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SEABIRD ASSEMBLAGES ATTENDING LONGLINE VESSELS IN THE ARGENTINEAN ECONOMIC EXCLUSIVE ZONE

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Resumen. – Ensambles de aves marinas asociadas a buques palangreros en la Zona Económica Exclusiva Argentina. – El objetivo de este trabajo fue estudiar la composición específica y la abundancia relativa de las aves marinas asociadas a los buques palangreros de altura operando en la Zona Económica Exclusiva Argentina (ZEEA). Se realizaron conteos durante el día a bordo de buques palangreros semipelágicos y de fondo en los años 2003, 2005 y 2006. Registramos un total de 56 510 aves compuestas por al menos 21 especies diferentes pertenecientes a ocho familias. El orden Procellariiformes, contribuyendo con 17 especies, fue el taxón de aves más abundante asociado a las embarcaciones. Durante el presente estudio, la mayor diversidad de especies ocurrió en los meses de primavera (15 taxones) mientras que, en los meses de otoño y verano, la diversidad fue intermedia (13 y 7–10 taxones, respectivamente). En la primavera de 2003, la especie más comúnmente asociada fue el Petrel Damero (*Daption capense*) mientras que, en los meses de otoño, los Albatros de Ceja Negra adultos (*Thalassarche melanophris*) fueron los más comunes. De la misma manera, el Albatros de Ceja Negra adulto fue el ave más abundante durante los meses de primavera y verano de 2005. Por último, la Pardela Cabeza Oscura (*Puffinus gravis*) fue el ave más común durante la primavera del 2006. Más del 75% de las especies registradas son migratorias y no nidifican en Argentina. Durante el invierno austral, diversas especies de aves marinas provenientes de Antártida e islas sub-Antárticas se mueven en dirección norte, alcanzando aguas de la ZEEA. Esta dispersión es realizada, en su mayoría, por Procellariiformes nidificando en esas regiones. La combinación de los sitios de alimentación ricos en nutrientes durante todo el año provisto por el Océano Atlántico Sudoccidental, particularmente la ZEEA, y la gran biomasa de aves y otros predadores tope pone de manifiesto la importancia ecológica a nivel global de esta región.

Abstract. – The aim of this work was to study the specific composition and relative abundance of seabirds attending commercial longline vessels operating in the Argentinean Exclusive Economic Zone (AEEZ). Daylight counts were performed on board of semi-pelagic and bottom longline cruises during 2003, 2005 and 2006. We registered an overall of 56,510 birds comprised by at least 21 different species belonging to eight families. The Procellariiformes, with 17 species, were the most abundant bird taxa. During this study, the greatest species diversity took place in the spring months (15 taxa) while, in autumn and summer, the diversity was intermediate (13 and 7–10 taxa, respectively). In spring 2003, the commonest species attending the vessels was the Cape petrel (*Daption capense*) while, in autumn, adult Black-browed Albatrosses

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(*Thalassarche melanophris*) were the most common species. Again, adult Black-browed Albatrosses were the most abundant birds attending the vessels during spring and summer of 2005. Finally, the Great Shearwater (*Puffinus gravis*) was the commonest species during summer 2006. More than 75% of the species registered are migratory and non-breeders in Argentina. During the austral winter, several seabird species from Antarctica and sub-Antarctic Islands moved north, reaching the waters of the AEEZ. This northward dispersion is performed chiefly by Procellariiforms breeding in those regions. The combination of the rich year-round foraging grounds provided by the waters of the south-western Atlantic Ocean, particularly the AEEZ, and the great seabird and other top predator biomass, highlights the global ecological importance of this region. *Accepted 24 August 2007.*

Key words: Seabird assemblages, commercial longlines, Argentinean Exclusive Economic Zone, southwestern Atlantic Ocean.

INTRODUCTION

Seabirds foraging distributions usually coincide with commercial fisheries in areas of significant marine productivity worldwide. Thus, both fisheries and seabirds interact in several ways, ranging from food resources competition (Tasker *et al.* 2000, Furness 2003), incidental mortality (Brothers *et al.* 1999, Gandini *et al.* 1999, Gandini & Frere 2006), and food supply in the form of fishery waste (Thompson 1992, Thompson & Riddy 1995, Yorio & Caille 1999). Several authors have suggested that these interactions caused the gathering of numerous seabird flocks close to fishing vessels (Wahl & Heinemann 1979, Thompson & Riddy 1995), and these attendances have been used to estimate the presence and relative abundance of pelagic seabirds in a given area (Olmos 1997, Marín *et al.* 2004, González-Zevallos & Yorio 2006).

