

Estimates of seabird by-catch along the Patagonian Shelf by Argentine longline fishing vessels, 1999–2001.

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Summary

The incidental mortality of albatrosses Diomedidae and petrels Procellariidae by longline fishing vessels, has been assessed and analysed in several areas of the globe. We provide the first direct estimates of incidental mortality rates of albatrosses and petrels along the Argentine Shelf and shelf break. The estimated by-catch rate for the whole period analysed (1999–2001) was 0.04 birds/1,000 hooks, with a maximum of 0.20 birds/1,000 hooks observed in 1999. Annual captures averaged 1,160 birds; however, the large variation observed indicates that annual by-catch may be in the order of thousands, with around 10,000 seabirds being killed by longliners through the study period. Most of the captures were observed along the Patagonian shelf break. At least 12 bird species were incidentally taken, with Black-browed Albatrosses *Thalassarche melanophris* and White-chinned Petrels *Procellaria aequinoctialis* accounting for about 80% of total captures. The information provided in this study allowed the design and future implementation of mitigation measures and new survey methods onboard longliners operating in Atlantic waters on the Argentine shelf.

Introduction

The incidental mortality of albatrosses Diomedidae and petrels Procellariidae by longline fishing vessels has been assessed and analysed in several areas of the globe. It is believed to be one of the factors leading to the population decrease of various seabird species, some of which face severe conservation problems (Croxall 1998, Tasker *et al.* 2000, Tickell 2000). In waters around Australia and New Zealand, the trends of seabird catch rates by Japanese tuna longline vessels over the last decade show an apparent fall from 0.4 birds/1,000 hooks to levels of between 0.1 to 0.2 birds/1,000 hooks and down to 0.02 birds/1,000 hooks due to the use of several mitigation measures (e.g. streamer lines, night setting, weighted lines) (Alexander *et al.* 1997, Baird 2000, Molloy *et al.* 2000). Based on current fishing levels, these recent rates equate to between 1,000 to 3,500 birds being killed each year (Gales *et al.* 1999). Since 1996 by-catch rates at South Georgia have been steadily decreasing, reaching in the year 2000 the rate of 0.001 birds/1,000 hooks set, which means less than 50 seabirds caught in about 15 million hooks set. This low mortality level was achieved by a combination of

several mitigation measures together with the temporal separation of the fishing season and the breeding season for seabirds (see Agnew *et al.* 1999, Robertson *et al.* 2001, among others). However, global by-catch remains a major threat to be addressed and probably still leads to around 0.4 captures for every 1,000 hooks set (see Robertson and Gales 1998).

Despite the low catch rates now prevailing in regulated fisheries in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Area, this by no means removes the problem for the albatross and petrel populations breeding in the area. This is because albatrosses and petrels perform large-scale foraging movements both during their breeding and non-breeding seasons (see Robertson and Gales 1998, Tickell 2000). Several studies have also shown clearly the importance of the Atlantic waters of South America – and mainly the Patagonian shelf and shelf-break – as a foraging area for pelagic seabirds (Prince *et al.* 1998, González-Solís *et al.* 2002, Croxall and Wood 2002, Huin 2002). Here, the reported by-catch rates are much higher than in the Antarctic and subantarctic: 0.32–0.10 birds/1,000 hooks in bottom longliners, 0.09–1.35 birds/1,000 hooks in pelagic longliners operating in waters off Brazil (Olmos *et al.* 2000), and up to 1.70 birds/1,000 hooks in Atlantic waters off Uruguay (Stagi and Vaz-Ferreira 2000). The only estimate of seabird mortality given for Argentine waters is based on fishing activity over the Patagonian shelf and the extrapolation of by-catch rates for nearby areas available in the literature: between 4,000 and 14,000 birds were killed in the Patagonian shelf between 1994 and mid 1995 (Schiavini *et al.* 1998).

Most of the 12 longline vessels operating in Argentine waters during the 1990s used the Spanish (double line) method while targeting mainly Patagonian toothfish *Dissostichus eleginoides* and kingclip *Genypterus blacodes*. Currently, ten longline vessels are fishing legally in the Patagonian shelf, most of them using the autolining (Mustad single line) method. Here, we give the first estimates of incidental mortality rates of albatrosses and petrels along the Patagonian shelf and shelf break, using data taken onboard fishing vessels by the National Observers Programme.

Methods

Data were collected between 1999 and 2001 by observers from the National Observers Programme of the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP, National Institute for the Research and Development of Fisheries) on board freezer longline vessels, and were analysed by staff of the National University of Mar del Plata (Biology Department) and the Dirección de Fauna Silvestre (Secretaría de Ambiente y Desarrollo Sustentable) in Argentina.

