

TRENDS IN SEABIRD AND PATAGONIAN TOOTHFISH *DISSOSTICHUS ELEGINOIDES* LONGLINER INTERACTIONS IN FALKLAND ISLAND WATERS, 2002/03 AND 2003/04

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SUMMARY

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The Patagonian Toothfish *Dissostichus eleginoides* longline fishery in the Falkland Islands is limited to two vessels that must operate to seabird conservation measures. Approximately 7.5 million hooks and 9.6 million hooks were set in 2002/03 and 2003/04 respectively, with observers present during the setting of 59% of all lines and observing 22% of all hooks recovered during the period. Eight mortality events were recorded during the two years, involving a total of 29 and eight Black-browed Albatrosses *Thalassarche melanophrys*, giving an observed catch rate of 0.011 and 0.005 seabirds per 1000 hooks in 2002/03 and 2003/04 respectively. Based on these bycatch rates, the estimated total mortality for 2002/03 was 80 Black-browed Albatrosses [95% confidence limits (CL): 58, 102] and for 2003/04, 44 Black-browed Albatrosses (95% CL: 28, 62). The total estimated number of seabirds secondarily hooked decreased from 239 seabirds in 2002/03 to 46 seabirds in 2003/04, and this reduction was attributable to the more effective use of mitigation measures. Injury and delayed mortality caused by the ingestion of offal, bycatch and used bait containing hooks (and to a lesser degree, from secondary hookings) cannot be estimated and is a significant cause for concern.

Key words: Black-browed Albatross, *Thalassarche melanophrys*, mortality, longlining, secondary hooking, Patagonian Shelf

INTRODUCTION

Incidental mortality of seabirds by fishing vessels setting longlines has been documented around the world, and the decline of many seabird species is linked to longline activities (e.g. Brothers 1991, Dalziell & De Poorter 1993, Weimerskirch *et al.* 2000, Lewison & Crowder 2003, Delord *et al.* 2005, Laich *et al.* 2006). Demersal longliners fishing for Patagonian Toothfish *Dissostichus eleginoides* in the Falkland Islands have hooked and drowned birds of six species, including Black-browed Albatrosses *Thalassarche melanophrys* and White-chinned Petrels *Procellaria aequinoctialis* (Barton 2002, Reid *et al.* 2004). A further 13 seabird species that are killed in longline fisheries elsewhere have been sighted in Falkland waters (Brothers *et al.* 1999, White *et al.* 2002).

A census of all Black-browed Albatross colonies in the Falkland Islands in 2000/01 estimated a breeding population of 382 000 pairs, a decline of 18% compared to that estimated in 1995/96, and because chick fledging success is high, this rapid rate of population decrease is suggested to be linked to fisheries mortality (Huin 2001). In Falkland Island waters, up to 150 vessels, predominantly squid jiggers and squid and finfish trawlers, can be working at any one time. The risk of seabird mortality on demersal longliners and trawlers is relatively well understood in the Falkland Islands, and successful mitigation measures have been developed and employed in these fisheries since 1996 and 2004 respectively (Reid *et al.* 2004, Sullivan *et al.* 2006).

Exploratory longline fishing commenced in the Falkland Islands in 1992 and began commercially in 1994 with the issuing of two licences (hence, a maximum of two vessels operate at any one time). The vast majority of longliners employed in the fishery have used the “Spanish” double-line system rather than an automated system (Brothers *et al.* 1999). Before 1996, very few specific seabird conservation measures were operative in the Falkland Islands toothfish longline fishery and incidental bycatch was high, with up to 90 Black-browed Albatrosses killed in a single day (Brothers 1995). Subsequently, seabird conservation measures were introduced, and from July 2001 onwards, the Falkland Islands longline licence has contained five conditions pertaining to line setting. These conditions are

- use of a 150-m bird-scaring (tori) line (or a design shown to be equally effective),
- line weighting of at least 8.5 kg/40 m for vessels using the “Spanish” system,
- prohibition of offal discard during setting,
- use of thawed bait and
- where practicable, night setting.

To reduce secondary hooking of seabirds during hauling (i.e. caught through the wing, leg or bill on the hook line during hauling and brought onto the vessel alive), discharge of offal should take place on

the side opposite to hauling. In addition, some “housekeeping” rules are imposed and monitored by observers. These include the use of metal-lined setting boxes (reduces the number of hooks snagging on the plastic edges); removal of all hooks from bycatch species, offal and used bait before discharge; use of a Brickle curtain of streamers across the hauling hatch (Brothers *et al.* 1999); and care in the removal of hooks from seabirds that are secondarily hooked.

Since 2001, observers from the Falkland Islands Fisheries Department (FIFD), Falklands Conservation (FC) and the longline fishing company, Consolidated Fisheries Limited (CFL), have worked aboard longliners to record seabird mortality and monitor adherence to licence conditions. FIFD and CFL observers also have an enforcement role and can intervene when licence regulations or best practices are not followed.

