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FACTORS AFFECTING THE INCIDENTAL MORTALITY OF SEABIRDS IN THE *DISSOSTICHUS ELEGINOIDES* FISHERY IN THE SOUTHWEST ATLANTIC (SUBAREA 48.3, 1995 SEASON)

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Abstract

This paper analyses all incidental mortality of seabirds recorded on Argentinian and Chilean vessels fishing for Patagonian toothfish (*Dissostichus eleginoides*) in Subarea 48.3 during the 1995 season. The data was obtained from the fine-scale reports submitted by each vessel to its national fishing authority and supplemented with the information collected by international scientific observers from each vessel. It was thus possible to evaluate almost all of the incidental mortality of seabirds observed during the season.

The total mortality recorded was 1 428 birds of which white-chinned petrels (*Procellaria aequinoctialis*) comprised 77.8%, southern giant petrels (*Macronectes giganteus*) 10.8%, black-browed albatrosses (*Diomedea melanophris*) 8.1%, wandering albatrosses (*D. exulans*) 2.0% and grey-headed albatrosses (*D. chrysostoma*) 0.7%. A total of 56 seabirds captured during hauling operations and released alive was also recorded. Within this group, the most abundant were *M. giganteus* (50%), *D. melanophris* (14.3%) and *P. aequinoctialis* (8.9%).

A study of the variables affecting incidental mortality shows that the distance from land, the lunar phase and the use of streamer lines and hook size were important sources of variation, both in vessels' analyses of catch of birds per unit effort (BPUE), as well as of the haul-by-haul data.

Résumé

Dans ce document, les auteurs présentent une analyse de la mortalité accidentelle des oiseaux de mer relevée sur les navires argentin et chiliens pêchant sur la légine australe (*Dissostichus eleginoides*) dans la sous-zone 48.3 pendant la saison 1995. Les données proviennent des déclarations à échelle précise envoyées par tous les navires à leurs autorités nationales de pêche et des informations rapportées par les observateurs scientifiques du système international embarqués sur chaque navire. Il a ainsi été possible d'évaluer la presque totalité de la mortalité accidentelle des oiseaux de mer observée pendant la saison.

En tout, la mortalité enregistrée s'élève à 1 428 oiseaux dont 77,8% de pétrels à menton blanc (*Procellaria aequinoctialis*), 10,8% de pétrels géants antarctiques (*Macronectes giganteus*), 8.1% d'albatros à sourcils noirs (*Diomedea melanophris*), 2% de grands albatros (*D. exulans*) et 0,7% d'albatros à tête grise (*D. chrysostoma*). De plus, 56 oiseaux de mer capturés pendant les opérations de remontée ont été relâchés vivants. Parmi ceux-ci, les plus abondants étaient *M. giganteus* (50%), *D. melanophris* (14,3%) et *P. aequinoctialis* (8,9%).

Selon l'étude des variables affectant la mortalité accidentelle, l'éloignement de la côte, la phase de la lune, l'utilisation de lignes de banderoles et la taille des hameçons sont des sources importantes de variation dans les analyses, tant de capture d'oiseaux par unité d'effort (BPUE) que des données par pose de palangre, réalisées pour chaque navire.

Резюме

В настоящей работе анализируются все случаи побочной смертности морских птиц, зарегистрированные на аргентинских и чилийских судах, проводивших промысел патагонского клыкача (*Dissostichus eleginoides*) в Подрайоне 48. 3 в ходе сезона 1995 г. Данные были взяты из мелкомасштабных отчетов, представленных каждым судном своему национальному промысловому ведомству, и дополнены информацией, собранной международными научными наблюдателями с каждого судна. Таким образом стало возможным дать оценку почти всем случаям побочной смертности морских птиц, наблюдавшимся в ходе этого сезона.

Общая зарегистрированная смертность составила 1 428 птиц, из которых 77,8% составили белогорлые буревестники (*Procellaria aequinoctialis*), 10,8% - южные гигантские буревестники (*Macronectes giganteus*), 8,1% - чернобровые альбатросы (*Diomedea melanophris*), 2,0% - странствующие альбатросы (*D. exulans*) и 0,7% - сероголовые альбатросы (*D. chrysostoma*). Также было зарегистрировано 56 птиц, пойманных в ходе выборки ярусов, но выпущенных впоследствии. В этой группе наиболее многочисленными явились виды *M. giganteus* (50%), *D. melanophris* (14,3%) и *P. aequinoctialis* (8,9%).

