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SEABIRD BYCATCH BY TUNA LONGLINE FISHERIES OFF SOUTHERN AFRICA, 1998–2000

*P. G. RYAN**, *D. G. KEITH** *and M. KROESE*†

The incidental mortality of seabirds in tuna longline fisheries is estimated for the continental South African Exclusive Economic Zone (EEZ). Fishery observers accompanied 13 fishing trips and observed 108 sets (143 260 hooks) during the period 1998–2000. Despite most lines being set at night, seabird bycatch rates were high, with a mean of 1.6 birds killed per 1 000 hooks. Japanese vessels (1% effort observed) had a higher bycatch rate (2.6 birds per 1 000 hooks, range per trip 0.1–5.4) than South African vessels (0.8, range 0.0–4.3; 17% effort observed), possibly as a result of gear differences. Bird bycatch differed regionally in relation to the numbers of birds attending vessels. In international waters off the Northern Cape and southern Namibia, where there are few birds, only one bird was caught on 93 600 hooks (0.01 birds per 1 000 hooks). Shy *Thalassarche cauta*, black-browed *T. melanophris* and yellow-nosed *T. chlororhynchos* albatrosses, and white-chinned petrels *Procellaria aequinoctialis* were killed most frequently. Based on 1998–1999 fishing effort, simple extrapolation suggests that 19 000–30 000 seabirds are killed annually in South Africa's EEZ, of which 70% are albatrosses. Confidence in these estimates is low, given the small proportion of effort observed, but it is clear that urgent steps are needed to reduce seabird bycatch within South African waters.

Key words: longline bycatch, seabird mortality, southern Africa

Large numbers of seabirds are killed each year by longline fisheries, when birds are accidentally caught and drowned while attempting to scavenge bait (Alexander *et al.* 1997, Brothers *et al*. 1999). There is compelling evidence that longline mortality is responsible for population decreases in several species of albatrosses and petrels (Bergin 1997, Gales 1998). Albatrosses and petrels are constrained in their ability to offset increased mortality by their very low reproductive rate (at most one chick per year) and delayed onset of reproduction. Consequently, even relatively modest additional mortality can threaten their populations. Concern about the impact of longlining on seabird populations has resulted in the United Nations' Food and Agriculture Organization (F.A.O.) requesting member nations to produce "Plans of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries" (F.A.O. 1999). In the first instance, this requires that member states assess whether a problem exists with seabird bycatch in their longline fisheries.

Tuna longlining was the first fishery implicated in the decrease in Southern Ocean seabird populations (Weimerskirch and Jouventin 1987, Croxall *et al*. 1990, Brothers 1991), and it remains problematic because of the high seabird bycatch rates, large total fishing effort, and cultural barriers to acceptance of mitigation measures (e.g. Gales *et al*. 1998, Robertson 1998, Olmos *et al*. in press). Ryan and Boix-Hinzen (1998) summarized the limited information available on incidental mortality of seabirds on tuna longlines set in international waters off southern Africa and highlighted the need for information on the impact of tuna longlining within the South African Exclusive Economic Zone (EEZ – all waters within 200 nautical miles of the coast). The present study reports on seabird bycatches based on data from independent fishery observers aboard South African and Japanese longline vessels operating in South African waters (excluding the EEZ around the Prince Edward Islands). Also, the impact of vessels operating in international waters off the Northern Cape and southern Namibia is assessed.

DESCRIPTION OF THE FISHERY

Japanese vessels have fished for tunas off South Africa since the early 1950s, and were joined by Taiwanese (Republic of China) vessels in the late 1960s. Under current bilateral fishing agreements, some 86 Japanese and 24 Taiwanese longline vessels fish in the South African EEZ each year (2001 data). Fishing takes place throughout the year, and both nations concentrate their effort off the south and east coasts of South Africa. The dominant species caught are yellowfin tuna *Thunnus albacares*, bigeye tuna *T. obesus* and albacore *T. alalunga*, plus small numbers

* Percy FitzPatrick Institute, University of Cape Town, Rondebosch 7701, South Africa. E-mail: pryan@botzoo.uct.ac.za
† Marine & Coastal Management, Private Bag X2, Rogge Bay 8012, Cape Town, South Africa