Here we document observed and estimated seabird mortality for the years 1 July 2002 to 30 June 2003 and 1 July 2003 to 30 June 2004, and we compare the results for this fishery with those for previous years (Brothers 1995, Reid *et al.* 2004).

METHODS

Data collection

Five Spanish-system longliners (including three flagged to the Falkland Islands and two flagged to Korea) and one New Zealand-flagged autoliner fished for between one and 18 months between July 2002 and June 2004. Falkland Islands-registered vessels generally used prefabricated concrete weights and some steel weights, and Korean- and New Zealand-flagged vessels used steel weights only. Observers made a total of 29 trips on longline vessels during the two years. During each observer trip, bird-scaring line configuration was recorded, and where concrete weights were used, 30 were weighed to 0.1 kg using the vessel’s electronic balance.

Setting and hauling observations

Seabird species abundance was estimated in a 500×500-m area astern of the ship at pre- and post-set and on one to 10 occasions during hauling. Northern *Macronectes halli* and Southern *M. giganteus* Giant Petrels and Northern *Diomedea sanfordi* and Southern *D. epomophora* Royal Albatrosses were not differentiated specifically. All sets with sufficient light for viewing were observed in their entirety from above the setting window on the stern deck. Foraging attempts made by seabirds on baited hooks were recorded following the methods of Reid & Sullivan (2004). Approximately 10% of lines that were set entirely at night were observed from the setting room and stern deck. Vessel direction and wind speed and direction was recorded for each line set.

When not involved in other observer activities and allowing for food and rest breaks, observers watched the hauling of as many hooks as possible so as to record killed and secondarily hooked seabirds. Observations were made from the bow deck directly above the hauling hatch, and most observation periods were randomly spread across the four to 12 hours taken to haul the line. FIFD observers were also required to spend every fourth day sampling fish in the factory. Where feasible, fish sampling was completed on lines for which low rates of seabird interactions were recorded during setting.

Where possible, hooked and drowned seabirds were hauled aboard, and the location of the hook was noted. Postmortems were

conducted ashore to determine sex, breeding status and stomach contents. Age of Black-browed Albatrosses up to six years of age was determined following Prince & Rodwell (1994).

Data analysis

Seabird mortality data were stratified spatially and temporally according to the regions and periods (“strata”) identified by Reid *et al.* (2004). The five temporal periods were Winter (1 May–31 August), Prospecting (1–30 September), Egg (1 October–31 December), Young Chick (1 January–28 February) and Old Chick (1 March–30 April). Reid *et al.* (2004) separated Falkland Island waters into two regions, Burdwood Zone (>53°15’S) and Falklands Zone (<53°15’S), because of a higher number of Black-browed Albatrosses around vessels fishing in 2001/02 near the Burdwood Bank as compared with the more northerly fishing grounds. During the Egg period in 2003/04, significantly more Black-browed Albatrosses and giant petrels were attending longliners in the Burdwood Zone than in the Falklands Zone ($t_{96} = 4.65$, $p < 0.01$, and $t_{96} = 5.05$, $p < 0.01$ respectively). Consequently, the two regions of Burdwood Zone and Falklands Zone were maintained in the present study.

The estimated number of seabirds killed and its variance were calculated using the per-hook estimator of Klaer & Polacheck (1997), as employed by Reid *et al.* (2004). No observations were made in the Falklands Zone in the Young Chick period in 2003/04, and the overall observed catch rate was applied to that period.

A significant number of albatrosses were observed hooked and drowned during the hauling of one section of a line in the Old Chick period. On enquiry, it was found that the bird-scaring line broke at the beginning of setting and was not replaced. Because all the other observed lines set in the same period had bird-scaring lines in use, this particular line was considered not to be random or representative of the other sets. For this reason, it was treated separately, and an estimate was made of the total mortality of this single line, which was then added to the overall estimate for the year.

Statistical differences in yearly estimates of seabird bycatch were determined using a Student *t*-test with a Dunn–Sidak correction.

Seabird secondary hooking data was not differentiated by time or region. The total number of observed secondarily hooked seabirds was used to calculate an annual estimate.

RESULTS

Hooks set and observer coverage

Lines were set in all strata except in the Burdwood Zone during the Prospecting period in 2002/03. Observer coverage reflected the general distribution of longlining effort in each year (Figs. 1 and 2). Hooks totalling 7 377 656 on 728 lines were set by longliners operating within Falkland Islands waters in 2002/03. Observers were aboard during the setting of 524 lines (72%) and watched some part of the hauling of 426 lines (59%). Of all hooks recovered in the fisheries in 2002/03, 23% were observed (Table 1).

In 2003/04, 9 631 512 hooks on 1048 lines were set. Lines totalling 710 (68%) were set with observers aboard, and some part of the hauling of 527 lines (50%) was seen. Of all hooks recovered by longliners, 22% were observed (Table 2).