Изучение влияющих на побочную смертность переменных показывает, что расстояние от суши, фаза луны, использование линей с отпугивающими флажками и размер крючка являются важными источниками изменчивости в анализе как прилова птиц судном на единицу усилия (BPUE), так и данных за каждую отдельную выборку ярусов.

Resumen

En este trabajo se examina la mortalidad incidental de aves marinas registrada a bordo de barcos argentinos y chilenos durante las operaciones de pesca del bacalao de profundidad (*Dissostichus eleginoides*) en la Subárea 48.3, en la temporada de pesca de 1995. Los datos tienen su origen en los informes a escala fina presentados por cada barco a su autoridad pesquera nacional y en los informes presentados por los observadores científicos de ambas nacionalidades De esta manera se pudo evaluar cerca del 100% de la mortalidad incidental de aves marinas observada durante la temporada.

La mortalidad total registrada fue de 1 428 aves, de la cual un 77,8% correspondió a petreles de mentón blanco (*Procellaria aequinoctialis*), seguida por un 10,8% de petreles gigantes (*Macronectes giganteus*), un 8,1% de albatros de ceja negra (*Diomedea melanophris*), un 2,0% de albatros errantes (*D. exulans*) y un 0,7% de albatros de cabeza gris (*D. chrysostoma*). También se registró un total de 56 aves capturadas durante los virados y liberadas vivas, y entre éstas las más abundantes fueron *M. giganteus* (50%), *D. melanophris* (14,3%) y *P. aequinoctialis* (8,9%).

El estudio de las variables que afectan a la mortalidad incidental demuestra que la distancia a las islas, el ciclo lunar, el uso de líneas espantapájaros y el tamaño de los anzuelos son fuentes importantes de variabilidad, tanto en los análisis de captura de aves por unidad de esfuerzo de los barcos (BPUE), como en los datos de lance por lance.

Keywords: Antarctic, fisheries, CCAMLR, *Dissostichus eleginoides*, incidental mortality, seabirds

INTRODUCTION

The decline observed in the populations of wandering albatross (*Diomedea exulans*) and other seabirds in the Southern Hemisphere has been linked to an increase in fishing effort in the longline tuna fisheries in subtropical waters and to the longline fisheries for Patagonian toothfish (*Dissostichus eleginoides*) which operate in areas close to the Antarctic (Gales, 1993; Brothers, 1991; de la Mare and Kerry, 1994; Vaske, 1991; Weimerskirch and Jouventin, 1994). This has been a major source of concern for the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) since the beginning of large-scale longline fishing for

D. eleginoides in 1991. In 1993 the Commission decided to establish an ad hoc Working Group on Incidental Mortality Arising from Longline Fishery (WG-IMALF) which would meet in 1994 to review the evidence of incidental mortality from the longline fishery, identify research requirements and advise the Commission on the development of mitigating measures. Although the report of this group (SC-CAMLR, 1994) contains a great deal of important information from nearly all of the Southern Hemisphere, it fails to place an actual value on the incidence of this problem due to the lack of information reported in fine-scale format from fishing activities in the area.

This shortage of information has been partially due to the lack of scientific observers placed on board fishing vessels in order to collect scientific information on seabird mortality during fishing activities, which in turn would help to further studies aimed at managing the fishery and the development and evaluation of methods of minimising the impact of fisheries on related species, as specified by Article II of the CCAMLR Convention. The advantage of placing scientific observers on fishing vessels was demonstrated by the large amount of information obtained by two observers on board a Chilean vessel during two previous seasons (see Ashford and Rubilar, 1994; Ashford et al., 1994; Ashford et al., 1995), as well as by other observers who took part in the stock depletion experiment designed by the CCAMLR Working Group on Fish Stock Assessment (WG-FSA) in 1993 (e.g. Jones and Parkes, 1994). For the 1995 fishing season, CCAMLR has requested its Members to ensure that each vessel participating in the *D. eleginoides* fishery has on board a scientific observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation (Conservation Measure 80/XIII).

