# Tori line designs for New Zealand domestic pelagic longliners

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# 1. Introduction

Demersal and pelagic longline fisheries overlap with foraging zones for a number of seabird species. Seabirds have learnt that longliners provide a predictable and substantial food supply in the form of squid or fish used to bait hooks, fish offal from processing catch, discarded bycatch, and uneaten bait discarded after hauling. Incidental mortality of seabirds predominantly occurs when seabirds either swallow or become entangled on the hook when the longline is being set and are subsequently pulled underwater and drowned.

Many individuals and organisations have recognised the benefits of minimising capture of seabirds, and are using various mitigation measures to try and reduce the numbers caught as well as develop more effective ways to prevent this interaction.

A tori line is one such mitigation measure. A tori line is a bird-scaring device towed behind the vessel, usually attached from a high point at the stern and consisting of a backbone from which streamers hang down at regular intervals. The use of tori lines on pelagic longliners in New Zealand has been mandatory since 1993, (Regulation 36A of the Fisheries (Commercial Fishing) Regulations 1993).Tori lines deter seabirds from flying behind the vessel and gaining access to baited hooks. However, problems with tori line entanglement in fishing gear have meant that there is still reluctance on the part of some fishers to employ a tori line. Misunderstanding or a lack of knowledge of legislative requirements has further aggravated the problem.

Recent changes to quota holdings in trawl fisheries inTauranga have prompted many fishers to refit their vessels as pelagic longliners to take advantage of non-quota migratory species of tuna. This has meant a near doubling in the number of pelagic longliners fishing out of Tauranga.

This is a short report prepared after spending three days during November 1998 in Tauranga assessing and building various tori line designs.

# 2. Aims

The tasks set for this project by the Department of Conservation were:

i) in discussions with domestic tuna fishers, design two or more tori lines for use on pelagic longline vessels;

ii) construct two such tori lines for use on pelagic longline vessels; and

iii) if the opportunity arises, trial the tori line on a pelagic longline vessel.

# 3. Tori line - design options

Design and construction of the tori lines was carried out with the cooperation of Mr Tony Dobbie a fisher based in Tauranga. Mr Dobbie was also kind enough to make available all necessary tools for the construction of tori lines on his vessel.

Materials were obtained from De Coro Fishing Supplies Limited, Totara Street, Mt Maunganui. The same or similar should be available from any good fishing supplies business.

## 3.1 BASIC REQUIREMENTS OF THE TORI LINE

In designing a tori line there are some basic conditions that had to be met in order for the line to be both useful and utilised by the fisher. Firstly there has to be minimal opportunity for entanglement with the fishing gear. If a fisher considers that there is a risk of losing expensive fishing gear and valuable fishing time due to entanglement problems with the tori line, there is an immediate disincentive to deploy the tori line. It must also be simple to construct and repair, allowing any replacement or repair to be done quickly and inexpensively. An extension of this concept is that the construction materials need to be readily available to the fisher. Steamers must be constructed so that they move freely and unpredictably and do not wrap around the backbone of the tori line, rendering themselves useless for their purpose of scaring birds.

The tori line must also comply with legislative requirements. An essential facet of the legislative requirement is the attachment point at the stern of the vessel. By law this shall be approximately 4.5 m above the water at the stern. This height is critical because it essentially dictates the length of the aerial section of the tori line which is the part that provides the bird-scaring effect over the longline. Any attachment point lower than this reduces aerial coverage over baited hooks and thus substantially reduces the effectiveness of the tori line. A high attachment point has the further advantage that it also lessens the risk of entanglement with wayward branchlines as they are thrown out of the boat after baiting. The tori line must be attached at a point that suspends it directly above where the baited hooks enter the water.

## 3.2 AERIAL SECTION OF THE TORI LINE

The backbone of the tori lines was made of white 3.5 mm monofilament. Monofilament was used because of its low weight, high strength, durability, and because it is easily obtainable if not already on the vessel. The opaque white colouring is presumed to be more visible at night than any of the other colours available, such as clear, red, and light blue. The precise length of the aerial section is dependent on several variables, specifically: the height of the attachment point; the speed of the vessel at setting; and, the amount of drag created by the in-water section of the tori line.

