SEABIRD CATCH RATES: AN ASSESSMENT OF CAUSES AND SOLUTIONS IN AUSTRALIA'S DOMESTIC TUNA LONGLINE FISHERY

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SUMMARY

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Observers aboard Australian longline vessels recorded seabirds hooked on six out of 16 shots in waters off south-eastern Australia. The mean catch rate was 0.92 birds per 1000 hooks, or 0.58 birds per 1000 hooks if only those birds confirmed killed are included. Features of fishing equipment and technique believed to be responsible for birds being hooked are described, and modifications to fishing practice which will decrease bait loss and seabird mortality discussed.

INTRODUCTION

Longline fishing for tuna by Japanese vessels is responsible for the death of large numbers of seabirds (Brothers 1991, Murray *et al*. 1993). Anecdotal evidence and the similarities between the fishing methods of the Australian tuna longline fleet and those of the Japanese suggested that similar problems may occur. This paper assesses the level of incidental mortality of seabirds caused by Australian tuna longline vessels, and identifies reasons for this. Updates have been made to the mortality rate by Whitelaw (1995) and Brothers *et al*. (1998a,b). Brothers (1991, 1994, 1995a) has identified factors that affect seabird catch rates by longline vessels, as well as various potential mitigating measures. The purpose of this study was to determine how fishing practices can be modified to decrease bird mortality without compromising, but perhaps improving, fishing efficiency.

Caton *et al*. (1995) describes the history of the Australian longline fishery for Southern Bluefin Tuna *Thunnus maccoyii*, but generally, knowledge of fleet activity is sparse. In 1995 there were approximately 45 Australian longline vessels fishing for tuna off the eastern and south-eastern coasts of the Australian mainland and Tasmania. Australian Fisheries Management Authority (AFMA) records indicate that fishing effort increased from 695 000 hooks in 1990 to 2.1 million in 1994 (Table 1). These figures are conservative because information on effort is known to be incomplete.

In contrast to Japanese longline vessels, most Australian vessels are dissimilar and not purpose-built for longlining, having been converted from other methods of fishing. Some may still engage in other methods of fishing in addition to longlining. Most are between 14 m and 25 m long and operate with three to five crew members. These features restrict fishing effort, daily catch potential, catch storage capacity and operating range, which in turn is restricted by weather conditions. The dissimilarities between vessels also complicate the problem of outlining standard solutions to the seabird mortality problem which can be applied across the entire fleet.

Each vessel typically sets 20–40 km of 3-mm diameter single strand monofilament mainline off a hydraulically driven reel while steaming ahead at four to eight knots. On some vessels a hydraulic line shooter is fitted on the transom to be used in conjunction with the reel. Between 500 and 1500 monofilament branchlines, each between 10 and 30 m long with a 10–20-g hook, are clipped to the mainline at intervals of about 30 m. Every 200 m the mainline is supported at the desired fishing depth by buoylines with plastic buoys attached. Whereas some vessels clip their branchlines between pairs of aluminium crimps fitted at regular intervals on the mainline, others with heavier clips attach branchlines anywhere along the mainline, also at regular intervals. This difference in gear configuration is of importance with regard to line-setting techniques and subsequent opportunities for seabird interaction.

Hooks are baited with whole Jack Mackerel *Trachurus declivis*, pilchard *Sardinops* sp., rattail (Macrouridae) or squid (Cephalapoda). Occasionally artificial lures (for example plastic squid 250 mm long) are used. As the mainline is set, each branchlines is clipped to it and the baited hook cast into the sea.

METHODS

Between October 1994 and October 1995 seven cruises aboard six longline vessels (see Table 2) were undertaken to record seabird interactions with fishing operations. Six cruises were in eastern and south-eastern Tasmanian waters on vessels targeting Southern Bluefin Tuna and the other was off the south coast of New South Wales, where the target species was Yellowfin Tuna *Thunnus albacares.* Sixteen shots, or a total of 11 975 hooks, were monitored. The term "shot" refers to a complete fishing operation comprised of setting and hauling a longline. Monitoring was undertaken using one observer per cruise, either the authors or one other person, all of whom had previous experience of Japanese tuna longline operations.