As a result of this and of the participation of Argentina in this fishery for the first time in 1995, agreements were drawn up between Chile and Argentina to arrange for the deployment of observers on each other's vessels. Consequently, this is the first time that nearly 100% of data on the total incidental mortality collected in Subarea 48.3 (southwest Atlantic) during the fishing season for *D. eleginoides* (in this case, from 1 March to 16 May 1995) has been summarised and analysed in a single paper. The data, which were obtained in fine-scale format, allowed the authors to assess the total mortality of seabirds by species and fishing area and to determine the rate of mortality in relation to the lunar phase, hook size, fishing area and streamer lines. Finally, the authors were able to draw some conclusions on the efficiency of conservation measures adopted to reduce incidental mortality of birds during fishing operations.

MATERIALS AND METHODS

This report examines the information recorded in CCAMLR haul-by-haul data reporting forms (C2 V5) submitted by the master of each vessel to his national fishing authority. Additional information from the reports of scientific observers was also taken into consideration. The final identification of birds whose taxonomic identification was doubtful was clarified later with the help of the expertise of WG-FSA members.

The data used in this analysis on seabird mortality and on birds captured and released alive were reported by six Chilean vessels and six Argentinian vessels, one vessel from each country having made two fishing trips, as indicated in Tables 1 and 3. Thus, 14 fishing trips (87.5%) out of a total of 17 trips made by vessels of all CCAMLR Members participating in the fishery were able to be analysed in this paper. Data on incidental mortality from the Korean vessel *Ihn Sung 66*, which made two trips during the season, and the Russian vessel *Itkul*, which fished only during the last week of the fishery, have not been included in the analysis.

All statistical analyses were done on two scales: by vessel and on a haul-by-haul basis. In the latter case, hauls were selected so that comparisons were only made between hauls for which the analysed parameter differed. For example, to calculate the effect of the streamer lines, hauls were chosen from an area in which several vessels fished at the same time using the same type of hook. As the data obtained had not been standardised, all statistical analyses were non-parametric and were carried out using Daniel's test (Daniel, 1978).

In order to complete the data series on the different hook sizes, data from the Chilean FV *Friosur V* were used. These were obtained during the most recent fishing season by Ashford et al. (1995) in the same area as was fished during previous seasons. The trend has been to standardise hooks to the 'balanced' type with a 30 mm gap. The range of hook sizes analysed was therefore between 24 and 31 mm.

RESULTS

Birds Captured and Released

Table 1 shows the number of birds captured and released by the Chilean and Argentinian fleets during hauling. Of the total number of birds captured and released from both fleets (Table 2), 50% were southern giant petrels (*Macronectes giganteus*), 14.3% black-browed albatrosses (*Diomedea melanophris*) and 8.9% white-chinned petrels (*Procellaria aequinoctialis*), followed by smaller numbers of other species.

Incidental Mortality of Birds

Chilean vessels set a total of 3 159 020 hooks during the fishing season, and the number of seabirds observed to have been killed was 1 178, giving a mortality rate (i.e. catch of birds per unit effort (BPUE)) of 0.37 birds/1 000 hooks. Argentinian vessels set a total of 2 176 138 hooks and 250 birds were observed killed, which gives a BPUE of 0.115/1 000 hooks.

Table 3 shows that 98.8% of the bird mortality in respect of all Chilean vessels was caused by three of that country's vessels. The birds most vulnerable to mortality during fishing activities were *P. aequinoctialis* (76.6 %), followed by *M. giganteus* (11.5%), *D. melanophris* (9.1%) and *D. exulans* (2%). Of the total number of birds killed by Argentinian vessels, 83.2% were *P. aequinoctialis*, 7.6% *M. giganteus* and 4% *D. chrysostoma*.

When considering both fleets together (Table 4), the most vulnerable birds were *P. aequinoctialis* (77.8%, 1 111 birds), followed by *M. giganteus* (10.8%, 154 birds), *D. melanophris* (8.1%, 115 birds), *D. exulans* (2.0%, 29 birds) and *D. chrysostoma* (0.7%, 10 birds).