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Table I: Tuna longline fishing effort within the South African EEZ and the proportion monitored by fishery observers, 1998–2000

Nation	*Annual effort (number of hooks)	Proportion (%)	Observed effort (number of hooks)	Proportion monitored (%)
South Africa	460 000	4	80 039	17.4
Japan	6 601 000	56	63 221	1.0
Taiwan	4 787 500	40	0	0.0
Total	11 848 500		143 260	1.2

* Effort based on 1998 data for the Japanese and Taiwanese fleets and 1999 data for the South African fleet

of southern bluefin tuna *T. maccoyii*. The vessels involved in this fishery form part of the large Japanese and Taiwanese fleet that target tunas throughout the world's oceans. Their fishing practices off South Africa are similar to those described in detail elsewhere (e.g. Brothers 1991, Murray *et al*. 1993, Robertson 1998). Catches by both nations within the South African EEZ peaked in the early 1990s, and effort has decreased somewhat since then, but was still in excess of 11 million hooks set in 1998 (Table I).

South Africa developed its own longline fishery for tunas in the early 1960s (Nepgen 1970), but this soon waned because of the poor quality of fish resulting in low prices, coupled with the development of alternative fisheries (Shannon *et al*. 1995). Interest in longlining for tuna commenced again in 1995, and in 1997 some 30 permits were issued to South Africans on an experimental basis. Initially, the fishery targeted bigeye tuna, but large bycatches of swordfish *Xiphias gladius* resulted in many permit holders switching to target this species, which commands a more stable price and requires less sophisticated handling at sea. The switch to swordfish also saw a change by most boats from Japanese-style, deep-water longlines to American-style, monofilament gear deployed with lightsticks. Initially, swordfish comprised up to 50% of catches, but by 2000 swordfish catches had dropped to only 10%, with catches dominated by yellowfin and, to a lesser extent, bigeye tunas. Despite a cut in the number of permits to 24, fishing effort has increased steadily since the inception of the fishery, and continues to grow.

MATERIAL AND METHODS

Fishery observers, contracted by South Africa's Marine & Coastal Management, Department of Environmental Affairs and Tourism, were placed aboard tuna longline vessels from 1998, although few trips were made until 1999. Most observers were placed on South African vessels, because of the ease of access. Many foreign-registered vessels are in transit, or only call at a South African port once, making it difficult to deploy observers. This resulted in a very low proportion of annual foreign fishing effort being observed (Table I).

Fishery observers reported fishing techniques (including line structure, timing of sets and hauls, use of a bird-scaring line, etc.), fishing effort (number of hooks set), and numbers of birds and other bycatch species caught. Some observers also estimated the numbers of birds attending vessels. Almost all counts were made during hauling, because most sets took place at night. Because not all observers were proficient at bird identification, counts of birds were combined into broad groups (e.g. albatrosses, gulls and terns). Up to three counts were made of each group at each haul by a single observer; the maximum count was used for each species/group at each haul.

Observers were requested to collect all birds killed for later examination, but this was not always feasible. In some cases, only the heads and feet of birds were kept for identification. Additional information on birds caught was obtained from carcasses or parts of carcasses returned by vessels without observers. Since 1999, permits allowing vessels to fish for tuna in the South African EEZ have requested that birds killed be landed for examination. Although few vessels complied, some specimens were returned to port. Birds for which no location was recorded were excluded from the analysis, because in some instances they could have been caught outside the South African EEZ. These birds included two species rarely encountered in South African waters (Ryan and Rose 1995): one light-mantled sooty albatross *Phoebetria palpebrata* and two adult grey-headed albatrosses *Thalassarche chrysostoma*. Where possible, birds were aged, sexed and standard measurements taken.