During line setting, all interactions between birds and baited hooks were recorded, noting their proximity to the vessel, the species involved, the nature of the interaction (e.g. surface diving, plunge diving, fighting over bait) and whether or not

TABLE 1

Fishing effort as number of hooks set by domestic vessels in the 200-nautical mile Australian Fishing Zone (AFZ) 1991–1994 (Source: Australian Fisheries Management Authority Logbook data)

	1990	1991	1992	1993	1994
9°–34°S	240 222	320 167	401 575	538 104	931 163
34° – 39°S	554 785	819 833	1 056 307	971 189	1 159 260
39° – 47°S	no record	6 530	157 579	10 440	no record
Total by Australian vessels	695 007	1 146 530	1 615 461	1 520 733	2 090 423
Total by Japanese vessels	22 539 823	13 795 787	16 703 466	18 138 914	16 854 986
Australian effort as % of Japanese effort	3.1	8.3	9.7	8.4	12.4

* not including hooks set by Australian/Japanese joint venture vessels

the bait was lost to a bird or the bird hooked. Similar records were kept during line hauling, and any birds landed dead on hooks were retained frozen for subsequent identification and processing (see Gales & Brothers 1995).

Aspects of vessel design, fishing equipment and setting and hauling techniques were recorded, to identify those factors which could be contributing to the incidence of seabird interactions. Of relevance to mention here is that one of the vessels observed was using a bird line to deter birds from taking bait. Aboard another bait discards were thrown to distract birds during line setting. Aboard two vessels firearms were discharged in the direction of birds in order to scare them when they attempted to take bait.

RESULTS

Birds were caught on six of the sixteen shots observed, and by four of the six vessels involved. The mean catch rate was 0.92 birds per 1000 hooks. If only those birds confirmed killed are included (i.e. discounting those birds released alive and one bird seen hooked but not landed), the mean was 0.58 birds per 1000 hooks. In Tasmanian waters alone, the hooking rate for birds was 0.81 per 1000 hooks, and if only those birds confirmed killed are included, the catch rate was 0.45 per 1000 hooks.

A total of 11 birds was caught. Eight were hooked when baits were taken during line setting (four Shy Albatross *Diomedea cauta*, one unidentified albatross, two Great-winged Petrels *Pterodroma macroptera* and one Short-tailed Shearwater *Puffinus tenuirostris*). Only seven of these birds were landed during line hauling, and of the seven, one albatross was cut away by crew before it could be identified. A further three Shy Albatross were hooked, two in the wing and one in the leg, within 30 minutes of each other during a haul on vessel E. All were tangled in branchlines after pursuing incoming unused baits. All were released alive with uncertain survival prospects.

Ten of the monitored sets began in darkness and continued into dawn or daylight, one began in daylight and continued into darkness, four were made entirely in daylight and one entirely at night. Line-setting time is an important factor influencing seabird catch rates. Birds were always present astern of the vessels during the twilight and daylight sections of all shots. However, their abundance and species composition varied between shots and over time within shots. They were not always absent during hours of darkness but, even when they were close astern at night, counting and identification were impaired by glare from deck lighting.

The level of interaction between birds and baits recorded during periods of adequate visibility astern varied from no interaction in one set on vessel C to the loss of 26% of baits to birds in another, with unsuccessful attempts made on a further 10% of baits during the same set aboard vessel A. In this instance two birds were hooked and drowned.

The percentages of baits lost to birds during each shot shown in Table 2 are minimum values, because only definite attempts on baits and their outcomes were included; it was difficult, particularly in poor weather and with rafts of birds settling over each bait as it sank, to record all attempts on baits with certainty.

One of the four Shy Albatross hooked during line setting was not on the hook when the line was hauled. The possible reasons for this are described by Brothers (1991).

DISCUSSION

The baited hooks were observed to pose a threat to seabirds following astern of the vessel: (i) as they were cast into the water and before sinking; (ii) if they float on or near the surface as a result of current or tide action during their soak time; or (iii) when hooks with unused bait were hauled back aboard the vessel.