Hooks were the main cause of death, mostly snagging in beaks, but also in other body parts, e.g. wings, breast or neck. Some birds became entangled in the longlines.

Effect of Distance from Land

There is a marked increase in the number of bird species and their density the closer one approaches the island of South Georgia, and a corresponding increase in the potential for interaction between birds and fishing operations. Vessels which operated closer to the island had a higher incidental mortality per 1 000 hooks (Figure 1).

Effect of the Lunar Cycle

Most hauls were made during the night and therefore the visibility of longlines, baits and streamer lines was low (except in the case of nocturnal birds such as *P. aequinoctialis*). Fishing under a clear sky and bright moon is thought to be potentially dangerous to birds. If this is so, then one would expect a higher rate of incidental mortality on moonlit nights.

Analysis of the haul-by-haul data of both fleets confirmed that hauls made during the full moon phase resulted in significantly more birds being captured per 1 000 hooks than those carried out at other times ($P < 0.01$; Kruskal-Wallis test; Dunn's test); the latter resulted in significantly more birds being taken in comparison with hauls conducted during the new moon quarter ($P < 0.03$). The Kruskal-Wallis test for the effect of the moon on all vessels yielded a probability of less than 0.001 ($H = 26.89$)*.

Figure 2 graphically represents information on mortality observed for both fleets three days before and three days after each phase of the moon. *P. aequinoctialis, D. melanophris* and *D. exulans* have a higher mortality when nights are brighter. Birds which have diurnal habits, such as *M. giganteus* and *D. chrysostoma*, do not seem to increase their activity in relation to the lunar cycle at this time of the year.

Some of the highest seabird mortality rates associated with the lunar cycle were seen for the FV *Puerto Ballena*. The observer on this vessel recorded the highest incidental mortality during bright nights when there was a full moon. A similar situation was observed by one of the authors of this paper (P.S. Rubilar) on board the FV *Marunaka*. It should also be noted that neither vessel deployed streamer lines.

Effect of Hook Size

Figure 3 shows seabird mortality per 1 000 hooks (BPUE) for one fishing vessel during the 1993/94 season, and for all vessels during the

* H = statistic for Kruskal-Wallis test

Table 1: Total number of seabirds caught and released during the 1995 *D. eleginoides* fishing season (Subarea 48.3).

Chilean fishing vessels:

Species	Common Name	*Isla Camila* Trip 1	*Isla Camila* Trip 2	*Cisne Verde*	*Puerto Ballena*	*Isla Sofia*	*Magallanes III*	*Isla Isabel*	Total
M. giganteus	Southern giant petrel	1	1	0	0	0	0	0	2
P. aequinoctialis	White-chinned petrel	0	0	1	0	1	0	0	2
M. halli	Northern giant petrel	0	0	0	0	4	0	0	4
D. melanophris	Black-browed albatross	0	0	0	0	3	0	0	3
P. papua	Gentoo penguin	1	0	0	0	0	0	0	1
E. chrysolophus	Macaroni penguin	2	0	0	0	0	0	0	2
	Unidentified penguin	0	0	0	0	0	0	0	0
Total		4	1	1	0	8	0	0	14

Argentinian fishing vessels:

Species	Common Name	*Estela* Trip 1	*Estela* Trip 2	*Marunaka*	*Arbumasa XXII*	*Arbumasa XXIII*	*Mar del Sur*	*Arbumasa XX*	Total
M. giganteus	Southern giant petrel	0	3	15	2	6	0	0	26
P. aequinoctialis	White-chinned petrel	0	0	3	0	0	0	0	3
	Unidentified petrels	0	0	0	0	4	0	0	4
D. melanophris	Black-browed albatross	0	0	5	0	0	0	0	5
D. chrysostoma	Grey-headed albatross	0	0	0	0	2	0	0	2
P. papua	Gentoo penguin	0	0	1	0	1	0	0	2
Total		0	3	24	2	13	0	0	42

Table 2: Total number of seabirds caught and released, by species, during the 1995 *D. eleginoides* fishing season.

