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# Optimizing Tori Line Designs for Pelagic Tuna Longline Fisheries

Report of work under
New Zealand Ministry of Fisheries
Special Permit 355

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Sea Grant
Washington

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## INTRODUCTION

Observations of seabird interactions with pelagic longlines were carried out aboard one of four Japanese vessels participating in the joint venture fishery for southern bluefin tuna in the New Zealand EEZ off the Fiordland coast from 23 April to 2 May 2008. The purpose of the project was to establish protocols to monitor seabird behavior in response to tori lines (also called streamer lines), and to begin to establish essential design elements for effective tori lines. This project was a collaboration of the New Zealand Japan Tuna Company, Ltd, the New Zealand Ministry of Fisheries, and Washington Sea Grant. Ed Melvin was the scientist aboard and made observations reported here.

Pelagic fisheries managed by international agreements (Regional Fishery Management Organizations or RFMOs) constitute one of the greatest conservation threats to Southern and Pacific Ocean seabirds. Although tori lines are the most widely prescribed seabird mitigation tool in longline fisheries, controlled studies demonstrating their effectiveness in pelagic fisheries in the context of production fishing have not been undertaken. Unlike demersal fisheries where all fishing gear sinks below the surface within 50 m of the stern, pelagic longlines are suspended between floats at the surface. This surface fishing gear makes tori lines more challenging to use in pelagic fisheries. Often fishers deploy tori lines to the leeward side of the gear where they are least effective, or do not deploy them at all for fear of hanging up on buoys at the surface jeopardizing the fishing operation. Further, the design and materials of tori lines have not been optimized via research for either demersal or pelagic longline fisheries.

In 2007 the Western and Central Pacific Fisheries Commission Scientific Committee debated the efficacy of different tori line designs used by various longline nations. The underlying science on competing designs was found lacking, frustrating progress toward required seabird mitigation in the fishery. The USA, Australia and New Zealand expressed keen interest in coordinating a series of trials to test various tori line designs in 2008.

This project was the initial critical step in the process of determining the optimal design of tori lines for pelagic longline fisheries. Establishing protocols to monitor seabird behavior in response to tori lines will enable subsequent definitive comparison of tori line designs. The study was also intended to allow for initial comparisons of the effectiveness of different tori line configurations.

## METHODS

*Need For a Permit*

Daytime observations of seabird interactions with tori lines were fundamental to the success of this undertaking. Currently under New Zealand law, vessels setting surface longlines are required to set their longlines at night (from 0.5 hours after nautical dusk to 0.5 hours before nautical dawn) unless they use line weighting (45 g or more metal weight per hook; New Zealand Gazette 2008). Because the four Japanese joint vessels deploy hooks with less than 45 g of weight at each hook, a special permit was required and granted to allow setting in daylight hours so that seabird observation could be made. To address the increased risk to seabirds that daylight setting with experimental tori lines might present, a limit of 30 seabirds with specific limits of ten albatrosses and 20 petrels, shearwaters and prions, was established for this project in conjunction with the Seabird Mitigation Technical Advisory Group (representatives from MFish, DoC, Seafood Industry Council, Birdlife International, and WWF New Zealand) as a permit condition.

*Vessels, Fishing Gear and Practices*

The observed vessel[1] was one of four Japanese owned vessels operating in the 2008 joint venture fishery. These vessels use similar longline gear and coordinate fishing activities so as to not overlap and tangle gear. Gear is set in parallel 5 nm apart in a north-south orientation and on a coordinated time schedule.

The observed vessel was over 55 m (length overall) with a crew of 22 persons. It sets longlines at a vessel speed of 10.6 knots and retrieves gear on average at 6.6 knots. Baited hooks were deployed using a bait casting machine (Figure 1), which delivered each bait approximately 8 m to the port side beyond the vessel's wake every 7 seconds. The bait casting machine functions to uncoil the monofilament trace of the branchline without tangles, thus making the setting process more efficient and consistent. Floats are tossed just starboard of the midline or at the midline.

