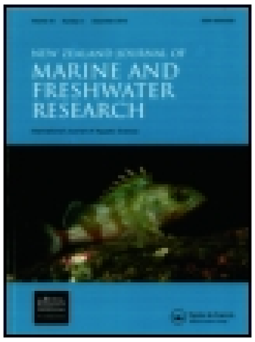

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New Zealand Journal of Marine and Freshwater Research

ISSN: 0028-8330 (Print) 1175-8805 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzm20

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To cite this article: Declan O'Toole & Janice Molloy (2000) Preliminary performance assessment of an underwater line setting device for pelagic longline fishing, New Zealand Journal of Marine and Freshwater Research, 34:3, 455-461, DOI: 10.1080/00288330.2000.9516947

To link to this article: http://dx.doi.org/10.1080/00288330.2000.9516947

New Zealand Journal of Marine and Freshwater Research, 2000, Vol. 34: 455–461
0028–8330/00/3403–0455 $7.00 © The Royal Society of New Zealand 2000

Short communication

Preliminary performance assessment of an underwater line setting device for pelagic longline fishing

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Abstract Baited branchlines were set from a tuna longlining vessel using an underwater setting device and their sink patterns compared with those of baited branchlines that were hand-thrown. Using a paired *t*-test at an hypothesised mean difference of 2 m, at a point 100 m astern of the vessel, baited branchlines set using the device were significantly deeper than those that were hand-thrown. Baited branchlines set using both methods showed a high variation in their sink patterns; on some sets they sank faster than others. The underwater setting device has potential to reduce seabird bycatch substantially with minimal intrusion on the normal operation of a longline fishing vessel. It delivers baits underwater (removing the visual cue of a hand-thrown baited hook to seabirds) and immediately places baited hooks outside the diving range of some vulnerable albatross species (*Diomedea* spp., *Phoebastria* spp., *Thalassarche* spp., and *Phoebetria* spp.).

Keywords seabirds; incidental mortality; longline fisheries; mitigation devices; underwater setting; sink rates; time depth recorders

INTRODUCTION

Seabirds are incidentally caught in a number of pelagic longline fisheries, particularly in the central north Pacific Ocean (Skillman & Flint 1997) and the Southern Ocean (Murray et al. 1993; Takenchi et al. 1997; Brothers et al. 1998; Ryan & Boix-Hinzen 1998; Stagi et al. 1998). Some albatross populations (*Diomedea* spp., *Phoebastria* spp., *Thalassarche* spp., and *Phoebetria* spp.) are being adversely affected by this source of mortality (de la Mare & Kerry 1994; Weimerskirch et al. 1997; Croxall et al. 1998; Waugh et al. 1999).

Seabird mortality caused by longline fishing occurs primarily during the linesetting operation. Baited hooks on 10–40-m long branchlines are cast from the rear of a travelling vessel, and are available to foraging seabirds for a period before the baits sink. Seabirds dive to retrieve these baited hooks and are sometimes hooked themselves, and drown.

Brothers (1991) shows that measures to mitigate this incidental capture of seabirds have been practiced around the world since the problem was identified. The most widely used method is the bird scaring line, which is a line with side streamers, towed astern directly above the water where baited hooks enter. Other measures include setting lines at night, weighting lines, and thawing bait.

Research has continued on new mitigation measures including development of methods to set baited branchlines underwater, rather than hand-throwing them onto the sea surface. Delivering baits under water reduces the time they are visible to seabirds and within the seabirds' diving range. Three different methods of underwater setting are currently in use or being developed around the world.