Species	Common Name	N°	%
M. giganteus	Southern giant petrel	28	50.0
P. aequinoctialis	White-chinned petrel	5	8.9
M. halli	Northern giant petrel	4	7.1
	Unidentified petrels	4	7.1
D. melanophris	Black-browed albatross	8	14.3
D. chrysostoma	Grey-headed albatross	2	3.6
P. papua	Gentoo penguin	3	5.4
E. chrysolophus	Macaroni penguin	2	3.6
Total		56	100.0

Table 3: Total incidental mortality by species, vessel and fleet during the 1995 *D. eleginoides* fishing season (Subarea 48.3).

Chilean fishing vessels:

Species	Common Name	*Isla Camila** Trip 1	*Isla Camila** Trip 2	*Cisne Verde*	*Puerto Ballena**	*Isla Sofia*	*Magallanes III*	*Isla Isabel*	Total
M. giganteus	Southern giant petrel	84	51	0	0	0	0	0	135
P. aequinoctialis	White-chinned petrel	207	243	131	322	0	0	0	903
M. halli	Northern giant petrel	0	0	0	0	5	0	0	5
D. melanophris	Black-browed albatross	93	7	2	0	5	0	0	107
D. exulans	Wandering albatross	0	0	0	24	0	0	0	24
E. chrysostoma	Grey-headed albatross	0	0	0	0	0	0	0	0
	Unidentified albatross	0	0	0	0	4	0	0	4
Total		384	301	133	346	14	0	0	1178

Argentinian fishing vessels:

Species	Common Name	*Estela** Trip 1	*Estela** Trip 2	*Marunaka**	*Arbumasa XXII*	*Arbumasa XXIII*	*Mar del Sur II**	*Arbumasa XX*	Total
M. giganteus	Southern giant petrel	0	3	1	1	6	8	0	19
P. aequinoctialis	White-chinned petrel	0	0	104	42	62	0	0	208
M. halli	Northern giant petrel	0	0	0	0	0	0	0	0
D. melanophris	Black-browed albatross	1	0	6	1	0	0	0	8
D. exulans	Wandering albatross	0	0	1	0	2	2	0	5
D. chrysostoma	Grey-headed albatross	0	0	1	0	0	9	0	10
	Unidentified albatross	0	0	0	0	0	0	0	0
Total		1	3	113	44	70	19	0	250

* without streamer line

Table 4: Total incidental mortality of seabirds during the 1995 fishing season.

Species	Common Name	N°	%
M. giganteus	Southern giant petrel	154	10.8
P. aequinoctialis	White-chinned petrel	1111	77.8
M. halli	Northern giant petrel	5	0.3
D. melanophris	Black-browed albatross	115	8.1
D. exulans	Wandering albatross	29	2.0
D. chyrsostoma	Grey-headed albatross	10	0.7
	Unidentified albatross	4	0.3
Total		1428	100.0

