DEEP-SETTING LONGLINE TECHNIQUE FOR BYCATCH MITIGATION TESTED IN HAWAII

I spent several weeks in Hawaii (June through August), fishing with one of the highliner boats that fishes in the Hawaii-based tuna longline fishery. I accompanied the boat, F/V Caroleigh, and crew on two of seven planned trips that collected data on the deep setting technique (see Fisheries Newsletter #109). The project was funded by the Joint Institute for Marine and Atmospheric Research (JIMAR), which is a part of the National Oceanographic and Atmospheric Administration (NOAA) that operates out of the University of Hawaii in Honolulu, Hawaii. Scientists from JIMAR’s Pelagic Fisheries Research Program (PRFP) at the Pacific Island Fisheries Science Center (PIFSC) worked with SPC to design a project to collect more data on the deep setting technique that was first developed by SPC and tested in Mooloolaba, Australia (Beverly and Robinson 2004). The technique uses a new gear design for longline fishing for tuna that sets all baited hooks below 100 metres, out of range of most sea turtles and other bycatch species such as billfish, but within the best range of the main target species, particularly bigeye tuna, using lead weights and paired floats and the mainline as long floatline (Fisheries Newsletter #114)

When the technique was first tested in Mooloolaba, it worked fine and the results were promising. Sets on one fishing trip in 2004, using the deep setting technique, caught 42% more bigeye tuna than sets using the boat’s normal configuration. However, because of the small amount of data (only 6000 hooks were fished in all) and the fact that bycatch was not monitored, the results of these trials were considered to be anecdotal and not significant. One of the recommendations coming from the project in Australia was that more testing was needed to get a more robust data set. In 2005, SPC began communicating with fisheries scientists, Chris Boggs and Mike Musyl, at JIMAR about the possibility of a collaborative project. The result was that SPC was invited to further test the deep setting technique using a tuna longline boat chartered especially for the experiments. Hawaii is an ideal place for testing bycatch mitigation methods because there is a well-developed longline fishery there and because they have several issues regarding bycatch in their longline fisheries (see Fisheries Newsletter #93, Dalzell 2000).

Tuna longline boats target tuna but catch other species as well, which are often called bycatch. Target species include bigeye tuna (Thynnus obesus), yellowfin tuna (T. albacares), and albacore tuna (T. alalunga). Bycatch can include striped marlin (Tetrapturus audax) — which is marketed in some areas — and fish that are discarded such as lancetfish (Alepisaurus spp.), snake mackerel (Gempylus serpens), and some sharks. Some bycatch species are discarded because they are endangered and are protected by law, including sea turtles, sea birds, and marine mammals. Research has shown that sea turtles spend most of their time in the upper 100 m of water (Polovina et al. 2003). Ten times more turtle encounters occur in the top 100 m of water than in deeper water (SPC 2001). Many billfish species are also usually encountered in the top 100 m of the water column. By contrast, two of the main target species of longline fishing — bigeye tuna and albacore tuna — spend most of the daylight hours (when most tuna longline boats are fishing) at depths greater than 100 m. Fishermen targeting these species usually fish deep. However, because of the way longlines are usually set, some hooks still fish in shallow depths even on a deep set.

The experiment conducted in Hawaii used two different setting techniques — control sets and deep sets. The experiment attempted to eliminate shallow hooks on deep sets to maximize catch of deep dwelling species such as bigeye tuna while reducing catch of other species. In the experiment, the boat was allowed to keep and sell all of the catch and choose the fishing areas, setting and hauling times, and number of hooks per basket. Deep sets were achieved by attaching paired 3 kg (6.5 lb) lead weights directly below paired floats on 75 m long portions of the mainline. Since the floatlines were 25 m long, the actual depth of the shallowest hooks was around 100 m. The rest of the fishing portion of the line was well below 100 m, often getting as deep as 300 m. The range of depths fished was from about 100 m to 250–300 m. The control sets, by contrast, fished a range of depths from about 25–50 m to 200–250 m. Depths were verified by the use of Star-Oddi temperature depth recorders (TDRs).

In order to compare catch rates on control sets (fishermen set the longline gear as they normally would) versus catch rates
on deep sets, paired sets targeting bigeye tuna were made. In other words, if the first set was a control set, then it had to be followed by a deep set in the same general vicinity and so on. Seven paired sets were made on each fishing trip. The only parameter that was changed between control sets and deep sets was the line configuration. Everything else, including the bait, time of set, time of haul, etc., remained the same. The experiment involved a total of 45 paired sets (45 control sets and 45 deep sets) or 90 sets total. Each set had 2000 experimental hooks so the total number of hooks fished in the experiment was 180,000. This should provide enough data to determine if the technique is viable. To be viable the mitigation technique must reduce bycatch and either increase or not change target species catch. From the fishermen’s point of view the technique must either not change revenue or it must increase revenue to be viable. One goal of the project, therefore, was to increase the bigeye tuna catch on the deep sets enough to offset any losses in revenue from a decrease in marketable bycatch (often called byproduct) such as striped marlin. At the fishermen’s and boat owners’ request the project will use fish auction data from all fishing trips to compare the economics of the two set types.

