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Te Papa Atawhai

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Manatū Ahu Matua

Tori line designs for small longline vessels

New Zealand

Prepared for the 12th Meeting of the Ecologically Related Species Working Group (ERSWG12)

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1 Abstract

Tori lines, or bird-scaring lines, are one of the key seabird bycatch mitigation measures for pelagic longline fisheries. A tori line suitable for use by small vessels operating in the New Zealand pelagic longline fishery was designed and is currently being tested under operational conditions at sea on several vessels. Testing is still underway but initial results indicate that the design is largely workable from a fishing perspective and represents an improvement over current tori lines in use. The tori line incorporated two sections: a lightweight aerial section with tubing streamers every 5 m and shorter tape streamers in between, and an in-water section of rope or monofilament nylon to generate drag whilst minimising the possibility of tangling with the longline. Composite poles were installed on several vessels to achieve higher attachment points, and to allow tori lines to be moved across the vessel. A breakaway system was used to reduce problems associated with tori lines tangling with the longline.

2 Introduction

Tori lines are one of the most thoroughly tested seabird bycatch reduction measures available, and have been proven effective in reducing seabird bycatch in both trawl and longline fisheries (Bull 2007, 2009; Løkkeborg 2011; Melvin et al. 2014). For pelagic longline vessels less than 35 m in length, best practice has been recognised as a single tori line with an aerial extent of 75 m or more, attached so the tori line is approximately 7 m high over the vessel stern. Brightly coloured streamers may be short or long, or both. It is recommended that short streamers are attached at 1 m intervals along the aerial extent, and long streamers at 5 m intervals (ACAP 2016).

While some New Zealand operators of small pelagic longline vessels successfully deploy tori lines on a regular basis, others report concerns about the safety of tori lines or do not consider that current best practice specifications are operationally feasible. Pierre & Goad (2016) report full details on a study conducted on land and on four different smaller vessels at sea to explore tori line designs and materials appropriate for use during demersal and pelagic longline fishing methods. The approach was structed by vessel speed, which broadly correlates with small-vessel longline fisheries targeting different species. Here we report further work currently underway to refine and adapt the recommended design options to at-sea commercial fishing conditions.

2.1 NEW ZEALAND SMALL VESSEL PELAGIC FISHERY

Vessels operating in the New Zealand pelagic longline fishery range in size from 12 to 25 m, and set between 15 and 30 nautical miles of longline daily, with a trip length in the order of 5 – 10 sets. Snood (branchline) length typically varies from 12 to 16 m of usually 2 mm monofilament nylon, attached to a 3 – 3.5 mm monofilament nylon mainline. Most vessels set straight from a free-wheeling hydraulic reel, without a line shooter, at speeds of 5 – 9 knots (typically 6 – 7 knots). Basket configuration is variable within and between vessels, and is generally what is altered to control gear depth. Surface floats of various sizes and attachment rope lengths are employed, with 300 mm hard floats the most common. Vessels often employ smaller hard or soft floats to use mid-basket, and generally all floats are set on a rope or a snood of at least 6 m, so are not directly attached to the mainline. Depths fished are typically in the range of 20 – 100 m. Whole defrosted squid (*Nototodarus sloanii*) is the most common bait, although some vessels will use sanma (*Cololabis saira*) for some hooks within some sets.

Target species include bluefin tuna (*Thunnus maccoyi, T. orientalis*) over the winter season, and bigeye tuna (*Thunnus obesus*) and swordfish (*Xiphias gladius*) more often during the summer months. Total fleet size is around 40 vessels, with some vessels fishing with other methods for part of the year.

Historically, most vessels configured snoods without weight close to the hook, but often with weighted swivels at the clip. The use of weights close to the hook has increased, to reduce bycatch and to allow skippers to set before nautical dusk under current regulations. Other mitigation measures employed include night setting, dyed bait, slack deployment of snoods, deeper sets, thawed bait, use of squid bait, and offal management.