The bird catch rate of 0.45 per 1000 hooks for eastern Tasmanian waters in this study is similar to the rate of 0.44 birds per 1000 hooks recorded for albatrosses by Brothers (1991) for all Tasmanian waters in winter. The rates recorded are higher than those reported by Klaer & Polacheck (1995) for the Japanese tuna longline fleet operating in the 200-nautical mile Australian Fishing Zone (AFZ). According to their analysis, the summer season (1 October – 31 March) catch rates of seabirds by Japanese longliners operating in eastern Tasmanian waters in 1991/2, 1992/3 and 1993/4 were 0.08, 0.22 and 0 birds per 1000 hooks, respectively. The catch rates for all observed Japanese vessels across the entire AFZ for the same years (where a fishing year is from April to March) were 0.08, 0.16 and 0.16 birds per 1000 hooks. The lower catch rates observed in the Japanese fleet may be attributed to differences in fishing equipment and technique and their increasing use of various mitigating measures, such as bird-scaring “tori” lines, which have not as yet been widely adopted by the Australian fleet. Comparisons between the catch rates reported in this study and the bird catch rates of the Japanese fleet should, however, be treated with caution given the disparate and small sample sizes on which they are based. Similar concerns about data reliability were expressed by Klaer & Polacheck (1995).

TABLE 2

Details of 16 shots observed aboard Australian longline tuna vessels in the AFZ between October 1994 and October 1995

Vessel	**A**	**A**	**B**	**B**	**C**	**C**	**D**	**D**	**D**	**E**	**E**	**F**	**F**	**F**	**F**	**G**
Area	S NSW	S NSW	E Tas	E Tas	E Tas.	E Tas.	E Tas.	E Tas.	E Tas.	SE Tas.	SE Tas.	E Tas.	E Tas.	E Tas.	E Tas.	E Tas.
Date	Oct 94	Oct 94	Dec 94	Dec 94	Dec 94	Dec 94	Dec 94	Dec 94	Dec 94	Oct 95	Oct 95	Oct 95	Oct 95	Oct 95	Oct 95	Oct 95
Shot no.	1	2	1	2	1	2	1	2	3	1	2	1	2	3	4	1
Hooks set	520	310	1026	1089	700	620	320	340	350	900	800	1250	1100	800	850	1000
Shot time	night/day	day	night/day	night/day	night/dawn	night/dawn	night/day	night/dawn	night/dawn	day/night	night	night/day	night/day	night/day	night/dawn	night/dawn
Birds caught alive	0	0	0	0	0	0	0	0	0	3	0	0	1*	0	0	0
Birds killed	2	0	0	0	0	2	1	0	0	0	2	0	0	0	0	0
Total birds caught	2	0	0	0	0	2	1	0	0	3	2	0	1	0	0	0
% bait known lost	26	0	1.5	1.5	0	2	0.8	0.8	0.3	0.4	unknown	0.5	0.5	0.3	0.2	0.2
% bait possibly lost	10	0	6	6	0	unknown	7.5	7.5	unknown	1	unknown	0.3	0.2	0.2	0	0

*Shy Albatross seen hooked during set, but not on hook when hauled.

In addition to the above reasons it is premature to extrapolate the bird catch rates recorded in this study to the entire Australian fleet because of the seasonal and geographic variations in bird abundance which may be expected. Also to consider is the apparent partial dependence of bird catch rates on differences in vessel design and fishing techniques within the fleet.

Factors influencing the level of interaction with hooks and subsequent mortality of seabirds occurring during fishing operations by Japanese longliners were identified by Brothers (1991, 1994) as:

(i) wind and sea state,
(ii) the rate at which baited hooks sink, which is influenced by whether bait is frozen or thawed, how much weight is used on the line, and how much air is trapped in the swim bladder and body cavity of bait fish or under the mantle of squid bait (see also Brothers *et al.* 1995),
(iii) the numbers and species of birds following astern,
(iv) the time of day of line setting,
(v) the use of bird-scaring lines as a mitigating measure,
(vi) the attraction of birds to discarded bait and offal from vessels,
(vii) the ability of crew to cast baited hooks away from the area of turbulent water immediately astern where upwelling water from propeller turbulence can return hooks to the surface.