Each hook (Mustad 0/6 tuna hook) had a 12 g weight immediately above the eye of the hook. Branchlines were made up of 5 components: 17 m of a hard lay braided line, 5 m of coated plastic line, 5 m of monofilament twist, 10 m of monofilament lines. The mainline, made of a monofilament twist, was set slack using a hydraulic lineshooter (Figure 2). Branchlines were attached to the mainline via a tuna clip by a crewman sitting at the midline of the stern immediately port of the lineshooter. A second crewman deployed baits via the bait casting machine holding the branchline until the monofilament section of the branchline uncoiled. A narrow stainless table between the two men held

[1] The identity of the host vessel is protected for the purpose of this report.

floats and branchlines ready for deployment (Figure 3). A third crewman baited the hooks on coiled branchlines stacked in piles of ten between tuna floats. In each basket of ten branchlines, three hooks were baited with whole Illex squid and the other seven were baited with whole sardine. The sequencing of the two bait types was consistent from basket to basket and set to set. Twenty "baskets" were deployed between radio beacons. Fourteen units of 20 baskets were deployed each set for a total of 2,840 hooks over an estimated distance of just less than 60 nm. This process takes 5.5 hours. Sets were made from north to south while hauls retrieved gear from south to north (See Anderson and McArdle 2002, Figure 1, for basic description of pelagic longline gear).

The gear was allowed to soak for approximately three hours and then retrieved from the end that was most recently set (south end). Gear is hauled from the starboard side via a hydraulic line hauler over a small roller at the starboard rail. Incoming line is heaped onto a table and hauled through PVC pipes to the aft top deck where it is lofted into bins. Three to four crewmen rotate unclipping branchlines and coil them using one of three vertical high-speed coilers (Figure 4). The 10 m monofilament section is hand-coiled. Branchlines are stacked where another crewman assembles them into bundles or stacks of ten each. One or two crewman untangled and/or repaired branchlines as necessary. The floats and coiled branchlines are moved to the stern via a conveyor belt running down the port side. Hooked fish are played by hand and landed through the sea door. Several crew abandon their assigned task and either help pull the fish in (by hand) or equip themselves with long handled gaffs or harpoons to assist in the landing process. Retained fish are finned, gutted, and gilled on the deck and the remaining trunks are moved quickly to freezers. The hauling process takes approximately 12 to 13 hours.

*Seabird Bycatch Mitigation*

The Vessel deployed two, 200 m long tori lines (Figures 5 and 6): one from a tori pole on the port side (Figures 7 and 8) and one from a mast centered at the stern. Individual streamers were made of polypropylene line approximately 10 mm in diameter with three strands of yellow plastic packing strap material folded through the twist in the poly line such that one meter of strapping extended from either side (Figure 9). Individual streamers were attached to swivels in the backbone with tuna snaps. Streamers extended to the water in light wind. Six streamers were attached to the tori line as the gear was deployed. The distance between the first streamer and the stern was approximately 25 m, but was reduced to within 11 m after the sixth day of fishing[2]. Single strands of yellow packing material were fitted through the twist of the poly backbone (sometime referred to as the bottlebrush style; Figure 6) beyond the last streamer.

The port tori pole stood approximately 13 m above the water. Its base was a stout, 2 m davit that arced 30 degree outboard from vertical at its top (Figure 8). The remainder of the pole was round stock steel telescoping in decreasing diameter and was further secured with 3 backstays running to the forward port rail. The tori pole (Figure 7) extended the

[2] Note that both of these configurations did not meet the tori line specifications gazetted for use in New Zealand waters. These specifications state that the first streamer must be within 5m of the stern.

tori lines an estimated 3 to 4 m outboard of the port side. At a setting speed of 10.6 knots, the aerial extent was 80 to 100 m with no towed device at the seaward end. The port tori line was hauled via a dedicated winch (Figure 8) and streamers were clipped on and off using tuna snaps. The stern mast was solid steel with a cross tree at approximately 8.2 m above the water line. Several crewmen hauled the starboard tori line manually.

A tori line of the Alaskan design (Melvin 2000) was deployed on 29 April from the stern mast or starboard tori line with a road cone minus the rectangular base (see results) as a towed device (Figures 10 and 11).

The observed vessel also used mitigation to prevent seabird bycatch while hauling longlines (Figures 12 and 13). Haul mitigation consisted of two 3 to 4 m stout bamboo booms lashed to the forward and aft stairway railings at the top deck with single poly line suspended from it. The suspended line had yellow packing strap material pushed through the twist of the line at approximately one meter intervals and held a plastic ring with bands of packing strap material hanging from the ring that just touched the water. This haul mitigation system was very effective at keeping birds away from baited hooks as gear was hauled – no interactions with hauled baited hooks were observed as retained bait was discarded at or near the starboard sea door.

*Sink Rates and Time Depth Recorders*
Star–Oddi time depth recorders (TDRs), model DST Centi – ex, were used to measure the sink rate of baited hooks (Figure 14). These devices are relatively small and light measuring 15 mm x 46 mm and weighing 12g in water and 19g in air. These instruments were configured by the manufacturer to measure depth at 0.07 m intervals with an accuracy of ±0.12 m every second from 1 m to 280 m. TDR data files were converted into EXCEL worksheets and transducer records were adjusted to the transducer reading at the known depth at 2 m as determined from static tests for each instrument. Time in seconds and sink rate in m/sec were calculated for each TDR record to 2 m, 5 m, and 10 m depths. In addition, the fishing depth and temperature one hour post setting were tabulated with the hope that it might provide some insight to the fishing operations.