Sink rates during normal fishing operations have been reported elsewhere (e.g. Pierre et al. 2013) and have shown considerable variability both between and within sets, and between vessels. Weighted gear has been shown to reduce the window of availability of baited hooks behind the vessel, however tori lines still need to provide protection for hooks to a considerable distance astern, especially given the overlap between pelagic longline fisheries and diving birds, such as black and westland petrels (*Procellaria parkinsoni and P. westlandica*).

Tori line regulations in New Zealand for pelagic longline vessels under 35 m (currently representing the whole pelagic longline fleet) include an attachment height of at least 6 m, an aerial extent of 75 m, and streamers reaching the surface of the water every 5 m for the first 55 m. Streamers of a minimum length of 1 m should also be attached along the whole aerial extent (75 m). Streamers must be attached by swivels.

Observer reports and discussions with fishers (Pierre 2016) have highlighted difficulties in meeting these regulations, particularly noting poor weather conditions, insufficient aerial extent, lack of high attachment points, and entanglements with fishing gear, especially floats and locator beacons.

The aim of this project was to produce and test a tori line based on recommendations from Pierre & Goad (2016) that could be routinely deployed under a range of commercial fishing conditions at-sea and was effective in reducing bird interactions with baited hooks.

3 Methods

Tori line design was split into two components; the ‘aerial section’ and the ‘drag section’ (Figure 1), and initially the design of each section was addressed separately.

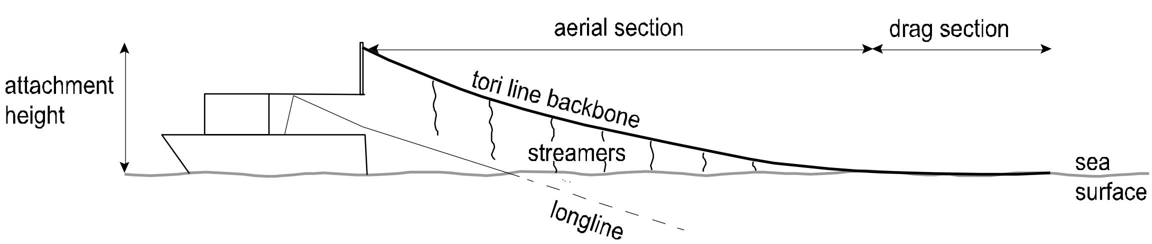

Figure 1: Tori line components.

A series of tests were undertaken ashore to determine the tension needed to achieve aerial extents between 50 m and 80 m. This was standardised by using a deployment height of 7 m and a relatively heavy aerial section equivalent to 9 mm diameter plastic tubing streamers every 5 m, varying in length but reaching the ground.

Three different tori line ‘backbone’ materials were tested: 3 mm monofilament nylon, 3 mm Ashaway tuna braid and 3 mm braided Dyneema winch rope (material specifications are detailed in Table 1). Tori lines were fixed to a fibreglass pole and the tension necessary to achieve each aerial extent was measured with a set of salter spring scales.

To generate sufficient drag tension to achieve the required aerial extent, a series of tests were conducted at sea, towing different drag sections behind a vessel at a speed of 6 knots. Drag sections included 3 mm monofilament nylon, 5 mm monofilament nylon and 8 mm rope. Lumo lead caps or plastic cones spaced at 1 m intervals along the 5 mm monofilament nylon were also trialled, aiming to reduce the length of drag section required. These drag generators were considered appropriate for pelagic longliners as they were thought to be least likely to tangle with the fishing gear. The drag generated was measured on the same set of 50 kg spring salter scales, ensuring that only the drag section under consideration was towed in the water. The aerial extent of one of two aerial sections was recorded for the different drag sections, towed at 6 knots with a 6 m attachment height. Aerial sections tested were either made of 5 mm diameter plastic tubing every 3.5 m or 9 mm plastic tubing every 2.5 m, both with a 3 mm Dyneema backbone.