## 3.3 STREAMER ATTACHMENT TO THE TORI LINE

The streamer attachment must allow the streamer line to swivel in every direction, while presenting minimal opportunities for a stray hook to catch the streamer. Various swivel systems were investigated for the streamer attachment point, and these are illustrated in Figure 1.

### 3.3.1 Streamer attachment method one

This attachment system was suggested by a tuna fisher. Essentially, 7 mm barrel swivels are incorporated into the backbone of the tori line. The monofilament is crimped into a tight attachment loop on either side of the swivel. The streamer is then threaded through the monofilament loop at the rear of the swivel and crimped. This system created a tight join that would provide few opportunities for stray hooks to catch on, though it did not allow full swiveling and independent movement for the streamer.

### 3.3.2 Streamer attachment method two

A three-way swivel is incorporated into the backbone wherever a streamer is to be attached. The streamer is attached to the third swivel. This system functions reasonably well, but is more expensive in time and components. The metal ring holding the three swivels together may be susceptible to catching stray hooks.

### 3.3.3 Streamer attachment method three

Method three was developed during this project. It uses a pre-shaped stainless sleeve with a 4.2 mm internal diameter, and a 5/0 stainless crane swivel already. This allowed a simple and firm attachment to the mainline by simply sliding the sleeve on to the monofilament backbone, then crimping either side of the swivel section on the sections provided to secure the sleeve in position. This design also means that the backbone is not weakened at swivel attachment points and the entire tori line backbone can be made using a single unbroken length of monofilament. The independent attachment of the swivel allows very free movement and the overall design is free of potential hook snagging features. The disadvantage of this method is that replacement of the pre-shaped swivels is difficult because of the need to slip them along the length of the backbone.

Each of the methods described has different advantages and disadvantages. Streamer attachment option three was selected for vessel trials in this project because of its ease of use, and low hooking potential.

## 3.4 STREAMERS FOR THE TORI LINE

The tori lines built for this project used a single streamer design, but the design is easily adjustable to allow paired streamers to be incorporated by fitting at the streamer crimp.

The streamers made were based on the design in the handbook *Catching Fish not Birds* (Brothers 1995) modified by Smith, that were used on the bottom autoliner *San Aotea* earlier in 1998 (Smith, pers. comm.). Streamers were constructed of 3 mm sekiyama threaded into a 4 mm internal diameter red polyurethane tubing. These were attached to swivels crimped on the backbone of the tori line by threading the sekiyama through the crane swivel eye-loop. An aluminium double sleeve crimp was then pressed over both the looped sekiyama and red tubing to secure the streamer in place.

Tori lines provided at the end of this project for trials on domestic pelagic longline vessels had streamers pre-made at lengths of 4 m, 3 m, and 2 m. These were left with instructions for the vessels involved in the trials to cut to the appropriate length for the position on the line.

## 3.5 THE IN-WATER SECTION OF THE TORI LINE

The tori lines built for this project have a substantial (30-40 m) section of bare backbone between the last streamer and the in-water drag section. This section allows the in-water section of the tori line to be effective even in heavy seas where there might be problems with the drag section skipping out of the water over or in between swells if this bare section were not present. This allows for minimal problems with skipping in heavy seas even when setting at the relatively high speeds used operationally by pelagic longliners (7-11 knots).

The in-water, or drag-creating, section of the tori line keeps the aerial section under tension, and as such is important in determining the length of the aerial section. This is especially important for domestic pelagic longliners as the scope for high attachment points is seldom as attainable as on larger foreign pelagic longliners. The in-water section also has the greatest potential to catch stray hooks as they pass in the water or slide down the tori line. The ideal design for this section of the line would therefore need to provide considerable drag, without providing any potential catch points, and still allow reasonable ease of hand hauling during its retrieval. It should also be noted that the longer the in-water section, the better the tori line sits over the longline being set.

Various in-water sections were tested for function and ease of handling by setting the line against the tide, and their drag-creating ability was tested by running them along a pier holding the bare section of monofilament preceding the drag section. This allowed a basic assessment of the amount of drag afforded by each, but is in no way a faithful simulation of a real situation. Similarly, hookup potential was assessed by fixing the preceding line to an object, then running a snood, with hook attached, down the length of the in-water section. This was done several times at various speeds. Again this provided an indication of potential problem areas, but does not truly simulate the process in a real situation.