Seabird species at risk during setting

During line setting, eight species were observed attempting to take baited hooks: Black-browed Albatross, Grey-headed Albatross *T. chrysostoma*, royal albatrosses, Wandering Albatross *D. exulans*,

giant petrels, White-chinned Petrel, Antarctic Fulmar *Fulmarus glacialis* and Sooty Shearwater *Puffinus griseus*. A mean of between 20 and 130 Black-browed Albatrosses were present during line setting, and the species was recorded during all seabird surveys

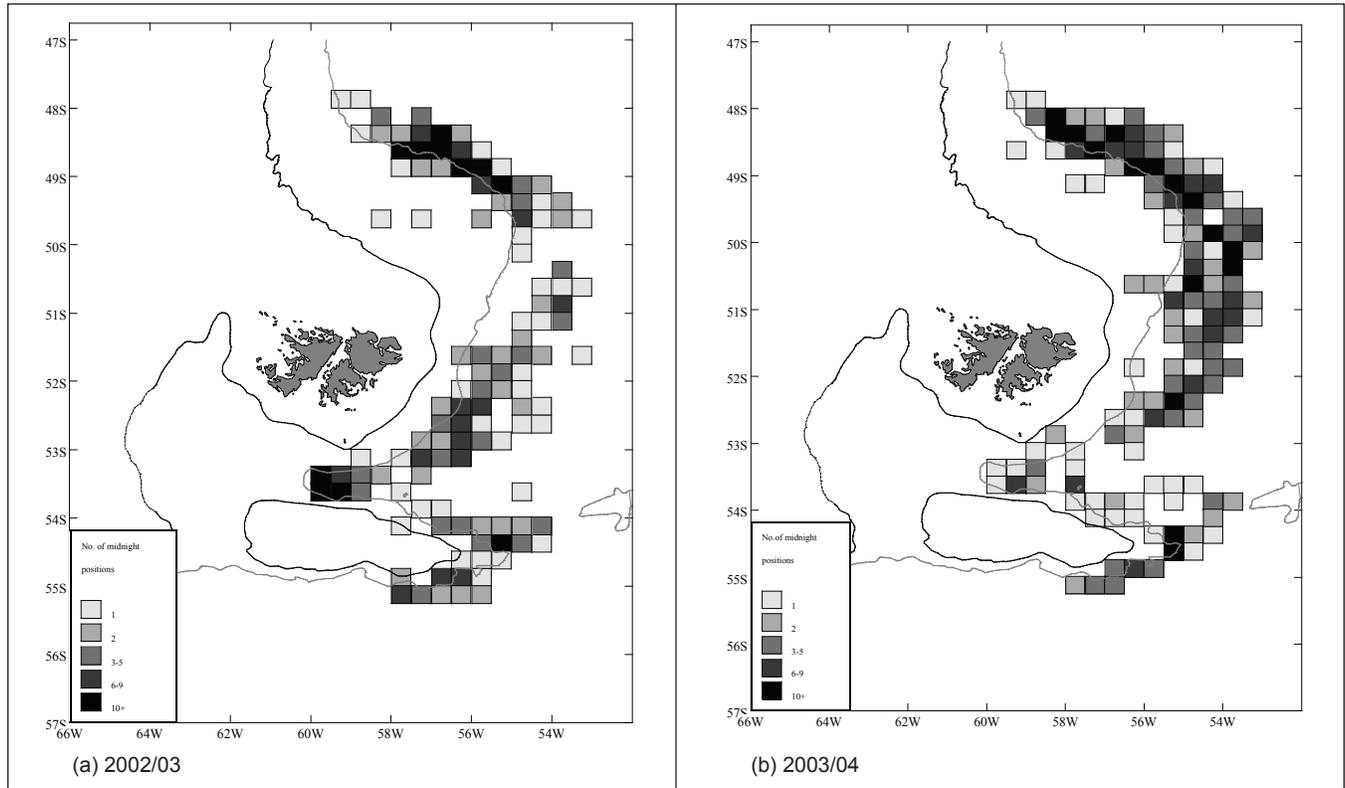


Fig. 1. Total longline effort, displayed as daily location per quarter ICES rectangle for the two vessels in (a) 2002/03 and (b) 2003/04.