On 25 April a single TDR was deployed. It was placed 1 m above the hook attached with Tesa tape and white plastic tape favored by the Fishing Master. With successful retrieval of this one TDR, two multiple TDR deployments were made on 26 and 27 April. In the first, five TDRs were attached with white plastic tape just above the weight at the hook on the first, third, fifth, seventh, and ninth branchlines within a single ten branchline basket. In the second, TDRs were attached in the same way to the 5$^{th}$ branchline in the first two baskets of the first, fourth, seventh, tenth and 13$^{th}$ 20 basket units between radar reflectors

*Seabird Observations*
The number of seabirds by species, in the air and on the water, was estimated in a 100 m hemisphere centered at the stern during line hauling and during daylight sets. Shearwaters and storm petrels were identified to the species group level. The number of seabird attacks on sinking baits by species were estimated out to 100 m of the stern for the area

inside the two tori lines and 5 m port of the port tori line. An attack was the taking a bait at or near the surface or a dive over where baits were sinking from the surface.

*Haul Observations*
Five observations of 20 baskets or more were made on five occasions between 26 June and 1 May to determine average time required to haul gear and to determine the frequency of fish catch.

**RESULTS**

*Daytime Observation While Line Setting*
The Vessel made nine sets from 23 April to 2 May: seven night sets and two sets that extended into daylight on 28 and 29 April. This routine allowed a total of two hours and 18 minutes observations of seabird behavior relative to the sink baited hooks and tori lines during daylight hours. In 37 minutes of daytime setting on 28 April, it was immediately clear that Buller's albatross (*Thalassarche bulleri*) were attacking baits soon after they landed 1- 3 m port of the port tori line. Because the first streamer on the port tori lines was approximately 25 m aft of the stern and the baited hooks were landing approximately 3 to 5 m astern outside the port tori line, seabirds had an unprotected 20 m span to pick up baits soon after they were delivered to the water. With a five knot wind from starboard, streamers moved little and birds could fly into the wind and drop easily on baits in this large unprotected window and further aft to port of the streamers of the tori line. In a single10-minute formal observation period, Buller's albatross made 11 attacks on baits. In five of these, the birds could be seen tugging on baited hooks at the surface. All but two attacks were 20 to 50 m of the stern. No attacks occurred within the two tori lines. As baits were brought to the surface, other birds would land on the water and compete for the bait. These bird aggregations grew in number as the distance from the stern increased and could be seen extending hundreds of meters astern.

During this time there were ten to 40 Buller's albatross and three to ten white-chinned petrels (*Procellaria aequinoctialis*) in the 100 m hemisphere centered at the stern of the vessel and 90 to 95% of these birds were in the air. Assuming a hook is set every 8 seconds (hook every seven seconds and floats every ten hooks), 75 hooks are set in 10 minutes. Consequently, if we assume that the 11 attacks were successful and resulted in a lost bait, then 11 of 75 baits were lost to bird depredation in these10 minutes or 14.7%. The vessel reported 11 birds killed in the section of line set during daylight: eight Buller's albatross, one black-browed albatross (*Thalassarche melanophrys*), and two white-chinned petrels.

In 101 minutes of observations of daytime setting on 29 April, Buller's albatross continued to attack baits soon after they hit the water despite the first streamer being moved to approximately 11 m of the stern. Again baits were landing 2-3 m port of the tori line well outside its protection. Wind of about 10 knots was from one o'clock as you face the wake allowing bird to drop on baits as they landed. In a single formal observation of 16 minutes, 19 bait attacks by Buller's albatross occurred within ten to 40 m of the stern – in 13 of these attacks the birds were seen tugging on baited hooks at the surface. Again, other birds would land on the water and compete for the bait brought to the surface and the aggregations grew in number as the distance from the stern increased and could be seen extending hundreds of meters astern. With larger swells than the day prior – approximately 2 m – some attacks were thwarted as a wind wave at the top of a swell broke on or near an attacking bird.

During this time there were 30 seabirds in the 100 m hemisphere centered at the stern: 20 Buller's albatross and ten white-chinned petrels, almost all in the air except for those with a bait or having missed a bait. Assuming 120 baits are set in this 16-minute period and all attacks observed resulted in a lost bait, 15.9 % of baits were lost to seabird depredation. Nine seabirds were reported killed by the vessel for the daylight portions of this set: seven Buller's albatross, one white chinned petrel and one wandering albatross (*Diomedea exulans*).