All designs incorporated the same 3.5 mm monofilament as the aerial section of the tori line. Crimps used were standard aluminium sleeve crimps with a centre diameter of 4.5 mm.

### 3.5.1 Tori line in-water section trial one

Six 20 mm rubber tap-washers were placed at 1 m intervals, with a single crimp on both sides.

This design will provide some drag at a high speed, but is possibly not enough when the generally low attachment height used is taken into consideration. The testing showed some signs of skipping that may be worsened at higher speeds. The size of the washers was ideal for preventing hookups. They easily fitted through the centre of the 16/0 circle hooks used on the *FV Bismarck*, and will fit through the slightly smaller 14/0 and 15/0 hooks that are also commonly used in the domestic pelagic longline fishery. The rubber material allows a degree of flex in the washer that also affords an easier passage for a hook running along the line, and in fact in many of the tests flicked the hook clear of the entire line.

### 3.5.2 Tori line in-water section trial two

Twelve 30 mm stainless washers with a 6.25 mm (1/4 inch) diameter hole at 0.5 m intervals were spaced at 0.5 m intervals along the line with a single crimp on the hind side, allowing a greater degree of pivot. To reduce skipping, a 5 m section of bare line trailing after the drag section was added.

This design created excellent drag, with the extra weight of the stainless washers and the trailing line preventing the skipping that was experienced in trial one. The inflexibility of the stainless steel washers made them a potential catching point for hooks.

### 3.5.3 Tori line in-water section trial three

Two metres of approximately 18 mm diameter clear plastic tubing was slid over the line, with a 20 mm rubber washer to prevent slip-back fixed with a crimp at the hind side.

After an initial test showed very little resistance through the water, repeated cuts were made across the hose in an attempt to increase drag. Though this design gave a greater drag with cuts made in the hose, it does not provide enough, and this will presumably decrease when the leading end of the hose is shrink-wrapped to lessen the chances of a hookup.

### 3.5.4 Tori line in-water section trial four

Some 12 x 20 mm rubber tap washers spaced at 0.5 m intervals were placed along the line with a single crimp on the hind side to prevent slippage. A 3 m section of bare line trails behind the last washer.

This design provided good drag and had the added advantages of using the 20 mm rubber tap washers that leave little opportunity for entanglement and hookups with the fishing gear. This design was provided to both vessels trialing tori lines.

# 4 Vessel trials

Two vessels were supplied with tori lines to trial as a part of their normal fishing routine. Both boats used the tori lines at night whilst setting their gear, and one was also set during daylight hours in order to assess the effectiveness of the line. The design of the tori lines is shown in Appendix 1.

## 4.1 VESSEL FEEDBACK

No seabirds were caught during setting by either boat, though two were hooked and released alive during retrieval of the gear. Both boats reported a large bird presence during the trials, with numerous attempts to take baits aborted due to the streamers on the tori line. One vessel reported a bird colliding with the tori line backbone after being startled by one of the streamers. There were few other reported interactions between seabirds and tori lines. The tori line was reported to be very visible during daylight, but at night (new moon) was difficult for crew to see outside of the light generated by the vessels. The crew found it difficult to assess whether the line was visible to seabirds when setting was done at night.

While there were no direct comments on the materials making up the streamers, comments were made about the low risk of catching on a stray hook that the streamers presented.

The drag sections of the lines provided to the vessels were reported to be very effective. The alternative drag sections provided to one boat were not trialed by the crew because they felt that the supplied drag section was very effective, and not likely to be improved on by any of the other designs. Despite these positive comments from the fishers, there was one hook up that resulted in a broken tori line when a hook caught on one of the rubber washers of the drag section. For the hook to catch on a washer implies that the hook is still at the surface beyond the aerial section of the tori line. If this is the normal situation, then the in-water section of the tori line needs to be absolutely hook proof, and washers may not be suitable. More trials of the tori line at sea, coupled with research to assess the sink rate of domestic longline gear will help clarify what the hook up potential is. Alternative in-water sections may need to be developed and tested.