Two pole designs were tested during initial sea trials, and comprised of 2 x 3 m lengths of fibreglass tube joined together.

Table 1: Materials used to construct tori lines

Material	Size	Colour	Supplier
Plastic tubing	9 mm	orange	Beauline
Plastic tubing	5 mm	orange	Beauline
Plastic tubing	5 mm	pink	Cookes
Ashaway tuna braid	3 mm	blue	Cookes
Dyneema winch rope	3 mm	yellow	Nautilus Braids
Lumo lead caps	12 mm diameter, 15 mm long	yellow	Fishtek Marine
Monofillament nylon	3 mm	clear	Maui Ocean Products
Monofillament nylon	5 mm	clear	Maui Ocean Products
Plastic cones	20 mm diameter, 15 mm long	black	Supply Services
Fibreglass tube	52 mm diameter	black	Kilwell Fibretube
Fibreglass tube	40 mm diameter	black	Kilwell Fibretube
Carbon fibre tube	62 mm diameter	white	Kilwell Fibretube
Plastic sister clips	4.5 mm	white	Ronstan
Holographic tape	0.25 m wide x 0.5 m double streamer	silver	Pestguard
Plastic tape	0.3 m wide 0.5 m double streamer	black	Bunnings

Tori lines were constructed for testing at sea during normal fishing operations. In some cases they were attached to 62 mm diameter 3.9 m long carbon fibre tubes (Kilwell Fibretube), installed on the vessel such that the attachment point could be moved across the vessel. Other vessels included in the trial had existing attachment points, and all tori lines were attached at least 6 m above the sea surface. Tori line designs were based on trial results, experience at sea, and information from discussions with skippers and crew. Several streamer types were incorporated into the design, to compare performance.

Tori lines trialled under normal fishing conditions used a 75 m 3 mm Dyneema backbone, with streamers at a maximum of 5 m intervals and a drag section of either 200 m of 5 mm monofilament nylon or 100 m of 9 mm braided rope (Figure 2). Streamers were placed at shorter intervals further behind the vessel, where the potential for bird activity was thought to be higher. For the last 10 m of the aerial section streamer spacing was increased to 5 m, to reduce the potential for entanglement, as it was thought that this part would spend some time in the water, especially in poor weather.