The vessel recorded a single Buller's albatross killed during night setting in the period from 23 April to 2 May.

*Seabird Observation During Line Hauling*
In nine formal counts during line hauling from 26 April to 1 May, Buller's albatross was by far the predominant species ranging from 30 to 120 birds in the count area astern of the vessel. White chinned petrels (8 to 30 birds per observation), white-capped albatross (*Thalassarche steadi*; 1 to ten birds per observation) and cape petrels (*Daption capense*; 1- ten birds per observation) were common. In all nine counts one to two wandering albatross were seen usually over 100 m astern of the vessel, but on one occasion flying within 30 m of the vessel. Storm petrels (*Oceanities* spp.), dark shearwaters (*Puffinus* spp.) and giant petrels (*Macronectes* spp.) were observed on occasion, but in very low numbers and inconsistently.

*Towed Device Deployments*
En route to the fishing grounds, tori line towed devices were trialled. The goal was to create drag to increase the aerial extent of a tori line and to displace the end of the tori line outside the wake so as not to catch on surface gear (hooks, the mainline or the floats). One purpose built device was tested. It was constructed of 15.2 cm (6 inch) PVC pipe with a rounded cap glued onto the aft end, and a flattened threaded cap on the forward end, resulting in a capped tube 0.7 m in total length. Galvanized eyebolts were fixed into the side of the aft cap and 18 cm aft of the threaded cap on opposite sides of the tube. Ballast (6.2 kg lead) was held in the aft end of the tube with high-density foam and sealed to keep the lead in the aft third of the tube. A 1 m road cone with 5 m of line was affixed to the aft eyebolt and a 50 m line was affixed to the forward eyebolt. The 6.4 mm diameter poly (balanced) 50 m line was attached to the crosstree of the aft mast on the upper deck at the stern. The device was towed at 10.6 knots to simulate the speed at which longlines are set on this vessel.

The device was highly effective at displacing the end of the tori line well outboard of the starboard wake, but the substantial drag of the device and cone at 10.6 knots snapped the line running to the mast after 5 minutes of towing. Without stronger line available further tests on a slightly larger device (1 m) of the same design were aborted.

A 1-m road cone was deployed on a 6.4 mm diameter line to determine how it would track and function as a tori line towed device. In this case the goal was to increase drag so as to increase the aerial extent and to have the device track in a predictable manner. The cone held in the water but would release suddenly flying up to a meter in the air leaving the 50-line to go alternately slack and very tight. This erratic behavior was deemed too unpredictable to function as a towed device for a tori line on a vessel setting at over 10 knots. At the suggestion of the Fishing Master, the rectangular base of the cone was removed leaving a simple cone shape with less drag (Figure 15). This altered cone was deemed acceptable because the cone tracked predictably holding the line at constant tension. The cone was rigged to the Alaska style tori line, which was deployed from the aft mast on the set made on 29 April.

*Gear Sink Rates*
The sink rate of baited hooks to 2 m varied widely from 3 sec to 17 seconds and averaged 7.9 seconds (median 8.0 sec) or 0.352 m/sec (Table 1). However, the sink rates from 3-5 m and from 5 to 10 m were more consistent and slower (0.266 and 0.225 respectively) suggesting that some TDR transducers did not read accurately in the first two meters of the surface.

Estimates of bait depth as a function of distance astern based on sink rates shows that baits were on average at a depth of 2 m at 43 m astern, 5 m depth at 68 m astern, and10 m depth at 129 m astern. If the two fastest sink rates are treated as spurious and deleted from this aspect of the analysis, these distances change only slightly to 48 m, 73 m and 133 m for the 2m, 5m, and 10 m depths.

In the within basket comparison, the hook on branchline one (closest to the float) reached 62 m, while, the hook on branchline 7 reached 127.4 m (Table 2). Temperature varied little for hooks 3 to 9 (11.5° to 11.6° C) beyond 100 m, while the shallower branchline at 62 m occupied water over 2 degree Celsius warmer (13.9°). Branchline 3 occupied a wide range of depths (35 m to 115 m) throughout the set suggesting a fish capture (Figure 16, top). Hook five occupied a narrower range of depths (< 90 m to 135 m) and a fairly constant temperature (Figure 16, bottom). All 15 records with the TDR at the hook showed a continuous sine wave throughout the set perhaps suggesting the catenary of line between floats and the branchlines are in a state of constant up–down motion.

Hooks set at the fifth place within a 10-branchline basket occupied a wide range of depths within a single set (105 to 177 m) but a fairly narrow range of temperatures (11.1° to 12.6°C; Table 2).

