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

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

This report was commissioned by the Science & Research Unit

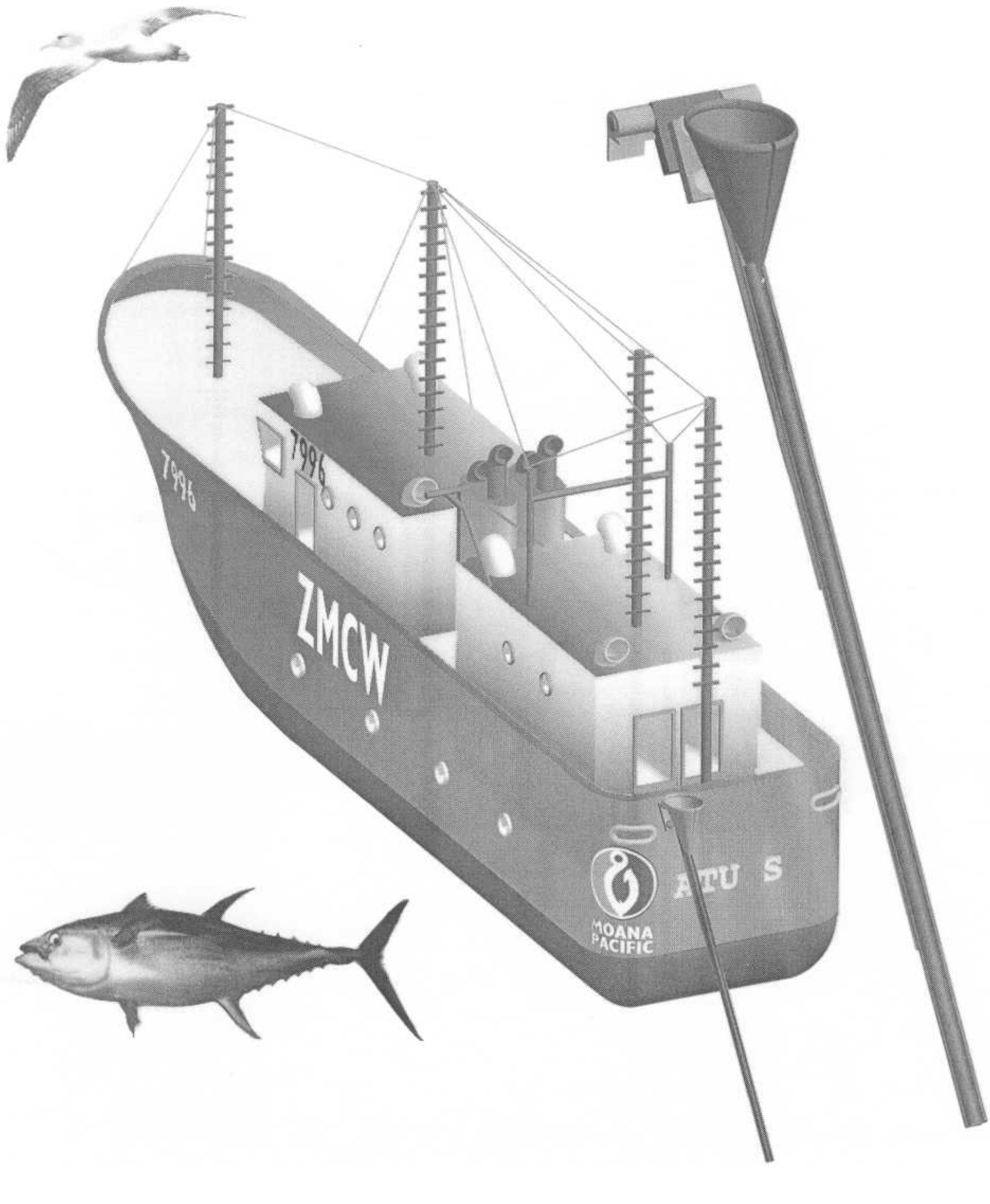
ISSN 1171-9834

Reference to material in this report should be cited thus:

Molloy, J., Walshe, K. and Barnes, P. (compilers) 1999.
Developmental stages of the underwater bait setting chute for the pelagic longline fishery. *Conservation Advisory Science Notes No. 246*, Department of Conservation, Wellington.

Keywords: pelagic longline fishery, bait placement, seabird bycatch, underwater bait setting chute.

CONTENTS



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

1. Introduction

by K. Walsbe 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.