One underwater setting method, designed for demersal longline vessels by a Norwegian company (Mustad and Sons) is commercially available (Lokkeborg 1998). This is a tube attached to the rear of the vessel through which the mainline and branchlines are fed. A second method, currently under development in New Zealand for pelagic longline vessels, is an underwater setting capsule. In

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Received 24 June 1999; accepted 28 March 2000

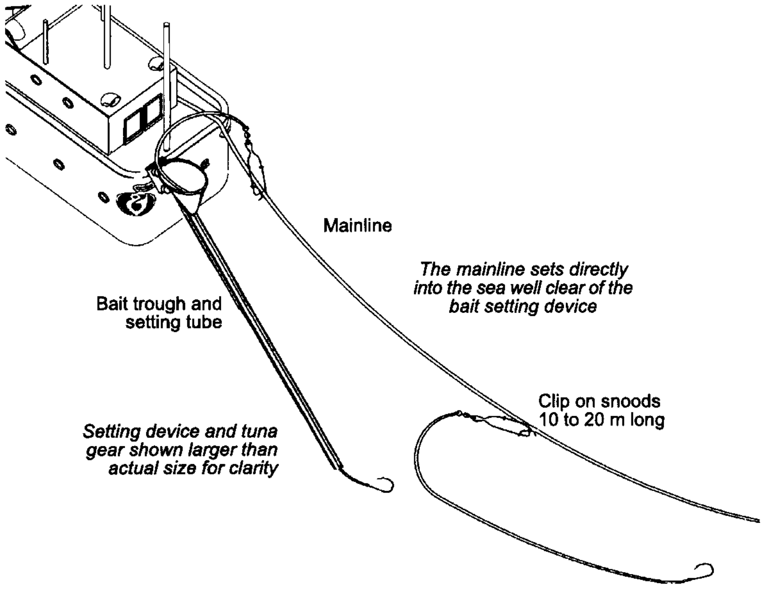


Fig. 1 The underwater setting device used in this study.

this system, baited hooks are placed in a small capsule that carries them under the water astern of the vessel where they are released (Smith & Bentley 1997). The capsule then returns in board where the process is repeated. The third method is an underwater setting chute for pelagic longline vessels and is currently being tested in New Zealand. This device, known as the "chute", is the subject of the present paper. Our aim was to determine if baited hooks set using the chute were deeper 100 m behind the vessel than those set without the chute.

MATERIALS AND METHODS

Underwater setting device

Barnes & Walshe (1997) report on an earlier prototype of the chute to that used in this study. The present chute (Fig. 1) is made up of three components: (1) the setting tube which, with the aid of water, carries the baited hook and branchline to the required deployment depth; (2) the bait trough at the top of the tube in which the baited hook and branchlines are placed; and (3) the hinge assembly, which allows the whole device to move sideways as well as forward and backwards.

This device was fitted to a tuna longline vessel in 1998 and trialled over a 6-month period to assess its performance. During the trial, the chute was attached to the stern, 1 m from the port corner. The chute delivers baits 4.2 m below the surface in calm conditions. This vessel normally uses a bird scaring line, and this practice was continued during these trials.

Observations made from on board the longliner during these trials had shown that bird activity began 100 m astern of the vessel at the point where the bird-scaring line came in contact with the water. To help assess the effectiveness of the chute, the depths that baited branchlines reached when set using the chute were compared to those that were reached by hand-thrown baited branchlines at a point 100 m astern of the vessel.

Fieldwork details

All trials were carried out between 21 August and 22 September 1998, in New Zealand's Exclusive Economic Zone (EEZ) between 171°00′–175°32′ E and 33°42′–35°03′ S.

Trials were conducted on board a 30 m New Zealand domestic tuna-fishing vessel, F.V. *Atu S.* The vessel used a 3.5 mm diameter monofilament mainline and 14.4 m monofilament branchlines. 16/0 tuna circle hooks were used with no swivels attached. All baits used in the trials were *Notodarus* spp. (squid) weighing between 140 and 160 g. The vessel's linesetting speed was 8–10 knots and a slack mainline was set using a lineshooter.