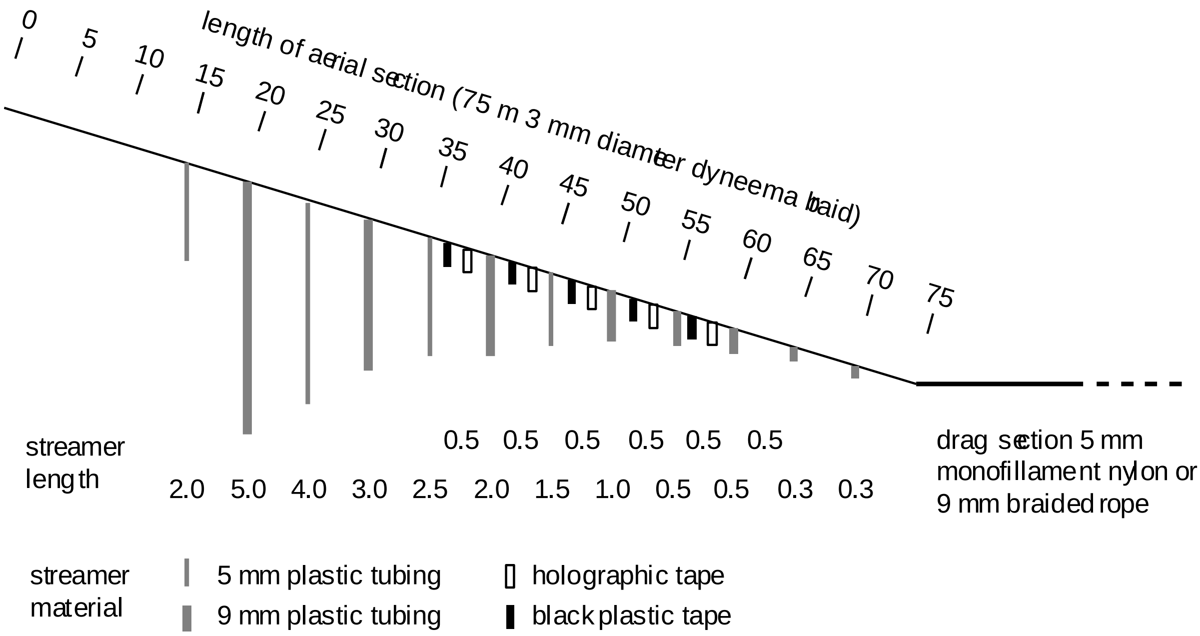

Figure 2: Diagram showing tori line design built for testing under fishing conditions.

Over the course of at-sea testing, an adjustable tension release was developed to control the maximum amount of tension a tori line could exert before breaking away from the attachment point (Figure 3).

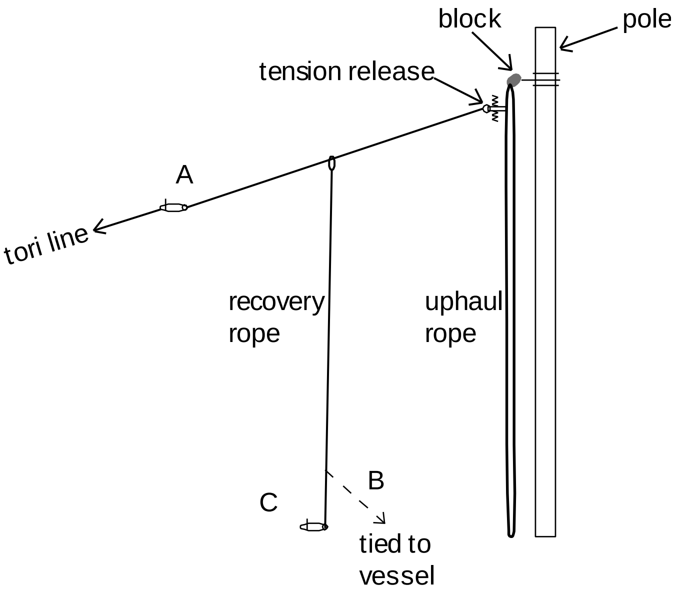

Figure 3: Breakaway system setup. Once deployed, the tori line is clipped on at A. If the pre-set tension is exceeded then the line will break away from the tori pole at the tension release and remain attached to the vessel at B. The tori line can then be clipped onto the longline using clip C and cut away from the vessel at B.

Illustrations and further details on a range of the materials used is provided by Pierre and Goad (2016).

4 Results

The tension required to support different aerial extents for an aerial section with streamers every 5 m varied with backbone type. Monofilament nylon had the most stretch, was heaviest, and required more tension to achieve a given aerial extent. Dyneema and Ashaway tuna braid required similar tension, although Ashaway tuna braid had more stretch (Figure 4).