The observer data were analysed separately for South African and foreign-registered vessels operating within the South African EEZ. South African vessels fishing in international waters outside the EEZ were treated as a third group. One Japanese vessel with an observer on board also fished in international waters. To examine the influence of location on bird mortality,

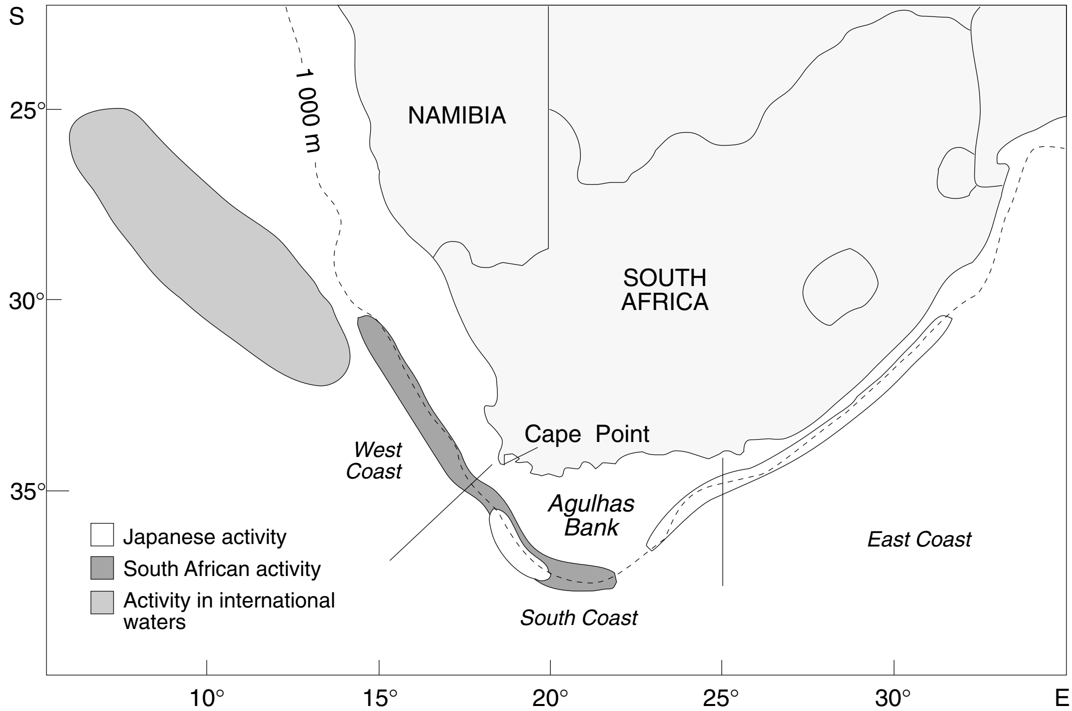

Fig. 1: Map of southern Africa showing the three areas where fishing observations took place along the edge of the continental shelf (1 000 m isobath) within the South African EEZ, and the area where fishing occurred in international waters

South African waters were divided into three broad zones (Fig. 1): the West Coast (north of a line running south-west from Cape Point), South Coast/Agulhas Bank (between that line and 25°E), and East Coast (east of 25°E). There were too few data to test for seasonal differences in bycatch rate; both Japanese vessels with observers fished in October 1999, whereas South African vessels with observers fished from November 1998 to June 1999.

RESULTS

Fishing within the South African EEZ was concentrated along the outer edge of the continental shelf, shown by the 1 000 m isobath in Figure 1. Observer reports were obtained for 13 fishing trips within the South African EEZ, involving 108 sets and 143 260 hooks (Table II). Most fishing effort (56% of hooks) was observed for South African vessels; only two Japanese and no Taiwanese vessels operating within the EEZ had observers, resulting in a very small proportion of annual foreign fishing effort being observed (Table I). Overall, only 1% of annual fishing effort was observed. South African vessels with observers fished off the West and South coasts, whereas the two Japanese vessels fished off the South and East coasts (Fig. 1). An additional seven cruises (66 sets, 93 600 hooks) on vessels operating outside the EEZ (all but one South African) were accompanied by observers. These vessels fished farther north than vessels operating within the EEZ (Fig. 1).