Method

Six model MK7 Time Depth Recorders (TDRs), sourced from Wildlife Computers, Redmond, WA,

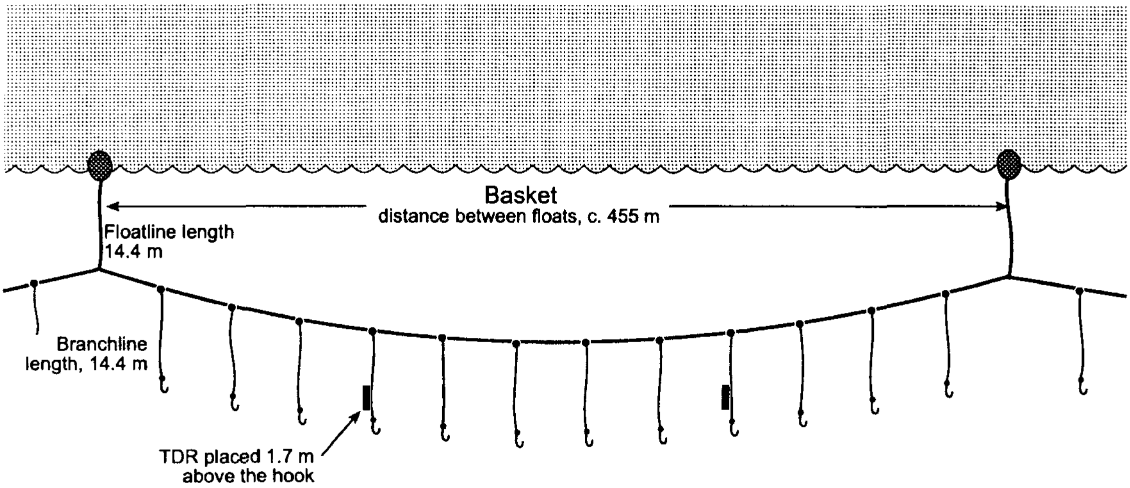


Fig. 2 Placement of time depth recorders in a basket.

United States, were used to measure the depth of the baited branchlines over time. Each TDR was attached to a branchline 1.7 m above the hook to avoid being lost to sharks. The TDRs weigh 12 g in sea water and measure 95 × 24 × 17 mm. Before each trial, each TDR was soaked in sea water for at least half an hour to allow it to adjust to ambient seawater temperature.

Branchlines with TDRs attached were placed in sequenced pairs along the mainline, two to a basket (See Fig. 2). Each TDR was placed an equal distance from a float at either end of a basket.

For each pair of branchlines with TDRs, one was deployed using the chute and the other was hand-thrown. All hand-thrown branchlines were cast away and behind the boat from the rear port corner. The decision as to which branchline of each pair was hand-thrown or set with the chute within each basket was determined using a random number generator. Each pair of TDRs was chosen randomly from the six TDRs on each day. Each TDR was configured to record depth once every second. TDRs were placed in sequential baskets at the start of the last third of the line.

Each TDR was retrieved when the line was hauled and the data file downloaded.

Data processing

Because the setting and hauling operation took up to 13 h the data files were too large for the manufacturer's supplied software. Therefore, for each data file, a zero calibration point was determined by manually inspecting the portion of the data file representing the pre-deployment soak. The first 30 s of data taken from the time the baited branchline with the TDR attached left the vessel were then treated by independently developed software. This software zero corrected the data and produced a graph of depth over time for this period. To convert time into distance behind the vessel the following equation was used:

$$d = \frac{1852\ t\ v}{3600}$$

where d = distance behind vessel after t seconds, v = speed in knots, 1852 = number of metres in a nautical mile, and 3600 = number of seconds in an hour.

RESULTS

Usable data were obtained from deployments of 20 pairs of TDRs over 10 separate linesetting operations. Data from three-paired TDR deployments could not be used because of interruptions to the line setting operation which affected the sink pattern of the branchline. One TDR was lost during the trials on the third set.

For every pair of TDRs, those set with the chute were deeper 100 m astern of the vessel than those

Table 1 Depth advantage gained by time depth recorders (TDRs) set through the chute compared to TDRs set by hand-throwing 100 m astern of the vessel.

