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Developmental stages of the underwater bait setting chute for the pelagic longline fishery

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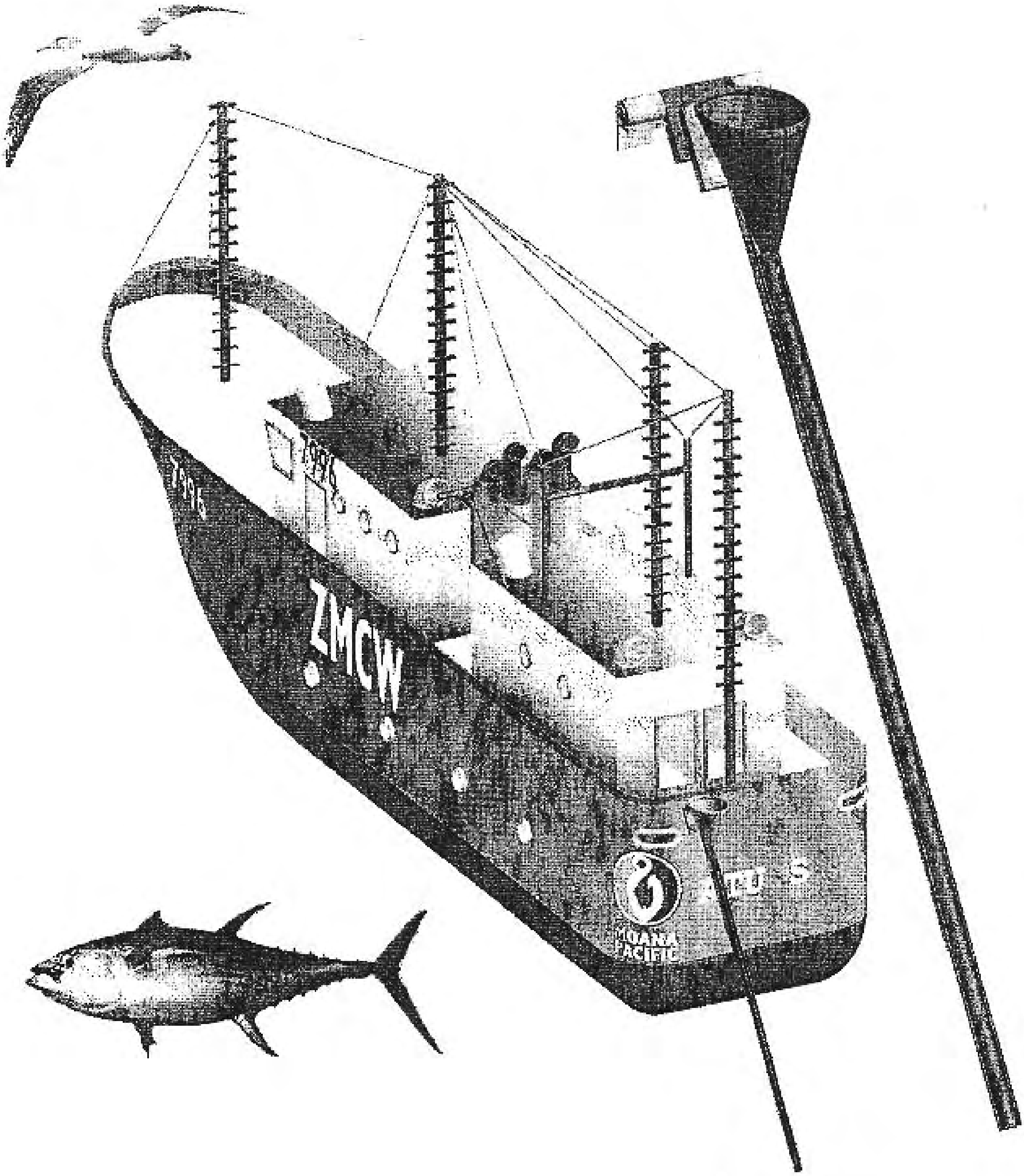


FRONTISPIECE. DIAGRAM OF AN UNDERWATER BAIT SETTING CHUTE IN PLACE ON A PELAGIC FISHING VESSEL.

1. Introduction

by K. Walshe and P. Barnes

The incidental capture of seabirds associated with longline fisheries has been recognised as a factor in population decreases in certain seabird species (Croxall et al. 1998; Weimerskirch et al. 1997). A number of different measures are used by fishers to reduce this incidental capture. These include tori lines, placing weights on snoods, restricting the setting to night time, using thawed bait, and using mechanical bait throwers.

Brothers (1991) found that, during the setting operation on pelagic longline vessels, most attempts by sea birds to take the bait occur within the first 100 m behind the vessel and rarely up to a maximum of 250 m. It is during this period that baits are within the diving range of some sea bird species. This report describes the development and testing of a chute that sets the baits at a depth of 3 metres or more below the sea surface. The purpose of this chute is to reduce the amount of time baits are within the diving range of sea birds.

The development of an underwater setting chute (hereafter referred to as the "chute") commenced in 1995, when Akroyd Walshe/Paul's Fishing Kites were contracted to design and build a prototype. The results of this phase of the programme are reported in Barnes & Walshe (1997).

This document reports on each stage of development and sea testing of the chute between October 1997 and February 1998.

2. Pelagic longline fishing in New Zealand

by K. Walshe and P. Barnes

The pelagic longline fishery in New Zealand targets albacore, bigeye, yellowfin and southern bluefin tuna (SBT). Of these only SBT has a catch limit - 420 tonnes. According to the Ministry of Fisheries (1997 data), the fleet is composed of approximately fifty domestic vessels and five chartered Japanese vessels.

The fishing operation is a twenty four hour cycle. A 20-60 nautical mile (nm) mainline is usually stored on a hydraulically operated spool, which is positioned in a variety of locations according to the deck layout of individual vessels. The line is run through a series of pulleys or roller guides and set from the stern of the vessel. Longliners vary in length from 10 to 50 metres.

On some vessels the mainline is set by simply driving the vessel forward, and the water resistance pulls it from the mainline spool.

Other vessels use a device known as a line shooter. This pulls the line from the spool at a speed faster than the vessel is travelling through the water. Line setters can be set to pull the line from the mainline spool at different speeds, giving the vessel's skipper flexibility in the depth his fishing gear settles at.

As the mainline leaves the rear of the vessel, a snood line with a baited hook attached at one end is clipped on to the mainline and manually thrown overboard to one side of the vessel. The snood lines are usually between 10 and 20 metres in length. Usually two or more crew are involved in the process. One of the crew is responsible for taking the correct hook from the snood box (which houses the hooked snoods when not in use), places the bait on the hook, and throws the snood over the stern of the vessel. The other crew member takes the other end of the snood and clips it to the mainline after the baited hook has been thrown. Each mainline has anything from 800 to 2600 snood lines clipped to it. The timing between snoods varies between 7 and 9 seconds on the New Zealand vessels.

Radio buoys are attached at each end of the line and at its centre. Floats are placed along the line approximately every 12-25 hooks, and each section between floats is termed a basket.

At the completion of this setting procedure, the line is left to soak for 10-16 hours. It is then retrieved and the cycle is repeated.

3. Trials of the underwater setting chute

3.1 TRIAL NO. 1 - F.V. *DANIEL SOLANDER*

by D Wrightson

The objective of the trial was to test the seaworthiness of a chute on a commercial vessel in open water conditions. Solander Fisheries Ltd provided the vessel F.V. *Daniel Solander* for this purpose.

The vessel was using demersal fishing gear during the period when the chute was tested, which meant it could not be used during fishing. However, because the key objective was to test the seaworthiness of the chute, this could be achieved by towing it behind the vessel on the way to the fishing grounds, and between sets during the fishing period.

Specifications of the F.V. *Daniel Solander*

The F.V. *Daniel Solander* is a purpose-built ex-Japanese pelagic longline vessel, with the typical semi-enclosed forward work deck low to the waterline, the wheelhouse midships three levels above the work deck and accommodation aft. This vessel is unusual in that, above the accommodation deck, a helideck pad extends out over the aft stern deck. The specifications are given in Table 1.

TABLE 1. VESSEL SPECIFICATIONS, F.V. *DANIEL SOLANDER*.

Length	Beam	Draft	Net tonnage	Power	Hull material	Crew
49 m	8.5 m	2.6 m	180.5 t	970 kW	Steel	15

Description of the chute

Figure 1 illustrates the chute built for the F.V. *Daniel Solander*.

Its total length, from the top of the trough to the base of the tube was 10.5 m. The tube section differed from previous designs by having a second length of tube welded under the grooved tube for added strength. Both tubes were 60 mm internal diameter.

Three paravanes were trialed: 1. Arrowhead paravane; 2. Flexiwing paravane; 3. Bi-wing paravane (Figure 2).

The chute was attached to the vessel 1.5 metres off the port quarter at the stern of the vessel. A base plate and hinge assembly was used to attach it to the stern. The hinge assembly operated through two arcs (Figure 3). One hinge pin was used to enable the chute to swing to port and starboard, and another to allow the chute to swing toward and away from the vessel. When the chute was fully deployed or recovered, a locking pin secured it in position (Figure 4). A hinged retaining arm secured the chute in the split collar during recovery and deployment.

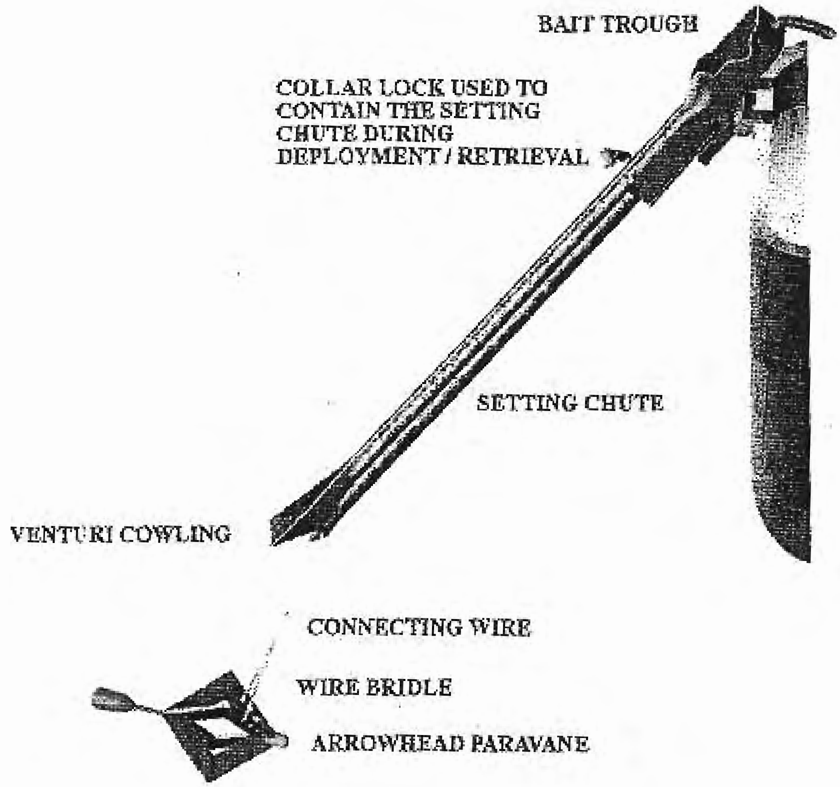


FIGURE 1. UNDERWATER BAIT SETTING CHUTE, SHOWING PARAVANE IN USE.

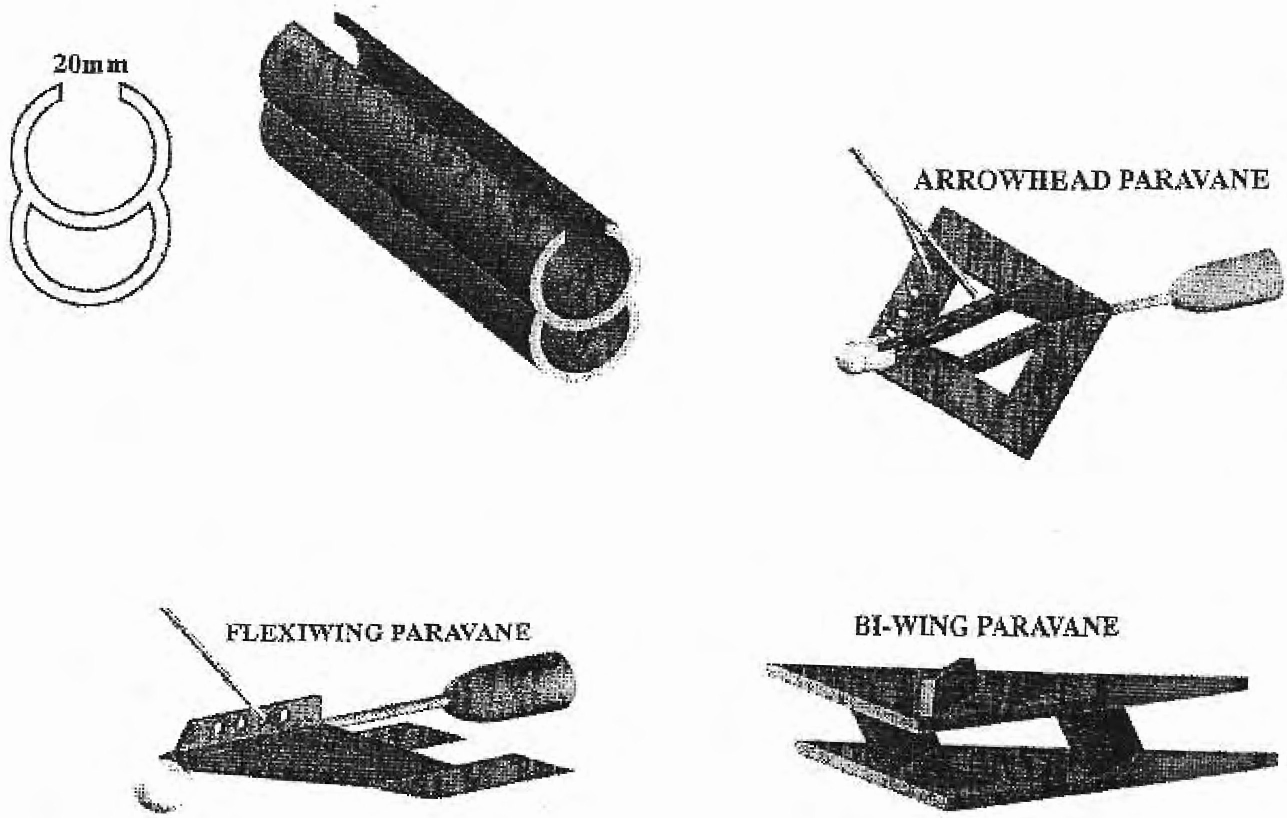


FIGURE 2. CROSS-SECTION OF SETTING TUBE TESTED ON THE FV DANIEL SOLANDER, AND PARAVANES USED; TOP RIGHT, ARROWHEAD ; BOTTOM LEFT, FLEXIWING; BOTTOM RIGHT, BI-WING.

FIGURE 3. HINGE ASSEMBLY FOR THE CHUTE.