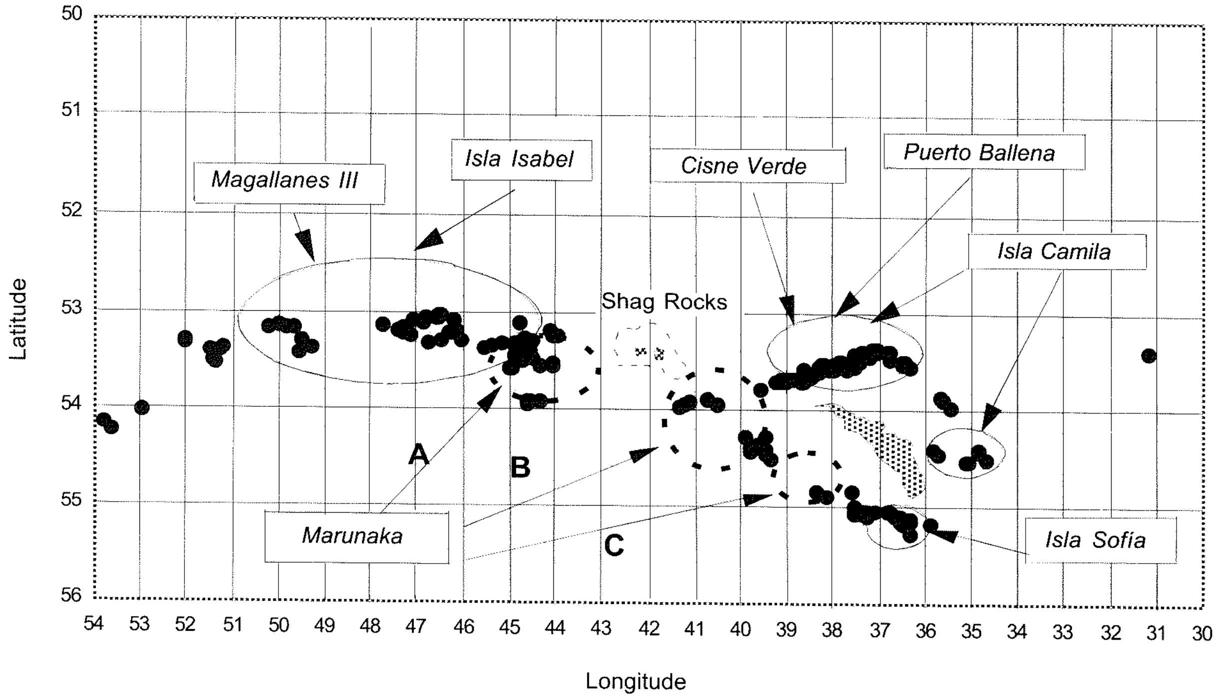

Figure 1: Position of Chilean vessels with lower incidental mortality (*Magallanes III* and *Isla Isabel*, BPUE = 0) and higher incidental mortality (*Cisne Verde* BPUE = 0.2, *Puerto Ballena* BPUE = 0.48 and *Isla Camila* BPUE = 0.92). One Argentinian vessel, *Marunaka*, is included since it conducted fishing operations in different areas with the following BPUE: A = 0.001, B = 0.11 and C = 0.33.

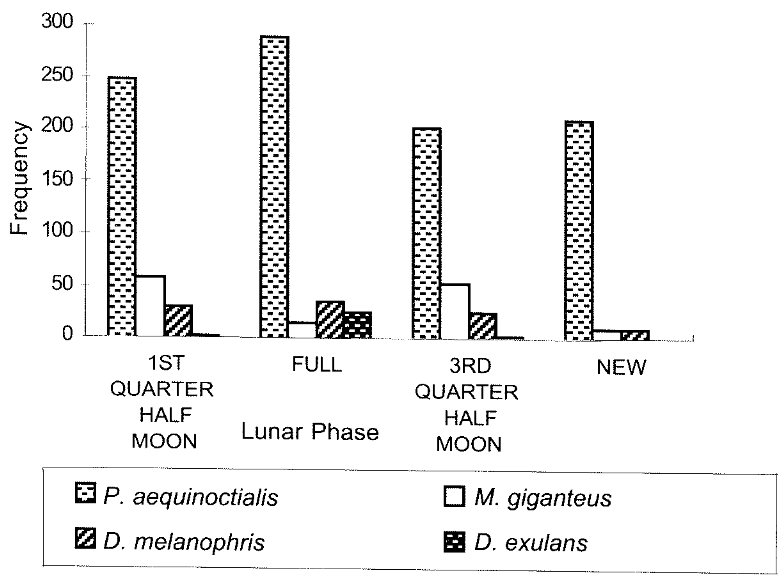

Figure 2: Incidental mortality, in relation to lunar phase, of the four most numerous bird species during fishery operations for *D. eleginoides* in Subarea 48.3, between March and May 1995.