Lineset no.	Pair no.	Depth advantage (m)	Wind speed (knots)	Sea conditions (Beaufort Scale)
1	1	4.5		
2	1	1.5	5	2
2	2	2	5	2
2	3	1.5	5	2
3	1	4.5	10	2
3	2	2	10	2
4	1	0.5	5	2
4	2	1	5	2
5	1	4	15	3
5	2	5.5	15	3
6	1	2.5	15	3
6	2	2.5	15	3
7	1	3	20	4
7	2	3.5	20	4
8	1	2	20	4
8	2	2.5	20	4
9	1	0.5	18	3
9	2	0.5	18	3
10	1	8.5	20	4
10	2	4.5	20	4

set by hand-throwing. Table 1 shows the depth advantage obtained by using the chute.

TDRs on branchlines set through the chute were between 5.0 and 15.5 m deep at 100 m astern of the vessel with a mean depth of 8.70 m, whereas those set by hand-throwing were between 3.0 and 11.0 m deep with a mean depth of 5.85 m (Fig. 3). The mean difference in depth between TDRs set using the two methods was 2.85 m at the 100 m point.

Using a paired *t*-test, an hypothesised mean difference of 2 m between TDRs on baited branchlines set with the chute and those hand-thrown 100 m astern of the vessel, was shown to be significant ($t_{0.05\,(1),\,19}$; $P = 0.035$).

Figure 4 shows the mean sink rate of TDRs set through the chute and by hand for the first 55 s after setting. The sink rates were similar for both setting methods. For the first 2 s after leaving the vessel, the TDRs set by both methods sank rapidly (0.44 m s^{-1} with chute; 1.13 m s^{-1} hand-thrown). From the 3–30 s mark their descent rate (0.09 m s^{-1} with chute; 0.09 m s^{-1} hand-thrown) was slower than for the 30–55 s period (0.20 m s^{-1} with chute; 0.22 m s^{-1} hand-thrown). TDRs set through the chute were on average 2.83 m deeper at any given second than those that were hand-thrown.

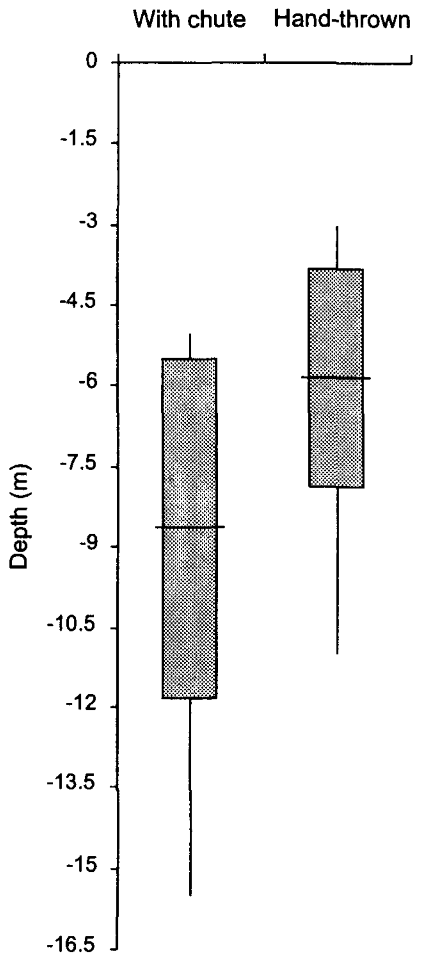


Fig. 3 Time depth recorder depths 100 m astern of the vessel for baited branchlines set with the chute and by hand-throwing; showing the mean (horizontal line), ±SD (shaded area), and the range (vertical line) for each method of setting ($n = 20$ for both).

Figures 5A and B show the first depth recorded for TDRs set using the chute ranged from 2.5 to 10 m and for the TDRs that were hand-thrown this ranged from 0 to 4.5 m. There was considerable variation in sink rate between line setting operations, particularly for TDRs on branchlines set through the chute.

DISCUSSION

The potential of the chute to reduce incidental capture of seabirds is promising. The mean depth that the TDRs emerged from the chute was 6.5 m, with

Fig. 4 Mean depth of time depth recorders (TDR) on branchlines set with the chute and by hand-throwing ($n = 20$) for the first 55 s after setting. Time = 0 was the first reading taken by the TDR after it had either left the chute or landed on the sea surface.