Points (i) to (v) were found to also occur in the Australian domestic tuna fishery. However, because Australian vessels are smaller and slower, the problem of upwelling water (vii) is not as prevalent. Observers in this study identified additional factors which could be expected to contribute to bird bycatch by Australian longliners as follows:

Hull size and shape

Unlike the purpose-built Japanese vessels, the Australian fleet is comprised of vessels of various design, many with low, open work decks aft. This design offers little physical impediment to birds targeting baits very close to the hull. Branchlines are hauled from a position midway along the hull, and because of the length of branchlines relative to hull length, hooks with unused baits may be dragged along in open water astern as branchlines are retrieved, leaving them vulnerable to bird strikes. In contrast, although Japanese vessels usually set much longer branchlines, their hulls are longer (40–55 m). Unused baits on hooks therefore tend to surface alongside the hull as they are hauled and are thus afforded some physical protection.

Fishing line mass and mass distribution on the line

The vessels observed were using a gear configuration typical of the Australian fleet (pers. obs.). Mainlines were much lighter, and hooks 50% lighter than those used in the Japanese fleet. These features decrease the sink rate of baits, but a 40-g weighted swivel often used at the midpoint of the branchline can assist the initial sinking rate, provided the branch line is cast correctly (see below).

The small hooks used by Australian vessels appear to have the capacity to kill bird species additional to those hooked by Japanese vessels. Evidence of this is that Great-winged Petrels that were observed caught for the first time by a longliner in the AFZ, despite observations of intensive feeding activity but no mortality on baited hooks set from Japanese longline vessels (N.P. Brothers unpubl. data).

Line-setting technique

Australian vessels set branchlines directly from storage bins whereas Japanese vessels set each as an individual coiled line by casting the baited hook and allowing the coil to run out. Casting techniques vary from vessel to vessel in the Australian fishery. The most appropriate system is to cast part of the branchline and the weighted swivel before the baited hook, which is retained until after the branchline is clipped to the mainline. This strategy ensures that the weighted swivel has an immediate influence on the sink rate of the bait.

If, however, the baited hook is cast first and then relied upon to pull the branchline from the bin before it is clipped to the mainline, the bait can be dragged on the surface astern where it is vulnerable to bird strikes. The likelihood of this occurring is increased when crew are bound to clip branchlines only between crimps on the mainline, and especially if a pair of crimps is missed and the branchline must be towed astern until the next pair of crimps comes off the mainline reel. This factor was responsible for two Shy Albatrosses being hooked during line setting on vessel E.

Line-hauling technique

In order to dislodge unused baits from hooks during hauling, crew members jerk each branchline hard. Dislodging the bait in this manner expedites hauling, and reduces the likelihood of birds being caught at this stage of the fishing operation. With hydraulic branchline haulers, birds have little opportunity to strike hooks retaining bait which was not successfully dislodged. Hand hauling, in contrast to mechanical hauling of branchlines, can take up to four times as long and allows birds more opportunities to strike at hooks retaining bait. This problem may be compounded if baits that cannot be dislodged by jerking the line are hauled aboard then deliberately flicked off the hooks into the water alongside. These baits attract birds to the area astern where hooks are coming to the surface. Further, if for some reason the crew hauling branchlines falls behind the hauling rate of the mainline and a backlog of unclipped branchlines with baited hooks trailing astern occurs, the hazard to birds is increased. This occurred on the occasion when three Shy Albatrosses were hooked during a haul. Similar problems were observed when the mass of mainline alone was used to drag the rest of the line from the vessel causing baited hooks to be dragged on the surface exposed to seabirds for longer. Such inappropriate line-setting techniques as this have also been observed in other longline fisheries with resultant high seabird mortality (Brothers 1995a).

Lighting

Most Australian longliners land their catch on the aft deck where processing is carried out, and at night adequate lighting for this is essential. However, the same degree of lighting is unnecessary for night time line setting, and it can be sufficient to assist birds to target baited hooks. This was considered responsible for two Shy Albatrosses being caught.

The reasons for seven of the 11 birds being hooked have been described, but for the other four birds the reasons were not as clearly identified. Given the frequency of opportunities that birds had to strike at baits, it is surprising that so few were hooked. A further consideration is that the Australian fleet can operate inshore of the Japanese fleet, and so encounters species as yet not known to be vulnerable to Japanese longline hooks.

For example, Australasian Gannets *Morus serrator* were recorded for the first time diving on baited hooks during this study.