The pelagic seabird community of the southwestern Atlantic Ocean has been well documented (Olrog 1958, Jehl 1974, Rumboll & Jehl 1977, Veit 1995), including historical reviews (Schiavini *et al.* 1999), spatial and temporal distribution (Montalti & Orgeira 1998, Orgeira 2001, Favero & Silva 2005), use of surrounding waters (Croxall & Wood 2002, Huin 2002), and interactions with fisheries (Thompson & Riddy 1995, Olmos 1997, Gandini *et al.* 1999, Gandini & Frere 2006, González-Zevallos & Yorio 2006). Nevertheless, the understanding of species composition and abundance of seabirds assemblages attending specific commercial fisheries at the Argentinean Exclusive Economic Zone (AEEZ) recently became clear to marine ornithologists.

Here we describe the composition and at-sea distribution of the pelagic seabirds attending semi-pelagic and bottom longline fishing vessels operating on the continental shelf off southern Patagonia, within the AEEZ.

METHODS

Study location. The fishery ground during autumn and spring 2003 was centered at moderate shallow waters (depths: 98–142 m), operating in an area comprised between 43º–49ºS, 58º–62ºW, off the border between Santa Cruz and Chubut provinces (Argentina). During summer 2005, the fishery moved north up to c 41ºS, but was in spring centered at deeper waters at 53º–60ºS, 58º–67ºW, off the coast of Tierra del Fuego province. During late summer 2006, the fishing cruise began off Puerto Deseado (47º45'S, 65º 56'W; Santa Cruz province) and ended at Buenos Aires port.

Data collection and description of the fisheries. Data were obtained on board of semi-pelagic and bottom longline fishing cruises from 22 March to 2 July, and from 24 September to 23 November 2003 (corresponding to the austral

autumn and spring, respectively), from 23 January to 9 March, and from 8 October to 4 December 2005 (summer and spring, respectively), and from 10 to 21 March 2006 (summer). Semi-pelagic longline fishery targets kingclip (*Genypterus blacodes*), operating year round, while bottom longline vessels capture patagonian toothfish (*Dissostichus eleginoides*), chiefly during the austral summer. Both fishery vessels use an autoline system comprising lines of variable length (10–40 km) from less than 10,000 up to 31,500 baited hooks with a mustad autobaiter (Gandini & Frere 2006, Gómez Laich *et al.* 2006, Seco Pon *et al.* 2007). Bait consists in chunks of thawed argentinean squid (*Illex argentinus*), chilean squid (*Dosidicus gigas*), and/or sardine (*Sardina pilchardus*). Fish by-catch in the king-clip fishery included patagonian cod (*Salilota australis*), blackbelly rosefish (*Helicolenus dactylopterus lahillei*), several rays species (*Raja flavirostris* and *Bathyraja* spp.), and big-eye grenadier (*Macrourus holotrachys*) in the patagonian tootfish fishery. Retrieved bait is discarded along with viscera (including heads and tails) from the processed fish, comprising the bulk of the offal discharged.

During each cruise, the relative abundance of associated seabirds was daily estimated using the methods described by Tasker *et al.* (1984). A least two counts per day were performed during each cruise; one conducted around 10:00 h local time (09.99 ± 4.1 h, n = 106), and the other nearly 18:00 h local time (17.47 ± 2.7 h, n = 219), from the house top deck during daylight hours, totalizing 325 censuses for all cruises. We considered a 90° sector between the bow and, depending on the weather conditions and visibility, one of the sides of the vessel was chosen for counting all birds seen within 300 m. We considered each setting as an independent sample even though birds could follow the vessel for days. Abundance is considered as numbers of birds throughout the text.

RESULTS

Species composition. An overall of 56,510 birds belonging to eight families were counted during the present study. Of the 21 species registered, the Procellariiformes were the most diverse taxa attending the vessels (n = 17 species). Flock composition in the vicinity of the fishing grounds differed markedly between the sampling periods (Table 1). The greatest species diversity occurred in the spring months, with 15 taxa observed vs 7–10 in summer. In autumn, the species diversity was intermediate with 13 taxa registered (Table 1).

In spring 2003, the commonest birds attending the vessels were the Cape Petrels (*Daption capense*), followed by adult Black-browed Albatrosses (*Thalassarche melanophris*) and Southern Giant Petrels (*Macronectes giganteus*). Interestingly, Wilson's Storm Petrels (*Oceanites oceanicus*) made up 9.5% of the individuals recorded, which was quite similar to the values registered for juvenile Black-browed Albatrosses (7.2%). In the same year, adult Black-browed Albatrosses, followed by the Cape Petrels along with juvenile Black-browed Albatrosses, were the most common species in autumn months. We found significant differences in the abundance of birds between sampling periods of 2003, encountering higher numbers in autumn (Kruskal-Wallis ANOVA, $H = 37.62$, $P < 0.002$; Dunn post-hoc comparison, $P < 0.05$).