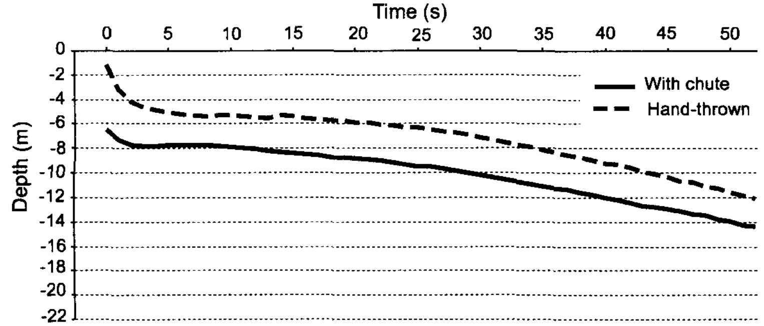
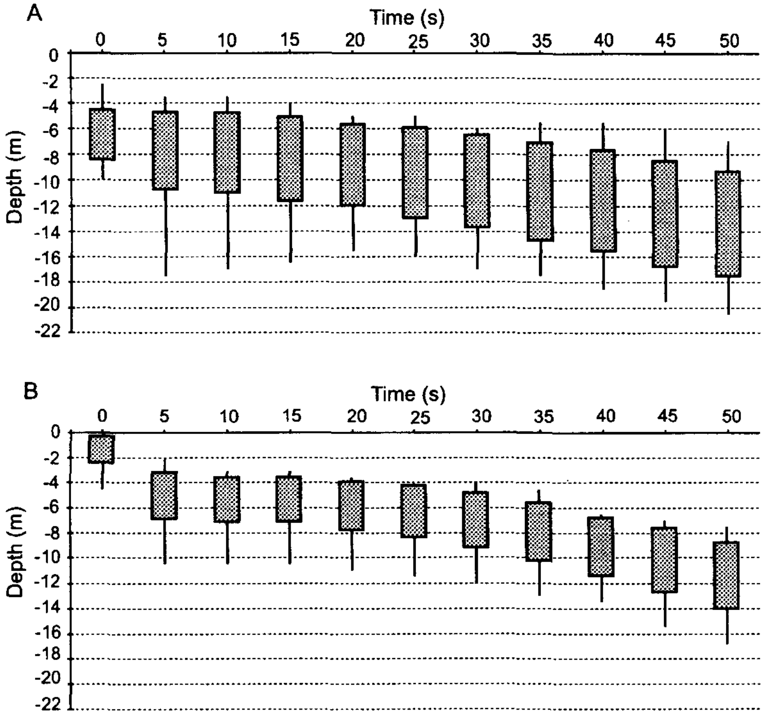


Fig. 5 Depth ranges of time depth recorders **A**, deployed with the chute and **B**, hand-thrown at increasing times after deployment (mean ±SD = shaded area; range = vertical line; $n = 20$ for each distance).



a range of 2.5–10 m. Therefore, the TDRs emerging from the chute were always deeper than the maximum diving depth of 0.6 m recorded for wandering albatross (*Diomedia exulans*) by Prince et al. (1994). They were also usually outside the maximum diving depths of 4.5 m for black-browed albatross (*Thalassarche melanophrys*) and 6.0 m for grey-headed albatross (*Thalassarche chrysostoma*) recorded in the same study. The chute also delivers the bait deeper in the water than shy albatross (*Thalassarche cauta*) normally dive to; Hedd et al. (1997) found that 87% of dives measured for this species were <3.5 m. Use of the chute in waters where these or other shallow diving seabirds species predominate is, therefore, likely to significantly reduce the chance of their accidental capture.

Several species of seabirds vulnerable to capture on longlines are proficient at diving. This includes species such as the sooty shearwater (*Puffinus griseus*) which has been recorded regularly diving to 38 m (Weimerskirch & Sagar 1996), white-chinned petrels (*Procellaria aequinoctialis*) recorded diving to 13 m (Hunn 1994), and light-mantled sooty albatross (*Phoebetria palpebrata*) to 12.4 m (Prince et al. 1994). However, use of the chute is likely to reduce capture rates of these species for two reasons.