Gear structure differed between South African and Japanese vessels. Japanese mainlines were woven monofilament (8–12 strands), whereas South African vessels all used single-strand 3–5 mm monofilament lines. Japanese vessels used long branch lines (average 37 ± 3 m) with a variety of structures (different lengths of monofilament, braided monofilament and Dacron rope), and no weighting other than a 2–3 m length of lead-core Dacron rope, usually attached close to the main line. South African vessels had shorter (16 ± 3 m), 2-mm monofilament branch lines

Table II: Tuna longline fishing trips within the South African EEZ monitored by fishery observers, 1998–2000

Nation	Trips with observers			Number of birds killed	Bycatch rate*
	Number of trips	Number of sets	Number of hooks		
South Africa	11	82	80 039	62	0.77 (0.0-4.3)
Japan	2	26	63 221	167	2.64 (0.1-5.4)
Taiwan	0	0	0	–	–
Total	13	108	143 260	229	1.60

* Birds killed per 1 000 hooks set, with the maximum and minimum bycatch rates per trip in parenthesis

with 60 g lead swivels positioned 1–3 m from the hook. Buoy rope lengths were the same (both 17 ± 3 m), but Japanese main lines were longer (45 ± 16 miles) with more hooks per mile (63 ± 26) than South African lines (32 ± 7 miles, 31 ± 8 hooks per mile). The difference in spacing between hooks resulted from shorter intervals between attaching traces (every 5–6 seconds on Japanese vessels, compared with every 9–15 seconds on South African vessels). Lightsticks were deployed routinely by South African vessels, typically within a few metres of the hook, and almost all sets were made at night (94%). No bird-scaring (*tori*) lines were deployed on South African vessels, despite this being a permit requirement. Japanese vessels set all lines at night, and the observer on one vessel reported that a bird-scaring line was used on "most" sets. They also deployed no lightsticks. Both nations used a mix of squid and fish bait. A bait-casting machine was used on only one vessel (the Japanese vessel within the EEZ that caught few birds).

Within the South African EEZ, 229 birds were killed, giving an average bycatch rate of 1.60 birds per 1 000 hooks (Table II). Bird bycatch rate was greater for Japanese (2.64 birds per 1 000 hooks) than for South African vessels (0.77, Table II). Highest bycatch rates were off the South Coast, but even within this region Japanese vessels caught more birds than did South African vessels (Table III). The high bycatch rate by Japanese vessels was influenced greatly by one trip that killed 164 birds on 12 sets. Ironically, this was the only vessel where the observer reported the use of a bird-scaring line, but the line's design and frequency of use was not specified. For this small sample, time of setting had little influence on the numbers of birds killed; no birds were caught on the five lines set during the day within the EEZ. One observer reported excessive deck lighting during night sets, which might account for the numbers of birds killed during night sets.

Albatrosses *Thalassarche* spp. (69%) and white-chinned petrels *Procellaria aequinoctialis* (28%) were the birds most frequently killed (Table IV). Unfortunately not all birds were returned to port, so identifications could not be verified, but most albatrosses probably were shy albatrosses *T. cauta*, which were the most abundant albatross species returned by vessels without observers (Table V). These vessels also returned carcasses of two species not reported killed by observers: Cape gannets *Morus capensis* and Subantarctic skuas *Catharacta antarctica* (Table V). The proportion of albatrosses returned to port by vessels without observers (52%) was less than that on vessels with observers (69%, $\chi^2 = 3.65$, $p < 0.1$), but this might reflect selective sampling. A more striking difference was the much higher proportion of albatrosses than petrels killed by South African vessels (92%) compared with Japanese vessels (60%, $\chi^2 = 19.47$,

Table III: Regional differences in seabird bycatch rate (birds killed per 1 000 hooks) on tuna longlines monitored by fishery observers off South Africa, 1998–2000

Region	Country	No. of hooks	Albatrosses	Petrels	All birds	Bycatch rate
West Coast	South Africa	31 325	12	3	15	0.48
South Coast	South Africa	48 714	45	2	47	0.97
	Japan	37 001	101	64	165	4.46
	Combined	84 013	146	66	212	2.52
East Coast	Japan	26 220	0	2	2	0.08
Offshore	South Africa and Japan	93 618	1	0	1	0.01