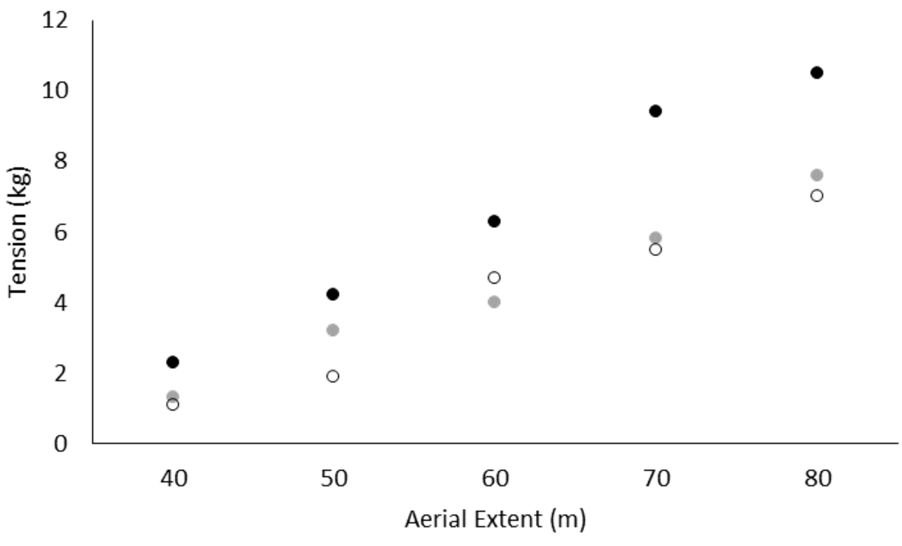

Figure 4. Tension required to achieve tori line aerial extents of 40 – 80 m, using three different backbone materials: 3 mm monofilament nylon (black), 3 mm Dyneema winch rope (open circles), and 3 mm Ashaway tuna braid (light grey) at an attachment height of 7 m. Nine mm plastic tubing streamers were placed every 5 m and reached the ground.

Unsurprisingly larger diameter in-water drag sections produced more drag, however the addition of plastic cones to monofilament did not provide a large increase in drag (Table 2).

Table 2: Drag generated, and aerial extent achieved, by different in water drag sections.

Drag section	200 m 5mm nylon	100 m 5mm nylon and 100 small cones	100 m 5mm nylon and 100 lumo caps	100 m 8mm 3 plait rope	200 m 3mm nylon	400 m 3 mm nylon
Aerial section	5 mm tubing at 3.5m	5 mm tubing at 3.5 m	5 mm tubing at 3.5 m	5 mm tubing at 3.5 m	9 mm tubing at 2.5 m	9 mm tubing at 2.5 m
Drag (kg)	11.5 - 12.5	6.5 - 7	5	16 - 20	4	9.5
Aerial extent (m)	70 - 80	50 - 70	50 - 70	not tested	not tested	70-75

At-sea testing is currently underway with tori line setups supplied to 6 vessels, with a further 3 installations underway.

Skippers of all participating vessels are currently using the supplied tori lines. The aerial extent achieved by the designs varied between vessels. In some cases adjustments were made such as shortening the drag sections and incorporating swivels.

Tangles with the longline occurred during initial testing on all vessels, with the tension releases operating effectively. Running tori lines to one side of the mainline, maximising attachment height and thereby minimising the length of in-water sections, all contributed to reducing the likelihood of tangles. Most tangles occurred in poor weather conditions, often when shooting downwind in 3 m+ swells, resulting in considerable changes in aerial extent as waves overtake the vessel.

5 Discussion

The aerial section of tori lines was kept as lightweight as possible, to minimise sagging, wind resistance, and potential for tangling with the longline. Three millimetres was considered a minimum backbone diameter from a handling perspective, especially when recovering tori lines by hand.

Greater tension than required to hold up the aerial section in calm conditions replicated ashore was desirable. This helped maintain the aerial extent in poor weather conditions, and reduced the deviation of the tori line sideways in crosswinds. A low stretch material for the aerial section was chosen to ensure that it did not store energy and fly back in the event of a tangle and break off.

Streamer configuration aimed to strike a balance between having enough streamers to deter birds, but not so many as to produce excessive wind resistance, more tangling points, and thus require impractically long drag sections. Streamers were not placed close to the vessel as birds have not been observed attacking baits immediately behind the vessel.