First, the chute delivers the baits under the water, thus removing the initial visual cue for seabirds following the vessel. This means it is likely to take longer for seabirds to locate bait, allowing the bait longer to sink. Second, because baits are deeper when the chute is used it will require more effort for seabirds to reach baits and return with them to the surface.

There was considerable variation in the sink rate of TDRs. However, the depth differences between TDR pairs on the same line 100 m astern of the vessel were similar in two-thirds of the linesets sampled, implying that the factor(s) influencing sink rate of TDRs usually remain constant **within** a line set, but can vary **between** line sets. This points towards influencing factors such as tide, current, or sea state.

The variation in sink rate was greater for TDRs set through the chute. The vertical movement of the chute in the water as a result of the vessel pitching was considered as one possible explanation. However, if this were so then the depth at which the TDR left the chute would be expected to have as high a variance as at later times. This was not the case. The depth range at the instant the TDRs left the chute was the smallest for all time periods assessed. Another possibility was that because the chute is attached to the stern of the vessel, TDRs set through the chute were entering water disturbed by propellor wash, compared to hand-thrown TDRs which were thrown to the port side of the vessel. If so, greater variance would be expected closer to the vessel where the force of propellor wash is greater; however, this was not evident.

For branchlines deployed both through the chute and by hand-throwing, the sink rate for the first 2 s appears to be faster than for the remainder of the period recorded. This may be because of the influence of the mainline. Initially, the branchlines may sink unimpeded but when they become fully extended below the mainline, the sink rate of the mainline may become the governing factor in determining their sink rates. If the mainline sinks more slowly than the branchlines it will slow the sink rates of the branchlines.

Similarly, in a study of the sink pattern of hooks on a Japanese pelagic longline vessel, Satani & Uozumi (1998) found that the change in depth of hooks was greater in the first second than at any time after. This corresponds with the results of our study where sink rate of the TDR was greatest in the first few seconds. Satani & Uozumi (1998) found that their hooks had reached between 10 and 22 m, 50 s after setting. In our study the depth range for the same time for hand-thrown hooks was 7–17 m.

The exact depth of the baited hooks on each branchline pair could not be determined with certainty because of the separation of 1.7 m between the TDR and the baited hook. However, it seems likely that the baited hook would be lower in the water because of the relative weight of the baited hook compared to the rest of the branchline, particularly if the bait was fully thawed, as it was in this experiment.

During our study, all linesetting was performed using a slack mainline. However, some pelagic longline vessels do not use line setters, and instead use the forward motion of the vessel to pull the mainline off the reel. This means the mainline enters the water under tension. It will, therefore, be important to undertake studies of the sink rates of mainlines set at different tensions, to assess the effect this has on the sink rate of the branchlines. The effect of factors such as different mainline and branchline materials and branchline lengths could also be measured.

Our study was undertaken at times and in places where seabirds vulnerable to capture on longlines were not abundant. In the future it will be important to assess directly the effectiveness of the chute by observing seabird capture rates. This will need to be done in different fisheries and seasons to assess the benefit of this mitigation measure.

ACKNOWLEDGMENTS

We thank Moana Pacific Fisheries Ltd for the generous assistance they have given throughout this study. In particular thanks go to Bruce Young, Brent Marshall, Jeff Moffat, and the crew of the *Atu S.* Paul Barnes and Kim Walshe also provided assistance and advice. Statistical advice was received from Ian West and Paul Starr. Helpful comments on the draft manuscript were received from Jaap Jasperse and Nigel Brothers. The work was funded by New Zealand pelagic longline fishers through the Conservation Services Levy paid to the Department of Conservation.

REFERENCES

Barnes, P; Walshe, K. A. R. 1997: Underwater setting methods to minimise the accidental and incidental capture of seabirds by surface longliners. Report on a prototype device developed by Akroyd Walshe Ltd. *Science for Conservation 66.* Wellington, New Zealand, Department of Conservation.