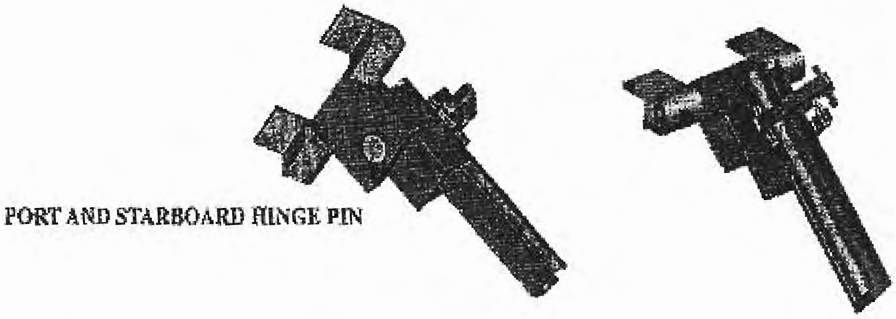
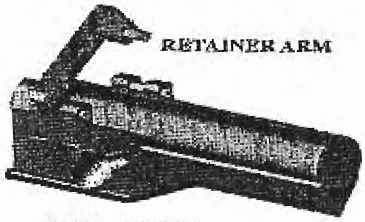


FIGURE 4. SPLIT COLLAR SYSTEM FOR SECURING THE CHUTE IN POSITION.



Retrieval and deployment system

The F.V. *Daniel Solander* has a helideck above the aft stern deck, and a hole was cut into this to allow the chute to be winched up and down through it. A 2.9 m high tripod was built on the helideck, and when the chute was fully retrieved, the trough rested directly above this frame (Figure 5). A length of 12 mm angle iron ran from the top of the tripod back to the hole in the helideck at approximately a 30° angle and protruded about 20 cm below to the stern deck. This acted as a guide for the chute as it was deployed and retrieved.

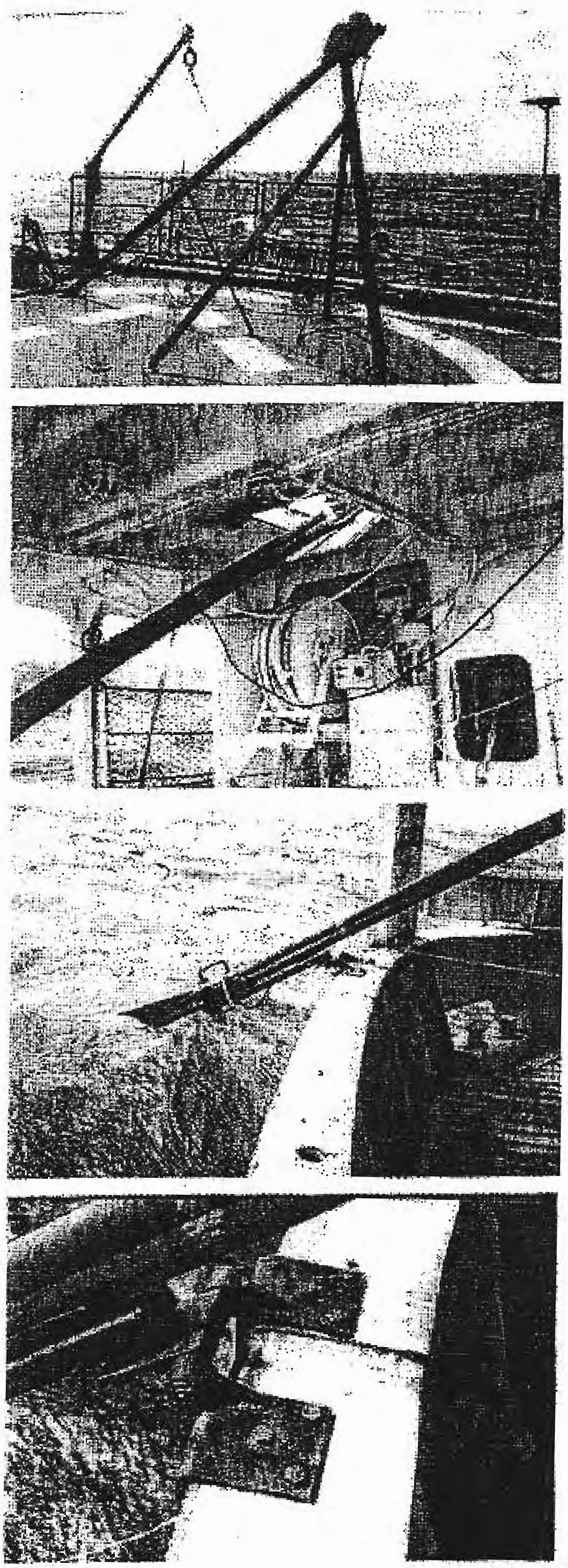
The chute, when fully retrieved, extended from about 1 m over the transom, up through the helideck, along the full length of the angle iron guide to where the trough rested on top of the A frame. It was secured in place by a pin through the lower end of the chute.

An angle bracket secured the chute to the stern of the vessel.

Method

During each trial the performance of the chute was observed and recorded. As well as written records of the performance of the chute, a video camera record of the chute's performance was also made. Marks were painted around the chute tube at metre intervals to determine the setting depth of the chute.

A summary of the trials, their locations and environmental conditions are given in Table 2.



Performance of the chute

Bait run times and entanglements

Baits were trialed through the chute on the third trial on 9 October 1997 while using the Arrow paravane.

The deck hose was connected to the trough to flush baited snoods through the chute. Bait flushing times were three to four seconds. After 14 baits were fed through the chute, a hook-up occurred on the paravane wire, resulting in the abandonment of snood timings.

With so few baits trailed through the chute, this trial could not be considered comprehensive.

Paravane operation

All three paravanes worked at keeping the chute down in the water column. The Arrowhead and Flexiwing were the most effective in terms of the angle of the chute and the setting depth (based on the number of metre marks visible above the water).

All of the October 1997 tests were made at towing speeds of 7 and 10 knots. At 10 knots all three paravanes appeared to be less effective, with the chute riding higher in the vessels wake. The Bi-wing paravane was the least effective at keeping the chute at the required angle.

At 10 knots towing speed, both the Flexiwing and Arrowhead paravanes (towed from the base of the chute on 5 and 6 m wire strops) made a very audible vibration noise. The vessel's skipper commented that this noise might deter the target species when pelagic longlining.

During the second set of trials, the vessel was travelling at a slower speed because of high seas, and the vibration noise experienced at higher speeds was not heard. After a few minutes' towing, the tail came away from the Flexiwing paravane.

FIGURE 5. RETRIEVAL AND DEPLOYMENT SYSTEM FOR THE CHUTE: (FROM THE TOP) THE TRIPOD ON THE HELIDECK; THE ANGLE IRON GUIDE; THE CHUTE SECURED WHEN FULLY RETRIEVED; ATTACHMENT TO THE STERN.

TABLE 2. DATE, LOCATION, AND CONDITIONS IN CHUTE TRIALS ON F.V. *DANIEL SOLANDER*.

DATE	LOCATION	TRIAL	CONDITIONS
09.10.97	Otago coast	Three trials when steaming to fishing grounds.	Relatively calm, 5–19 kt, SW swell 1.0 m.
05.11.98	Chatham Rise	Two trials between fishing operations.	Rough seas, SW wind up to 38 kt, SW swell 2.0–2.5 m and breaking.

All three paravanes used in the five trials were affected by the vessel's propeller wash. The propeller rotated clockwise with a pull from port to starboard, and the paravanes were pulled towards the starboard stern quarter. The angle of the chute appeared to vary from 15 to 20 degrees to starboard. With the second set of trials, the length of wire strop was increased in an attempt to clear the paravane from the propeller wash, but the effect was the same.

Base plate and hinge operation

The base plate and hinge were effective and did not appear to place excessive force on to the stern transom plating. The chute was observed to flex and show signs of movement, but this appears to be from water resistance rather than force transmitted from the paravanes.

No part of the base plate hinge or chute malfunctioned during the trials. On completion of the trip some obvious rust marks were starting to appear. It may be that a non-rusting material is required if the chute is to be used continuously.

Performance of the retrieval and deployment system

Difficulties were experienced with the deployment and retrieval system. When the chute was three-quarters deployed, the trough was still protruding through the hole cut through the helideck. The downward pull of the paravane in the water jammed the chute against the edge of the hole in the helideck, and it took up to three crew straining on ropes to clear the hole. Once the chute was fully deployed and contained in the pivot arm with the retaining collar, the main locking pin had to be inserted to connect the chute to the pivot arm by aligning holes drilled into each component. This often required the repositioning of the chute in the pivot arm by the winch person before the holes would align and the locking pin could be inserted.

During the second set of trials, in gale conditions, considerable bending occurred as the chute was retrieved. At the point where two-thirds of the chute were out of the water, the paravane was still working against the crew hauling in, and with a swell of two or more metres, the amount of curve the paravane end of the chute took up was considerable. No damage resulted from this action on the chute.

Recommendations

Given the very limited sea trails of the chute during this trip, it was still considered to be untested. However, several modifications were recommended.

1. The paravanes should be incorporated into the chute, making it a one-person operation, removing the dangers and difficulties associated with deployment and retrieval of the paravane and wire strop in large seas.
2. Some form of cradle, guide or track could be developed to contain the chute during deployment/retrieval operations, allowing for a one-person operation.
3. The use of a hydraulic winch with hand control at the stern deck, to allow for a one-person operation, creating a smooth and simple deployment/retrieval of the chute.
4. An even longer and stronger tube, to allow deeper bait delivery and clear the vessel's wake more effectively.
5. The chute should be positioned away from the prop wash and the disturbance of the water column, therefore avoiding the prop wash effect while towing the deployed chute.
6. The feed tray should be detachable during retrieval or deployment of the tube.
7. A longer paravane tow strop could be used to enable the chute to be fully set before the paravane need be deployed; this would prevent any pressure or loading on the chute while only half deployed in the water. If this system was used, a way of tripping the paravane would need to be found for the retrieval phase.

3.2 TRIAL NO. 2 - F.V. *BRENDA KAY*

by D. Wrightson

The objective of this trial was to evaluate the operating performance of a chute on a smaller longline vessel in a range of sea conditions, and to set 4000 hooks through the chute under the normal fishing conditions. It was hoped that during the fishing operations, severe weather conditions would allow the chute to be used in rough water so that its durability and the performance of the attached paravanes could be evaluated.

The F.V. *Brenda Kay* (Tobe International) was selected as a suitable vessel to carry out the sea trials.

Specifications of vessel and longlines used

The F.V. *Brenda Kay*'s steel construction and clear deck room made it a suitable vessel for the trial. Other vessels with small stern areas, overhead canopies, aft wheelhouses, or masts of insufficient height to position a block enabling a retrieval angle of forty degrees at the chute would require further modification of the chute set up to operate the chute effectively.

The specifications of the vessel and the longlines used are provided in Table 3.

TABLE 3. F.V. *BRENDA KAY* SPECIFICATION AND LONGLINE CONFIGURATION ANS DIMENSIONS.

LENGTH	BEAM	DRAFT	GROSS WEIGHT	POWER	HULL MATERIAL	CREW NUMBER
13.8 m	4.8 m	2.3 m	32.0 t	171kW	Steel	3
CONFIGURATION		MAINLINE	SNOODS	FLOATS		BASKET SIZE
		30 mm (approx.)	950	58		25 hooks (approx.)
DIMENSIONS		MAINLINE DIAMETER	SNOOD DIAMETER	BUOY LINE DIAMETER		
		4.0 mm	2.2-2.0 mm	2.2-2.0 mm		

The main line was routed from the longline reel on the port side of the vessel, across to the starboard side, through a block suspended from the wheelhouse roof, then at right angles down to the line shooter. The shooter was not used during the chute sea trials. The longline reel was always set on "free wheel", and the mainline was tight as it fed over the stern.

A buoy and one radio beacon were deployed from the stern and attached to the main line. Once the pole and radio buoys were clear and the mainline was slowly running off the longline reel, two additional floats were clipped on to the mainline before baiting snoods were deployed. One unusual feature of the F.V. *Brenda Kay*'s fishing gear was the use of snoods as float lines. This allowed total freedom for the skipper to determine number of snoods in each basket.

Two types of bait were used for all the real-time at-sea trials:

(1)sanmar (approx. 130 sanmar per carton),

(2)squid (approx. 160-220 squid per carton).

Cartons of bait were left in the hold until the vessel had reached the start way point for the set. The cartons were then opened and the semi-frozen baits separated and placed into bins at the stern, thawing while the set progressed.

Description of the chute

The chute trialed was a 5.7 metre length of 6 cm diameter steel pipe (Figure 6) connected to the vessel in the same way as on the F.V. *Daniel Solander*, by a base plate bolted to the aft transom and contained by a pivot-arm and chute locking pins (see Figures 3, 4).

The dorsal section of the tube had 2.5 cm width slot along the full length of the tube. At the base of the tube a section of it was cut away and flared to allow clear movement of the expelled bait. A split cowling was welded around the bait exit point to maximise the tube venturi effect.

On the base of the bait exit cowling a bracket was welded vertically, and through this, four separate holes were drilled, allowing for four different points of connection for the paravane wire strop. The position of the wire strop used for all the F.V. *Brenda Kay* trials was the hole furthest back from the dorsal snood groove down the length of the chute tube or lowest hole when the chute was fully deployed.

Marks were painted on the chute at one metre intervals from the base. A record of the maximum and minimum number of marks visible above the water line was kept during setting. The angle of the chute in the water was estimated, and the maximum and minimum depth determined from this.

The top end of the tube was welded to the trough. The trough was half a metre in length and oval in shape, with sides approximately 10 cm high. Water was fed in from the top of the trough via a connection point to the deck hose. The water then flowed from the top of the trough down its full length, through the point where the trough neck is welded to the chute tube and on down the tube to the bait exit point at the base of the chute.

Two steel plates were welded horizontally from a point above the weld that connects the chute tube and trough, and extended some 10-15 cm above the trough floor into the trough. These horizontal plates were to act as line guides for the snoods (Figure 6). The trough had a cut out section on the right hand side of approximately 5 cm to allow easier use of the snood line guides.

Bait was fed into the trough allowing the water flow to carry the bait the full length of the tube. Once the bait had entered the tube, the crew member baiting it would allow the snood line to lie under the guide plate, preventing loose or slack line entering the snood groove before the bait had exited the base of the chute via the exit point and clearing the cowling. It was thought necessary for the snood line to exit the snood groove before the bait had cleared the exit and cowling to prevent it from looping out of the groove and tangling at the exit point or lower on the paravane strop. It was also considered undesirable for the snood line to leave the tube before the bait, as its early release could cause a bait to be forced prematurely from the tube, allowing it to be set at a shallower depth than the desired three metres.

A similar flexiwing paravane to that used on the F.V. *Daniel Solander* was used (Figure 2), except that lead weights could be inserted into the nose of the paravane and an additional two attachment points had been drilled in the dorsal section.

The chute was attached to the vessel using a similar base plate, hinge and and pivot arm as that used on the F.V. *Daniel Solander* (Figures 3, 4). The chute base plate was attached to the aft transom horizontal stern plate, 80 cm from the port stern quarter, at a height of 50 cm above the deck plating.

Retrieval and deployment system

The chute configuration used on the F.V. *Brenda Kay* is shown in Figures 7 and 8. The retrieval system used for the trials consisted of one double block shackled to the vessel's mast approximately 6.5 metres above the water line. A single block with a shackle was connected to a lug at the base of the chute feed trough. An 8 mm three-strand rope was laced between two blocks and rigged to advantage; this block configuration is known as a "Handy Billy" or "Jigger".