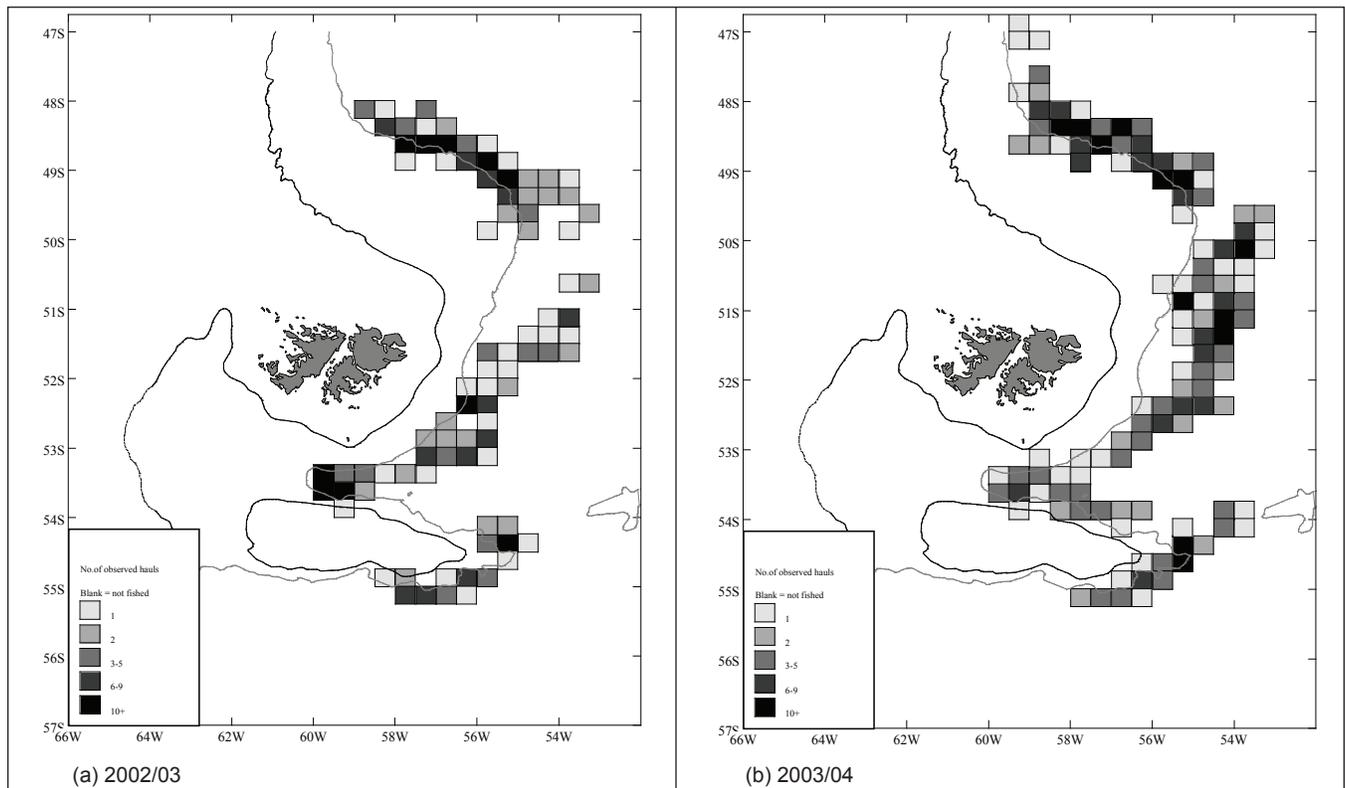


Fig. 2. Hauling observation effort per quarter ICES rectangle in (a) 2002/03 and (b) 2003/04.

(Table 3). Black-browed Albatrosses made more foraging attempts than did any other species, with a mean of 30 to 60 attempts per line made during the Egg, Young Chick and Old Chick periods as compared with a mean of 15 during both the Winter and Prospecting periods (Table 4). White-chinned Petrels were generally present only between the Egg and Old Chick periods, but that species was the second most prolific at making foraging attempts (Table 3).

Observed and estimated seabird mortality

Vessels reported only the killed seabirds recorded by observers; no seabirds were reported killed in daily catch reports when observers were absent from vessels. Observers recorded 29 dead Black-browed Albatrosses in three separate incidences in 2002/03 and nine dead Black-browed Albatrosses in five incidences in 2003/04 (Tables 1 and 2). In four incidents, a single Black-browed Albatross

TABLE 1
Estimated numbers of Black-browed Albatrosses *Thalassarche melanophrys* killed by period and fishing region in Falkland Island waters in 2002/03^a

Period	Region	Hooks		Observed killed	Observed catch-rate (birds/1000 hooks)	Estimated killed	CV
		Total	Observed				
Winter	Burdwood	141 600	32 940	0	0.000	0	0.00
	Falkland	2 209 707	544 658	2	0.004	8	0.27
Prospecting	Burdwood	0	0	0	0.000	0	0.00
	Falkland	757 365	240 073	0	0.000	0	0.00
Egg	Burdwood	871 645	159 785	0	0.000	0	0.00
	Falkland	1 076 885	159 331	0	0.000	0	0.00
Young Chick	Burdwood	1 355 786	394 724	0	0.000	0	0.00
	Falkland	241 390	9 525	0	0.000	0	0.00
Old Chick	Burdwood	512 673	142 533	0	0.000	0	0.00
	Falkland	202 205	41 663	0	0.000	0	0.00
Isolated line	(Young Chick, Burdwood)	8 400	3 175	27	8.504	71	0.15
TOTAL	Burdwood	2 881 704	729 982	0	0.000	0	0.00
	Falkland	4 487 552	995 250	2	0.002	8	0.27
	TOTAL	7 377 656	1 728 407	29	0.011	80	0.14
95% confidence limits				0.003	22		

^a 95% confidence limits calculated as 1.96 times the coefficient of variation (CV). The isolated line was set without a bird-scaring line after it broke at the beginning of line setting.