During spring 2005, adult Black-browed Albatrosses followed by the Cape Petrels were the most abundant birds attending the vessels, with 39% and 35%, respectively, of all individuals registered. In summer months, adult Black-browed Albatrosses were the commonest birds followed by lesser numbers of White-chinned Petrels (*Procellaria aequinoctialis*) (Table 1). Numbers of birds between sampling periods of 2005 were not significantly different (Kruskal-Wallis ANOVA, $H = 0.08$, $P = 7.69$).

TABLE 1. Seabirds following longliners for each sampling period off southern Patagonia. For each species, the total number, mean number of individuals per flock and standard deviation are shown.

Species	Spring 2003[a]			Autumn 2003[b]			Spring 2005[c]			Summer 2005[d]			Summer 2006[e]		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Wandering Albatross															
Diomedea exulans (adult)	351	7.16	6.2	590	16.38	15.1	129	2.98	3.3	76	1.81	2.5	9	2.37	0.7
Wandering Albatross															
Diomedea exulans (juvenile)	35	3.83	3	-	-	-	2	2	-	-	-	-	-	-	-
Royal Albatross															
Diomedea epomophora	151	9.41	6.7	2	0.05	0.2	55	2.11	2.8	-	-	-	17	5.5	3.5
Black-browed Albatross															
Thalassarche melanophris (adult)	5059	81.58	38.8	8140	226.1	10.34	2204	41.57	42.4	2984	70.19	48.3	177	17.69	9.9
Black-browed Albatross															
Thalassarche melanophris (juvenile)	1492	26.16	17.9	4505	125.1	61.1	14	4.67	2.1	254	6.04	6.1	79	7.94	6.8
Grey-headed Albatross															
Diomedea chrysostoma	39	9.75	10.8	-	-	-	4	1.34	0.6	-	-	-	-	-	-
Light-mantled Albatross															
Phoebetria palpebrata	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-
Southern Giant Petrel															
Macronectes giganteus	4118	66.42	44	3530	98.05	62.3	336	8.01	7	196	4.67	5.8	32	4.57	2.7
Northern Giant Petrel															
Macronectes halli	-	-	-	-	-	-	450	9.18	7.9	-	-	-	5	2.5	0.7
White-chinned Petrel															
Procellaria aequinoctialis	856	14.8	16.2	1560	43.33	27.1	152	3.62	3.1	635	15.11	16.8	160	17.72	18.49
Cape Petrel															
Daption capense	6073	97.94	63.2	4511	125.3	114.6	1967	37.11	29.8	-	-	-	-	-	-
Great Shearwater															
Puffinus gravis	38	2.54	2.4	363	10.08	18	10	5	5.6	79	1.88	3.7	192	19.22	34.4
Sooty Shearwater															
Puffinus griseus	179	5.26	7.3	2	0.05	0.3	2	2	-	8	0.19	0.4	6	3	2.8
Wilson-s Storm Petrel															
Oceanites oceanicus	1955	33.71	22.2	2201	61.13	99.6	132	3.38	1.8	-	-	-	46	5.75	3.7

TABLE 1. Continued.

Species	Spring 2003[a]			Autumn 2003[b]			Spring 2005[c]			Summer 2005[d]			Summer 2006[e]		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Southern Fulmar															
Fulmarus glacialoides	1	1	-	11	0.3	0.6	14	1.55	0.8	-	-	-	-	-	-
Atlantic Petrel															
Pterodroma incerta	-	-	-	-	-	-	-	-	-	13	1.68	0.4	-	-	-
Soft-plumaged Petrel															
Pterodroma mollis	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
Common-diving Petrel															
Pelecanoides urinatrix	40	20	14.14	-	-	-	-	-	-	-	-	-	-	-	-
Thin-billed Prion															
Pachyptila belcheri	-	-	-	-	-	-	172	15.68	31.5	-	-	-	-	-	-
Snowy Sheathbill															
Chionis alba	3	1	0	8	0.22	0.5	-	-	-	-	-	-	-	-	-
Skua															
Catharacta spp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Magellanic Penguin															
Spheniscus magellanicus	2	2	-	-	-	-	-	-	-	-	-	-	5	2.5	0.7
Cattle Egret															
Bubulcus ibis	108	21.6	43.8	3	0.08	0.3	-	-	-	-	-	-	-	-	-

[a]37 flocks; 20,500 birds; mean flock size = 103.2 ± 80.7 birds.
[b]120 flocks; 24.427 birds; mean flock size = 106.3 ± 33.3 birds.
[c]86 flocks; 4209 birds; mean flock size = 100.9 ± 58.6 birds.
[d]128 flocks, 5646 birds; mean flock size = 100.7 ± 68.4 birds.
[e]28 flocks; 728 birds; mean flock size = 60.64 ± 34.8 birds.