The chute was placed into the pivot arm and secured with the hinged collar with the paravane end of the chute extending over the stern. The paravane was

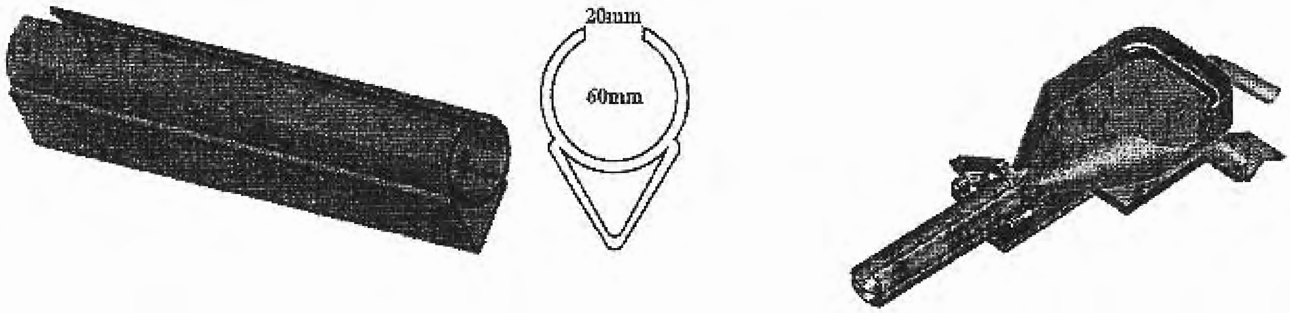


FIGURE 6. (ABOVE LEFT) CHUTE DESIGN AND (RIGHT) TROUGH USED ON F.V.*BRENDA KAY*.

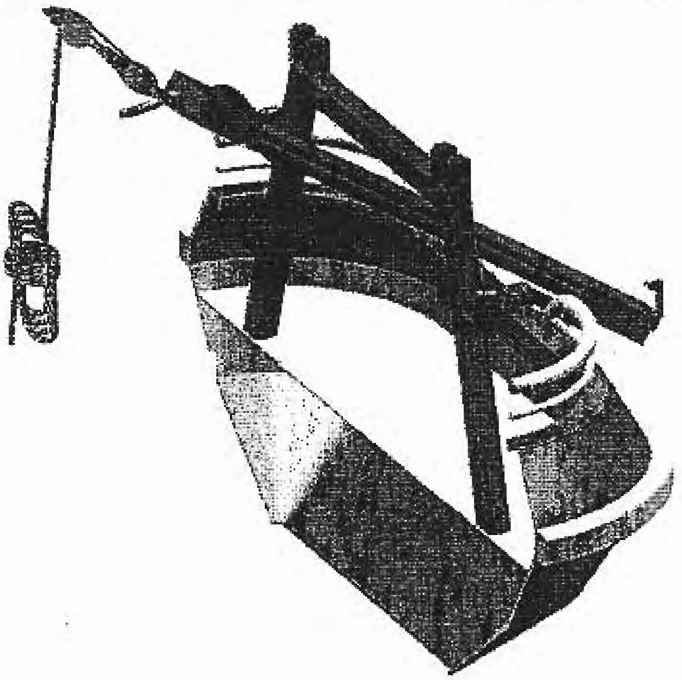


FIGURE 7. DEPLOYMENT AND RETRIEVAL SYSTEM USED ON F.V. *BRENDA KAY*. THE HOISTING GEAR WAS ATTACHED TO THE MAST ABOVE THE WHEELHOUSE. AN EXISTING GANTRY ON THE VESSEL CAUSED SOME OBSTRUCTION TO THE CHUTE.

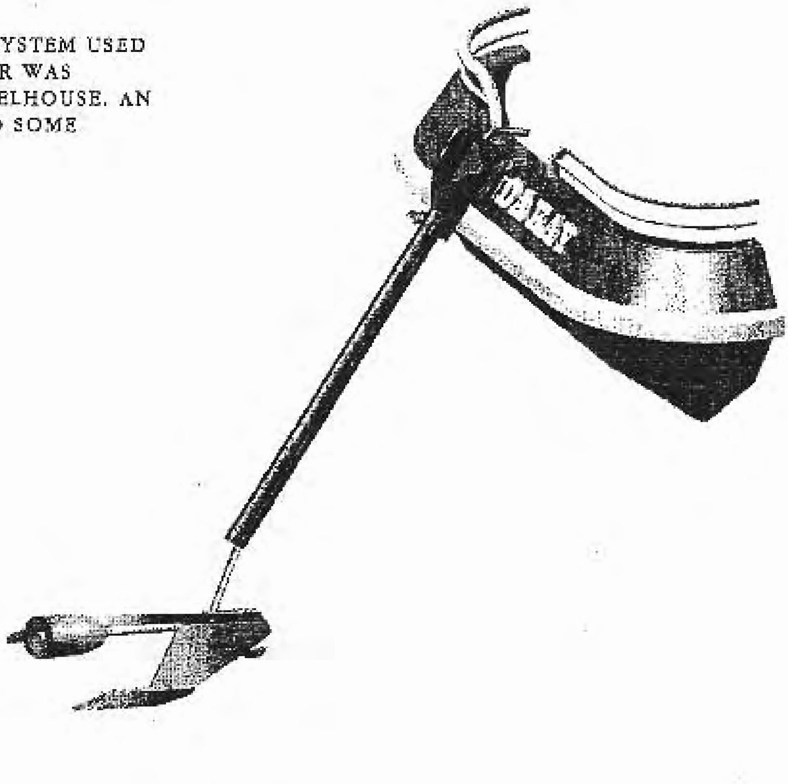


FIGURE 8. CHUTE IN USE ON F.V. *BRENDA KAY*. THE HANDRAIL HAD TO BE RECESSED TO ALLOW FOR IT.

then attached to the wire strop at the third attachment point from the front. The strop attachment to the chute was checked and the shackle tightened if necessary.

The single block was attached to the lug at the feed trough and the chute was hoisted above the deck to about a thirty degree angle. The paravane was then deployed over the stern of the vessel and allowed to trail just below the sea surface in the vessel's wake; at this point the vessel was idling into or with the weather.

One person controlled the descent of the chute with the down haul length of rope from the "Handy Billy" block assembly. Up to three persons would assist by pushing from various positions along the chute length. It was difficult to get the chute moving through the pivot arm, as the steel seemed to bite and grip with friction, due to the paravane's downward pull on the chute.

The position of the stern gantry and the height that the chute was mounted at the stern meant that to haul the chute above the gantry would scrape the bottom of the chute over the gantry surface. It was decided to go under the gantry, which meant that the chute's angle of entry was less than 45 degrees. This made it even more difficult to deploy and retrieve because the paravane was trying to keep the chute at a 45 degree angle.

Once the chute was fully deployed and the pivot arm guide bar had positioned itself between the two brackets welded to the base of the chute feed trough, the locking pin was inserted through all three and secured with a small clip. The chute was now completely secured to the pivot arm and the retaining collar of the pivot arm could be unpinned and folded out of the way. While the pivot arm retaining the collar was in place, it was impossible to apply baited snoods through the chute, as the collar obstructed the snood groove.

Fishing procedure using the chute

Because the first few snoods in the bin were often tangled, it was decided to set the first two or three baskets by throwing the baited snoods out on the port quarter, as would normally be done. This also allowed the crew to get into a routine. The skipper would then fine-tune the vessel's course to see that the chute was running at the correct angle and was towing well. Once these first baskets had been set, the crew started placing the baited snoods into the feed trough and allowing snoods to be set through the chute. This would continue until the completion of the set or until the skipper determined otherwise.

The total number of hooks trialed through the chute was calculated by counting the total number of hooks in the snood bins, and subtracting ten plastic lures (always thrown clear), total numbers of floats set, and total number of baited snoods not deployed through the chute. On occasion, due to problems with the snood tangling on the chute, only a portion of the total available snoods were set through it. An estimation was made of the total snoods remaining and back-calculated for a total set.

Trial location and timing

There were two one day shake-down sea trials with the F.V. *Brenda Kay*'s skipper, crew and chute developer, Paul Barnes, on board. The developer was present to install the chute, fine-tune paravane settings, and answer any questions or concerns the skipper or crew might have. These trials took place on 26 November 1997 and 4 December 1997 and four to five nautical miles seaward of the port of Tauranga. On the second shake-down trial, baited snoods were trialed through the chute.

Commercial fishing trials took place around an area called the Colville Ridge, 100 miles north-east of the port of Tauranga, where the F.V. *Brenda Kay* was based. It was envisaged that two trips of up to five days' fishing would be required to complete the trial requirements of 4000 hooks (through the chute). However, the fishing was considerably better than expected and the longest trip was only three fishing days due to the number of tuna landed and the relatively small hold. The three trial trips took place on: Trip One: 27 November to 1 December 1997; Trip Two: 6–9 December 1997; Trip Three: 11–14 December 1997.

The weather and sea conditions encountered during the two shake-down trials are summarised in Table 4. Both of these trials occurred during daylight hours.

During the trials, setting was conducted at night between 2040 and 0523 hours—in accordance with accepted fishing practices developed to minimise sea bird capture. Table 5 summarises weather and sea information recorded during the commercial fishing sea trials. Weather conditions during the trial sets were more settled than would have been preferred, with only one of the five trial sets undertaken in wind and sea conditions of over 25 knots.

TABLE 4. WEATHER AND SEA CONDITIONS DURING SHAKE-DOWN TRIALS OF THE CHUTE.

DATE	WIND DIRECTION	WIND SPEED (kt)	SWELL DIRECTION	SWELL HEIGHT (m)	CLOUD COVER (%)
26.11.97	SW	25	SW	0.5	90
04.12.97	SW	15	NE	0.5	100

TABLE 5. WEATHER AND SEA CONDITIONS DURING COMMERCIAL FISHING SEA TRIALS OF CHUTE ON F.V. *BRENDA KAY*.

START DATE	TRIAL SET NO.	WIND DIRECTION	WIND SPEED (KT)	SWELL DIRECTION	SWELL HEIGHT (M)
28.11.97	1	NW	15	NW	0.75
07.12.97	2	SW	18	SW	1.5
07.12.97	3	NE	10	SW	0.75
13.12.97	4	ESE	25	ESE	2.5
13.12.97	5	NE	10	NE, SE	1.0–0.5

Performance of the chute

Entanglements

Hook entanglements on the chute occurred during four of the five trial sets. Table 6 shows the number of entanglements recorded and, if known, how the entanglement occurred.

TABLE 6. NUMBER AND CAUSES OF ENTANGLEMENT.

TRIAL SET NUMBER	TOTAL SNOODS THROUGH CHUTE	NUMBER OF ENTANGLEMENTS	REASONS FOR ENTANGLEMENTS AND POSITIONS OF ENTANGLEMENTS ON THE CHUTE
1	0	2	Incorrect tail float fitted to paravane making the paravane run at a shallow setting. Two float lines tangled.
2	683	3	1. Snood tangled on paravane wire 2. 360 degrees snood wrap round chute tube 3. Hook-up on exit cowling
3	817	2	1. Unknown 2. Hook-up on exit cowling
4	648	7	1. Float line entanglement 2. Snood hook-up - unknown, cut away 3. Snood hook-up - unknown, cut away 4. 360 degrees snood wrap around chute tube 5. Snood hook-up - unknown, cut away 6. Snood hook-up - unknown, cleared itself. Snood cleared itself 7. Snood hook-up - unknown, cut away.
5	876	0	No hook-ups during this set

In order to confirm where a snood was caught, the chute was retrieved back on board the vessel with the snood still attached to the mainline and the hook still connected to the chute at the fouling point. Because of the time involved and the number of crew required (at least two) it was deemed easier to haul the mainline back to the vessel until the offending snood could be reached. On a number of occasions, particularly with rougher sea conditions, hauling the mainline back removed the pressure from the hook, and the hook came free. On the two occasions when hooks were observed in the entangled position, calm conditions would have contributed to the hooks remaining connected to the chute throughout the chute retrieval operation. The setting operation resumed once the hook was freed and the vessel was up to speed.

Chute

On the first fishing trip while retrieving the chute, a weld three metres from the feed trough joining two lengths of chute tube together parted. The two lengths continued to be held by the angle-steel backing. The cracked weld prevented any further trials on this first trip. On arrival back at the port of Tauranga, arrangements were made through Moana Pacific's workshop to repair the weld. Alterations were also made to the retaining collar and the pivot arm and base of the feed trough to make alignment a simple operation.

Once these alterations were made, no further problems were experienced with the chute's durability. On the return to the port of Tauranga after completion of trial trip number two, cosmetic alterations were required to the exit cowling and snood groove at the base of the chute tube, where observed hook-ups were taking place.

On the third fishing trip, during set six, under heavy weather conditions, the vessel was required to reverse back on the set gear five times, responding to individual hook-ups on the chute. During one of these reversals the extension bar of the vertical hinging was bent down about fifteen degrees at the point where the pivot arm's horizontal hinging attached to the extension plate. This in no way damaged the chute or affected its performance during the final set.

On completion of trial trip three and the return to Tauranga, the entire chute was removed from the vessel, including the base plate. No structural damage was noticed around the four bolt holes linking the chute to the vessel, or any surrounding steel work on board.

The chute angle, when fully deployed, was consistently recorded at forty-five degrees to the stern of the vessel, using a plastic angle measuring device taking the form of a protractor with a central measuring arm.

Trough

Sufficient water flow from the vessel's deck hose through the connection at the back of the feed trough was required to deliver baited snoods to sea level. The water flow was directed towards the point where the chute tube joined the neck of the feed trough. However, there was not enough water flushing around the sides of the trough, and baits stuck to the trough base. This was compounded by an additional difficulty of the chute being placed too far to port, requiring the crew person baiting to twist their torso from snood bin and bait to the chute trough. The distance between snood bin and the chute encouraged the crew to lightly toss baited snoods at the chute feed trough rather than placing them in it, allowing the possibility of baits missing the feed trough altogether. While no baits were observed missing the feed trough, this situation cannot be ruled out as a possible cause of entanglement.

Paravane

Only one type of paravane, the Flexiwing, was used during these trial sets. No damage was sustained by the paravane during these trials.

No difference was observed to the effectiveness of the paravane during differing weather conditions. During set six, when the most extreme weather conditions were encountered and the most snood hook-ups recorded, it is possible that the considerable movement of the vessel, both vertical and horizontal, through the sea-way affected the chute and snood interaction and the paravane performance.

During the trials, when the chute was fully extended in the deployed situation, it was noticeable that it had a 10 to 15 degree offset angle to starboard. This was also observed with the chute trialed on the F.V. *Daniel Solander*, and was presumed to have been created by the propeller wash. The skipper of the F.V. *Brenda Kay* was uncertain which way his vessel's propeller turned, as it was difficult to tell from observing the propeller wash. However, as the direction of the offset angle was the same as for the previous F.V. *Daniel Solander* trials, it is assumed that the F.V. *Brenda Kay*'s propeller had a clockwise rotation.

Performance of the deployment and retrieval system

The F.V. *Brenda Kay* was an ideal vessel for these trials, with a large uncluttered stern-deck, an uncluttered mast area with good height, and a hull of steel construction allowing for easy, clean attachment of the chute. There was also an ideal area above the deck to stow the chute when not in use. However, a number of difficulties were experienced during the trial sets.

1. An old, poorly maintained double-block was secured to the mast with a large shackle and then lashed into position pointing aft. A single-block (new) was laced to the double-block with 8 mm polypropylene rope to complete the "billy tackle". Had the double-block been in good working order, this block and tackle would have aided the speed and ease of the chute retrieval and deployment operation.

2. Another problem resulted from the force of the paravane pulling the chute down during deployment and retrieval. The problem arose when the chute feed-trough passed under the stern gantry. With the paravane forcing the chute to a 45 degree angle, the feed-trough had to be pulled down by one of the crew for the chute to clear the overhead gantry as it passed beneath it. During calm sea conditions this was not a problem, but when the vessel was influenced by any sea, the chute became difficult to control, even though it was contained by the pivot arm and collar. Retrieving or deploying the chute above the gantry would have been dangerous in anything but calm seas.

3. After repeated settings, it appeared that there was an increase in friction between the steel of the pivot arm and the angle steel of the chute backing. This increase in friction was possibly due to rust build-up or loss of paint, and was worsened by the loading caused by the paravane. This resulted in the chute "sticking" to the pivot arm during deployment and retrieval.