Mitigating measures

Night setting of longlines has been identified as an effective way to reduce bird bycatch, although some species such as White-chinned Petrels *Procellaria aequinoctialis* remain vulnerable even in darkness (Ashford *et al.* 1995, N.P. Brothers unpubl. data). Whereas only one of the vessels observed completed an entire set in darkness, 11 sets were made partially in darkness. It can be difficult for individual boats to maintain a night-setting routine when the close proximity of other vessels, as is often the case, necessitates a coordinated setting and hauling routine to avoid line tangles.

Whereas the only birdline observed was considered to be of poor design (see Brothers 1995b for desirable attributes of bird lines), no birds were hooked in the two shots for which it was set. This is consistent with experience aboard Japanese longline vessels where even poor quality birdlines can bring about dramatic decreases in bait loss and bird mortality.

The practice of throwing unwanted baits to distract birds during setting can be effective in the short term, but should be discouraged as it could be expected to reinforce the association birds make between vessels and the ready availability of food. Whenever firearms were used to scare birds away from baits, the birds dispersed for a few minutes then resumed searching for baits. The use of firearms was therefore ineffective as a means of preventing bait loss.

Regardless of the details surrounding individual incidents of bird mortality witnessed on Australian vessels, the principles of avoiding seabird bycatch remain the same for all longline vessels:

(i) all baits are vulnerable when they enter the water and require the mechanical protection of a birdline (even when night setting), a line-setting chute or a modified hull which can set fishing gear underwater,
(ii) the faster that baits can be made to sink, the less opportunity there is for birds to take them, which points to the importance of using thawed baits and weights on branch lines,
(iii) dragging baited hooks on the surface should be avoided by modification of set and haul techniques where necessary,
(iv) discarding unused baits and offal should not be done in a way that attracts birds to fishing vessels, particularly during the time when baited hooks are set.

This study has revealed that along with other longline fisheries, it is likely that the Australian domestic tuna longline industry is contributing to the decrease in abundance of many species of seabirds. This is both an economic problem and a conservation issue. The Australian fishing effort is forecast to increase, and with any increase there will be an even greater need to resolve the problem of seabird mortality. Therefore monitoring of the Australian domestic tuna longline fishery is continuing to refine seabird catch estimates further and to measure the progress of mitigation. It appears that bird catch rates are variable between vessels, and some vessels may be responsible for higher catch rates than others as a result of unsatisfactory fishing equipment and practices.

In early 1996 AFMA regulations made the use of bird-scaring described by Brothers 1995b) compulsory during line setting for all longline vessels operating south of 30ºS in the AFZ. AFMA also revised its logbook system for the Australian tuna fishing industry in January 1996 which allows fishermen to record seabirds killed, etc. The diligence of those recording this information will determine the value of it for monitoring seabird catch rates in the future.

The information gained aboard foreign and domestic fishing vessels has been used to produce guide books to help fishermen overcome seabird mortality and improve their fishing efficiency. The Japanese version of this book was published in 1994 (Brothers 1994) and 2000 copies distributed among the Japanese tuna fleet.

Finally, the level of seabird interaction with fishing operations is a financial worry to fishers. A value can be put on the direct cost of bait lost and fish not caught, and Brothers (1991) calculated this in Australian Dollar terms for the Japanese Southern Bluefin Tuna fleet. It is more difficult to place a value on the inconvenience caused to fishermen by bait loss to birds, or the damage that seabird mortality can do to the public image of the longline industry.

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REFERENCES

ASHFORD, J.R., CROXALL, J.P., RUBILAR, P.S. & MORENO, C.A. 1995. Seabird interactions with longlining operations for *Dissostichus eleginoides* around South Georgia, April to May 1994. *CCAMLR Sci.* 2: 111–121.

BROTHERS, N. 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean. *Biol. Conserv*. 55: 255–268.

BROTHERS, N. 1994. Catching fish not birds – a guide to improving your longline fishing efficiency. Hobart: Pandani. (in Japanese).

BROTHERS, N. 1995a. An investigation into the causes of seabird mortality and solutions to this in the Spanish system of demersal longline fishing for Patagonian Toothfish *Dissostichus eleginoides* in the South Atlantic Ocean. CCAMLR Working Paper WG-FSA-95/58.

BROTHERS, N. 1995b. Principles of birdline construction and use to reduce bait loss and bird deaths during longline setting. CCAMLR Working Paper WG-IMALF-94/19.

BROTHERS, N. 1995c. Catching fish not birds. Australian longline version. Hobart: Parks and Wildife Service.