TABLE 2
Estimated numbers of Black-browed Albatrosses *Thalassarche melanophrys* killed by period and fishing region in Falkland Island waters in 2003/04^a

Period	Region	Hooks		Observed killed	Observed catch rate (birds/1000 hooks)	Estimated killed	CV
		Total	Observed				
Winter	Burdwood	48 000	6 120	0	0.000	0	0.00
	Falkland	3 160 552	828 051	2	0.002	8	0.30
Prospecting	Burdwood	24 000	12 720	0	0.000	0	0.00
	Falkland	694 800	253 673	2	0.008	5	0.00
Egg	Burdwood	1 179 560	289 019	0	0.000	0	0.00
	Falkland	1 350 010	243 083	3	0.016	22	0.38
Young Chick	Burdwood	128 100	34 450	0	0.000	0	0.00
	Falkland	1 603 400	0	0	0.004	7	0.20
Old Chick	Burdwood	595 780	246 751	1	0.004	2	0.21
	Falkland	847 310	189 592	0	0.000	0	0.00
TOTAL	Burdwood	1 975 440	589 060	1	0.002	2	0.21
	Falkland	7 656 072	1 514 399	7	0.005	42	0.21
	TOTAL	9 631 512	2 103 459	8	0.005	44	0.20
95% confidence limits				0.002	17		

^a 95% confidence limits calculated as 1.96 times the coefficient of variation (CV).

was killed; in two incidences, two were killed; and in one incidence, three were hooked and drowned in a 40-m section of the longline. Three incidences occurred during Winter, one during Prospecting, two during Egg and one during Old Chick period. A further 27 dead Black-browed Albatrosses were observed during three hours of observation on one line in the Burdwood Zone in the Young Chick period in 2002/03. The observed catch rate was 0.011 and 0.005 seabirds per 1000 hooks in 2002/03 and 2003/04 respectively.

Based on these bycatch rates, a total of 80 Black-browed Albatrosses [95% confidence limits (CL): 58, 102] are estimated to have been killed in Falkland Island waters during 2002/03 and 44 (95% CL: 28, 62) in 2003/04 (Tables 1 and 2). The total number of seabirds killed in 2003/04 was significantly lower than in the previous year at 134 (95% CL: 80, 188; Reid *et al.* 2004; $t_{732} = 2.46, p < 0.05$). Estimated numbers of seabirds killed in 2001/02 and 2002/03 were not significantly different ($t_{557} = 1.84, p > 0.05$).

TABLE 3
Mean abundance (mean) and frequency of presence (%) of eight seabird species during the setting of between two and 57 daytime sets in each time period in the Falklands and Burdwood zones during 2003/04^a

Species	Falklands								Burdwood					
	Winter (51 surveys)		Prospecting (24 surveys)		Egg (57 surveys)		Old Chick (12 surveys)		Winter (2 surveys)		Egg (41 surveys)		Old Chick (12 surveys)	
	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)
Black-browed Albatross <i>Thalassarche melanophrys</i>	22	98	32	100	78	100	29	100	18	100	137	100	49	100
Giant petrels <i>Macronectes</i> spp.	14	100	10	100	18	100	4	58	7	100	62	100	4	83
White-chinned Petrel <i>Procellaria aequinoctialis</i>	3	12	0	0	10	98	7	100	0	0	8	63	10	100
Royal albatrosses <i>Diomedea</i> spp.	2	33	2	50	1	30	2	17	1	50	5	49	1	8
Wandering Albatross <i>D. exulans</i>	2	31	1	4	2	26	3	67	2	50	3	37	2	67
Antarctic Fulmar <i>Fulmarus glacialoides</i>	5	41	4	50	1	11	5	33	0	0	0	0	3	50
Grey-headed Albatross <i>T. chrysostoma</i>	3	41	1	13	1	9	5	42	0	0	1	15	2	42
Sooty Shearwater <i>Puffinus griseus</i>	1	2	0	0	3	21	2	17	0	0	0	0	1	8

^a Note that in the Young Chick period in Falklands and Burdwood zones and in the Prospecting period in Burdwood Zone, no lines were set during daylight hours to allow seabird surveys to be conducted.

TABLE 4
Mean number of foraging attempts per line made by eight seabird species during each season in 2002/03 and 2003/04 combined

Species	Winter (n=73) ^a	Prospecting (n=29) ^a	Egg (n=141) ^a	Young Chick (n=29) ^a	Old Chick (n=48) ^a
Black-browed Albatross <i>Thalassarche melanophrys</i>	15	16	29	52	59
Giant petrels <i>Macronectes</i> spp.	3	0	17	0	2
White-chinned Albatross Petrel <i>Procellaria aequinoctialis</i>	2	0	80	27	39
Royal albatrosses <i>Diomedea</i> spp.	0	0	1	0	0
Wandering Albatross <i>D. exulans</i>	0	0	3	0	3
Antarctic Fulmar <i>Fulmarus glacialoides</i>	17	2	3	0	3
Grey-headed Albatross <i>T. chrysostoma</i>	9	4	3	4	13
Sooty Shearwater <i>Puffinus griseus</i>	0	1	4	0	3

^a Lines where foraging attempts were recorded.