The crews found the tori lines relatively easy to deploy and retrieve, but the drag on the line was quite substantial on retrieval whilst the vessels were still moving. The line could be retrieved more easily if the vessel was slowed or stopped once the fishing gear had been set. Tori lines were stored by simply coiling the line up, then taping the coil to prevent tangles. One of the vessels also taped the free ends of the streamers to the backbone upon retrieval for easier storage. This prevented streamers from tangling with the rest of the line during retrieval and storage. The leading hand on one of the vessels suggested a plastic electric-fence reel as an ideal method of storage for a tori line.

There were no problems with manoeuvring the vessel whilst the tori line was deployed. There were also no apparent problems with twisting of the tori line whilst it was deployed. One of the tori lures had a swivel incorporated near the tori line attachment point on the vessel.

Tori line attachment points on the vessels were at 4.5 m and 6 m respectively. Using the streamers as a guide, on the boat with a 6 m attachment height at the stern an estimated aerial coverage of around 105 m, and no problems with streamers wrapping around the backbone were reported. Using the same estimation technique, the vessel with an attachment point at 4.5 m reported that they had about 70 m aerial coverage and that the last two streamers were fully in the water, with the third to last streamer almost entirely in the water. The streamers that were submersed tended to wrap around the backbone. This vessel had been instructed to cut off the streamers that were fully submerged in the water, and cut the remainder to the required length, though this was not done. The placement of the streamers on a tori line is contingent on the length of the aerial section and the height of the attachment point on the vessel.

The interviewees both commented that they thought that the lines were possibly too long, and that this might explain the hookup on one vessel and the dragging streamers on the other. However, the length of the tori line is unlikely to be a factor in either of these situations: the slow sink rate of the fishing gear is likely to be the contributing factor to the first, and the low attachment point coupled with incorrect placement the cause for the second.

Neither of the interviewees thought that having more streamers at smaller intervals would have a detrimental effect on the ability to easily handle and store the tori lines.

## 4.2 FUTURE IMPROVEMENTS

The tori lines designed and built over the course of this project require further research in some areas.

### 4.2.1 The colour of both the backbone and the streamers

We do not know enough about the visual capacity of seabirds to confidently prescribe a standard colour for tori line materials. We can be confident that seabirds are predominantly visual feeders, and that they therefore have good vision. Night setting by longliners has been proven to reduce the accidental capture of seabirds. This should point to the fact that the visual acuity of seabirds is substantially reduced at night, and so any material used in the manufacture of tori lines needs to be visible in low light levels. Research needs to be carried out in this area to allow the development of an appropriate material or colouring for backbone and streamers.

### 4.2.2 The height of the attachment point of tort lines

Tori lines work by excluding seabirds from gaining access to baits. The greater the length of the aerial section of this tori line, the more effective it is. This is influenced by the height of the attachment point. If vessels do not have a high attachment point that is in line with the point where baits land in the water, the skippers need to be encouraged to install a tori pole specifically for this purpose.

### 4.2.3 Line swivel system

Despite there being no report of twisting or torsion in the tori line, a swivel system for the whole line could possibly be explored to negate any tendency for the line to twist whilst in use.

### 4.2.4 Weak points in the line

In the event that fishing gear tangles or is hooked up in the tori line, a weak point in the tori line could be an efficient way of preventing permanent loss or damage of fishing gear, as tori lines will be easier and cheaper to replace. As a further development of this, the rubber washers of the drag section, as potential hookup points, could be weakened by one or more incomplete cuts in each washer (see Figure 3). This would allow any hook that collects a washer to simply rip it from the tori line with no damage to the tori line or the fishing gear itself.

# 5. Conclusions

During this project several methods of streamer attachment were developed. Each had different advantages and disadvantages, and final choice may be personal. The use of monofilament as a backbone for tori lines was trialed and found to work well. The materials used for side streamers were again shown to be good for this purpose. Confirmation that higher is better for attachment points was also given. Further work in developing a catch-free drag section needs to be pursued, as does the development of more visible construction materials.