The data analysed in this work provide a partial insight into the by-catch occurring during setting (i.e. the deployment of the longline) and hauling (i.e. the recovery of the longline) operations of longliners fishing along the Argentine Patagonian shelf and shelf-break. Observers were not dedicated full time to gathering information on seabird by-catch since they were tasked to work in the factory too. A total of 2,479 line settings were analysed, which represented 17% of total fishing effort during the study period. Of the observers' reports analysed, 91% contained reliable information about birds captured. When available,

information regarding the use and effectiveness of mitigation measures (night setting, use of bird-scaring streamer lines) during line settings is included.

In the case of vessels targeting Patagonian toothfish, fishing effort (i.e. number of hooks set) was directly estimated on the basis of fishing reports. No data were available from the vessels targeting kingclip and in this case, fishing effort was estimated on the basis of total captures and historical efficiency of longliners fishing this species. Overall estimated fishing effort was considered to have an accuracy in the order of $\pm 10\%$ since the Patagonian toothfish fishery represented more than 75% of total longline fishing effort during the study period.

Most (80%) of the information provided came from line settings carried out during spring and summer (September to February), while the other 20% were set during fall and winter (March to August). Total seabird mortalities were estimated by direct extrapolation of results obtained from the reports analysed, to total fishing effort observed in each year and the whole study period.

Mean capture rates are given \pm one standard deviation. Chi square (χ^2) tests were used to compare captures observed between seasons and after the use of different mitigation measures. Due to the small observed frequencies in 2×2 comparisons, conservative analyses were performed by using Yates's correction. During the data analysis we followed the procedures given in Zar (1999).

Results

Estimated by-catch rate for the whole period analysed was 0.04 ± 0.40 birds/1,000 hooks, with a maximum of 0.20 ± 0.30 birds/1,000 hooks reported during 1999 (Table 1). Maximum rate per trip was 0.26 birds/1,000 hooks, while maximum rate per longline set was 14.81 birds/1,000 hooks. A steep decline in captures was observed when comparing the by-catch values for 1999 with those from the following years ($\chi^2 = 743.3$, $df = 1$, $P < 0.001$). On the basis of around 29 million hooks set annually, and an average of 0.04 birds/1,000 hooks, 1,160 seabirds would be killed annually along the Patagonian shelf. However, if higher by-catch rates were more typical (e.g. 0.26 birds/1,000 hooks considering the upper boundaries of the 95% confidence interval observed) then this value could be more than 7,000 birds. Most captures were observed close to the edge of the continental shelf or on the shelf break, between 37°S and 48°S, where most of the fishing effort was also concentrated (Figure 1).

At least 12 bird species were incidentally taken, comprising six albatross and six petrel species (Table 2). Most birds killed were Black-browed Albatrosses *Thalassarche melanophris* or White-chinned Petrels *Procellaria aequinoctialis* (more than 55% and 20% of total captures, respectively). No other species accounted for more than 5% of total birds taken (Table 2).

Of the total line setting operations analysed, 99% contained information on the use of mitigation measures. Most (93%) of the birds reported were incidentally taken during line settings. Bird-scaring streamer lines were used considerably more frequently during daytime sets than during night-time sets (83% and 48%, respectively). The use of streamer lines significantly reduced the level of by-catch ($\chi^2 = 242.5$, $df = 1$, $P < 0.001$), both during day and night settings (reductions of 78% and 74%, respectively, $\chi^2 > 51.1$, $df = 1$, $P < 0.001$ in both comparisons). The number of seabirds captured during settings by vessels using the Spanish

Table 1. Number of line sets and by-catch rates (birds/1,000 hooks deployed) observed in longline vessels fishing in Argentine shelf and shelf break in the period 1999–2001.

	1999	2000	2001	Overall
Mean by-catch rate (\pm SD)	0.20 \pm 0.30	0.02 \pm 0.40	0.08 \pm 0.18	0.04 \pm 0.40
95% Confidence Interval (CI)	0.13–0.26	0.01–0.04	0.06–0.10	0.02–0.05
Number of settings analysed	71	2,008	400	2,479
Maximum observed rate	1.11	14.81	1.85	14.81
Settings without by-catch	51 %	96 %	63 %	89 %
Vessels using S/A method ^a	2/0	2/12	1/3	5/15
Hooks deployed annually	35 \times 10 ⁶	26 \times 10 ⁶	26 \times 10 ⁶	29 \times 10 ⁶
Total birds taken (95% CI)	7,000 (4,550–9,100)	520 (260–1,040)	2,080 (1,560–2,600)	9,600 (6,370–12,740)

^aSpanish (S) vs. Autoline (A)