*Haul Observations*
In haul observations over four days, 107 baskets (2,140 hooks) were observed. Average time to retrieve ten branchlines and a float ranged from 2.2 min to 3.8 min and varied with the number of fish caught and weather. In four hours and 49 min of observations, a

total of 42 hooks (~ 2% of hooks) were occupied: one bluefin tuna, 16 sharks, 11 fish, and 3 unidentified fish. In this time 11 fish were lost. The rate of fish loss has safety implications regarding line weighting with leaded swivels or safe-leads.

## DISCUSSION

*Seabird Bycatch Mitigation Performance*
Clearly the seabird bycatch mitigation tools – dual tori lines and 12 g leads on each hook – failed during daylight hours, killing 20 birds in 138 minutes. This failure was due to the bait casting machine delivering baited hooks 2-3 m outside the port tori line and the first streamer of the tori line being over 25 m astern[3]. Together these factors left a 20 m span that seabirds could exploit baited hooks at will. When the first streamer of the port tori line was moved to within 11 m of the stern on the second day, the capture rate dropped from 0.30 birds per min to 0.08 birds per min. Although an improvement, this rate of seabird mortality is unacceptable. Being that baits landed port of the port tori line, the starboard tori line became irrelevant to scaring birds. In this case, the bait casting machine neutralized the mitigation effect of tori lines by pitching the bait beyond their protection. Bait loss to birds of 14.7% to 15.9% could have huge negative consequences for the fishing operation – a clear example of a no-win situation.

Being that there was no obvious way to improve this situation at sea, the seabird quota of the permit was exceeded and daytime fishing ceased. As a consequence, tori line designs could not be compared; however, a protocol was established, but not fully tested. From this experience it is clear that the objective of seabird bycatch mitigation in pelagic longline fisheries is to eliminate dives within 50 to 80 m of the stern when gear is within 5 m of the surface. If a tori line can be developed that protects gear within 100 m of the stern, tori lines could be very effective and reduce most seabird mortality. Also, it was absolutely clear that any bait brought to the surface is made available to all birds in the area, including poor diving and shy birds like wandering albatross. Protocols must focus on birds that bring bait to the surface, and can ignore subsequent chaotic aggregating behavior, which would be very difficult to quantify.

*Improving Seabird Bycatch Mitigation*
Although the configuration of the bait casting machine and the port tori line performed very poorly, either redesigning the tori pole and/or adjusting the force of the bait cast by the bait casting machine can fix the situation. Regarding the former, the tori pole at 9 m above the deck with three backstays was highly stressed even with nothing on the seaward end of a 200 m tori line. Any thought of attaching even a seine float as a towed device to increase the aerial extent or the port tori line attached to the pole was quickly dismissed for fear of breaking the delicate pole. There were several replacements on board suggesting that the crew anticipated tori pole breaks. A supporting structure along

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[3] Note the tori line did not meet New Zealand's regulated tori line specifications, which require that the tori line be positioned over the sinking baited hooks and that the first streamers are 5 m from the stern of the vessel.

the lines of the New Zealand boom and bridle system would allow positioning the tori several meters further outboard than the tori pole and be of sufficient strength to support a line with a towed device, which could maximize tori line aerial extent and pull the seaward end away from surface gear.

Because of language differences, possible modifications to the bait casting machine were not discussed (with me) or explored while at sea. It is clear that this device makes longline deployment more efficient by uncoiling the monofilament trace of the uncommonly long branchline (37 m). Tangles in this part of the line would defeat the fishability of that branchline. Also tossing each bait by hand is likely to be less efficient, require more effort by crew, and result in wide variability in where the bait lands at the surface throughout a 5.5-hour gear setting process. Adjustments to the bait casting machine to better place the baits should be explored and implemented to make this vessel less of a threat to seabirds. This experience makes it absolutely clear that a bait casting machine is not a seabird bycatch mitigation tool as has been suggested by some in the RFMO community.

With regard to improving tori line design there were several qualitative observation made that are helpful and should be included in future tests. The color of streamers and perhaps the backbone of the tori line are important. The orange tubing typical of the Alaska tori line stood out dramatically in the drab grey of the sea, where as the pale yellow and pale blue plastic packing strap material used in the fabrication of this vessel's tori line provided little contrast and was difficult to see even in daylight. Changing packing strap material to a bold orange or red could possibly improve performance of tori lines.

Observations here strongly suggest that the distance between the first streamer of the tori line and the stern is very important to scaring birds from baited hooks. In this case 25 m plus distance was clearly too far and moving it to 11 m improved performance slightly. The 5 m required distance in the NZ gazetted rules are a likely best distance, in that birds were observed to take machine-casted baits at 10 m with the 11 m stern spacing.