Of the 38 Black-Browed Albatross deaths observed during 2002/03 and 2003/04, 23 albatrosses were hooked through the bill, seven were hooked through a wing, two were hooked through the throat and hook location was not recorded in six cases. Of 21 dissected Black-browed Albatrosses caught during the Young Chick period in 2002/03 where sex and age could be determined, 19 were males five years old or older and two were females six years old or older. The albatrosses killed in other incidences in which sex and age were ascertained were two young (two to three years old) and two old (five years old or older) individuals of each sex. Of 29 stomachs examined, 24 contained food, with 19 containing between one and nine pieces of bait.

Causes of mortality

Of all lines, 80% and 58% were set at night or during nautical twilight in 2002/03 and 2003/04 respectively. Only one of the eight incidences of mortality occurred at night (Table 5).

On all occasions but one, a bird-scaring line was deployed during line setting. On one longline, set during early dawn, the bird-scaring line broke after becoming caught on the anchor chain immediately after being deployed; it was not replaced. Following this incident, 27 Black-browed Albatross deaths were observed. During 25 of the 29 observer trips conducted during the two years reported here, vessels employed a bird-scaring line with two to three main lines and a buoyant object such as a small buoy joining the lines at the seaward end. Observers conducted four observer trips on Korean-registered longliners where a single bird-scaring line was deployed.

An additional bird-scaring line of Alaskan design (no design details known) was trialled on nine daytime sets until a seabird mortality occurred when some streamers caught on hooks, slowing the rate at which the hook line sank. The Alaskan design needed to be attached at least seven metres above the water surface, which may not have occurred during the trial on the Falklands-flagged vessel.

Line weighting was at or above 8 kg/40 m during eight of 14 observed trips in 2002/03 and during 11 of 15 observed trips in 2003/04. Although three of the eight incidences of mortality during the two-year period occurred when line weighting was below 7.3 kg/40 m, three mortality events that occurred in the breeding season were on lines whose line weighting was at or above 8.0 kg/40 m (Table 5).

During 2002/03 and 2003/04, offal was discarded during setting on at least one occasion during four of 29 observed trips. Offal was released during one of the eight incidences of mortality, in which a Black-browed Albatross was mortally hooked through the wing (Table 5).

Fewer than 50% of setting boxes were metal lined on five of 14 observed trips in 2002/03 and during one of 14 observed trips in 2003/04. One incidence of seabird mortality occurred in each year on vessels using mostly unlined setting boxes (Table 5). All mortality incidences occurred during winds at or above 4 on the Beaufort Scale, but from a variety of directions relative to the vessel (Table 5).

Mortality caused by bird-scaring lines

One Black-browed Albatross and one Pintado or Cape Petrel *Daption capense* were entangled in bird-scaring lines during the Egg period of 2003/04 in a joined two-line design lacking a terminal buoy. When a buoy was subsequently added, no further seabirds were entangled. An additional Black-browed Albatross was killed in a joined three-line design with a terminal buoy in the Old Chick period of 2003/04.

On these occasions, the bird-scaring line was not hauled in. However, it was subsequently shown that Black-browed Albatrosses can survive such entanglements. On two separate occasions in December 2004, a Black-browed Albatross was entangled in the

TABLE 5
Setting conditions on lines where Black-browed Albatrosses *Thalassarche melanophrys* were hooked and drowned

Period	Region	Birds (n)	Time	Tori line design	Weighting regime (kg/40 m), type	Offal discarded	Metal-lined box	Wind (Beaufort)	Relative wind direction
2002/03									
Winter	Falkland	1	Day	3-Line	7.3, Cement	Yes	100%	4	Port
		1	Night	1-Line	8–10, Steel	No	30%	4	Port
Isolated line	Young Chick, Burdwood	27	Dawn ^a	Not used	Approx. 8, ^a cement	No	100%	NR	NR
2003/04									
Winter	Falkland	2	Day	3-Line	7.2, Cement	No	100%	7	Starboard
Prospecting	Falkland	2	Day	3-Line	7.3, Cement	No	100%	7	Stern
Egg	Falkland	1	Day	2-Line	8–10, Steel	No	30%	7	Stern
		3	Day	3-Line	8.5, Cement	No	100%	7	Stern
Old Chick	Burdwood	1	Day	2-Line Alaskan	8.3, Cement	No	100%	5	Stern

^a No weights were measured, and the observer approximated the line weighting at 8 kg/40 m. The last 15 minutes of setting occurred during nautical dawn, but only hooks set before dawn were seen hauled back onto the vessel.