I made two trips, one in June and the second one in July. Each trip lasted about three weeks. All fishing was done in Hawaii’s EEZ or in surrounding international waters. Data were taken on two forms: the South Pacific

Top: F/V Caroleigh
Middle: Lead weight with snap
Bottom: Icing the fish
Regional Longline Logbook and the SPC/FFA Regional Longline Observer Catch Monitoring Form LL-4. On the first trip I measured all fish and recorded all data. On the second trip, JIMAR Fisheries Biologist, Dan Curran went along with me to learn the deep setting technique and to record data. Dan then trained observers from the NOAA's Pacific Islands Regional Office (PIRO) Observer Program for all subsequent trips. This included going on the third trip and seventh trip. All data were recorded by NOAA observers on trips three through six.

Before I left Hawaii, Dan had a brief look at the data from the first two trips and found some interesting preliminary results. Of all fish caught during the first two trips on a total of 56,000 hooks, the deep sets caught 59% of the main target species, bigeye tuna, while the control sets caught 41%. For one of the principle bycatch species in question, striped marlin, the deep sets caught just 12% while the control sets caught 88%. The figure below shows the relative percentages of most of the species caught during those trips. It should be kept in mind that these results, although very promising, are only from 56,000 hooks of a total 180,000 hooks that will be fished, and are therefore very preliminary. Results of the total experiment will eventually be published as a manuscript after all data are analysed.

The materials needed for this project were all purchased by JIMAR in Hawaii and included the following:
- 160 three kg (6.5 lb) lead weights with bails for line attachment;
- Six coils of 6.4 mm tarred polyester floatline;
- 60 x 360 mm hard plastic longline floats;
- 400 longline snaps;
- Two pairs of cutters;
- Two small Swedish fids; and
- One set of Star-Oddi TDRs (15 units, connector box, software).

Prior to leaving on the first trip the crew assisted Steve and Dan in splicing all of the lines on the lead weights and floats. This extra gear was needed to supplement the boat’s normal compliment of floats and floatlines.

F/V Caroleigh is the newest boat in the fleet owned and operated by Pacific Ocean Producers in Hawaii (dba Vessel Management Associates). The specifications of F/V Caroleigh are as follows (Anon 2004):

- **Vessel type:** Tuna longliner
- **Owner:** Vessel Management Associates
- **Designer:** Hal Hockema & Associates
- **Builder:** Fred Wahl Marine Construction
- **Construction:** Steel with aluminum pilothouse
- **Launched:** 2003
- **Cruising range:** 10,000 nm (16,200 km)
- **Length:** 24 m
- **Beam:** 6 m
- **Depth:** 2.75 m
- **Fish hold:** 73 m³
- **Bait freezer:** 9 m³
- **Fuel:** 36,824 liters
- **Fresh water:** 8236 liters
- **Main power:** TAMD 165C Volvo 382 kW
- **Reduction gear:** Twin Disc MG516 5.05:1
- **Shafting:** Aquamet 11.43 cm diameter
- **Propeller:** 160 cm x 125 cm four blade bronze Rice Propeller
- **Propulsion controls:** Mathers Micro Commander
- **Steering system:** FWMC
- **Gensets:** 2 Northern Lights MP445T-55kW

A comparison of percentages of fish caught on deep sets and control sets from two trips (56,000 hooks).
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Hydraulics: FWMC

Longline reel: Lindgren-Pitman Superspool III (50 nm)

Longline setter: Lindgren Pitman LS-3

Fishing gear: 2500 monofilament branchlines, 100 floats and floatlines

Each fishing day the line was set starting at about 08:00. The bait was a mix of 50% sanma (Cololabis sairii) and 50% California sardine (Sardinops sagax). Setting generally took about four hours for control sets and a little longer for deep sets. As an aside, F/V Caroleigh is set up to do side setting (Brothers and Gilman 2006). In other words, the line setter is on the starboard rail, forward of the wheelhouse and baited branchlines are thrown over the side and not the stern. This is the best method found so far to mitigate bycatch of seabirds. The bait sinks out of reach of the birds before reaching the stern of the boat. Hauling usually started about 18:00 and continued until 02:00 or 04:00 the next day. All fish were iced in the single large fish hold after being spiked, bled, and gilled and gutted. All fish were eventually sold at the auction block in Honolulu (United Fishing Agency).

The Captain of F/V Caroleigh, George Ching, has been fishing in the Hawaii longline fishery for several years. He started on Japanese basket gear boats as a deckhand and later switched to monofilament, eventually working his way up to captain. George is part Hawaiian (Hawaiian-Chinese on his father’s side) but has but also has other Pacific Island Origins. His mother is from Pohnpei. This is probably why F/V Caroleigh has an all Pohnpeian crew (George has had the same crew for over two years). The three crew members – Allen Lenzy, Otto Dannis, and Mac Malakai – are all from Pohnpei. The hard work and professionalism of the captain and crew made the experimental fishing go very smoothly.

REFERENCES


SPC. 2005. Set your longline deep: catch more target fish and avoid bycatch by using a new gear design. A brochure produced by the Secretariat of the Pacific Community. (To obtain a copy contact Steveb@spc.int. Available in English, French, and Spanish.)