Although tori line designs could not be compared quantitatively, the multiple packaging straps passed through the twist of the line making up the streamers and the line making up the backbone as used on this vessel could make these lines look bigger especially if the color were changed to red or orange. It is extremely difficult to imagine that a tori line with only packing straps passed through the backbone and devoid of streamers could be effective at scaring birds. We were poised to compare the performance of tori lines with and without streamers; however, the extreme seabird mortality seen during daylight hours preempted that comparison.

*Towed Device Performance*

Trials of the purpose built towed device in which the line snapped due to the amount of drag created by the offset tube and the attached cone strongly suggests the towed device created too much drag and should be redesigned for vessels setting this fast (10.6 knots). Washington Sea Grant plans to redesign the towed device using a smaller diameter PVC tube (10.2 cm or 4 inch) and to ballast the device with water rather than lead. Using water for ballast would reduce drag, ease handling and eliminate the need to locate lead. The new design will attempt to make the device self filling and draining as it is lifted in and out of the water making it easier to handle from upper decks.

*TDR Performance*
Given that this effort is one of the two first applications of Star-Oddi TDRs to measuring the sink rates of pelagic longline gear and sink rates in the upper two meters of the water column were highly variable, these sink rate data, especially to 2-m, are considered preliminary. Plans are being developed to further test and calibrate these "new" devices at a wide range of known depths. Calibration issues aside, these data suggest that the baited hooks on this vessel sink relatively quickly compared to other tests, and that a well designed tori line must protect baits from birds – especially aggressive diving birds like Buller's albatross and white-chinned petrels – out to 80 m or more to be successful.

*Lessons Learned*
Although circumstances did not allow for extended opportunity for behavioral observations, this trip brought to light previously unknown vulnerabilities in the seabird bycatch mitigation systems of at least one joint venture vessel, and possibly the other three New Zealand joint venture vessels and other high seas tuna vessels. The basic elements of protocols for quantifying seabird numbers and behavior were established for further testing, new designs for towed devices were conceived, as were the need for new ideas on tori line and tori pole design.

*The Future*
Most importantly, a collaborative relationship was established among the partners – the New Zealand Japan Tuna Company, Ltd, the New Zealand Ministry of Fisheries, and Washington Sea Grant. In debriefing this experience with the Solander Group and the Ministry of Fisheries, there was consensus that expanding this effort to controlled experiments on two or more vessels in 2009 would be greatly beneficial. More work in 2009 would provide an opportunity to remedy the vulnerabilities identified in 2008 and to extensively test tori line and tori pole designs and possibly other seabird bycatch mitigation technologies relevant to the New Zealand joint venture fishery and other high seas pelagic longline fisheries. Ideally an expanded effort of controlled experiments would incorporate ideas of the Fishing Masters in the joint fishery and other experts. Extending the collaboration to scientists at the National Research Institute of Far Seas Fisheries, Fisheries Research Agency, Japan could also be of great value. Noted are the facts that vessels participating in the 2009 fishery will not be known until late 2008, and that several issues must be addressed including: daytime fishing, permits, limits on the number of seabird taken in the fishery, redesign of tori poles and redesign or modifications to bait casting machines.

With existing funding to Washington Sea Grant from the David and Lucile Packard Foundation for multinational seabird bycatch mitigation work in 2009, and perhaps added support from the New Zealand government and industry, the opportunity exists to put in place a research program that could conclusively answer fundamental questions regarding best practice seabird bycatch mitigation technologies for pelagic tuna fisheries.

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Table 1. Sink rate data for three separate TDR deployments. All TDRs were attached to branchlines at the hook with the exception of April 25, the TDR was attached 1-m above the hook. April 26 TDRs were attached to every other branchline within a ten-branchline basket. April 28 TDRs were placed on the 5th branchline within adjacent 10 m baskets in the first, fourth, seventh, tenth and thirteenth group of 20 baskets between radar reflectors. Distance astern is the mean seconds to depth times vessel speed of 5.445 m/sec (10.6 knots). Sink rates are m/sec.