NR = not recorded.

bird scaring line and, although being trapped for up to 10 minutes (the time taken to retrieve to the line), both albatrosses were later released without apparent injury (HMO pers. obs.). Vessels are now instructed to cease setting immediately if seabirds become entangled with the bird-scaring line.

Seabird species and risks during hauling

During hauling, Black-browed Albatrosses and giant petrels were present during every seabird survey conducted, with highest numbers in the Egg and Young Chick periods (mean > 150) as compared with other periods (Table 6). Means of five to 15 royal albatrosses and Wandering Albatrosses were present at hauling during 50% to 90% of seabird surveys. Royal albatrosses and Wandering Albatrosses were thought to have consumed the vast majority of discarded offal and bycatch fish (HMO & TAR pers. obs.).

Discharge of discards from both sides of the vessel during hauling was reported on four of 14 observer trips in 2002/03. These discharges included occurrences during three observer trips on one vessel, but the practice ceased after a factory alteration. All vessels were reported discharging discards on the side opposite to hauling during 2003/04. A Brickle curtain was employed during only eight trips in 2002/03, but during all observer trips in 2003/04.

During hauling, 56 and 10 seabirds (26 Pintado Petrels, 20 Black-browed Albatrosses, 17 giant petrels, one Grey-headed Albatross, one Wandering Albatross and one White-chinned Petrel) were recorded hooked in 2002/03 and 2003/04 respectively. The rates of secondarily hooked seabirds were 0.032 and 0.005 seabirds per 1000 hooks respectively, giving an estimated total number of seabirds hooked of 239 in 2002/03 and 46 in 2003/04. Petrels were hooked primarily through the foot or wing; albatrosses tended to be hooked through the bill and neck.

During four of 14 observer trips in 2002/03, hooks were either not removed or infrequently removed from bycatch species, offal and used bait before discard; in 2003/04, only one observer trip recorded hooks not always being removed.

DISCUSSION

Seabird mortality

Black-browed, Grey-headed and Wandering Albatrosses, and Pintado, giant and White-chinned Petrels have previously been

caught as bycatch on toothfish longline vessels in Falkland Island waters (Brothers 1995, Barton 2002, Reid *et al.* 2004). During 2002/03 and 2003/04, 38 Black-browed Albatrosses were observed hooked and drowned. During this period, a giant petrel was also reported hooked and drowned by a FIFD observer working on a Falklands-registered toothfish longliner fishing on the high seas southeast of the Falkland Islands (FIFD unpubl. data).

Half of the mortality events during 2002/03 and 2003/04 were of multiple albatrosses along short sections of longline. This highlights a problem: The hooking of one seabird causes increased mortality, because the line sinks more slowly due to the positive buoyancy of the seabird and its struggle to resist being pulled under water (Reid & Sullivan 2004).

Mortality of Black-browed Albatrosses in this study occurred under one or some of the following conditions:

- Lack of a bird-scaring line
- Line weighting below 8.0 kg/40 m
- Daytime setting
- Discarding of offal during setting
- Use of unlined setting boxes
- High winds

The importance of mitigation measures in the Falkland Islands longline fishery supports previous research in the islands and elsewhere (Løkkeborg 1998, Robertson 2000, Melvin *et al.* 2004, Reid & Sullivan 2004). The critical need for a bird-scaring line was highlighted by the multiple mortality event on the only longline set during 2002/03 and 2003/04 period without such protection. The Falkland Islands Government successfully prosecuted the fishing master and owner of the vessel, and CFL as the charterer of the vessel. Our research also identified that a line-weighting regime of 8 kg/40 m on Spanish-system longliners may not be sufficient to prevent all Black-browed Albatross mortality during the breeding season.

Changes in mortality rates between 2001/02, 2002/03 and 2003/04

Brothers (1995) reported bycatch rates of up to 90 Black-browed Albatrosses per day by longliners in Falkland Island waters. However, by 2001/02, it was estimated that only 134 seabirds, including 126 Black-browed Albatrosses and eight White-chinned

TABLE 6
Mean abundance (mean) and frequency of presence (%) of seven seabird species during between 97 and 486 surveys made during hauling in each time period during 2002/03 and 2003/04 combined

	Winter (486 surveys)		Prospecting (286 surveys)		Egg (440 surveys)		Young Chick (97 surveys)		Old Chick (204 surveys)	
	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)	(mean)	(%)
Black-browed Albatross <i>Thalassarche melanophrys</i>	75	95	97	100	153	100	259	100	66	100
Giant petrels <i>Macronectes</i> spp.	108	100	124	100	121	100	189	100	51	100
Pintado Petrel <i>Daption capensis</i>	168	100	237	100	127	100	3	49	32	63
White-chinned Petrel <i>Procellaria aequinoctialis</i>	2	7	4	9	12	80	11	89	19	95
Royal albatrosses <i>Diomedea</i> spp.	9	67	6	81	13	88	10	88	6	49
Wandering Albatross <i>D. exulans</i>	4	74	3	87	8	88	7	91	9	97
Grey-headed Albatross <i>T. chrysostoma</i>	4	37	2	23	1	6	0	0	3	55

Petrels, were killed annually because of the effective employment of mitigation measures by longline vessels fishing in the Falkland Islands (Reid *et al.* 2004). The estimated bycatch rate for the longline fishery in the Falkland Islands between July 2001 and June 2004, based on observations of between 19% and 23% of hooks recovered each year, did not decrease significantly between 2001/02 and 2002/03 (0.016 and 0.011 seabirds per 1000 hooks respectively). However, the bycatch rate for 2003/04, at 0.005 birds per 1000 hooks, was significantly lower than that recorded during the previous two years.