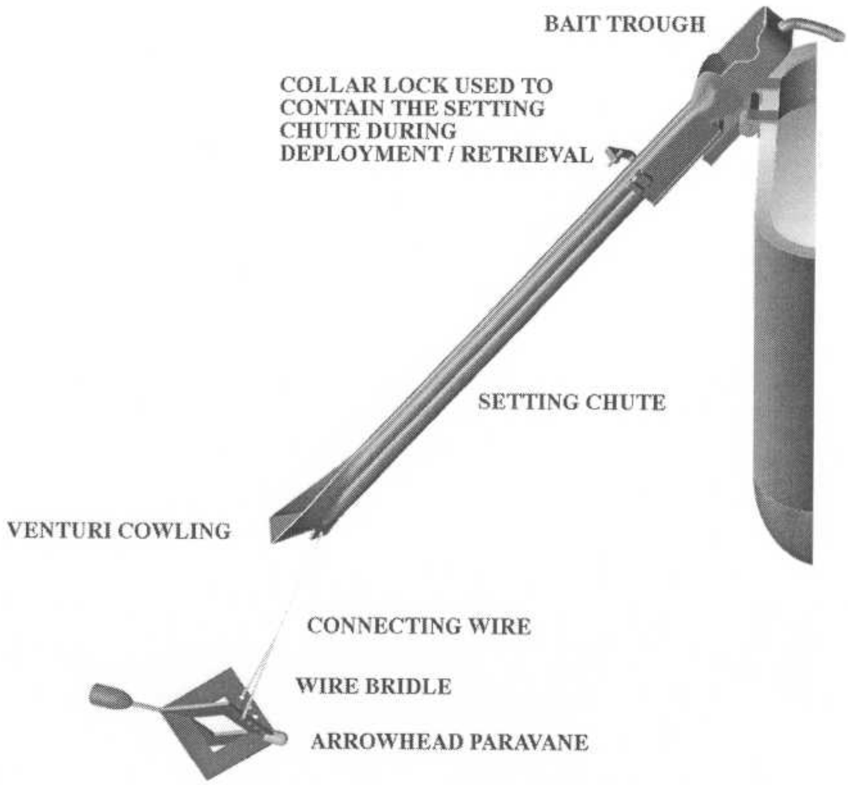


FIGURE 1. UNDERWATER BAIT SETTING CHUTE, SHOWING PARAVANE IN USE.

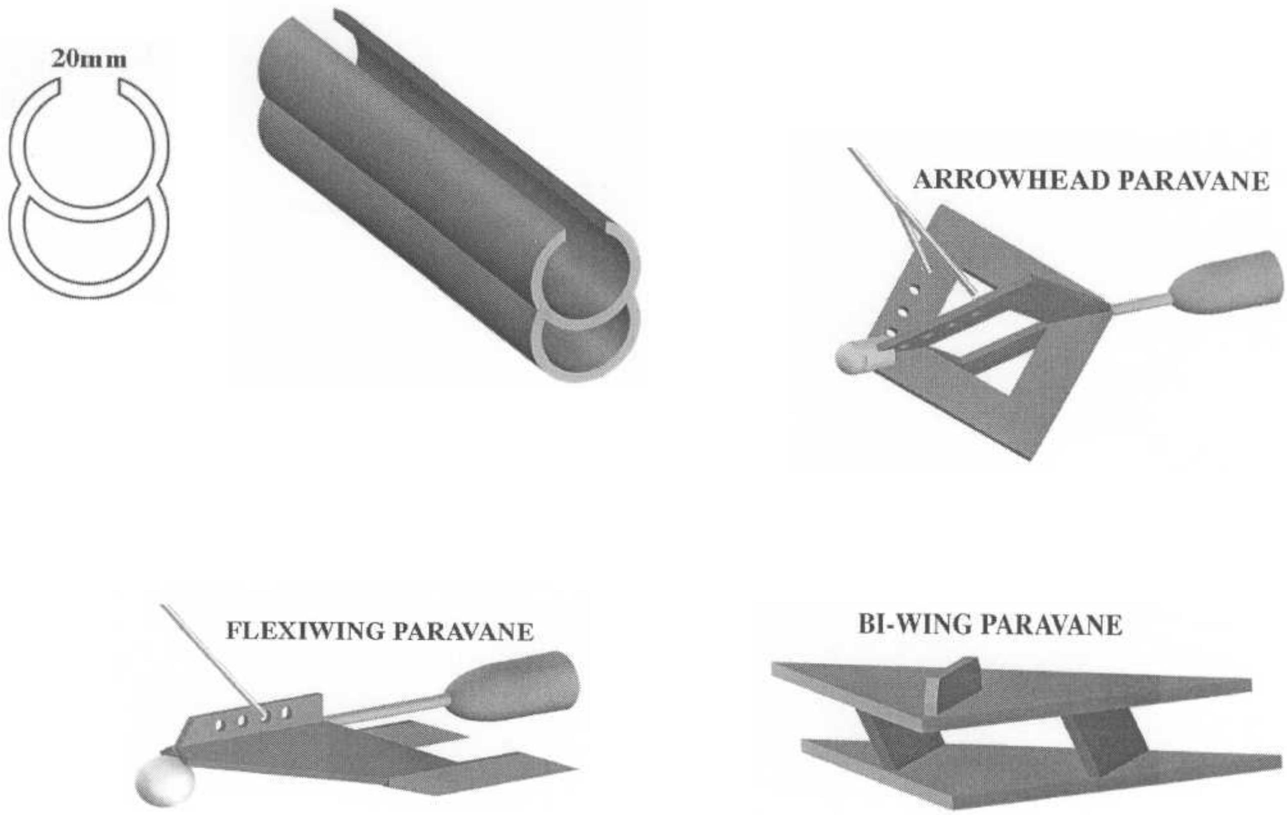


FIGURE 2. CROSS-SECTION OF SETTING TUBE TESTED ON THE FV DANIEL SOLANDER, AND PARAVANES USED: TOP RIGHT, ARROWHEAD ; BOTTOM LEFT, FLEXIWING; BOTTOM RIGHT, BI-WING.