Performance of bait types used

Squid

Squid are an ideal bait for the chute as they are incredibly flexible, moulding themselves to any shape without being damaged or affecting the hook placement. Squid baits have the added ability, should they jam at the neck of the trough, to block the water flow, allowing build-up to a volume where the water then forces the bait through the neck of the trough. Owing to the size of the squid, they seemed to stay within the chute until being expelled at the exit point and would not readily clear the chute prematurely through the snood groove.

Sanmar

Sanmar are an imported, elongated bait fish resembling a garfish. Because of their long and slender shape, difficulties were experienced in getting the baits to move through the feed trough. If the baits were placed either side of the main water flow they had a tendency to remain where they landed because of insufficient water flow. Sanmar were hooked between the eyes and would land with the tail facing towards the neck of the trough. Because of their elongated shape and relative firmness, water would not build up behind them, requiring the person baiting to jerk the snood to reposition the fish into the trough's water flow. If the sanmar landed directly into the main water flow through the trough, the sharp angle of the trough neck narrowing to meet the same diameter as the chute tube would cause these fish to often jam across the narrow neck, again requiring the snood to be jerked to realign the bait with the water flow. On occasions, three or four attempts would be required to align a bait.

Discussion

Entanglements

From observations of the trial sets, a number of reasons for the baited snood entanglements came to light:

1. It was assumed that a minimum snood length of ten metres would be trialed. However, snood lengths of approximately six metres and possibly less were present in the snood bins. Snoods are continually cut back because of shark damage or general wear and tear. The shorter snoods created tension on the hook while the hook was still in the chute tube, dragging the eye and shank out through the snood groove, the point, barb and kerb of the hook remaining inside the chute groove. The hook then dragged down the groove edge because of tension in the snood from the pull of the mainline and the vessel's forward momentum, with the hook then jamming on the flaring of the exit cowling at the base of the device.

2. Sanmar baits, being long and thin, were able to wash out of the snood groove if tension came on to the snood before the baited hook had cleared the exit point. If this occurred near the surface, there was a possibility that the forward wash of the vessel's wake could wash the baited hook around the chute tube in a 360 degree turn. This bight of snood could then slide down the chute tube to the flaring and hook up or slide further on to the paravane wire and hook up there. A similar snag would occur if there was too much water from the deck hose travelling down the chute and washing the sanmar baits out of the snood groove.

3. A loop of snood nylon may occur through the snood groove above the point where the chute entered the water. As it is dragged under the water surface this loop is pinned to the underside of the chute tube by water pressure, slides the length of the chute tube and hooks up on the exit cowling or on the paravane wire.

4. During trial set four, with winds of 25 knots or more and an estimated swell of 2.5 metres, five snood hook-ups were recorded. All of these hook-up points in or on the chute were unobserved and can only be guessed at. It is possible that the increased movement of both vessel and the chute, because of the size of the swell, were involved in these additional hook-ups.

5. A factor that influenced the results from these trials was the relative inexperience of the crew. It was their first season with the surface longline fishery. In contrast, trip number three had an experienced crew member who did a relief trip. This person's understanding of timing, baited snood placement and all-round knowledge of the setting operation, had a direct effect on the lack of entanglements and successful outcome of the final set.

Safety issues

The use of the chute, including deployment and retrieval, its use while deployed, and the need for it to be securely stowed on board on completion of each trial set uncovered a number of safety-related issues:

1. During these trials, retrieval and deployment required three people: one controlling the rope through the blocks and two pushing and straining on the chute tube to move it through the pivot arm and collar. This should be a one-person operation, as other tasks required the crew's attention at this time.

2. For installation of the device on the F.V. *Brenda Kay*, the stern railing had to be removed. It was considered important that adequate railing "surround" the work area at the stern and that minimum amounts of railing be removed.

3. Concern was expressed that, with the chute in the deployed position and with five metres of chute tube and attached paravane trailing in the vessel's wake, the chute would interfere with the rudder or propeller should the skipper want to reverse or stop suddenly. During the trial setting operations, it was necessary for the vessel to be stopped quickly due to snood entanglements on the chute. With reverse momentum, the vessel was pushed back along its own wake, therefore pushing the chute against the vessel's stern. No problems were in fact encountered at these times, although the possibility of damage to the rudder or propeller was constantly considered.

5. There were few hand holds on the wheelhouse roof, and while the chute was being hauled on to the roof with the block and tackle, it could swing from side to side across the deck. This operation was potentially dangerous.

Recommendations

1. Entanglements

It is imperative that baited snoods should not miss the feed trough when placed into it. Should this occur, it is possible for the baited snood, on falling into the vessel's wake, to tangle at some point on the chute. The feed trough could be redesigned with higher sides that would catch wayward baits and reposition them into the feed trough.

Shorter snoods result in tension between the snood clip on the mainline and the baited hook in the chute. The tension drags the hook shank out over one side of the snood groove, allowing a hook-up on the snood exit cowling.

Too much water through the feed trough and chute may expel baits where the trough water flow meets the sea surface water level in the chute. The water is forced out through the snood groove, forcing baits out with it. The narrowing of the snood groove would prevent baits being flushed out prematurely.

There needs to be good co-ordination between the person clipping snoods on to the mainline and the person deploying baited snoods through the chute. This prevents strain being applied on the baited snoods in the chute, which has been identified as a cause of entanglement. Floats also need to be deployed in a controlled way to prevent float lines snagging on the device.

2. Positioning of the chute

The chute should be positioned on the stern so that the crew person does not need to stretch or twist their body in order to place baited snoods into the feed trough from their baiting position.

3. Water flow through the feed trough

A consistent, evenly spread water flow must cover the entire base of the feed trough. This would prevent the baits sticking to the base or jamming in the neck of the trough.

4. Paravane performance

With the exception of one trial set in rough sea conditions, only calm sea trials have taken place. The effects of high sea conditions on the paravane's action and the relationship between the paravane and increased hook-ups at the base of the chute under high sea conditions are still not known. The increased vessel movement by large swells may adversely affect the paravane's performance in some way.

5. Deployment and retrieval of the chute

The use of appropriate blocks is necessary to control speed and the ease with which the chute can be controlled through deployment or retrieval. Some form of frictionless pads or rollers positioned on the pivot arm, allowing free movement of the chute backing through the pivot arm and collar, would assist in deployment and retrieval of the chute.

6. Varying vessel configurations

Chute storage, deployment and retrieval systems, and position of deployed chute will need to be tailored to particular vessels because of the existence of aft wheelhouses, canopies, stays, masts, rigging, and additional fishing equipment on different vessels.

3.3 TRIAL NO. 3 - F.V. *ATU S*

by D O'Toole

The objective of trial number 3 was to set a minimum of 4000 hooks through the modified chute under the normal fishing conditions on a commercial fishing vessel, and evaluate its seaworthiness and ease of use. The trial was undertaken on the domestic longline fishing vessel F.V. *Atu S*, owned by Moana Pacific Ltd.

Vessel specifications

The F.V. *Atu S* specifications are provided in Table 7, together with a summary of its fishing gear.

TABLE 7. VESSEL SPECIFICATIONS FOR FISHING VESSEL F.V. *ATU 5*.

LENGTH	BEAM	DRAFT	GROSS WEIGHT
32 metres	6.4 metres	4 metres	181 tonnes

Summary of fishing gear	
Mainline	3.5 mm nylon with 450 kg breaking strain - Brand "Tollon"; 74 km of line on board and about 65–70 km used per line.
Snoods	2.02 mm nylon with 215 kg breaking strain - Brand "Shogun" (Japanese type), each 14.4m long.
Hooks	Three types: 17/0 Eagle claw, Japanese 3.6, and Mustad 16/0 DR Tuna Circle hooks. An armour spring and crimp used to attach each hook to its snood.
Clips	2.6 mm x 100 mm with a 6/0 barrel swivel.
Floats	25 kg buoyancy, 360 mm in diameter. Float line = 14.4 m of 5 mm rope.
Line shooter	LS4 monofilament line setter (Lindgren-Pittman). Usually sets at 10.5 knots or 325 rpm (main wheel 1m circumference).
Light sticks	100 mm Big light.
Setting details	Speed of vessel normally 8.5 knots. Normally 1320 hooks per line; one snood every eight seconds, 12 per basket with 1.5 empty baskets by beacons; 3 beacons per set.

Description of the chute

A number of new design features were incorporated into the chute constructed for the F.V. *Atu 5* to overcome problems experienced on earlier trials. The changes are described below. The chute was attached to the stern at the centreline (Figure 9).

Chute

The main section of the chute was 9.5 m long, and tapered along its length. The slot width was milled to two different widths along the length of the chute: 11 mm above the water line and 20 mm below the water line. The decreased width above water level was to help constrain the water flow and trace within the device above sea level. A 3.5 metre length of RHS, a 12 mm x 50 mm M/S flat bar and two 12 mm rounds were welded on the lower side of the chute (Figure 10) to aid deployment and retrieval of the device through the new roller carriage section (see description below) and to increase the strength of the chute.

Two horizontally opposed and partially overlapping brushes were added to the top section of the chute (Figure 11) to retain the snood inside the chute until the force from the mainline pulling the other end of the snood released it from the chute.

A conical trough was used. This had a piece of pipe around the top edge to carry the water to a series of holes placed at 50 mm intervals around the inside perimeter (Figure 11). This was designed to ensure an even water flow inside the trough to help align the bait for entry into the neck of the chute. Unlike earlier designs, this trough was detachable from the chute. A slight curve on the mainline side of the trough was to prevent the traces becoming snagged on any corners.

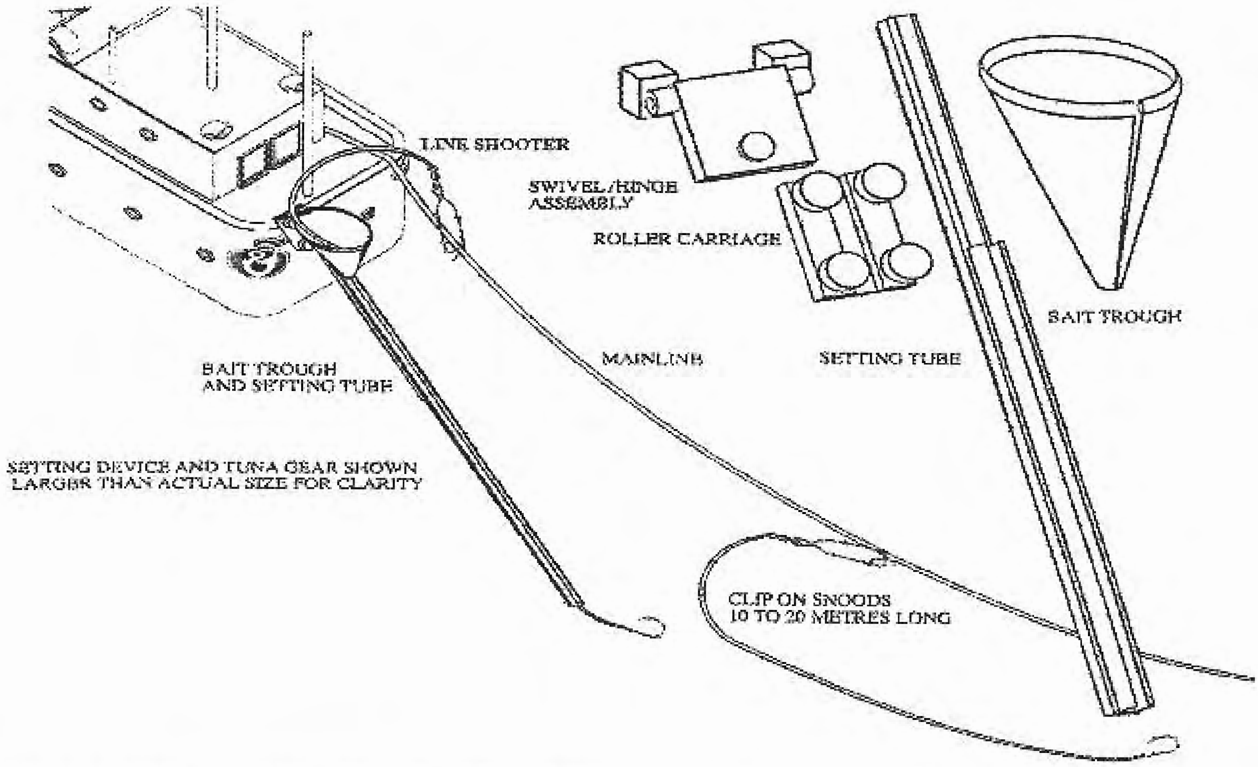


FIGURE 9. UNDERWATER SETTING CHUTE IN USE ON F.V. *ATU 5*.

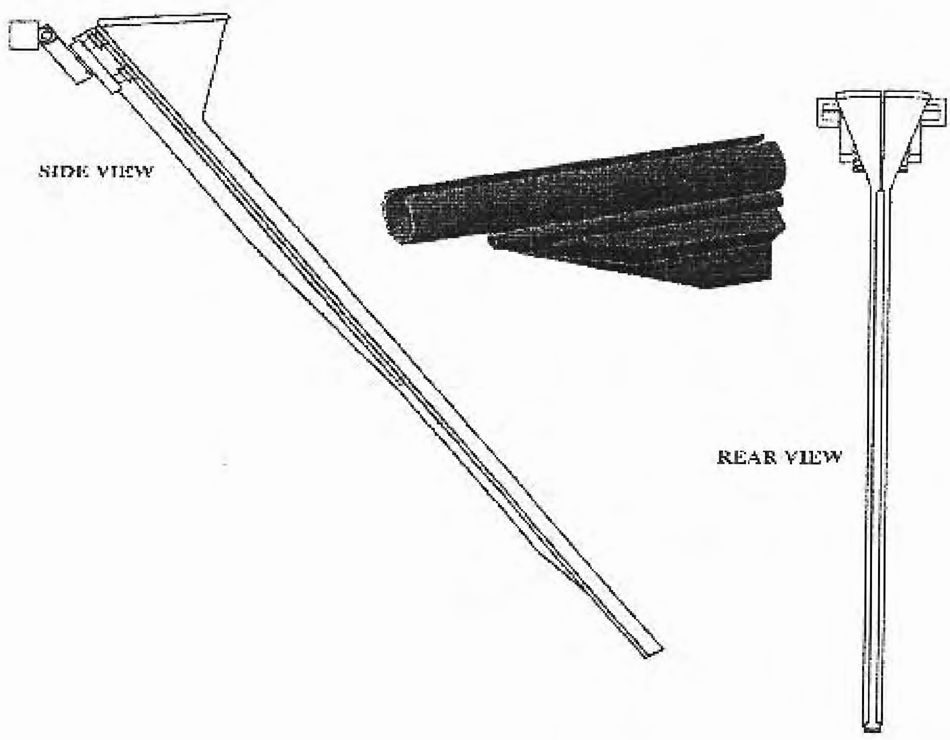


FIGURE 10. VIEWS OF THE CHUTE.

Deployment and retrieval system

A roller carriage system which significantly improved the ease with which the chute could be retrieved and deployed was developed (Figure 12). The nylon rollers constrained the chute during recovery and deployment without the jamming that occurred with the previous slide system or any need of a locking arm.

On the first trial on the F.V. *Atu S* the chute was fitted in the centre of the stern gunwale. Recovery and deployment were achieved by fitting a pulley system to the top of the stern mast with a locating bracket mounted further down the mast (Figure 14).

Strop attachment

Because of problems with the paravanes, an alternative system for maintaining the chute at the required angle in the water was devised. This involved a chain and shock absorber system joining the tube to the transom of the fishing vessel (Figure 13). The length of chain dictated the angle of the chute and consequently the setting depth.

Results

On 17 February 1989, while F.V. *Atu S* was steaming to the fishing grounds, the chute was deployed. Deployment was simple and took less than five minutes. The chute was set at an angle of forty degrees from vertical, the angle being measured using a suspended vertical spirit level and adjustable protractor. It performed well during the two hours of steaming at approximately ten knots.