Table IV: Seabirds killed aboard tuna longline vessels operating within the South African EEZ, 1998–2000, as reported by fishery observers

Species	Nationality of vessel		Total	Proportion (%)
	South African	Japanese		
Shy albatross *Thalassarche [cauta] cauta*	13		13	5.7
Black-browed albatross *T. melanophris*	4		4	1.7
Yellow-nosed albatross *T. chlororhynchos*	2		2	0.9
Albatross spp.	38	101*	139	60.7
White-chinned petrel *Procellaria aequinoctialis*	3	61	64	27.9
†Pintado petrel *Daption capense*	0	5	5	2.2
†Great-winged petrel *Pterodroma macroptera*	2	0	2	0.9
Total	62	167	229	

* All were reported to be shy albatrosses, but in the absence of any specimens, this cannot be confirmed
† In the absence of specimen evidence, the identification is unsubstantiated

$p < 0.001$). This pattern persisted even among vessels fishing in the same area (South Coast: $\chi^2 = 18.77$, $p < 0.001$), but its cause is unclear.

Only one bird, a black-browed albatross *T. melanophris*, was killed on longlines set outside the EEZ, giving a bycatch rate estimate of only 0.01 birds per 1 000 hooks (Table III). This low rate was achieved despite 15% of sets taking place during the day. Bird-scaring lines were used by one vessel during daytime sets.

Most shy and black-browed albatrosses examined were subadults or immatures, whereas most yellow-nosed albatrosses were adults (Table V). The preponderance of immature black-browed and shy albatrosses killed may result in part from many birds being caught in summer, when adults are scarce in South African waters (Ryan and Rose 1995). There was a tendency for more female albatrosses to be killed: six of eight shy albatrosses and six of nine black-browed albatrosses were female. Observers reported two banded birds, both caught on the Agulhas Bank in September 1999: an Atlantic yellow-nosed albatross *T. [c.] chlororhynchos* banded as a chick on Gough Island in March 1997 and a Cape gannet banded as a chick on Mercury Island in March 1996. One bird returned by vessels without observers was banded: a wandering albatross *Diomedea exulans* killed on the Agulhas Bank in October 2000 was banded as a chick on Bird Island, South Georgia, in October 1998. Based on measurements in Marchant and Higgins (1990), eight sexed shy albatrosses all came from the population breeding on the Auckland Islands (sometimes regarded as a separate species, white-capped albatross *T. [cauta] steadi*).

In addition to birds killed, some birds were caught alive and released. These were not recorded by most observers, but on one trip with 10 sets that killed three albatrosses, five others (one shy, one black-browed and three yellow-nosed *T. chlororhynchos*) were caught and released alive.

Numbers of birds attending vessels ranged from 0 to 310, with twice as many birds at vessels off the

Table V: Seabirds killed by tuna longline vessels operating within the South African EEZ and returned to port for identification, 1998–2000

Species	Adult	Immature	Total
Wandering albatross *Diomedea [exulans] exulans*	0	1	1
Tristan albatross *D. [e.] dabbenena*	1	0	1
Shy albatross *Thalassarche [cauta] cauta*	12	15	37
Black-browed albatross *T. melanophris*	0	13	13
Yellow-nosed albatross *T. chlororhynchos*	5	1	6
White-chinned petrel *Procellaria aequinoctialis*	–	–	39*
Cape gannet *Morus capensis*	3	0	3
Subantarctic skua *Catharacta antarctica*	–	–	1*
Total	21	30	101

* State of maturity not determined

Table VI: Number of seabirds attending tuna longline vessels during hauling, 1998–2000