# 6. Acknowledgements

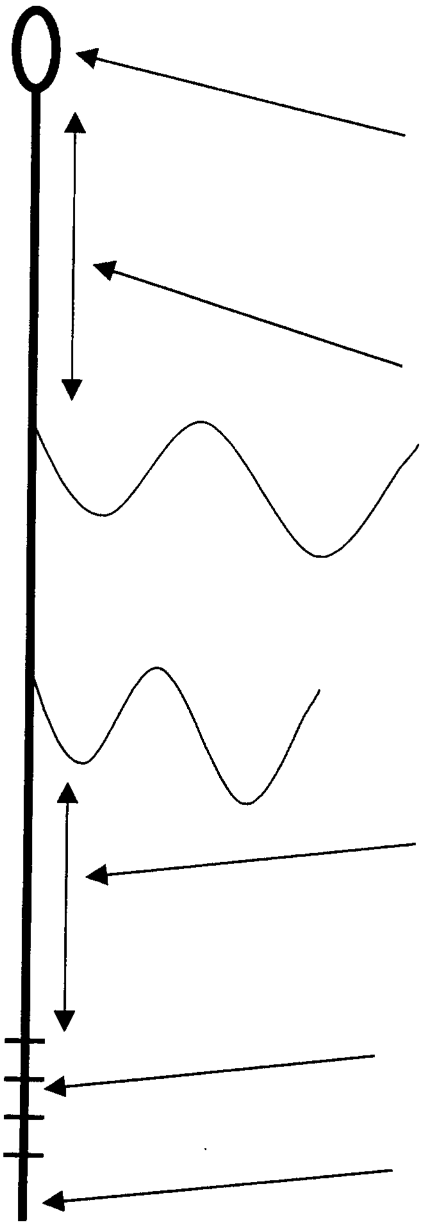
Thanks go primarily to Tony Dobbie and leading hand John for the use of their boat, tools, expertise, connections, and good humour. Thanks also go to John and Ron Broomhall for their interest and helpful comments on tori line performance. Thanks also go to Janice Molloy of DOC for making arrangements prior to and during my trip, and useful comments before and during my time in Tauranga and, with Neville Smith of MFish, providing a substantial editorial review of the first draft.

# References

Brothers, N.0995) *Catching Fish not Birds: a guide to improving your longline fishing efficiency*. Australian Longline Version. Tasmanian Parks and Wildlife Service,Tasmania.

## APPENDIX 1. Final design of tori line tested during this project

Overall length =150 m approx.



The attachment point is a simple loop in the monofilament using a double crimp. This should be attached to the boat at the stern using a US-made alligator clip. These have less potential for becoming detached, because their design has a greater overlap in its clip than its NZ-made counterpart.

The distance between the stern of the boat and the first streamer is between 15 and 20 m, but should ideally be around 5-10 m.

The tori lines provided for trials had streamers at 15 m intervals.

The gap between the last streamer and the start of the drag section is around 30-40 m. This is to prevent skipping of the drag section over swells when setting at higher speeds.

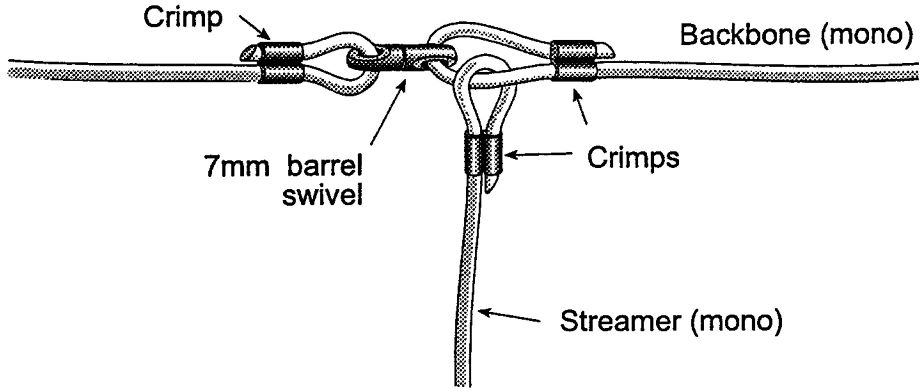
The drag section itself is around 6 m long, see text for description.

After the drag section there is a further 5 m of bare monofilament that further protects against skipping.