Brothers, N. 1991: Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean. *Biological Conservation 55*: 255–268.

Brothers, N. P.; Gales, R.; Reid, T. 1998: Seabird interactions with longline fishing in the AFZ: 1997 Seabird mortality estimates and 1988–1997 trends. *Wildlife Report 98/3*. Tasmania, Parks and Wildlife Service.

Croxall, J. P.; Prince, P. A.; Rothery, P.; Wood, A. G. 1998: Population changes in Albatross at South Georgia. *In*: Robertson, G.; Gales, R. *ed*. Albatross biology and conservation. Chipping Norton, Surrey Beatty and Sons. Pp. 69–83.

de la Mare, W. K.; Kerry, K. R. 1994: Population dynamics of the Wandering Albatross *Diomedea exulans* on Macquarie Island and the effects of mortality from longline fishing. *Polar Biology 14*: 231–241.

Hedd, A.; Gales, R.; Brothers, N.; Robertson G. 1997: Diving behaviour of the shy albatross *Diomedia cauta* in Tasmania: initial findings and dive recorder assessment. *Ibis 139*: 452–460.

Hunn, N. 1994: Diving depths of white-chinned petrels. *The Condor 96*: 1111–1113.

Lokkeborg, S., 1998: Seabird by-catch and bait loss in long-lining using different setting methods. *ICES Journal of Marine Science 55*: 145–149.

Murray, T. E.; Bartle, J . A.; Kalish, S. R.; Taylor, P. R. 1993: Incidental capture of seabirds by Japanese southern bluefin tuna longline vessels in New Zealand waters, 1988–1992. *Bird Conservation International 3*: 181–210.

Prince, P. A.; Huin, N.; Weimerskirch, H. 1994: Diving depths of albatrosses. *Antarctic Science 6*: 353–354.

Ryan, P. G.; Boix-Hinzen, C. 1998: Tuna longline fisheries off Southern Africa: the need to limit seabird bycatch. *South African Journal of Science 94*: 179–182.

Satani, M.; Uozomi, Y. 1998: Sinking movement of a hook of tuna longline immediately after shooting observed by small time depth recorder. Unpublished report, CCSBT-ERS Working Group. Document number 9806/12. Tokyo, Japan.

Skillman, R.; Flint, E.N. 1997: Mortality of Laysan and Black-footed albatrosses in the Hawaii pelagic longline fishery. *Pacific Seabirds 24*: 23.

Smith, M.; Bentley, N. 1997: Underwater setting methods to minimise the accidental and incidental capture of seabirds by surface longliners. Report on a prototype device developed by MS Engineering. *Science for Conservation 67*. Wellington, New Zealand, Department of Conservation.

Stagi, A.; Vaz-Ferriera, R.; Marin, Y.; Joseph, L. 1998: The conservation of albatrosses in Uruguayan waters. *In*: Robertson, G.; Gales, R. *ed*. Albatross biology and conservation. Chipping Norton, Surrey Beatty and Sons. Pp. 220–224.

Takenchi, Y.; Uozumi, U.; Tanaka, U. 1997: Preliminary analysis of incidental catch and catch rate of seabirds by the Japanese Southern Bluefin Tuna longline fishery in the years 1995 and 1996 fishing years. CCSBT-ERS/9706/10.

Waugh, S. M.; Weimerskirch, H.; Moore, P. J.; Sagar, P. M. 1999: Population dynamics of black browed and grey headed albatross *Diomedea melanophrys* and *Diomedea chrystoma* at Campbell Island, New Zealand, 1942–1996. *Ibis 141*: 216–225.

Weimerskirch, H.; Brothers, N.; Jouventin, P. 1997: Population dynamics of wandering albatross *Diomedea exulans* and amsterdam albatross *D. amsterdamensis* in the Indian Ocean and their relationships with long-line fisheries: conservation implications. *Biological Conservation 79*: 257–270.

Weimerskirch, H.; Sagar P. M. 1996: Diving depths of sooty shearwaters *Puffinus griseus*. *Ibis 138*: 786–794.