Species	Number of seabirds (Mean ± *SD*)			
	West Coast (*n* = 27)	South Coast (*n* = 56)	East Coast (*n* = 11)	Outside South African EEZ (*n* = 17)
Albatrosses	19.2 ± 1.18	31.2 ± 36.0	6.5 ± 6.1	9.8 ± 7.5
White-chinned petrels	14.1 ± 10.3	42.3 ± 39.2	21.2 ± 12.2	5.2 ± 9.2
Other petrels	0.9 ± 1.8	6.8 ± 9.0	4.4 ± 5.5	21.5 ± 13.8
Stormpetrels	2.1 ± 3.5	2.7 ± 6.4	0.2 ± 0.6	0.9 ± 1.9
Gannets	0.3 ± 0.8	0.4 ± 1.1	1.8 ± 4.0	0.0 ± 0.0
Skuas	1.3 ± 1.9	1.6 ± 2.2	0.1 ± 0.3	0.4 ± 1.1
Gull and terns	3.1 ± 5.2	1.3 ± 4.1	0.5 ± 0.9	0.1 ± 0.5
All birds	4.1 ± 19.3	86.4 ± 70.5	34.5 ± 24.2	37.9 ± 21.9

n = Number of hauls for which bird counts were made

South Coast than either the West or East coasts (Table VI). There was a strong relationship between the incidental mortality of seabirds and the numbers of albatrosses and white-chinned petrels attending vessels (Fig. 2). Vessels fishing in international waters attracted fewest birds. The numbers in Table VI are inflated for this region, because counts were made only from one vessel fishing in October, which attracted a small flock of pintado petrels *Daption capense*. Observers on other vessels in this area commented on the virtual absence of birds attending vessels.

DISCUSSION

Seabird bycatch rates on pelagic longline fisheries in the southern hemisphere average fewer than 0.4 birds per 1 000 hooks (Alexander *et al*. 1997, Bergin 1997, Brothers *et al*. 1999), considerably lower than those recorded in the South African EEZ. The only fisheries that have bycatch rates as high as those reported here are off Brazil and Uruguay (Vaske 1991, Neves and Olmos 1998, Stagi *et al*. 1998, Olmos *et al*. in press). The difference between the fishery off South Africa and that in the Australian EEZ is especially marked. Bycatch rates off Australia fell from initial values of around 0.7 birds per 1 000 hooks in 1988 to 0.15 in the 1990s (Gales *et al*. 1998). Similar improvements in bycatch rate were reported off New Zealand in the early 1990s (Murray *et al*. 1993). These decreases in incidental mortality of seabirds were achieved by implementation of mitigation measures, such as obligatory use of bird-scaring lines at all sets, thawing all bait before use, and a prohibition on daytime setting (Klaer and Polacheck 1998). Some mitigation measures are already part of permit requirements for vessels operating within the South African EEZ: use of bird-scaring lines during sets, adequate line weighting to ensure "optimal sinking rates", and no offal dumping during setting. Unfortunately, it seems that as yet there is little compliance with these regulations, although accurate assessment of compliance levels is complicated by the fact that observers may influence fishing practices. The decreases in bycatch off Australia from the 1980s to 1990s also coincided with an increase in observer coverage. Greater observer coverage, especially of foreign vessels operating in South African waters, is a priority.

The bycatch rate within the South African EEZ is considerably greater than that reported from adjacent international waters. Seabird bycatch by the Japanese bluefin tuna fleet fishing south of Africa averaged 0.36 birds per 1 000 hooks during 1992–1996, with a trend towards decreasing catch rates during 1995–1996 (Ryan and Boix-Hinzen 1998). The greater bycatch within the EEZ probably results in part from the large numbers of birds that aggregate in South African shelf waters and along the shelf-break (Ryan and Rose 1995). The three species most frequently caught within the EEZ (shy and black-browed albatrosses, and white-chinned petrels) are much more abundant over the shelf and shelf-break than in adjacent oceanic waters. Also, birds foraging in this area are predisposed to attend fishing vessels, because they rely to a large extent on scavenging discards from hake *Merluccius* spp. trawlers (Ryan and Moloney 1988).