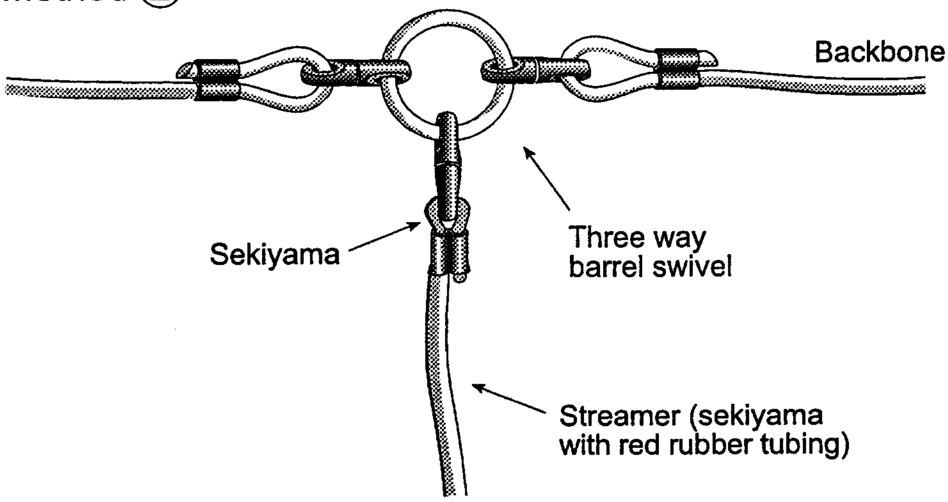
# APPENDIX 2. Cost approximation for tori line design.

| MATERIALS | Units | Unit Price | Total |
|---|---|---|---|
| 3.5 mm monofilament | Approx. 150 m | $0.185/m | $27.75 |
| 4.2 mm Sleeve w. 5/0 crane swivel | 7 | $0.50 | $3.50 |
| 4.5 mm aluminium double sleeve | 8 | $0.18 | $1.44 |
| 3.9 mm aluminium stopper | 12 | $0.16 | $1.92 |
| 2.5 mm braided nylon (sekiyama) | approx. 20 m | $0.70 | $14.00 |
| 3.5 mm red tubing | approx. 20 m | $0.35 | $7.00 |
| 20 mm rubber tap-washers | 12 | $0.60 | $7.20 |
| Total ($NZ) | | | $62.81 |