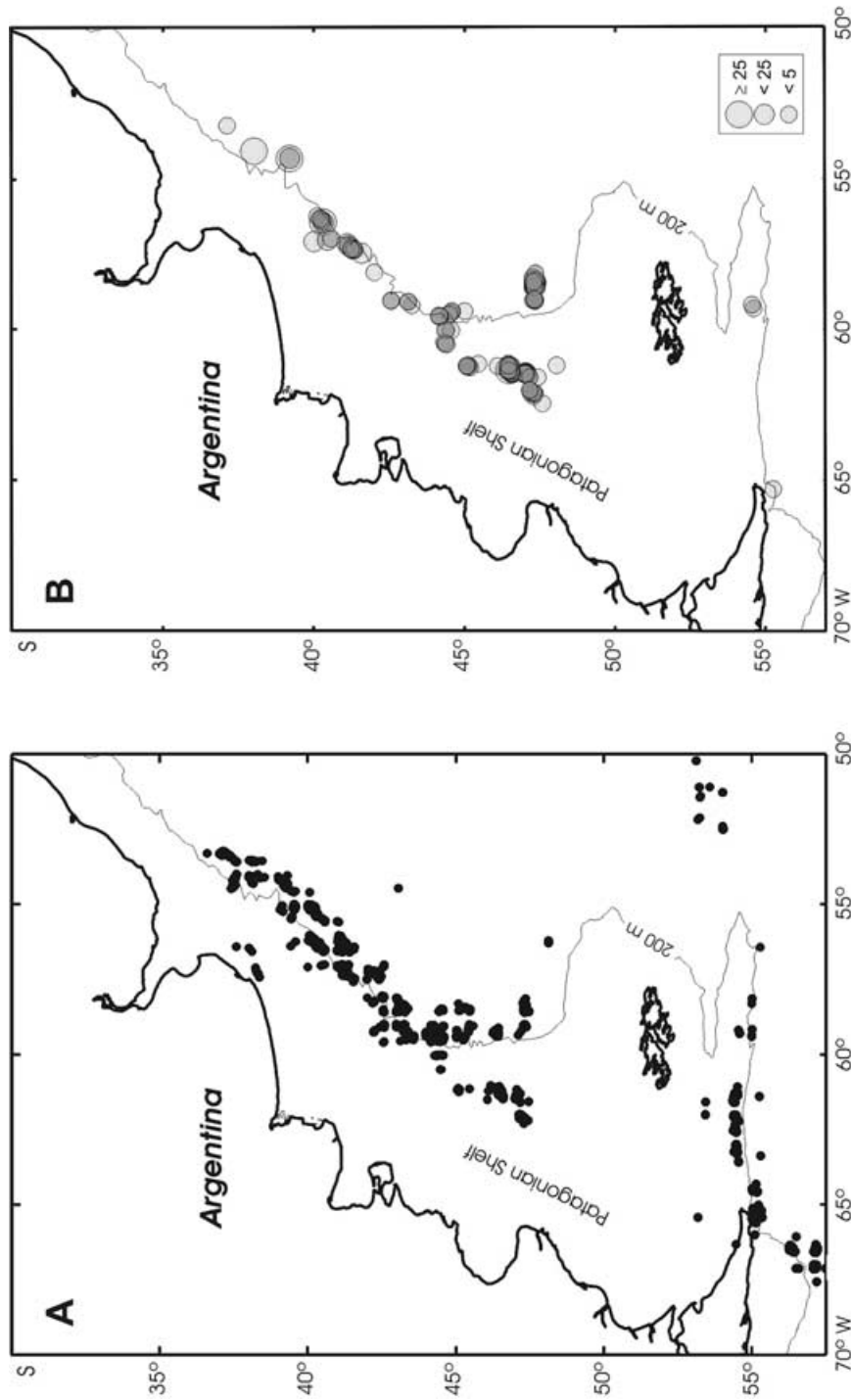


Figure 1. Distribution of sets analysed by longline fishing vessels in Patagonian shelf and shelf break (A), and location and number of seabirds taken (B) in those sets.

Table 2. Percentage by-catch by species, recorded by observers on board longline fishing vessels on Argentine shelf and shelf break. Status of conservation of species is given in parentheses: Vulnerable (V), Endangered (E) (BirdLife International 2001).

		1999 (n = 163)	2000 (n = 394)	2001 (n = 344)	Total (n = 901)
Wandering Albatross ^(V)	<i>Diomedea exulans</i>	11.7	–	0.3	2.2
Southern Royal Albatross ^(V)	<i>Diomedea epomophora</i>	6.1	–	0.9	1.4
Black-browed Albatross ^(V)	<i>Thalassarche melanophris</i>	13.5	84.8	45.3	56.7
Grey-headed Albatross ^(V)	<i>Thalassarche chrysostoma</i>	1.2	–	1.5	0.8
Sooty Albatross ^(V)	<i>Phoebastria fusca</i>	–	0.3	–	0.1
Southern Giant Petrel ^(V)	<i>Macronectes giganteus</i>	9.2	0.3	5.2	3.8
White-chinned Petrel ^(V)	<i>Procellaria aequinoctialis</i>	53.4	1.0	26.2	20.1
Cape Petrel	<i>Daption capense</i>	–	3.0	8.7	4.7
Sooty Shearwater ^(V)	<i>Puffinus griseus</i>	3.1	3.0	–	1.9
Grey Petrel	<i>Procellaria cinerea</i>	–	–	0.9	0.3
Southern Fulmar	<i>Fulmarus glacialisoides</i>	–	–	0.3	0.1
Tristan Albatross ^(E)	<i>Diomedea dabbenena</i>	0.6	–	–	0.1
Unidentified birds		1.3	7.3	10.8	7.6