| Date | Placement | 2 m Seconds | 2m Rate | 2 to 5 m Seconds | 2 to 5 m Rate | 5-10 m Seconds | 5-10 m Rate |
|---|---|---|---|---|---|---|---|
| April 25 | 1 | 12 | 0.169 | 12 | 0.250 | 23 | 0.217 |
| April 26 | 1 | 8 | 0.258 | 8 | 0.375 | 23 | 0.217 |
| April 26 | 3 | 17 | 0.132 | 11 | 0.273 | 27 | 0.185 |
| April 26 | 5 | 3 | 0.680 | 10 | 0.300 | 24 | 0.208 |
| April 26 | 9 | 9 | 0.230 | 18 | 0.167 | 23 | 0.217 |
| April 28 | 4-1 | 8 | 0.251 | 17 | 0.176 | 21 | 0.238 |
| April 28 | 4-2 | 5 | 0.404 | 13 | 0.231 | 18 | 0.278 |
| April 28 | 7-1 | 8 | 0.259 | 11 | 0.273 | 18 | 0.278 |
| April 28 | 7-2 | 3 | 0.677 | 6 | 0.500 | 15 | 0.333 |
| April 28 | 10-1 | 12 | 0.180 | 15 | 0.200 | 26 | 0.192 |
| April 28 | 10-2 | 13 | 0.158 | 18 | 0.167 | 38 | 0.132 |
| April 28 | 13-1* | 5 | 0.418 | 10 | 0.300 | 18 | 0.278 |
| April 28 | 13-2 | 4 | 0.575 | 13 | 0.231 | 34 | 0.147 |
| Mean | | 7.9 | 0.352 | 12.5 | 0.266 | 23.8 | 0.225 |
| Median | | 8.0 | 0.258 | 12.0 | 0.252 | 23.0 | 0.217 |
| Distance Astern (m) | | 43.2 | | 68.1 | | 129.5 | |

Table 2. Hook depth (m) and temperature (°C) one hour after deployment for two separate deployments (see Table 1).

| Date | Position | Depth (m) | Temperature C |
|---|---|---|---|
| April 26 | 1 | 62.0 | 13.9 |
| April 26 | 3 | 108.0 | 11.6 |
| April 26 | 5 | 123.4 | 11.5 |
| April 26 | 7 | 127.4 | 11.5 |
| April 27 | 9 | 109.9 | 11.6 |
| | | | |
| April 28 | 1-1 | 133.4 | 11.4 |
| April 28 | 1-2 | 140.7 | 11.4 |
| April 28 | 4-1 | 176.6 | 11.1 |
| April 28 | 4-2 | 163.3 | 11.1 |
| April 28 | 7-1 | 161.3 | 11.4 |
| April 28 | 7-2 | 159.9 | 11.5 |
| April 28 | 10-1 | 151.7 | 11.0 |
| April 28 | 10-2 | 155.3 | 11.0 |
| April 29 | 13-1 | 105.2 | 12.6 |
| April 30 | 13-2 | 159.8 | 11.8 |

Figure 1. Bait casting machine.

Figure 2. Lineshooter.

Figure 3. Setting longlines.

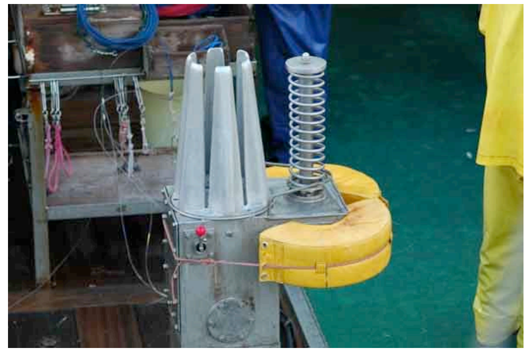


Figure 4. Line coiler

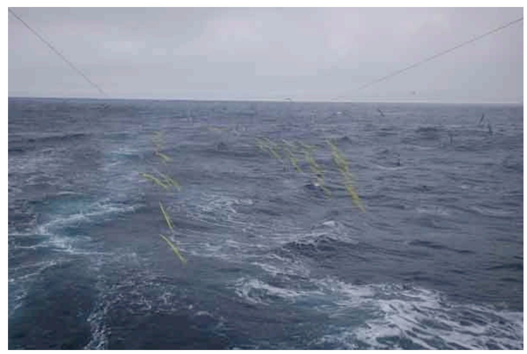


Figure 5. Tori lines.

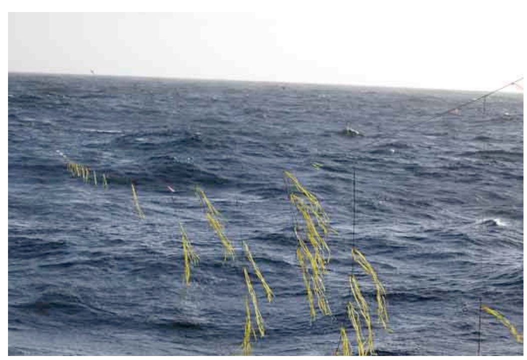


Figure 6. Tori lines.