The marked regional differences in seabird bycatch within the South African EEZ probably were determined in part by the numbers of birds attending longliners in each area (Fig. 2). Surprisingly, there was no increase in bycatch on sets made during the day, because this typically is the single most impor-

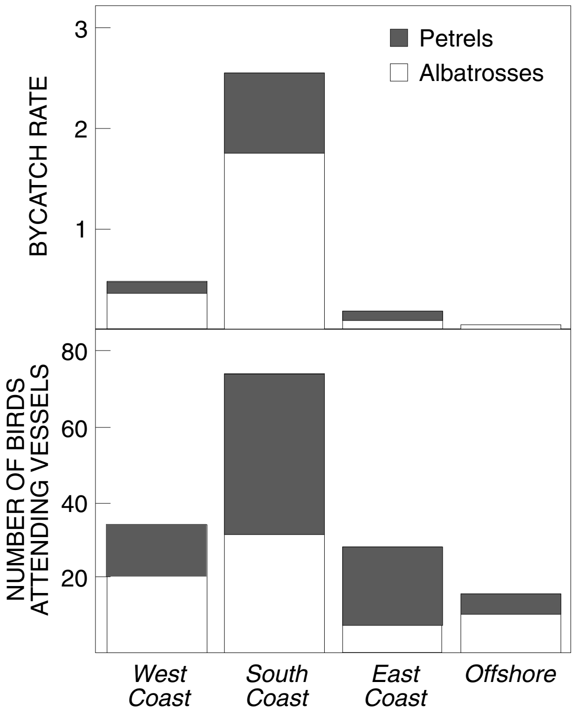

Fig. 2: The bycatch rates of albatrosses and petrels compared with the average numbers of albatrosses and petrels attending tuna longline vessels in three areas off the South African coast, and in international waters off the Northern Cape and southern Namibia (see Fig. 1)

tant factor determining bycatch (e.g. Klaer and Polacheck 1998). However, levels of deck-lighting during night sets need to be investigated. It is unusual for albatrosses to be caught during night sets, suggesting that light levels are excessive. The difference between Japanese and South African vessels may be related to gear differences. The longer branch lines and absence of weights near the hooks may result in Japanese hooks remaining close to the surface longer than hooks set from South African vessels. Japanese vessels may also attract more birds owing to the greater density of hooks and longer trip lengths (bird numbers at vessels tend to increase during successive sets made in the same area; cf. Barnes *et al*. 1997). These differences may also account for the greater numbers of petrels killed by Japanese vessels.

Assessing the impact of the South African tuna fishery on seabird populations requires an estimate of the numbers of birds killed. The reliability of extrapolated mortality estimates is compromised by the low proportion of fishing effort observed, especially for foreign vessels (Table I). However, in the absence of more complete datasets, a precautionary approach should be adopted, and actions taken on the assumption that the extrapolated estimates are accurate. Extrapolating from the bycatch data and using annual effort data in Table I, the estimated annual seabird mortality within the South African EEZ is 19 000–30 000 birds, of which 70% are albatrosses. A value of 19 000 birds is obtained by applying the average bycatch rate (1.6 birds per 1 000 hooks) across the fishery. Treating Japanese and South African vessels separately and assuming that Taiwanese vessels catch birds at a rate intermediate between Japanese and South African vessels (a conservative assumption, given that Taiwanese vessels use gear similar to Japanese vessels), increases the estimate to 25 000 birds. Assuming Taiwanese bycatch is similar to that of Japanese vessels, raises the estimated mortality to as many as 30 000 birds per year.

The estimated numbers of birds killed in the South African EEZ is an order of magnitude greater than the estimated bycatch by tuna longlining within the Australian and New Zealand fisheries, and is more than double that in the Brazilian fishery (Murray *et al*. 1993, Gales *et al*. 1998, Olmos *et al*. in press). The bycatch rates by both South African and Japanese fisheries are both well in excess of the suggested interim target level of 0.05 birds per 1 000 hooks (Environment Australia 1998). Clearly there is need for urgent action to reduce seabird bycatch within South African waters. Several proven measures to reduce bycatch are known (Brothers *et al*. 1999), but merely writing these into permit conditions is insufficient. Robertson (1998) describes the problems involved in changing longline fishing practices, and highlights the need for strong incentives to bring about change. The South African government must get to grips with this problem if it is to meet its national (Anon. 1997) and international (F.A.O. 1999) responsibility to conserve seabirds. As a first step, much higher proportions of fishing vessels must be accompanied by observers that are trained to assess the impacts on seabirds, and advise on effective measures to reduce seabird bycatch.

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