## Method ①




## Method ②




## Method ③

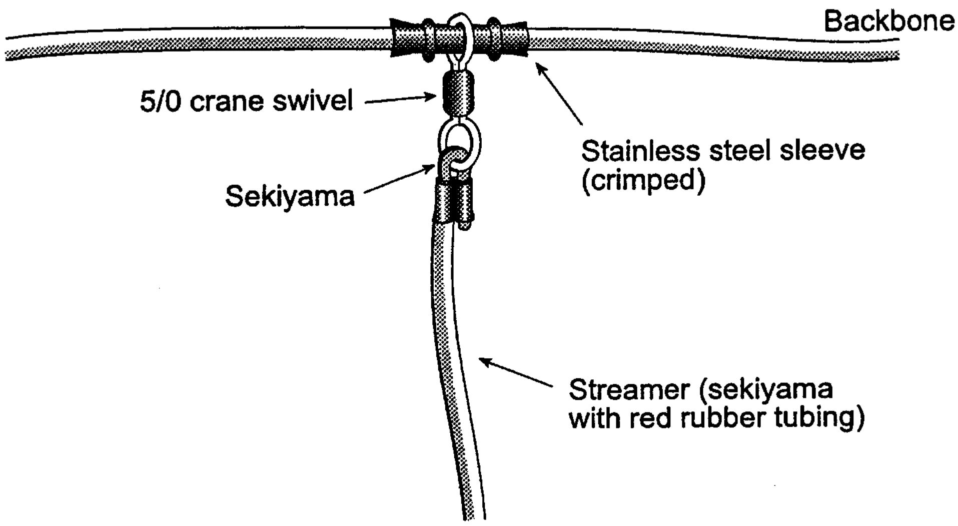



Figure 1. Streamer attachment methods

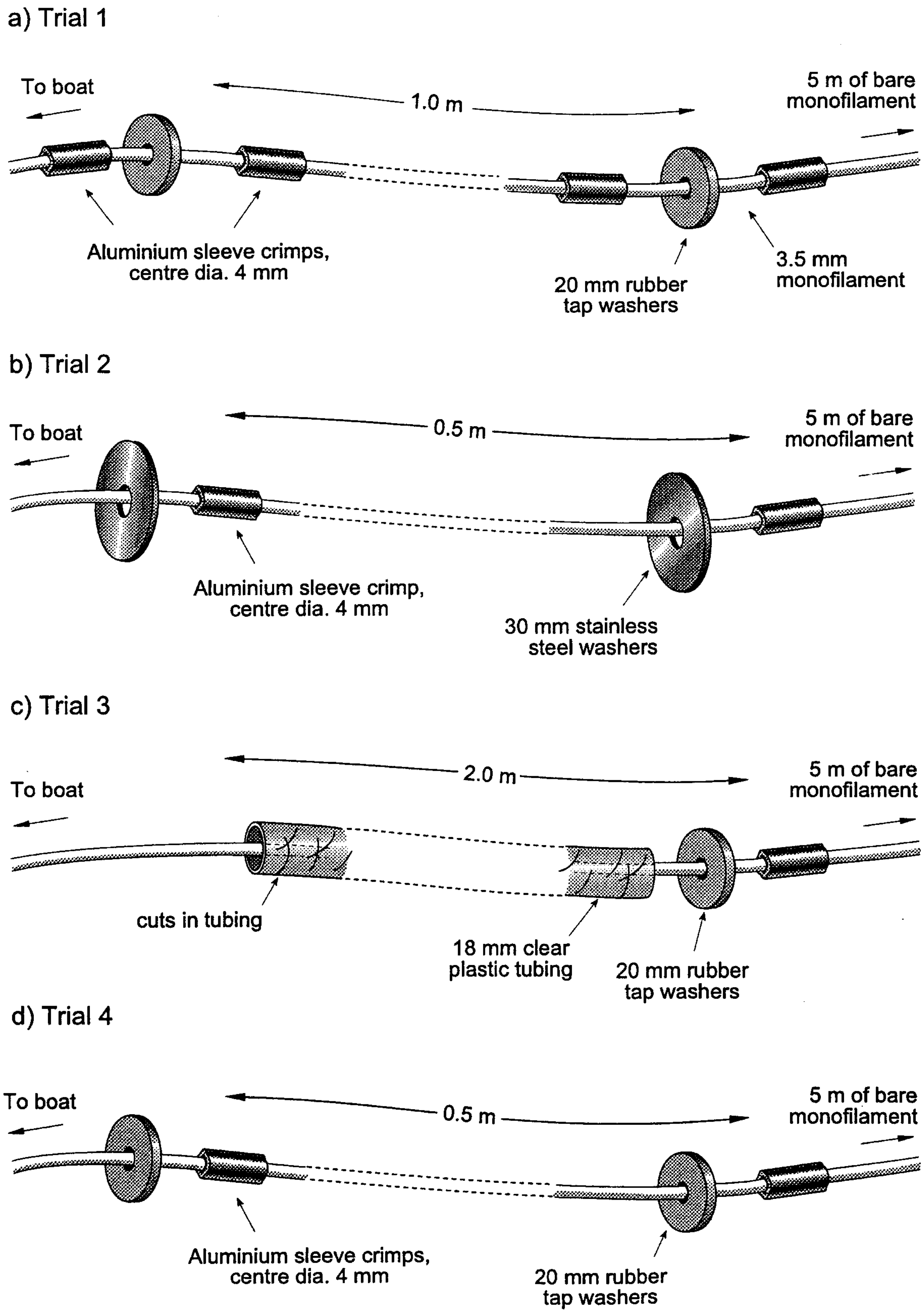



Figure 2.Trials of different in-water sections.

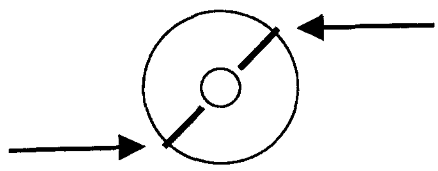


Figure 3. Intentional weak points cut in rubber washers.