method (0.05 birds/1,000 hooks) was significantly greater than on the vessels using the autolining method (0.035 birds/1,000 hooks) ($\chi^2 = 52.34$, $df = 1$; $P < 0.001$). Significant differences were observed when comparing by-catch levels between seasons ($\chi^2 = 405.3$, $df = 3$, $P < 0.001$), with by-catch rates during the summer being higher than those reported during autumn, winter and spring.

Discussion

The estimated capture rate reported here of 0.02 to 0.20 birds per 1,000 hooks deployed, was much lower than that reported in other areas located north of the Patagonian shelf. For example, in waters off Uruguay, the by-catch rate reached 1.7 birds per 1,000 hooks (Stagi and Vaz-Ferreira 2000). The rates from Brazilian waters showed the widest range, varying from 0.10 to 0.32 birds per 1,000 hooks for bottom longliners, and from 0.09 to 1.35 birds per 1,000 hooks for pelagic longliners targeting broad-billed swordfish *Xiphias gladius* (Olmos et al. 2000).

The estimated average annual mortality along the Patagonian shelf of 1,160 birds should be considered as the minimum number of seabirds taken. The large variation indicates that annual by-catch levels may be in the order of thousands, with around 10,000 seabirds being killed by longliners between 1999 and 2001. These values were similar to estimates for the whole longline fleet operating in Brazil, which might cause the death of more than 7,000 seabirds per year (c. 4,200 and 3,100 seabirds by bottom and pelagic longliners, respectively) (Olmos et al. 2000). However, it is important to consider that the fishing effort (in terms of fishing fleet) in Brazilian waters (35 bottom and 22 pelagic longliners, only considering the pelagic fleet operating in southern waters) is much greater than that reported for Argentina (12 bottom longliners).

Black-browed Albatross and White-chinned Petrel were the most affected species, together accounting for 77% of total captures. These results were in close agreement with data from pelagic longliners off Brazil, where 45% of reported captures were White-chinned Petrels, and 24% Black-browed Albatrosses (Olmos et al. 2000). However, these species were less abundant in the Brazilian bottom

longlining coastal fleet, in which more adept diving seabirds (e.g. Great Shearwater *Puffinus gravis*, *Procellaria* spp.) were the main reported species (Olmos *et al.* 2000).

Black-browed Albatross and White-chinned Petrel were recently included in the IUCN Red List of Threatened Species (BirdLife International 2001). The above populations in particular, known to forage in the study area, showed important decreases in the number of breeding pairs on South Georgia (at a rate of 4% per year for the period 1975–2000) (Robertson and Gales 1998), and Malvinas (Falkland) Islands, where the population fell by some 87,000 birds (about 20% of the population) in the period 1995–2000 (N. Huin pers. comm.). The results provided in this study reinforce the fact that these known population declines of Black-browed Albatross in the Malvinas (Falkland) Islands and South Georgia, and White-chinned Petrels at South Georgia (Berrow *et al.* 2000) are, at least partially, linked to by-catch in longline fisheries.

Recently, the Federal Fishery Council (Consejo Federal Pesquero, CFP) of Argentina recommended to INIDEP the quantification – through the Observers Programme – of incidental mortality of seabirds (together with marine mammals and sea turtles) during commercial fishing operations (CFP N° 03/01). This is currently carried out with the assistance of national universities and government organizations in Argentina. Here, each coastal province is responsible for the management of their fisheries and living resources within 12 nautical miles, whereas offshore fisheries are under the national government's control. Argentine fishery legislation is in the process of change, but currently no legislation exists regarding the incidental capture of seabirds and other fauna. Among the local needs related to the conservation of albatrosses and petrels and the reduction of incidental mortality, the following points should be addressed in the near future: (1) give priority and continuity to the Observers Programme; (2) provide legal support to resolution N° 03/01 of the CFP; and (3) update and extend the educational material provided to observers and fishermen, emphasizing the importance of incidental capture data, the use of appropriate mitigation measures, and the consequent benefits of more efficient profitable fisheries. The information provided in this study allows the design and future implementation of mitigation measures and new survey methods onboard longliners operating in Atlantic waters on the Argentine shelf.

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