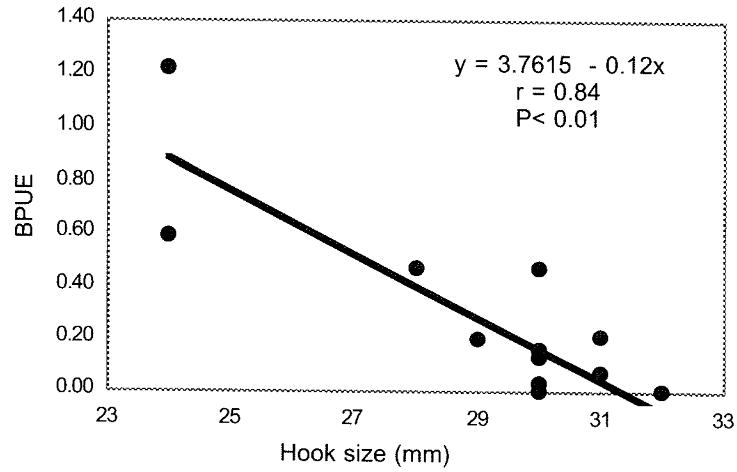

Figure 3: Relationship between hook size (gap measured in millimetres) and the rate of incidental mortality of marine birds during longline hauls performed by Argentinian and Chilean vessels in Subarea 48.3 between March and May 1995. (r - coefficient of correlation, P - probability)

1995 season. A significant inverse relationship is shown ($r = 0.84$, $n = 12$, $P < 0.01$) between the estimate of BPUE and hook size. As hook size (measured in accordance with CCAMLR guidelines) increases, BPUE decreases. The highest rates of incidental mortality were obtained with the straight hook type Mustad no. 24 used by FV *Isla Camila* during the 1995 season, followed by the Maruto no. 26 used by FV *Friosur V* during the 1993/94 season. The latter differs from the Mustad type mainly in the shape of the barb.

It is more difficult to compare the fine-scale data because of the limited opportunities offered by the database and because the differences between the hooks used this year are less than those included in Figure 3. Nevertheless, one comparison could be made. The catch rate of a vessel which used small hooks (24 mm width) was compared with those of other vessels fishing nearby and at the same time which used hooks equal to or larger than 29 mm. The results indicate that the statistic for the Kruskal-Wallis test ($H = 8.593$), which enables us to reject the null hypothesis (that hook size has no effect on catch rates) with a probability of $P < 0.001$.

Effect of Streamer Lines

The observers reported that three of the Argentinian vessels (one of which completed two fishing trips) and two of the Chilean vessels did not deploy streamer lines. However, because they conducted their operations at various distances from shore, only two of them showed high mortality rates, while one vessel which fished mainly near the Rhine Bank showed practically no mortality during hauls carried out at night. By contrast, vessels which deployed streamer lines displayed high levels of mortality, especially of *P. aequinoctialis*, when fishing near the islands. Figure 4 shows a comparison between BPUEs observed on vessels with and without streamer lines.

A review of fine-scale data on hauls which were chosen based on their similarity with respect to the time they were conducted, lunar cycle and distance from shore, showed that 72 hauls were made without streamer lines and 17 with streamer lines. Under these conditions, the Kruskal-Wallis test gave a value of $H = 8.21$ ($P < 0.001$), therefore the null hypothesis (that streamer lines have no effect on catch rates) is rejected.

DISCUSSION

Nearly 100% of the incidental mortality of seabirds reported from Subarea 48.3 during the 1995 season was analysed in this paper. The vessels excluded from this analysis were the *Ihn Sung 66*, which the observer reported as having killed only four birds (Kozlov, 1995), and the *Itkul*, for which the observer reported no mortality (Zaitsev, 1995). The total number of birds killed, estimated using observers' data and the fishing logbooks of each vessel, amounted to 1 428, of which 77.8% were reported as being *P. aequinoctialis*. This figure is probably an

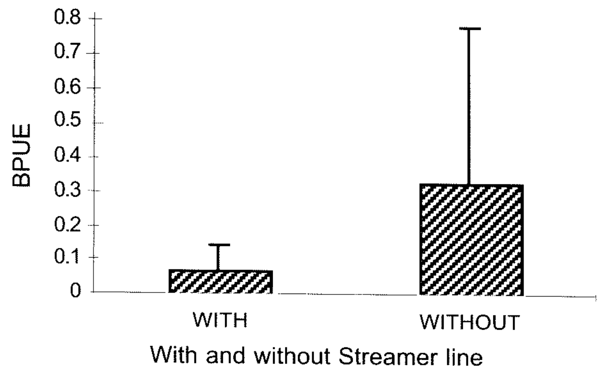

Figure 4: Comparison between the total incidental mortality observed on vessels with (N = 7) and without (N = 6) streamer lines. Values correspond to the mean plus one standard deviation of the BPUE for each vessel.

underestimate since many vessels carried only one scientific observer, which makes it virtually impossible to ensure 100% coverage of all longline sets. However, all sets were observed during hauling and all birds hooked were recorded, thus only birds hooked and released underwater were lost from the count. The estimate is therefore very close to reality.