The Falklands Islands National Plan of Action—Seabirds for reducing incidental catch of seabirds in the toothfish longline fishery aims to reduce seabird mortality to below 0.01 birds per 1000 hooks by 2004/05 and to below 0.002 birds per 1000 hooks by 2006/07 (NPOA—FI 2003). The rate of reduction in mortality between 2002/03 and 2003/04 indicates that the fishery was meeting the NPOA—FI schedule at that time. The low mortality rate between July 2002 and June 2004 suggests that longlining within Falkland Island waters has a minor role in the current population decline of the Falklands Black-browed Albatross.

Mortality caused by bird-scaring lines

In fisheries where bird-scaring lines are used, contact between seabirds and bird-scaring lines and streamers is known to occur, but no fatal entanglements have been reported (E. Melvin, P. Lurcock & G. Robertson pers. comm.). In the Falkland Islands, three seabirds were fatally entangled in bird-scaring lines in 2003/04; additionally, a Wandering Albatross banded as a fledging at South Georgia was similarly killed on a Falkland Islands—registered toothfish longliner fishing on the high seas southeast of the Falkland Islands in February 2004 (FIFD unpubl. data). The bird-scaring line design used by vessels fishing in Falkland Island waters involves joining multiple lines at the seaward end with a buoy; bird-scaring lines in other fisheries for the most part use single or multiple separated lines. At least two interpretations are possible for the observed mortalities within Falkland Islands waters:

- mortalities are occurring in other areas, but are not being reported; or
- there are problems with the bird-scaring lines currently being used within the Falkland Islands.

Bird-scaring line collisions and entanglements should be monitored by observers on vessels using these designs to determine whether they pose a threat to albatrosses.

Secondary hooking

Gilman *et al.* (2005) suggest that estimates of longline seabird mortality need to take into account delayed mortality caused by secondary hooking and hook ingestion through the consumption of longline discards containing hooks. However, few published estimates include reference to rates of either type, although Gandini *et al.* (2004) reported the secondary hooking of 29 Southern Giant Petrels over a three-month period on a demersal longliner fishing in Argentinean waters.

In the Falkland Islands longline fishery, the total estimated number of seabirds secondarily hooked decreased from 239 seabirds in 2002/03 to 46 seabirds in 2003/04, because of the increased use of the Brickle curtain, and measures to prevent offal and used bait washing out of the hauling bay. Although most seabirds secondarily

caught during 2002/03 and 2003/04 were hooked in the leg or wing, which may not have caused considerable long-term problems, seven seabirds were hooked through the bill, possibly causing long-term problems or death.

On islands in southern Chile and on South Georgia, longline hooks have been found in diet samples collected from adults and chicks of Wandering and Black-browed Albatrosses alike (Arata & Xavier 2003, Xavier *et al.* 2004). Limited diet sampling of Black-browed Albatrosses in the Falkland Islands has not revealed hook consumption (N. Huin pers. comm.). In Falkland Island waters, royal albatrosses and Wandering Albatrosses—and, to a lesser extent, Black-browed Albatrosses and giant petrels—are most at risk from consuming discards with hooks.

The removal of hooks from bycatch species, offal and used bait on longliners fishing in the Falkland Islands improved from a vessel compliance of 71% of observer trips during 2002/03 to 93% in 2003/04. Concurrently, the number of seabirds seen with snoods sticking out of their bills also decreased (HMO pers. obs.). Increased hook removal from discards was attributable to persistent education and monitoring by observers and captains. The use of a stronger snood line might also prove to be part of the solution.

CONCLUSION

The seabird mortality estimates for 2002/03 and 2003/04 suggest that longlining in Falkland Island waters currently continues to play a relatively minor role in the identified decline of the Falkland Islands Black-browed Albatross population. The observed reduction in the bycatch rate is thought to be the result of more effective use of mitigation measures and a generally higher awareness of the problem of seabird mortality among fishers. Further improvement is needed, particularly in the area of meeting the licence line-weighting requirement, if the limit of 0.002 birds per 1000 hooks set is to be reached for 2006/07 (NPOA—FI 2003). Injury and delayed mortality caused by the ingestion of offal, bycatch and used bait containing hooks and, to a lesser degree, from secondary hooking cannot be estimated accurately and remains a significant cause for concern.

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