The chute was then deployed and used during a normal setting procedure. After 13 minutes of setting, the mainline carried across the transom to the chute and become tangled around the shackles connecting them. The skipper removed the chute and continued shooting in the normal manner. Details of the trial conditions are provided in Table 8.

Discussion

During setting, the mainline is ejected from the stern, via a line shooter, at a faster rate than the vessel is steaming. This allows a greater sag in each basket. As a result of this there is an excess of mainline floating in the water just behind the stern during setting. When combined with the propeller wash, wind and swell, it is an easy matter for the line to become tangled around the strop connector.

TABLE 8. DETAILS OF TRIAL OF CHUTE ON F.V. *ATU S*.

Date	Start time	Finish time	Start position	Finish position	Wind speed	Wind direction	Swell height	No. of hooks	Vessel speed	Line speed
17/2/98	1950	2320	35° 17' S 172° 14' E	35° 24' S 172° 26' E	15 kt	N	2.5 m	840	8.5 kt	12.5 kt

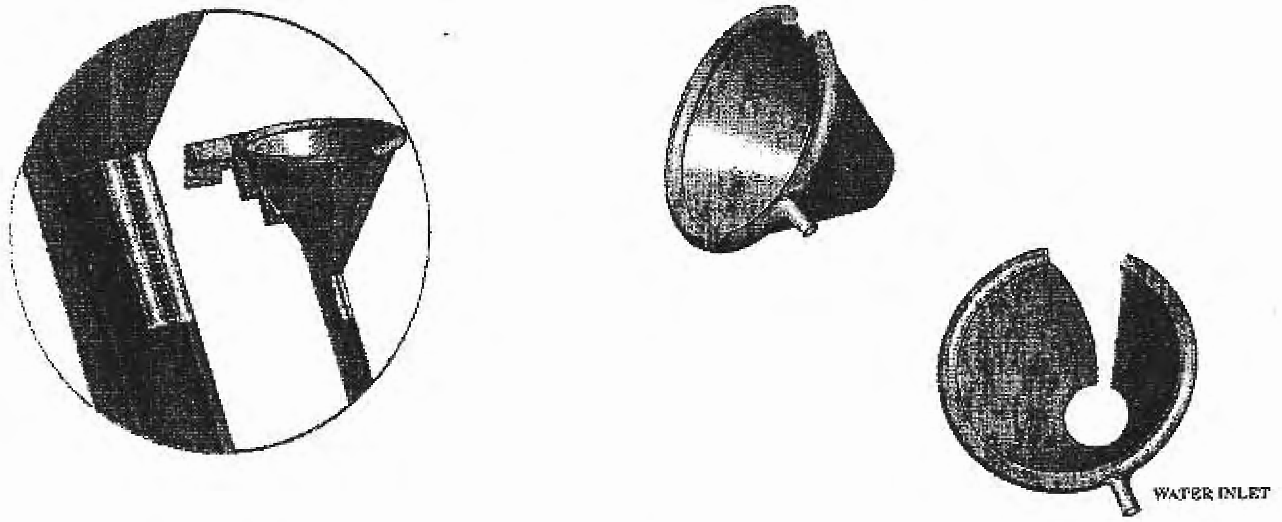


FIGURE 11. (LEFT) VIEW OF BRUSHES AT TOP OF CHUTE AND (RIGHT) DETAIL OF TROUGH.

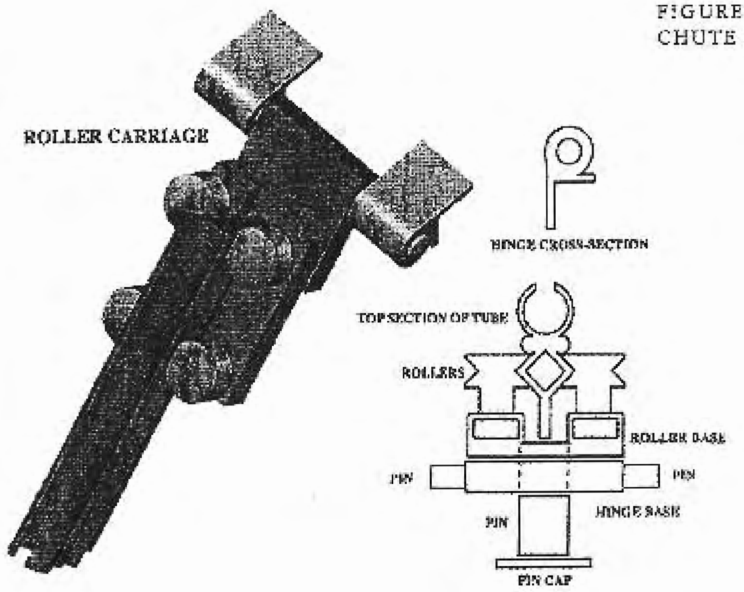


FIGURE 12. DETAIL OF ROLLER CARRIAGE SYSTEM FOR DEPLOYING AND RETRIEVING THE CHUTE.

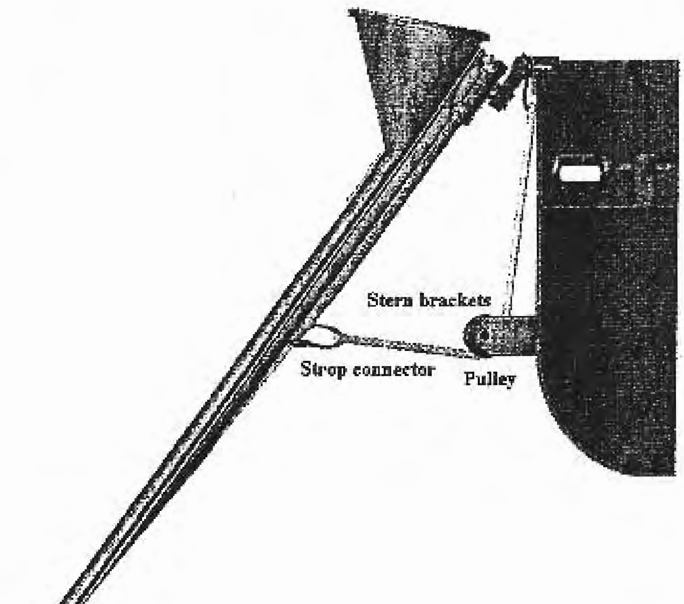


FIGURE 13. STROP ATTACHMENT USED TO CONTROL THE ANGLE OF THE CHUTE.

Design modifications

The skipper on the F.V. *Atu S* suggested the following modification to the chute.

1. Attachments at and below the waterline.
Nothing should be in the water at all except the chute, especially if the chute is operating along the vessel's centreline. Any attachments at the base of the transom or on the chute beneath or near the waterline increase the chances of foul-ups.

2. Streamlining
With the current design, force on the chute is created by drag through the water. This is exacerbated by its proximity to the prop wash. A potential way to minimise this would be to increase the streamlining of the leading edge of the chute.

3. Chute backbone
The square metal support which makes up the leading edge may need to be strengthened.

4. Position
The chute would have much less chance of foul-ups if placed on the port side of the vessel. This also minimises the chances of bait loss through the force of the propeller wash. In normal setting circumstances, baits are thrown off the port side. This is to minimise both foul-ups and bait loss. The F.V. *Atu S* has a three-person setting team (minimum) which allows for setting the chute up on the port side.

Conclusion

During the short period the chute operated, the device successfully deployed bait under the water. The device achieved its purpose and the design performed that function well. What remained to be done was implementation of a deployment method based around the port side and stronger simpler points of attachment. These points should not be construed as a major problem. The chute was very close to achieving its initial objective of a successful 4000 hook trial.

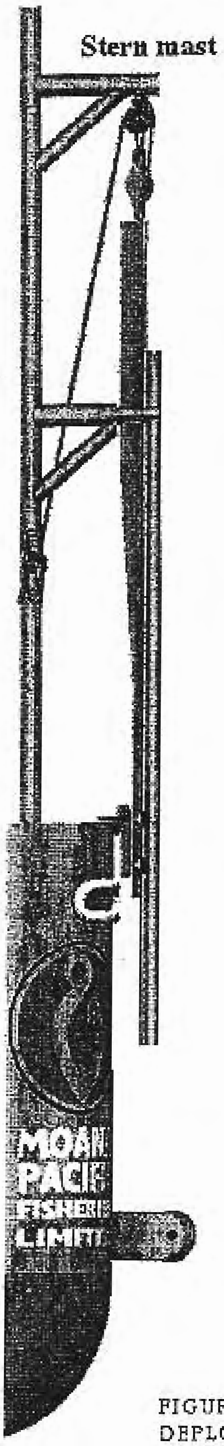


FIGURE 14. FIRST DEPLOYMENT AND RETRIEVAL SYSTEM USED ON F.V. *ATU S*.

3.4 TRIAL NO. 4 - F.V. *ATU S*

by D. O'Toole

On the previous trial, shackles and chain that coupled the device to the boat tangled with the mainline. To overcome these problems, the connection point was moved 1.5 m up the chute, so that it was well clear of the waterline. A rubber shock absorber system was incorporated into the connection to minimise direct and sudden impact on the device while maintaining it at an angle which enabled the bait delivery depth of 3 m to be met. This consisted of a size 4 Forsheda mooring compensator spliced on to 24 mm nylon rope. With these devices, one turn on the rope around the compensator gives 200 mm of stretch, two turns give 335 mm of stretch, and three turns (as shown in Figure 15) give 470 mm. Tension of 1100 ft lb was required to achieve full stretch with three turns.

Methods

One double sheave and one single sheave block were used for recovery and deployment of a 9.5 m device (see Figure 16). The lifting jib was mounted on top of the stern cabins. It was positioned to be as in-line as possible with the streaming position of the setting tube. This allowed the chute to be drawn up to a point beyond the balance point of the tube on the roller carriage/hinge assembly. Once the tube had been drawn up past the section that located the chute in the rollers, it could be lifted clear of them. The quick-release clip attaching the shock connector to the chute was released during recovery and connected during deployment. The trough clipped on and off during these procedures.

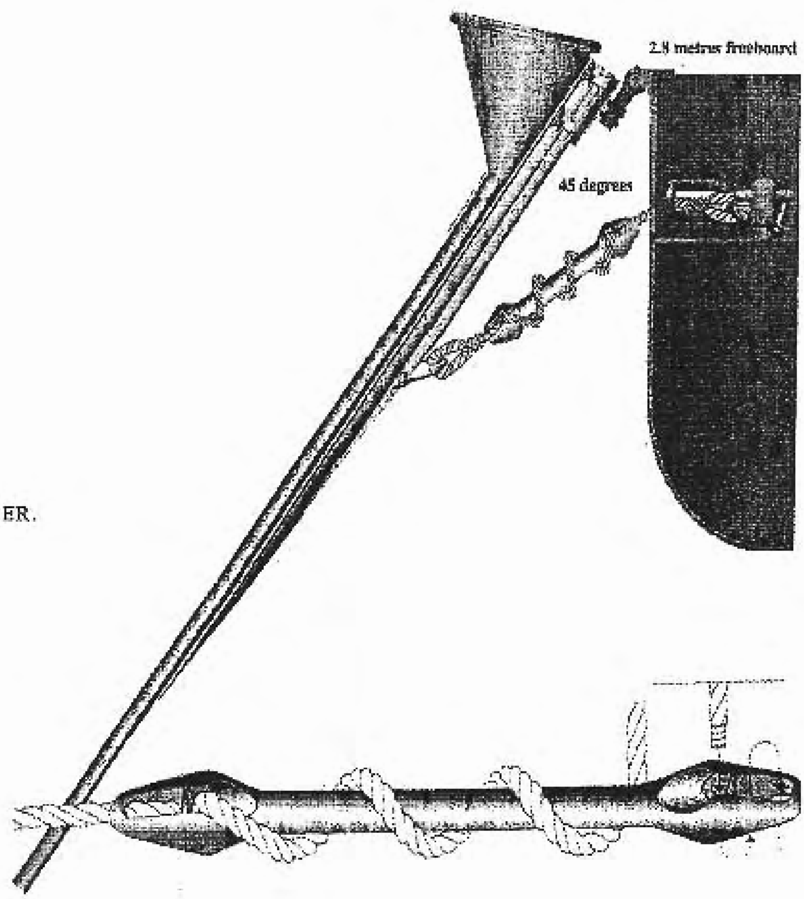


FIGURE 15. VIEW OF THE SHOCK ABSORBER.

FIGURE 16. SECOND METHOD OF DEPLOYMENT AND RECOVERY OF THE CHUTE TRIALED ON F.V. *ATU S*.

The chute was labelled along its length at 0.5 metre intervals, from 3 m above the end of the chute, where the bait exits, to 6 m along its length. From observing which of these labels was at the water line at any given moment, it was possible to determine how deep the chute was delivering the bait. For example, if the first label, at 3 m, was at the water line, it meant that a bait leaving the chute at that moment would be 1.4 m under the water. These depths and related labels on the chute are shown in Table 9.

TABLE 9. BAIT DELIVERY DEPTHS OF CHUTE RELATED TO LABELS ON IT.

Distance (m) from bottom of chute	Label on chute	Depth of bait delivery (m)
3	1	1.4
3.5	2	1.75
4	3	2.1
4.5	4	2.6
5	5	3.2
5.5	6	3.8
6	7	4.7

TABLE 10. LOCATION OF TRIALS, THIRD TRIP F.V. *ATU S.*

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
34° 25' S 174° 09' E	34° 14' S 174° 54' E	34° 26' S 175° 15' E	35° 08' S 175° 69' E	Not recorded

The chute's setting depth was monitored three times in each setting operation. This was done by noting the label closest to the water at five second intervals for a period of five minutes. This gave fifteen minutes of monitoring during each set to determine where the most common setting depth was.

Results

The new system was tested five times, four times in an actual line setting operation and once while steaming. The trials were conducted off the north-east coast of New Zealand; their location is given in Table 10.

The conditions were mild for all four fishing sets, and the fifth trial during normal steaming. For all the shots the swell was never above 1 m and the wind always from 10 to 15 knots. The vessel speed was always between 8 and 9 knots.

The chute delivered 5270 baited hooks without entanglements during the four sets.

The elasticity of the Forsheda mooring compensator deteriorated over the four sets and this reduced the setting angle and depth of the chute. On the first set the bait exit point was consistently deeper than 3 metres, but by the fourth set the depth of the bait exit point had reduced to around 2 metres.

Discussion

The chute met the requirements for number of hooks delivered without the entanglement problems of previous trials. One or two light sticks caused minor entanglements, but this was soon rectified by placing the light stick further up the branch line so that it did not come into contact with the chute. The operators of the chute found it simple to use.

However, the chute did not meet its requirement for setting hooks at a depth of 3 m. Initially the setting depth was mainly in excess of 3 m, but by the fifth set more than half of the hooks were being set at a depth less than 3 m. This is most probably due to a stretching of the rubber strop used to govern the setting depth, as it was noticed by the third day that the chute was riding higher in the water because of this. Given the mild conditions in which testing was performed, the crew of the vessel and the observer believed that under strong conditions the rubber would have snapped.

Conclusion

A stronger and more reliable measure for governing the setting depth was required. The skipper suggested that a strong steel spring in place of the rubber would be more effective.

Addendum

Since this trial a new method for controlling the setting depth on the chute has been developed and trialed. This system involves a caged spring which is strong enough to withstand the considerable pressures placed upon it by the chute, while still maintaining the required setting depth (Figure 17). Observations over a ten day period during setting confirmed a constant setting depth in excess of three metres.

The spring shock absorber is connected to the chute by a double hook that fits either side of the keel of the chute and over a 20 mm pin which is fitted permanently through the keel section (Figure 18). The weight of the spring and chain and the size of the RHS (square hollow steel tube) that the keel is welded to prevents the hook disengaging while the chute is deployed.