The estimate of seabird mortality obtained is 2.4 times less than the projections made by Dalziell and De Poorter (1993) for the 1991 season and is calculated for a higher number of vessel-days (720 vessel-days in this study, as compared with 581 vessel-days for the 1991 season). On the other hand it is quite clear that during the 1994 season, 91.8% of hauls were carried out at night and only 8.2% during daylight hours. This means that, according to the ratio observed by Ashford et al. (1995), 2 523 birds would have been killed (85% greater mortality) had all hauls been conducted during the day. These comparisons clearly show that the most effective conservation measure adopted to minimise incidental mortality is that requiring longlines to be set only between the times of nautical twilight.

Ashford et al. (1995) reported that in the 1994 season the highest mortality was of *P. aequinoctialis*, a nocturnal bird. It is interesting to note that the number of *D. exulans* captured (29 birds) was much lower than expected. According to the observers' reports these birds maintain a greater distance from the vessel than other species of albatross, obtaining their food by attacking other birds which dive and get closer to the vessels, such as *D. melanophris* (Acevedo, 1995; Gordon, 1995; Rubilar, 1995). The number of all species of albatross killed seems to be less than 11% of the total mortality, which nonetheless represents a potential risk for some local populations.

With respect to the birds captured and released alive during hauling, the highest incidence of such events took place on vessels which dump offal and by-catch from the side on which the longline is hauled. Only one vessel has a discharge chute on the opposite side and this vessel did not report any birds being hooked on its longlines. The fact that such a simple measure had enabled the vessel to avoid attracting birds during setting the line, makes this measure appealing to fishermen. Even the crew considers that the absence of birds increases the vessel's ability to catch fish of commercial value. This fact should be included in the education manual for fishermen to be produced by the CCAMLR Scientific Committee (see Brothers, 1994).

The identification of four factors related to the magnitude of incidental seabird catch is perhaps the main achievement of this paper, which is in contrast to the great importance elsewhere attributed to only one of these factors, i.e. the streamer line. A fishing captain who was interviewed by one of the authors considered that the use of streamer lines during night settings was not justified, firstly because birds do not see them and also because it may disrupt fishing operations since his vessel was not a purpose-built longliner. Our findings disagree with this view and show that this factor is significant when considered in isolation. The confusion over this issue has probably arisen because streamer lines have little effect in areas further from shore, distance being another important factor which affects the magnitude of incidental mortality.

The statistically significant correlation between the size of hooks used (12 different sizes) and incidental mortality clearly demonstrates that hooks equal to or larger than 30 mm in width should be used in order to reduce this problem. A conservation measure governing hook size is currently in force in Argentina which has the additional advantage of positively affecting the harvesting pattern of the fishery (B. Prenski, pers. comm.). In the authors' opinion it would be advisable to adopt a conservation measure which takes into account the range of distribution of *D. eleginoides*, as an additional element which would help in the avoidance of incidental mortality of seabirds in longline fisheries.

It is clear that CCAMLR should develop, as a matter of urgency, an educational manual written in a style easily understood by fishermen. It is pointless to require the use of streamer lines if fishermen do not understand what they are for. The mere presence of scientific observers on board is no guarantee that streamer lines will be deployed as, in order to obtain the best possible information, it is essential for observers to maintain good relations with the crew. Each observer attempted to explain the reasons behind the measures adopted by CCAMLR. However, the need to maintain a role which is clearly defined and is not to be confused with the role of an 'inspector' did not allow them to point out or criticise possible infringements. Notwithstanding, the presence of observers allowed the collection of reliable information since all observers collaborated in the preparation of haul-by-haul reports; this is the first time incidental mortality of seabirds from fishing operations has been reported in fine-scale format. This should be made standard practice in the *D. eleginoides* fishery.

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