Smooth drag sections were preferred by skippers, and consequently no separate towed objects were employed. The choice between longer, smaller diameter monofilament or shorter, thicker, braided rope was left to the skipper. Some skippers felt more comfortable towing the longer, less likely to catch monofilament, whereas others were happier with a shorter length of rope.

The monofilament nylon drag sections required a reel for convenient recovery and storage, whereas the rope drag sections could be simply flaked into a bin or drum by hand. Both options have advantages but in many cases the need for a purpose-built reel dissuaded skippers from selecting a monofilament drag section. Streamers longer than 1 m were attached using plastic sister clips, such that they could be removed for storage, however skippers all selected to leave them on the tori line, and ensure that streamers were not tangled during deployment.

Tori lines were constructed to minimise catch points and all joints were tapered and taped over, except tape streamers which were threaded through the lay of the Dyneema backbone to allow them to pull out in the event of a tangle.

The ability to adjust the tori line attachment point across the vessel is thought to have reduced the likelihood of tangles with the longline. Running tori lines slightly downwind of the longline was favoured by some skippers, when setting beam onto the weather. This was still observed to be effective in disturbing the flight paths of birds, as they tended to approach the line from downwind.

Swivels were not used to attach streamers as they have not been observed to be useful by the authors. If deployed tangled around the tori backbone, then streamers tend to stay tangled. When deployed correctly, streamers do not tend to tangle often during set, and swivels have not been observed to reduce tangling. Excluding swivels made the tori lines lighter and eliminated potential catch points with the longline.

Swivels may be necessary in tori line backbone. Tori lines were built without swivels for all vessels, but despite all efforts to produce non-rotating drag sections, the vessel wake on one vessel produced sufficient rotation of the tori line to require the insertion of swivels. In this case, two ball bearing swivels were inserted, one between the drag section and aerial section, and one half way along the aerial section, to provide redundancy.

The breakaway system employed had several safety advantages.

- It protected the tori pole from excessive loads.
- Breakaway tension can be adjusted to ensure that it is sufficiently high to hold the tori line under normal operations but breaks away under increased tension associated with a tangle.
- The tripping tension, once adjusted, is consistent, i.e. it does not weaken over time.
- When caught in the fishing gear, the tori line breaks away from the pole but remains attached to the vessel within reach of crew setting the gear. It can then be clipped onto the longline, so it is not lost.

No weak links were incorporated into the tori line itself for two reasons. Firstly, if, for example, the drag section tangles and breaks away then the remaining aerial section sags and is more vulnerable to tangling with fishing gear. Secondly, the breakaway system used maximises the chance of recovering the whole tori line, which is advantageous from both an economic and a marine pollution perspective.

Tori lines were not found to be ‘fit and forget’ for any vessels. All installations required time and effort to tailor to the vessel and the skipper. Some of this was achieved by the authors at sea and between trips ashore, but skippers and crew also made changes and refinements at sea.

6 Conclusions

There has been an increased focus on the design, efficacy, and use of tori lines on pelagic longline vessels over the course of the project. Pelagic longline skippers have been welcoming and keen to develop improvements to their setups and a workable solution for their fishery.

Translating results from field tests conducted under favourable conditions to produce tori lines useable in the dark, when shooting longlines in poor weather conditions, is a challenging process and is still underway. We are fortunate in working with patient and supportive vessel owners, skippers and crew.

Overall, we are confident that the design reported here and currently being trialled provides improved tori lines behind pelagic longliners, but there is undoubtedly potential for further refinements and improvements following feedback from skippers after extended periods of use.

The current at-sea trials are due for completion by June 2017, at which stage full reporting and formal recommendations for optimal tori line designs for small vessels will be made.

7 Acknowledgements

This paper summarises the main results relevant to small vessel pelagic longliners from projects MIT2014-02 and MIT2015-02 commissioned by the Department of Conservation, New Zealand as part of Conservation Services Programme (www.doc.govt.nz/csp). Funding for the projects was primarily by a levy on relevant commercial fish stocks.

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