BROTHERS, N., FOSTER, A. & ROBERTSON, G. 1995. The influence of bait quality on the sink rate of bait used in the Japanese longline tuna fishing industry: an experimental approach. *CCAMLR Sci.* 2: 123–129.

BROTHERS, N., GALES, R. & REID, T. 1998a. Seabird interactions with longline fishing in the AFZ: 1996 seabird mortality estimates and 1988–1996 trends. Wildlife Report 98/1. Hobart: Parks & Wildlife Service, Tasmania.

BROTHERS, N., GALES, R. & REID, T. 1998b. Seabird interactions with longline fishing in the AFZ: 1997 seabird mortality estimates and 1988–1997 trends. Wildlife Report 98/3. Hobart: Parks & Wildlife Service, Tasmania.

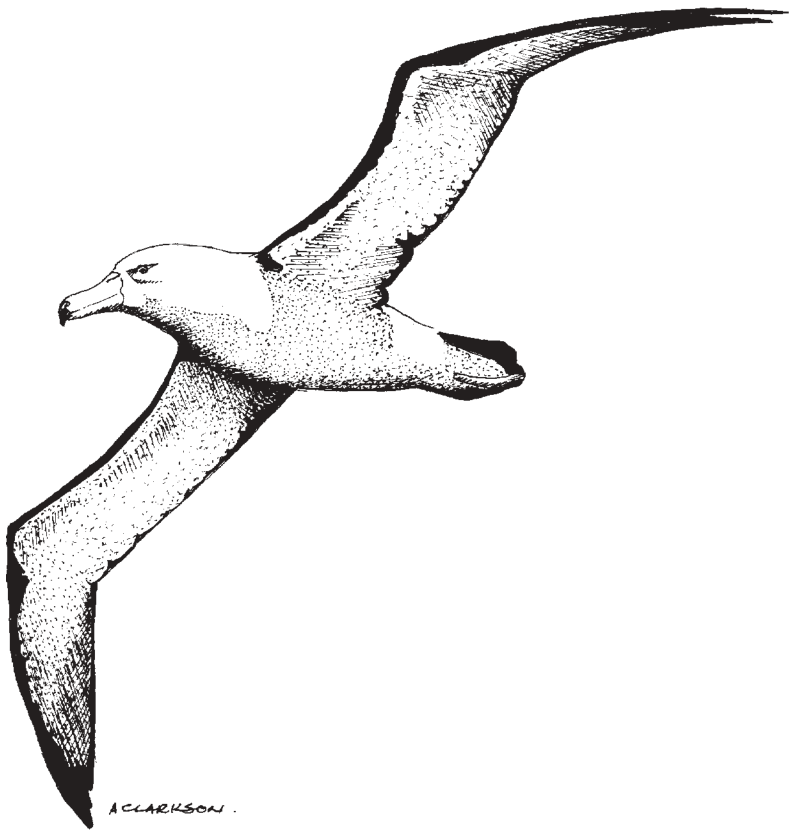
CATON, A.E., WARD, P.J., COLGAN, M.K., WILLIAMS, K.F., RAMIREZ, C. & SKOUSEN, T. 1995. The Australian 1989–90 to 1994–95 Southern Bluefin Tuna seasons. Bureau of Resource Science Working Paper No. WP//95, Canberra.

GALES, R. & BROTHERS, N. 1995. Characteristics of seabirds caught in the Japanese tuna longline fishery in the Australian region. First International Conference on the Biology and Conservation of Albatrosses. Hobart. 28 August–1 September 1995 (abstract). p. 29.

KLAER, N. & POLACHECK, T. 1995. Japanese longline seabird bycatch in the Australian Fishing Zone April 1991 – March 1994. Catch and catch rates by area and season and an evaluation of the effectiveness of mitigation measures. Hobart: CSIRO Division of Fisheries.

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 1998–1992. *Bird Conserv. Int.* 3: 181–210.

WHITELAW, W. 1995. Some observations on seabird bycatch by Australian tuna longline fishing vessels. Document prepared for the first meeting of the CCSBT-ERS WG, 18–20 December 1995, Wellington New Zealand. CCSBT-ERS/95/46.



Shy Albatross by Anthony Clarkson
(Harrison *et al. 1997. The atlas of southern African birds*)