FIGURE 3. HINGE ASSEMBLY FOR THE CHUTE.

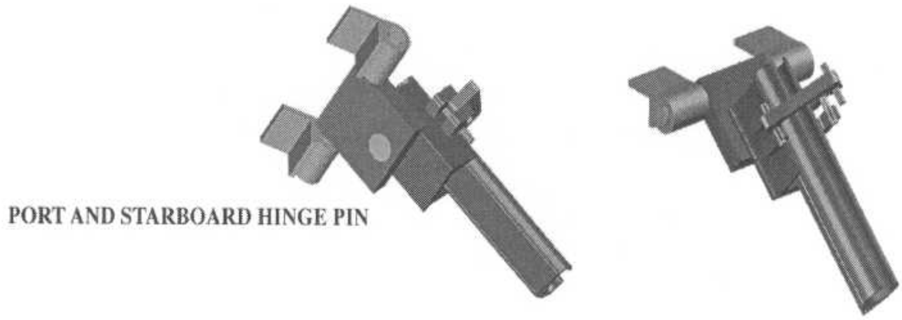
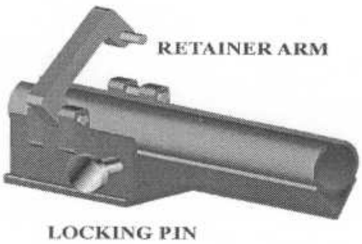


FIGURE 4. SPLIT COLLAR SYSTEM FOR SECURING THE CHUTE IN POSITION.



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.

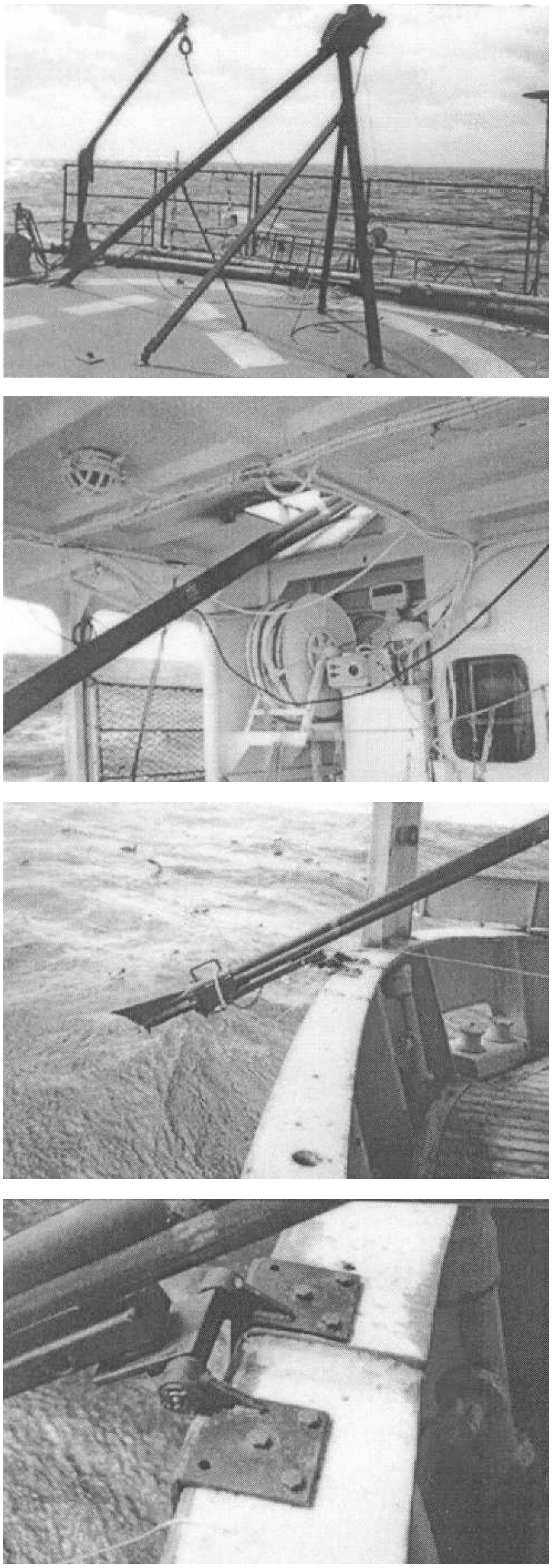


FIGURE 5. RETRIEVAL AND DEPLOYMENT SYSTEM FOR THE CHUTE: (FROM THE TOP) THE TRIPOD ON THE HELIDECK; THE ANGLE IRON GUIDE; THE CHUTE SECURED WHEN FULLY RETRIEVED; ATTACHMENT TO THE STERN.

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

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