The double hook is designed to be able to pass completely through the roller carriage, and is connected and disconnected with a steel gaff while above it.

This hook can only be connected or disconnected when the chute is in the half deployed or half recovered position. All connection and disconnection operations are done safely without the operator having to lean over the side or the stern.

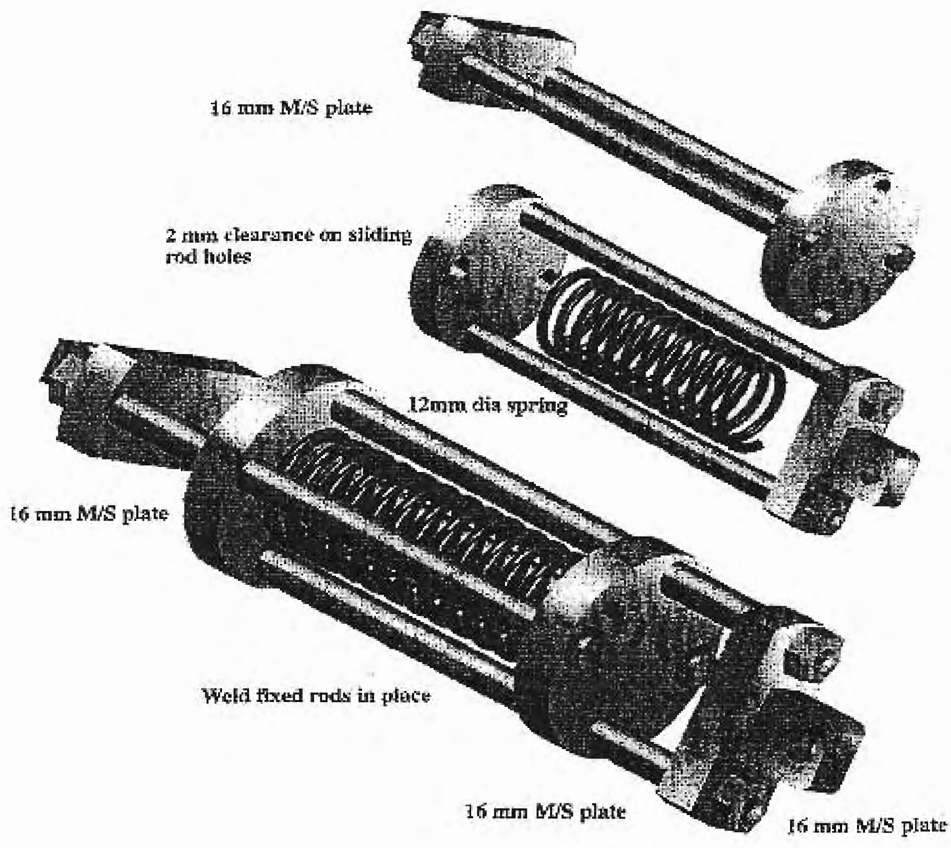


FIGURE 17. IMPROVED SHOCK ABSORBER USING A STEEL SPRING.

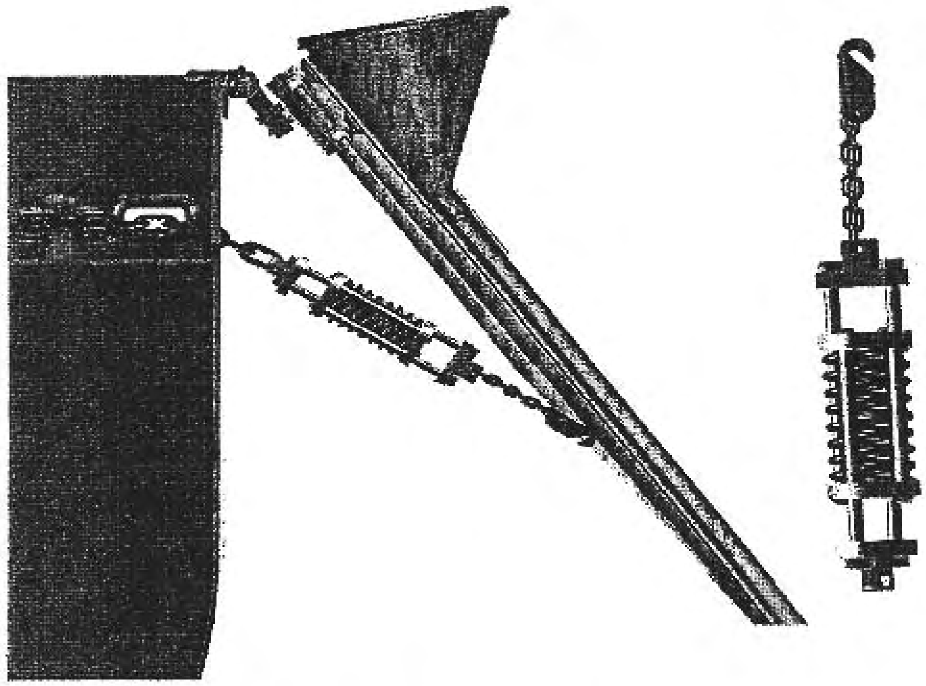


FIGURE 18. SPRING SHOCK ABSORBER CONNECTED TO THE CHUTE.

3.5 BAIT SETTING TIMES

by K. Walshe

An important operating standard for the chute is speed with which baits can be fed into it. New Zealand vessels set one baited hook between every 7 and 9 seconds. A number of timing experiments were carried out on the various models, and the results are summarised in Table 11.

TABLE 11. RUN TIMES FOR VARIOUS TYPES OF BAIT AND VARIOUS TUBE LENGTHS.

LENGTH OF TUBE	VESSEL SPEED (KNOTS)	BAIT	NUMBER OF TRIALS	MEAN (SD) OF RUN TIMES (SECONDS)
6	6.5-7.5	sanmar (50 g)	23	4.49 (0.57)
6	6.5-7.5	squid (20-30 count)	54	3.93 (0.53)
6	6.5-7.5	squid (40-60 count)	56	4.08 (0.44)
6	6.5-7.5	sanmar (50 g)	49	3.40 (0.27)
6	6.5-7.5	squid (20-30 count)	46	3.16 (0.39)
7	6.5-7.5	sanmar (50 g)	50	3.52 (0.97)
7	6.5-7.5	squid (20-30 count)	50	3.35 (0.42)
9	6.5-7.5	sanmar (50 g)	7	4.01 (0.28)
9	6.5-7.5	squid (20-30 count)	29	4.05 (0.67)

4. Conclusions from all commercial trials

4.1 CHUTE CONFIGURATIONS

The configurations on three commercial vessels reflected both the incremental design changes from the experience gained during the trial process and requirements of individual vessel layout, fishing practices and skipper/crew requirements. Although the basic design concept remained unchanged, each vessel had unique requirements. If the chute is used widely in the fishery it is likely that a range of options will be necessary to tailor it to each vessel's requirements.

Setting tube

The setting tube operated in a range of setting depths from three to seven metres. As the length of the tube increases, so do the weight and strengthening required. Figures 19 and 20 outline some of the modifications in tube design and material under consideration for the development of a 12 metre chute for a 50 metre tuna vessel. As the weight increases, other aspects of the chute (such as the carriage and deployment and retrieval system) will require strengthening as well.

On several trials problems occurred where the snood was pulled out of the setting tube before the baited hook had left the base of the tube. The use of brushes at the top of the tube has overcome this problem.

Cross-section

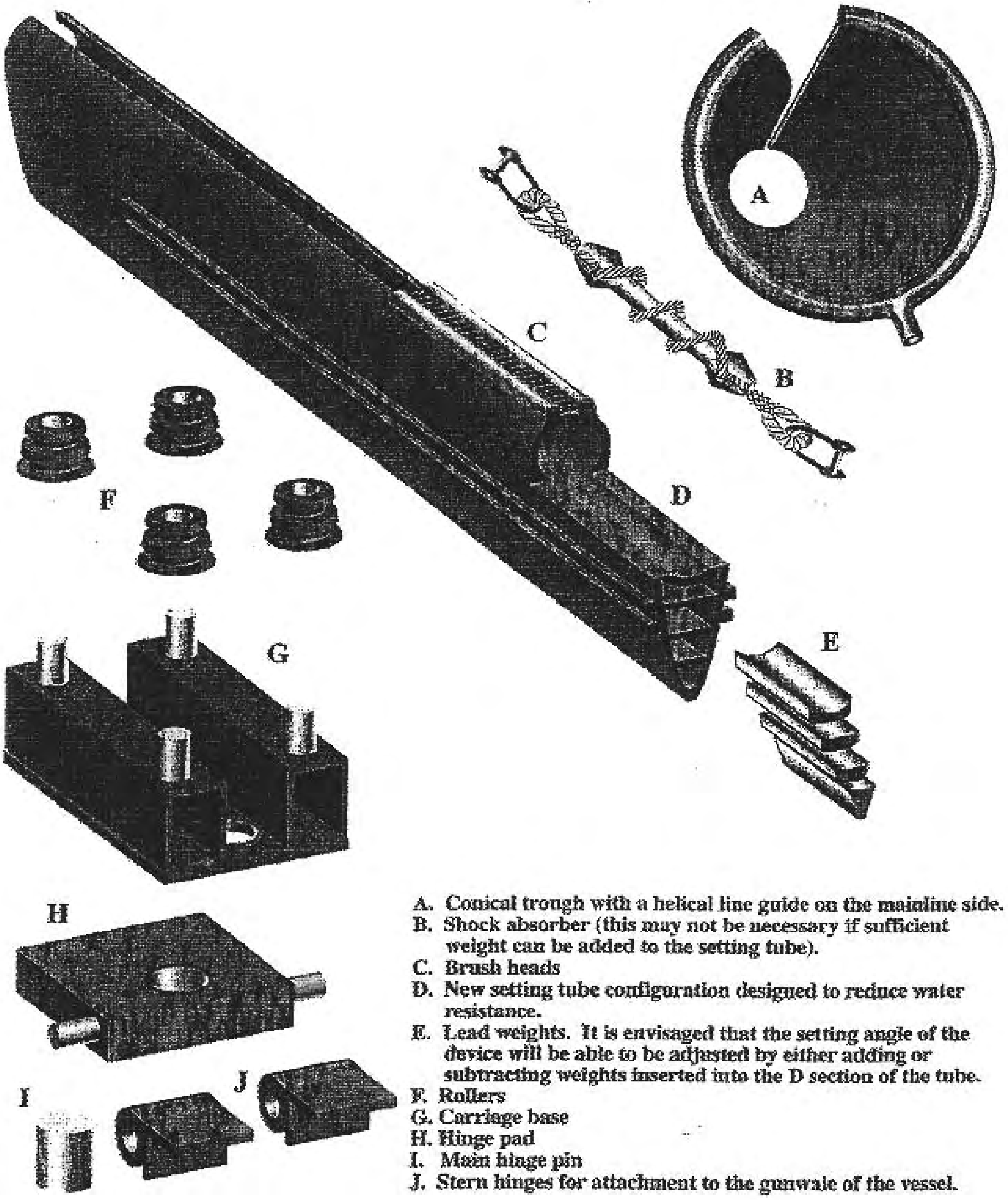
To reduce the tension on the connection between the vessel and chute, it may be advantageous to streamline the underwater cross-section of the chute. A 12.5 m 180 mm D section steel device has been tested behind the DOC vessel M.V. *Hauturu*. Because of the low freeboard on this vessel, the setting depth was in excess of 7 m. Despite the additional drag on the chute due to the excessive length of the setting tube, a setting angle of about 45 degrees was achieved. This has led to concerns that the 180 mm configuration may be too heavy.

It is proposed that the section be trimmed back to 120 mm as in Figure 20 and re-tested on the same vessel.

It may be economically viable to extrude the device from aluminium (Figure 20). A stainless steel liner could be used to protect the inside of the setting tube from the points of the hooks, and lead weights could be used to adjust the setting angle.

Bait trough

The major design requirement for the trough was to ensure adequate and even flushing of the water over the trough surface and the smooth passage of water to the mouth of the setting tube. The devices with multiple water outlets at the top of the trough provided adequate flushing.



A. Conical trough with a helical line guide on the mainline side.
B. Shock absorber (this may not be necessary if sufficient weight can be added to the setting tube).
C. Brush heads
D. New setting tube configuration designed to reduce water resistance.
E. Lead weights. It is envisaged that the setting angle of the device will be able to be adjusted by either adding or subtracting weights inserted into the D section of the tube.
F. Rollers
G. Carriage base
H. Hinge pad
I. Main hinge pin
J. Stern hinges for attachment to the gunwale of the vessel.

FIGURE 19. PROPOSED DESIGN OF A CHUTE, USING EXPERIENCE GAINED FROM SEA-GOING TRIALS.

Hinge assembly

The basic hinge assembly with the use of shock absorbers performed effectively in all trials.

Carriage system

Problems occurred in moving the tube into and out of the setting position during the trials with both F.V. *Daniel Solander* and F.V. *Brenda Kay*. An improved roller carriage design used on the F.V. *Atu S* second trial has overcome this problem. For the larger 50 metre vessels a hydraulic lift may be necessary because of the increased length and weight of the chute.

Setting angle devices

Paravanes

When paravanes were trialed in the open sea by tuna fishing vessels significant problems occurred. The commercial trials identified three drawbacks in using the paravanes.

1. The paravanes made setting the chute difficult in rough seas. Once the paravane was in the water it created a strong downward force, making retrieval of the device from the water a slow and arduous process. Setting tubes fitted with paravanes were also difficult to deploy and retrieve, particularly in adverse conditions.

2. Larger vessels with vastly greater propeller wash turbulence experienced problems with two of the paravane types, being unable to hold the minimum setting angle required. Although the Arrowhead paravane had the smallest surface area of any of those trialed, it was by far the most powerful and the only one that achieved a correct setting angle when trialed from the F.V. *Daniel Solander* in the Southern Ocean.

3. During the setting process, hooks and snoods were occasionally caught in the paravane, causing delays in the longline setting operation while the chute was retrieved and hooks/snoods removed. Potential causes considered for the problem ranged from operator error to a backwash phenomenon behind the vessel.

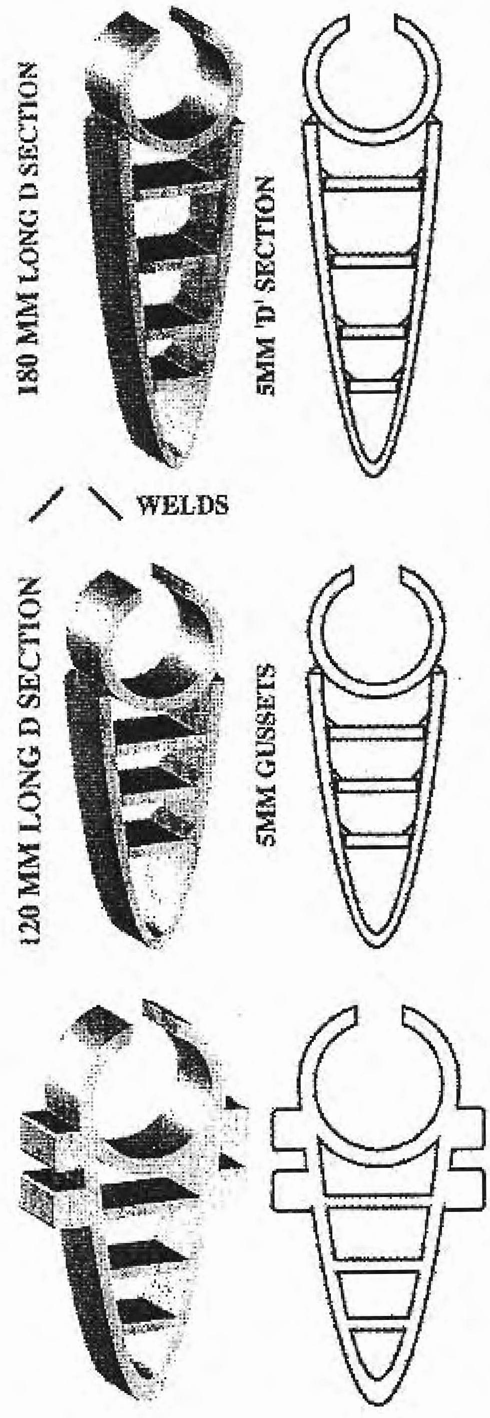


FIGURE 20. PROPOSED IMPROVED CROSS-SECTIONS TO THE CHUTE.

