his gloved hand in contact with the mainline so that the clips are stopped by his waiting hand as the clip slides along the smooth monofilament mainline. His other hand controls the boat and spool. Once a clip is felt it is released and passed to the crew to land any catch, remove any unused bait and stow the gear. Some boats save the used bait to be reused the next day, with coarse salt sprinkled over the used bait to keep it firm.

Figure 13. Work station where the vessel operator controls the vessel and mainline reel during the haulback. (NOAA FISHERIES, PIR)

When a fish is encountered the crew gaffs it aboard. **Figure 14** sghows a large swordfish being landed onboard a Hawaii-based longline vessel. The vessel operator may slow or stop the boat for large fish or tangles. The fish killed, bled are placed in the ice hold as soon as possible. Longline fishermen in Hawaii do not head and gut the catch except for swordfish and retained shark species. These species are headed, finned and gutted prior to icing as soon as possible after landing. Tuna are "spiked" with a special stainless steel tool to preserve quality and extend shelf life. The spike is pushed into the brain and serves to kill the fish quickly and destroy the central nervous system that slows decomposition. The spike is then used to tear the gills on both sides of the head which is flushed with a seawater deck hose to promote bleeding. Soon after, the deck hose is inserted into the mouth to flush out the stomach, as it is believed that stomach contents and stomach acids will increase spoilage. Some boats will insert a thin plastic rod or section of mainline into the brain hole left by the spike. The rod is pushed all the way down the spine, destroying the spinal chord in a process known as "rodding". This procedure is believed to prevent breakdown of the meat in what is called "burnt tuna syndrome[6]" and increase the quality and shelf life of sashimi grade tuna. The fish are packed in the ice to cool and are later repacked during the trip as the surrounding ice melts.

Figure 14. Landing a large swordfish during the haulback. (NOAA FISHERIES, PIR)

[6] Burnt tuna syndrome is caused by the oveheating of muscle tissues by excessive exercise as may occur when a fish is hooked.

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