Figure 7. Port tori pole

Figure 10. Alaskan tori line.

Figure 6. Port tori pole davit and winch.

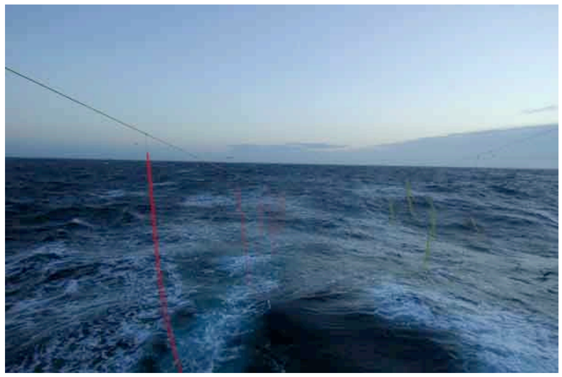


Figure 11. Alaska tori line (left) and joint venture vessel tori line (right).

Figure 9. Joint venture vessel tori line streamers.

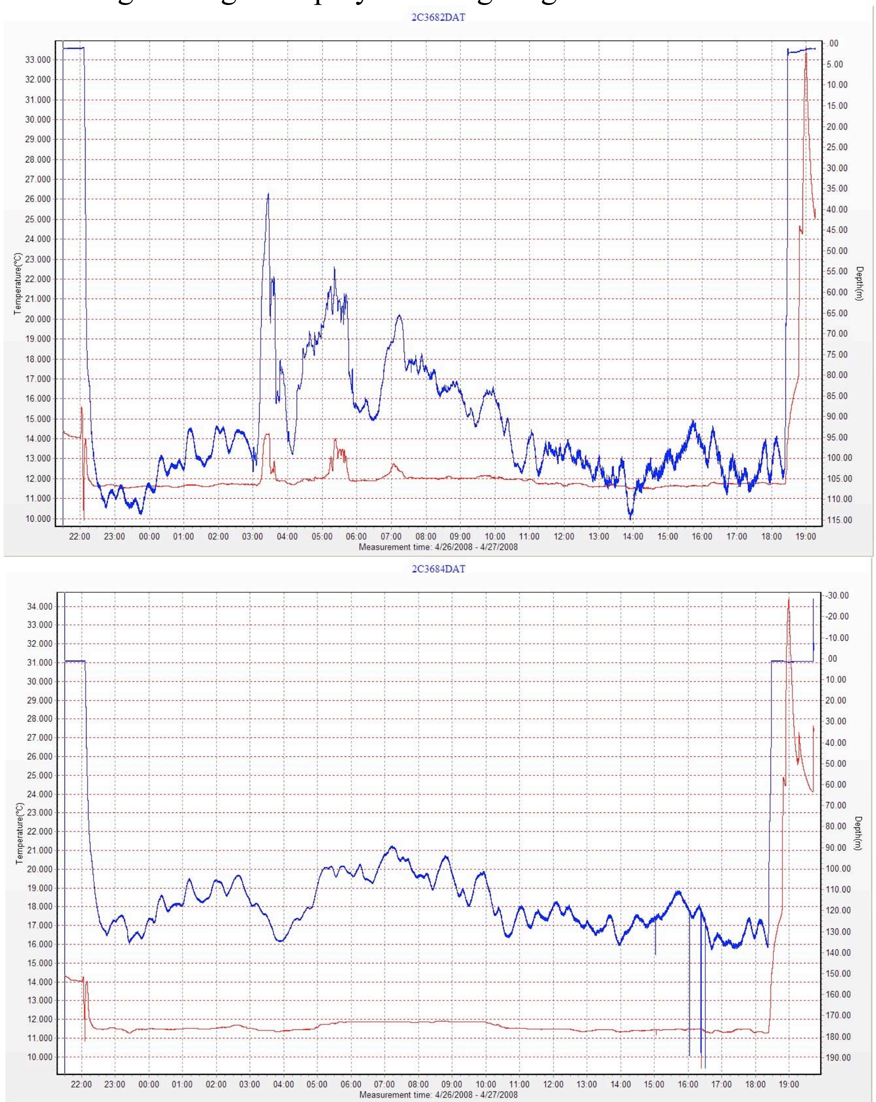
Figure 12. Haul mitigation.

Figure 14. Star-Oddi TDRs taped to branchlines at the hook.

Figure 13. Close up - haul mitigation.

Figure 15. Modified road cone with 1.7 kg weight as a tori line towed device.

Figure 16. The depth (m) and temperature (°C) for TDRs 3 (top) and 5 (bottom) deployed 26 April 2008 throughout a gear deployment targeting southern bluefin tuna.

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