Shock absorbers

The shock absorber method of angle setting has successfully operated in rough seas over several trips on a 30 metre tuna vessel. The use of a Forsheda mooring compensator may be appropriate for smaller (10–15 metre) vessels, but larger vessels will require a spring shock absorber (see Figures 15 and 18).

Weighted tube

An alternative to the shock absorber method may be to add weight to the tube to set the angle of the setting tube. Weights could be added or subtracted to adjust for varying setting speeds and propeller wash conditions (see Figure 19E).

Recovery and deployment devices

The optimal angle for deploying and retrieving the chute is the angle of set when the device is fishing (40 to 50 degrees). Because of vessel configurations, none of the trials was able to deploy and retrieve at this angle. The vertical deployment and recovery device (as used on the first F.V. *Atu S* trial) was the least effective method and potentially the most hazardous if the chute (when vertical) had broken loose from the mounting in a rough sea.

The need for up to five crew to deploy and retrieve the chute (as occurred on the F.V. *Daniel Solander* trial) can be overcome by the use of a modified carriage system (see Figure 19) and a hydraulic retrieval and deployment device. For vessels up to 30 metres in length, a simple block and tackle pulley system would be sufficient to deploy and retrieve the chute.

Safety issues

The early commercial trials identified a number of safety issues related to the operation of the chute. Modifications made for the F.V. *Atu S* second trial ensured adequate safety of the crew during the deployment, retrieval and fishing stages. These modifications included removing the paravanes, reducing the friction of the setting tube on the carriage system, changes in the securing system for the device when not in use, and changing the deployment and recovery system so that crew did not have to lean out over the stern of the vessel.

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Seabird/fisheries interactions
Final report of advisory officer

CONSERVATION ADVISORY SCIENCE NOTES: 295 2000

Keith, C.

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Te Papa Atawhai

Seabird/fisheries interactions

Final report of advisory officer

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Abstract

In November 1998 participants of a tuna longline stakeholders meeting recommended that a technical officer be appointed to the domestic tuna fleet in order to meet with fishermen and provide assistance, advice and information on how to minimise seabird bycatch in the pelagic longline industry. This position initially commenced in March 1999, and continued until September 1999. During the course of the project, 41 fishers were successfully contacted, and productive conversations held. Tori lines were constructed for those vessels that required them. Five sea trips were undertaken during which time seabird observations were made, tori lines were tested and modified, and TDRs were deployed to study the sink rate patterns of the longline. An informal information folder was created to provide fishers with a basic reference guide to seabird bycatch mitigation.

1. Introduction

1.1 BACKGROUND TO THE FISHERY

The history of pelagic longlining in New Zealand is a relatively short one. Japanese longliners have been fishing in the area that is now the New Zealand Exclusive Economic Zone (EEZ) since the 1950s (Duckworth 1995), but it has only been in the last 10 years that there has been a significant increase in the number of domestic vessels fishing using this method.

The domestic fleet is made up of predominantly small vessels varying between 12 and 25 m in length. There are some 60-70 vessels based in ports all over the country, but generally these vessels are concentrated in ports on the east coast of the North Island from Gisborne up to Mangonui, and on the west coast of Auckland.

The pelagic longlining operation in the New Zealand domestic fleet is based on setting a single line ranging from 15 to 40 nautical miles (nm) in length. Most vessels set one line every 24 hours, though some will set 2-3 smaller lines in the same time period. Most fishers in the New Zealand domestic fleet try to set their lines at night, with general setting times dictated largely by the rest of the fleet. Because lines can be set as close as 2 nm apart, fishers must set in unison to avoid gear crosses due to strong tide or current. As a result, vessels fishing as a part of the main fleet will generally commence setting within an hour of each other, and will set parallel to a set of marks provided by the other vessels in the area. (Marks are positions given in latitude and longitude to describe where a given vessel will begin and end the setting of their longline.)

Setting of the longline takes 3-6 hours, dependent on vessel speed, longline length and the number of hooks set. Hooks are baited with either imported squid or a pilchard-like fish known by the fishers as Sanmar. Snoods may also have a luminous light-stick placed approximately 3m from the hook. (A snood is an 8-14 m length of 1.8-2.0 mm monofilament that is clipped to the backbone at one end and has the baited hook at the other.)

The longline is left to soak for 8-15 hours before it is hauled. Retrieval of the longline takes 5-10 hours dependent on the length of the line and the number of fish caught (the more fish there are the longer the line takes to haul due to the processing requirements of the fish).

The mainline, or backbone of the longline is made of a heavy gauge (3.0-4.0 mm) nylon monofilament. The backbone is suspended between plastic floats at intervals chosen by the vessel master. Between floats, 10-25 snoods are suspended from the backbone, according to preferred fishing depth. Depths targeted are generally between 40 and 200 m, dependent on target species.

Until recently the fishery was concentrated over the summer months, with a slow period over winter when many vessels switched to other fisheries, such as bottom longlining for bluenose or ling. However, as knowledge of tuna movement and behaviour through winter has improved, the fishery has become a year-round operation, with vessel masters and fishing companies becoming much more willing to move their vessels between ports and frequently travelling long distances in order to reach suitable fishing grounds. This has resulted in a fishery where water temperatures dictate a northward trend for the fleet over the winter months.

The domestic tuna fleet targets several species of tuna, but generally the target species will vary by season, water temperature, geographical area, and perceived market value.

The most commonly targeted species in the fishery are southern bluefin tuna, *Thunnus maccoyii*, and bigeye tuna, *Thunnus obesus*. During autumn and early winter months there is a concentration on southern bluefin tuna in more southerly latitudes, while bigeye tuna is caught year round, but moves north with the retreat of warmer water during winter. Lines set to catch one of these species of tuna will often catch the other species, and will often also catch yellowfin tuna, *Thunnus albacares*, northern bluefin tuna, *Thunnus thunnus*, and albacore tuna, *Thunnus alalunga*.

Other species commonly caught as bycatch include swordfish *Xiphias gladius*, moonfish *Lampris guttatus*, oilfish *Ruvettus pretiosis*, and rudderfish *Centralophis niger*. Although swordfish are not directly targeted, as there is a prohibition on the targeting of swordfish by longliners, these fish can make up a substantial proportion of the catch.

1.2 SEABIRD/FISHERY INTERACTIONS IN THE DOMESTIC PELAGIC LONGLINE FLEET

Demersal and pelagic longline fisheries overlap with the foraging zones of a number of seabird species. Seabirds have learnt that fishing boats provide a consistent and predictable supply of food in the form of squid or fish used to bait hooks, discarded offal from processed fish, used bait returned on the haul, and unwanted bycatch fish species.

The consistent supply of food means that fishing vessels are seldom without the company of seabirds during the fishing operation. Brothers (1991) reports an average of 10.8 albatrosses closely following Japanese longliners during setting off Tasmania, and Duckworth (1995) comments that there can be hundreds of smaller birds such as petrels and shearwaters following vessels in the New Zealand domestic fleet.

Seabirds can potentially become hooked or entangled in the longline during setting; the baited hook can be swallowed by the larger seabirds, such as albatrosses, while smaller seabirds tend to be caught by either becoming foul-hooked or entangled in the line.

While all seabirds are predominantly visual feeders, some species are better adapted to foraging behind fishing vessels than others. Larger seabirds such as albatross generally only conduct food searches from the air or at the surface, so only scraps or baits seen from above the water are likely to be taken, but many of the smaller seabirds search for scraps by swimming on the surface with heads dipped under the water. If a bait or scrap is located, then some of these seabirds are capable of diving very deep to retrieve them. Some smaller species of petrel, such as the sooty shearwater *Puffinus griseus*, have been recorded diving to a maximum depth of 67 metres while foraging for food, though more commonly these seabirds dive to maximum depths between 16 and 40 m (Weimerskirch & Sagar 1996).

Because they are much more proficient at retrieving baits than the larger albatrosses, smaller seabirds may bring the baits that would otherwise be unavailable to the larger species back to the surface. Often when the bait has been retrieved, the larger, more aggressive species, such as black-browed mollymawks and wandering albatross, will chase the smaller species away, and eat the scrap or bait themselves (Brothers 1991).

1.3 BACKGROUND TO THE TECHNICAL OFFICER POSITION

In a stakeholders meeting in November 1998 it was suggested that a technical officer be appointed to the domestic tuna fleet in order to meet with fishermen and provide assistance, advice and information on how to minimise seabird bycatch. It was agreed that the appointee would visit each port used by the northern tuna longline fleet and visit with the skippers on each vessel, providing advice on ways to improve the effectiveness of any seabird streamer (tori) lines in use. Where no tori line existed, the advisory officer would assist in the design and construction of one for that vessel.

The person would also discuss other ways to prevent seabirds from accessing baited hooks during the setting and hauling of the line, explain why the capture of seabirds was a concern, and provide the vessel with other information relevant to the fishery. Fishing trips would be undertaken on some vessels, if required, in order to provide the best vessel-specific advice on seabird bycatch mitigation.

It was hoped that the position would also provide a means of collecting feedback and gaining information from vessel masters and other fishers by listening to their opinions and experience on how to prevent or reduce the problem of seabird bycatch.

1.4 OBJECTIVES FOR PROJECT

The key objectives for the project were based around a liaison/education role within the tuna longline fleet. Key tasks for the project included:

- Meeting with the skippers of as many vessels in the North Island tuna longline fleet as possible.
- Providing vessel-specific advice on how best to address the problem of seabird bycatch.
- Explaining to the skippers why seabird conservation issues are of concern, from both a conservation and fisheries perspective.

Further to these key objectives were the aims of developing good working relationships with as many skippers in the fleet as possible and obtaining a high degree of knowledge of the tuna fishery in order to relate better to the fishers, and to provide the best possible advice.

2. Results

During the course of the contract, 41 vessels in ten ports were visited, and constructive conversations were had with the fishers on most of those vessels. Nine other vessels were approached on one or more occasion, but were unoccupied, unwilling, or unavailable to talk.

The majority of fishers were either approached at the vessel berth, met through other fishers or company representatives, or contacted the advisory officer directly themselves. Fishers were given a brief summary of what the project was about and what the project was trying to achieve. Although conversations were free-flowing and often covered a broad range of topics, a key range of questions was covered in any given meeting. These essentially covered the length of time the skipper had been longline fishing, whether or not the vessel held and employed a tori line during the normal fishing operation, and general fishing strategy (set times, haul times, regions most commonly fished). This information was used to gain a better understanding of the fishery as a whole. Other means of seabird bycatch mitigation that the skipper used or had previously used were recorded, as were any opinions or observations that the fishers had made on the behavioural patterns or species presence of seabirds that were commonly encountered. A Vessel Questionnaire form was used to ensure a degree of consistency for the more salient topics that were covered.

In conversations, the development of the fishery itself was often discussed, as were fishers opinions on subjects such as the Conservation Services Levy (CSL) and the respective roles of the Department of Conversation and the Ministry of Fisheries in the tuna longline industry. Concerns raised by fishers on various issues related to these roles (departmental research priorities, quota and compliance issues, and the growth of the industry without appropriate control mechanisms) were discussed, and referred to more appropriate sources for information if it was required.

The advisory officer was also contacted several times regarding the identification of unusual species of fish that were caught and brought back to port. These were sent to the Museum of New Zealand for identification. On one occasion, the advisory officer was given a tag recovered from a blue shark, and asked to send it to the appropriate place on behalf of the vessel.

2.1 FISHER RESPONSE TO THE PROJECT

There has been a range of responses to the advisory officer project and position, though generally, and for the large majority of fishers, response to the project has been very positive. Fishers were often pleased to receive information on seabirds, and showed a great deal of interest in being able to learn more about the species that they encountered every day. Some described the behaviour of some species in great detail, and were genuinely concerned with the public and political perceptions that surrounded their industry. Many pointed to the historical and superstitious relationship between people in the maritime professions and albatrosses as a reason to be concerned with preventing seabird bycatch.

Many fishers conveyed that, although they considered that there was no "seabird problem", they appreciated the provision of a personal approach by the department in the form of an advisory officer. The idea of having a single, approachable and available person who has a working knowledge of the industry and the people involved was well received. Skippers often commented that it was good to be able to talk directly with a representative from the department, rather than receiving correspondence from an anonymous representative somewhere inside the department.

As an extension of this, it was felt that the position of advisory officer has provided fishers with someone whom they can approach to talk about their concerns. This is extremely important to many fishers, who can give their opinions as individuals without having to feel they represent the whole tuna longline fleet.

Fishers who had taken the advisory officer on sea-trips found the information gained from time-depth recorders (TDRs) extremely valuable, as it provided them with knowledge of the behaviour of the longline over the course of a set. It also provided confirmation on depths fished by hooks in different positions of the longline, and how tide, weather, or gear configuration can affect the depths that the longline will fish. One fisher approached the advisory officer some months after the sea-trip and commented that since he was given the information provided by the TDRs, he had caught more southern bluefin tuna than ever before.

These fishers also greatly appreciated having someone from the Department of Conservation on board who could not only provide information on seabird-fishery interactions, but was knowledgeable about the fishery, and could also function as a part of a working crew. This meant that disruptions to the fishing operation were kept at a minimal level.

Fishers also commented that they appreciated having an advisory officer who was willing to go to sea on the small domestic vessels to observe and learn first-hand the level of seabird-fishery interaction. They also appreciated that the advisory officer was willing to listen to the fishers themselves rather than relying on very high (and possibly inaccurate or inapplicable for New Zealand) figures of seabird mortality used by some Non-Governmental Organisations (NGOs) and the media.

Those fishers who were opposed to the project largely objected because they believed that CSL money should be spent on projects that benefit them directly, and that the position of advisory officer provided them with no visible benefit. As an extension of this, a number of fishers objected to the levy as a whole on the basis that they believed that moneys gathered were being used to fund research in non-longline related issues, and that the levy was simply another method of "revenue gathering" for the government.

Some fishers stated that, although they felt that the advisory officer position was beneficial to the fishery and the relationship between the industry and the Department of Conservation, the likelihood of long-term change as a result of the project was not great. Reasons for this were largely based on the fact that the position of advisory officer was a temporary one, and that, once the project was finished, any impetus created by the person in the position would be lost. Any personal or professional relationship, or indeed, knowledge of the domestic tuna fleet, that is established over the course of a contract period between the advisory officer and tuna fishers would likewise be lost on completion of contract.

A small number of fishers felt that the advisory officer's position was only a token one, and that there would be little chance that, even if they gave them their suggestions, opinions or feedback to the department through the advisory officer would actually get through to anyone who "mattered". The end result would be that public and political perceptions of the fishers and the fishery as a whole would not be changed by the position.

2.2 PERCEPTION OF THE PROBLEM

By far the majority of fishers interviewed (98%) did not believe that they had a "seabird problem". When the number of birds caught in the past was asked for or volunteered, most of the fishers said that they had caught 5 or fewer seabirds in the past year, most of which were "muttonbirds", and many of which were caught on the haul and subsequently released alive.

Fisher perceptions were largely based around the belief that the domestic tuna longliners did not have a seabird bycatch problem as is perceived by the public and that this perception is a result of media and departmental speculation.

2.3 SKIPPER OPINION ON FACTORS INFLUENCING SEABIRD CAPTURE

Fishers often offered their opinion on what the major causes of seabird capture were. These can mostly be grouped into generalised categories. These categories are listed by the number of times that each issue was expressed. Percentages indicate the number of mentions, unprompted, by fishers, but these figures may not necessarily accurately reflect the attitudes of all longline fishers. Those categories without percentages given were mentioned less often, but still frequently enough to be included here.

1. Most seabird bycatch problems are associated with setting lines during the day. Most fishers believed that, because they set their lines at night when there are fewer birds present, they had no problem with the bycatch of seabirds, though many did concede that there were more birds active at certain times of the month and in certain conditions. (92%)

2. Other domestic fisheries kill more seabirds than domestic tuna longliners, but are not levied to pay for any related research. Many tuna fishers had experience in other fisheries where they had encountered what they perceived as a much higher rate of seabird capture. Fisheries that were pointed out as having high seabird capture rates (in order of mention) were snapper longliners, other bottom line fisheries, and factory trawlers. (61%)

3. Foreign licensed or joint venture longline vessels catch more seabirds than domestic longline vessels. (56%)

4. The area being fished can affect the rate of seabird catch. In particular, areas mentioned were East Cape, and the fishery on the south-western coast of the South Island.

5. Most seabirds are caught around the full moon when seabird activity is higher.

Many of the factors that are expressed here are the same as or similar to those noted in Nelson (1998) and Duckworth (1998), which would indicate that there have been very few changes in the overall perception of the problem of seabird bycatch in the past few years. Three of the factors identified here (daylight setting, geographical area, and moon phase) have been previously recognised by researchers, but the fact that there has been little movement to improve the situation, or further research on reducing the impacts of these factors, is indicative of the stasis that is surrounding the matter of seabird bycatch.

2.4 MITIGATION MEASURES SUGGESTED BY FISHERS IN THE DOMESTIC TUNA FLEET

Although there has been little change in overall perceptions of the problem, many fishers had given the situation some thought, and gave suggestions on how they had previously prevented or reduced seabird bycatch on their vessels. Some suggestions were not likely to be effective as mitigation measures, but other ideas were often well thought out and were likely to help reduce seabird bycatch. Many of the fishers had employed these methods, not because of seabird bycatch issues, but because seabirds were thought to be removing a significant number of baits from hooks, thereby reducing the efficiency of the fishing operation. The ideas are listed below with an explanation or comment on their effectiveness.

1. Night setting. This was by far the most common mitigation measure used by the domestic tuna fleet. Night setting has been shown to significantly reduce capture of seabirds (Duckworth 1995) although its effectiveness around the full moon period is reduced (FAO 1999).

2. Bait thawing. Thawed baits sink faster than frozen baits (Brothers et al. 1995), meaning that the baited hook is available to seabirds for a shorter time.

3. Reduction of deck lighting during setting. This measure reduces the amount of light on the water thereby making it more difficult for seabirds to see baits that would otherwise be hidden by darkness.

4. Dropping baited hooks into the wash of the vessel. Essentially the idea is that a baited hook dropped into the down-cycle of the propeller wash will be rapidly pulled down to a depth that will be safe from foraging seabirds. There is some evidence to suggest a "sweet-spot" in the propeller wash of longline vessels (Okazaki 1998), but information gathered from TDRs on domestic tuna longliners during this project suggests that, while baited hooks may initially sink very rapidly in the propeller wash, they will almost always be caught in the turbulence created by the wash, and very quickly be spun back up to within 1-2 m of the surface. Baited hooks have been recorded at these very shallow depths more than 60 seconds after leaving the vessel. Results of these trials will be described in a separate report (Keith in prep (a)). This method is not recommended as a means of reducing seabird bycatch.

5. Line guides. These work on the opposite principle of the previous method. Essentially a length of monofilament is run from the stern quarter, then the baited hooks are cast over this line, which holds the hooks outside of the propeller wash, ensuring they are not caught in turbulence. Although there have been no tests done on the effectiveness of

this method, it is likely to have a positive effect on the sink rate of baited hooks.

6. The stern quarter water spray. This idea has been trialed by a number of skippers in an attempt to prevent seabird capture during the hauling of the longline. A deck-hose is set up to spray water out from the stern quarter on the side of the vessel on which the gear is being hauled. The most common approach used by seabirds during the haul of the vessel is generally from the stern quarter (pers. obs.), so a strong spray of water may discourage seabirds from pursuing baited hooks that trail at the side of the vessel during the haul.

2.5 TORI LINES CONSTRUCTED FOR THE PROJECT

A high proportion of fishers visited during the course of the project were not interested in the tori lines being offered by the department. Reasons for this included the belief that, because they set at night, there was no need for a tori line, or the fact that they already had a tori line on board.

Many had used tori lines in the past, but had experienced difficulties in the use of them. The risk of entanglement in fishing gear was often given as a major reason for discontinuing their use in the past, or hesitance in employing one now. Tori lines were also refused because fishers had found that those they had used previously were too complicated to use easily as a part of the normal fishing operation, particularly on retrieval. A small proportion of fishers believed that tori lines simply did not work, and that there were other more effective ways of preventing seabird bycatch (predominantly night setting).

Most were aware that tori lines were compulsory, but not all were aware that the use of tori lines was compulsory for every set, instead thinking that it was compulsory only to carry a tori line on the vessel.

As a result, tori lines were made up for only 6 vessels during the project, with additional requests for 2 lines received at the end of the project. Some vessels had their own tori lines that appeared to be acceptable, or would be with a few minor or moderate changes. The appropriate suggestions were made to the skippers of these vessels.

It is hoped that with the continued relationship between an advisory officer and the domestic tuna fishers, a greater awareness of the legal requirements for the use of tori lines will be promoted. In addition, the introduction of tori lines that are increasingly easy to use and safe from the potential for entanglement should reduce the opposition that many fishers hold against using tori lines. From this point, education will be the key to promoting a more widespread use of tori lines.

Tori line design

The tori lines constructed for each vessel differed according to the requirements of the skipper, or the limitations of the individual vessel, such as the availability of a superstructure that provides a suitable attachment point for the line. Despite these differences, the make-up of the tori lines remained relatively consistent between vessels. The design used was based on a tori line developed in Keith (1999), though with the benefit of on-vessel trials, it was possible to further refine and develop the design.

A description of key issues in the development, design and construction of tori lines is given in Keith (1999):

In designing a tori line there are some basic conditions that [have] 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. The tori line must also be simple to construct and repair.... An extension of this concept is that the construction materials need to be readily available to the fisher. Streamers 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 of the tori line that provides the bird scaring effect over the longline. Any attachment point lower than this restricts 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 the tori line directly above where the baited hooks enter the water.

Construction materials

A number of different tori line designs were constructed and tested over the course of the project. The greatest difference in construction materials was the use of alternative backbone material. Tori lines were constructed and trialed using 4.0 mm orange twine, 4.0 mm nylon green danline, and white 3.5mm monofilament. Red monofilament was trialed for visibility in low light conditions, but was not as visible as white. Final tori line designs were constructed using white 3.5 mm nylon monofilament, predominantly as this appeared to be the most visible material in low light conditions. Also a monofilament backbone reduces the chances of becoming caught or entangled with a stray hook or float. Lastly, replacement or repair of tori lines constructed using a monofilament backbone can be done using materials that are largely already on the vessel.

The lines were constructed to be between 150 and 220 m in length, dependent on the requirements of the vessel, and, as previously stated, were coloured white for better visibility in low light conditions. (If the skipper did not approve of other methods as a means of increasing drag to create a longer aerial section, a longer line was provided, as increasing the length of the line in the water provides a greater degree of drag.) Between 8 and 12 streamers of varying length were attached to the backbone at 5 m intervals. Streamers were constructed using lengths of 3 mm luminous rubber tubing with a small (30 cm) section of 2.02 mm monofilament crimped inside the trailing end of each streamer to increase rigidity and reduce the chance of them wrapping around or tangling with fishing gear. Each tori line used 12-30 rubber washers to improve drag while providing little opportunity for tangling with a hook.

Each tori line was provided to vessels pre-wound on to a plastic hose reel for easy deployment, retrieval and storage. Including the hose reel, the cost of a constructing a tori line using new materials was approximately $110; a more detailed breakdown of costs is provided in Appendix 1. More details on the design and at-sea testing of tori lines developed during this project are provided in a further paper (Keith, in prep (b)).

3. The tuna fishers folder

Because not all the necessary information can always be passed on effectively in the course of one of two meetings, a folder was prepared for distribution amongst the domestic tuna fleet. The folder includes a wide range of subject matter on issues and subjects that affect the domestic tuna fleet and perhaps provides a more full description of the advisory officer's role in that fleet.

Information covered in the folder included a basic identification guide for the most common seabirds that are likely to be seen around fishing vessels in the domestic tuna fleet, the research that the department is doing in the area of seabird bycatch mitigation, and suggestions and instructions for tori line construction and regulations. Some information on the fishery itself was included, as was a basic description of the use of archival tags on longline gear as a method of understanding its behaviour over the course of a set.

The response to the folder to date has been extremely positive, with fishers finding it informative and useful. The seabird identification sections have been found useful for those fishers interested in improving their knowledge of seabirds that are often encountered.

4. Sea trips

During the course of the contract, five sea trips were undertaken on four small domestic tuna vessels. Trips averaged six days in length and included the setting and retrieval of, on average, four longlines. Several primary reasons existed for these sea trips:

1. To gain a comprehensive understanding of the operation of a small domestic longliner in the North Island tuna fleet.

2. To gain a better knowledge of seabird/fisheries interactions in this fishery, and to develop a better understanding of what the potential is for seabird capture in different situations.

3. To provide, manufacture, prepare and test tori lines for the vessel. If the vessel already had a tori line, advice was given on how it could be improved.

4. To provide the fishers with a description of the depth of their longlines over the course of the whole soak period, and to gain information for the Department of Conservation on the sink rate of baited hooks using information gathered from timed-depth recorders (TDRs) attached to snoods.

In order to understand the fishery more completely, one trip was taken in every main region fished by the North Island tuna fleet. Fishing trips were carried out from the western coast of Auckland up to Cape Reinga, with two trips corresponding to the same latitudes on the eastern coast, one based from Auckland, one from Tauranga. In the more southerly latitudes on the east coast, one trip was spent fishing between East Cape and Gisborne, and another was undertaken in the Bay of Plenty.

Twenty sets were observed in full or in part, with five sets containing a part or full daylight component. It should be noted that this is not a normal proportion of sets done during daylight hours. The skippers of these vessels were kind enough to shoot their gear during daylight hours so that the advisory officer could make observations on seabird behaviour, abundance, and seabird interaction with the fishing vessel and the tori line.

These observations are discussed more fully in a further paper (Keith, in prep (c)).

5. Timed-depth recorder results

Initial TDR results indicate that there is wide variation in the sink rate of baited hooks, but that these variations are relatively consistent between vessels. According to data collected from TDRs, a baited hook may sink at a rate that results in the hook reaching a depth of 5 m by the end of the aerial section of the tori line. This translates to approximately 50 m, or 15 seconds after the baited hook is thrown clear of the vessel. In other situations, such as if the bait is not cast clear of the vessel wake, the bait may be as shallow as 1 m at a distance of 200 m, or approximately 1 minute after the snood has been thrown clear of the vessel.

Preliminary results, however, show that a typical baited hook (on a 14 m snood using 2.02 mm nylon monofilament and a 17/0 Eagle claw hook baited with approximately 150 g squid) attached to a backbone being spooled directly off the longline reel (no line shooter) will sink at a rate of 0.092 m/s (n=22), which puts the baited hook at a depth of approximately 1.4 m by the end of the aerial section of the tori line (50 m). Aerial section of tori lines varies from vessel; if the minimum height of attachment as set in legislation is adhered to (4.5 m), an aerial section of around 35 m is achieved. This figure is markedly increased on vessels with the scope for higher attachment of the tori line. Again, it needs to be stressed that there is a very high degree of variation in these results, as a direct result of a large number of factors. Much of this variation can be attributed to such factors as weather effect, and particularly crew performance while casting the baits outside the vessel wake. Sometimes a mistimed casting of the snood can result in the baited hook being dragged back into the propeller wash. These factors and the general variation expressed in these results are discussed more in depth in Keith (in prep (a)).

6. Discussion

The advisory officer project has provided a good base for a better understanding and better relationship between the domestic tuna longline fleet and the Department of Conservation. Longline fishers have long felt that they were being unfairly targeted by the department with the CSL, without contributing much to the problem itself. Of particular concern are a small number of fishers who state (whether in jest or otherwise) that the amount paid in conservation levies not only justifies the capture of seabirds, but in some situations may promote it.

It needs to be stated that this opinion represents a very small minority of fishers in the industry, and that the great majority of fishers are concerned with accidental seabird capture and take at least some steps to avoid it. Certainly, from observations made and discussions held during the course of this project, it does not appear that there is any single vessel among the domestic fleet that could be considered as a "problem" vessel. It is true, however, that there is a relatively consistent low level of seabird capture within and between domestic vessels, which means that seabird bycatch is still an issue for the fleet as a whole.

Fishers mostly accept this explanation, but still feel that they pay too much for the number of seabirds that they personally catch. They also understand that other fisheries, such as the driftnet fishery, have closed because they could not find a satisfactory solution for their problem, and do not want the same to happen to their fishery.

A large factor in the success of this position is the development of trust through familiarity, which by definition cannot exist within the framework of an ephemeral or temporary position that is passed around from contractor to contractor. The development of trust means that a greater understanding of the industry can be gained on a personal level with fishers who might not otherwise be involved in negotiations or meetings with other parties, or with the department.

Often, during organised or more formal gatherings, fishers do not feel that they can express their opinions freely and without opening themselves to criticism or condemnation by their peers. They do not want to be seen as saying something that may be taken as anti-industry, or pro-department, or taking a stand that may be considered as representative of the industry as a whole.

7. Conclusions

The need for the development of a better relationship between fishers and the department has been highlighted several times in this report. As a function of this, there needs to be a degree of consistency in maintaining the relationships that have been developed as a part of this project. A good working relationship is the key to better understanding the needs of the industry when it comes to conservation issues, and this can only be developed if there is consistency and continuity with the people that are developing the relationships.

A very high proportion of fishers expressed a desire to have more feedback on research being done in relation to their CSL moneys. Fishers are genuinely interested in what is going on with issues related to their industry, and have a real desire to understand more of what is going on around them. It was expressed that perhaps an advisory officer was a good means of providing this feedback.

The position of advisory officer, seabird/fisheries interactions was essentially created to provide the domestic tuna longline fleet with someone who could act in an education/liaison capacity for the Department of Conservation. The position allowed the development of a good working relationship with a number of fishers in the fleet, and has provided others with an understanding of the issues that the department is trying to address. Overall response to the project from fishers has been very positive, and in order for the progress that was achieved in the project to be maintained, there needs to be continuity. This can be achieved by contact on a regular basis so that relationships and contacts that have been developed are maintained.

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Appendix 1. Cost approximation for tori line design

Materials	Units	Unit price	Total
3.5 mm monofilament	Approx. 150 m	$0.185/m	$27.75
Plassay garden hose reel	1	approx	$40.00
4.2 mm Sleeve w. 5/0 crane swivel	10	$0.50	$5.00
4.5 mm aluminium double sleeve	2	$0.18	$0.36
3.9 mm aluminium stopper	26	$0.16	$4.16
3.0 mm luminous rubber tubing	approx. 20 m	$1.08	$21.60
2.02 mm nylon monofilament	approx 3.0 m	$0.92	$2.76
20 mm rubber tap washers	12	$0.60	$7.20
Total ($NZ)			$108.83