Finally, in summer 2006, Great Shearwaters (*P. gravis*), along with adult Black-browed Albatrosses, were the most abundant birds, followed by White-chinned Petrels (Table 1).

Seabird incidental mortality. An overall of 134 birds, comprising at least 44 Black-browed Albatrosses and 64 White-chinned Petrels in autumn, and 18 Black-browed Albatrosses along with four White-chinned Petrels in spring, were killed in vessels fishing for patagonian toothfish and kingclip in 2003 (data derived from Gómez Laich *et al.* 2006). An overall of 74 birds were incidentally taken during the summer cruise of 2005; of these, 76% were White-chinned Petrels and the remainders were Black-browed Albatrosses (Seco Pon *et al.* 2007). Only six Great Shearwaters were taken during the fishing cruise of 2006. We lack information on seabird mortality trough spring 2005.

DISCUSSION

Black-browed Albatross was the most abundant species following longline vessels, totaling 44% of all individual recorded throughout the study period. These birds frequently follow fishing vessels (Brooke 2004), being benefiting from discards along the Patagonian Shelf (Croxall & Gales 1998). According to Favero & Silva (2005), near a million of Black-browed Albatrosses could be using waters off Argentina as foraging grounds, including breeders, non-breeders and juveniles, either permanently or stationally. Also, White-chinned Petrels are significantly associated to the same foraging grounds of Black-browed Albatrosses (Veit 1995), and both species had been frequently registered using discards from the Argentine hake *Merluccius hubbsi* trawl fishery (Gonzalez-Zeballos & Yorio 2006). Its jointly presence could prone them to become seriously affected by commercial fishing operations (Gales 1998, Brothers *et al.* 1999) since they are the most commonly taken species following longline vessels operating off Argentina (Favero *et al.* 2003, Gandini & Frere 2006, Gómez Laich *et al.* 2006).

Cape Petrels were the most abundant bird during spring 2003, and the second most important bird registered during autumn 2003 and spring 2005, contributing 18% and 35% of all individual records, respectively. These birds are strongly attracted to ships and tend to congregate in great numbers around fishing vessels (Brooke 2004) where they scavenge garbage and other floating items (Rumboll & Jehl 1977).Southern Giant Petrels along with the Northern Giant Petrel (*M. halli*), considered as opportunistic scavengers and often gregarious foragers (Brooke 2004), are also frequently observed following commercial vessels in national and international waters east of the AEEZ (Marín *et al.* 2004, González-Zeballos & Yorio 2006). The association between this species and commercial fisheries could have ecological implications due to the ingestion of marine debris (Copello & Quintana 2003). Great Shearwater is also described as a scavenger when foraging behind fishing vessels (Brooke 2004).

In this study all the species registered following fishing vessels except the Southern Giant Petrel, (*Skua*) spp., the Magellanic Penguin (*Spheniscus magellanicus*) and the Cattle Egret (*Bubulcus ibis*) are migratory and non-breeders in Argentina (Narosky & Izurieta 2003). During the austral winter, several seabird species which breed mainly in Antarctica and sub-Antarctic Islands moved north reaching warmer waters off Argentina, Uruguay and Brazil (Croxall & Wood 2002), regions collectively referred to as the southwestern Atlantic Ocean (Bastida *et al.* 2005). These vast latitudinal movements are performed chiefly by the Procellariiformes breeding at Malvinas/Falkland Islands, South Georgia and Antarctica during the non-breeding seasons (Prince *et al.* 1992, Croxall &

Wood 2002, González-Solís *et al.* 2002).

Clearly, offshore fishing vessels generate considerable amounts of discards that become available to seabirds (Furness 2003) causing numerous flocks to gather towards fishing vessels (Wahl & Heinemann 1979, Thompson & Riddy 1995). Food supplied by longline fisheries, as well as the hook bait offer, is used by a large number of birds in different regions (Kock 2001, Furness 2003). In the Atlantic Ocean, Olmos (1997) registered 19 species attending bottom longliners operating off southern Brazil and Marín *et al.* (2004) encountered 21 species within the Uruguayan Economic Exclusive Zone, plus 16 species in the international waters. Our results support the regional and global ecological importance of the southwestern Atlantic Ocean (Croxall & Wood 2002), particularly the Patagonian shelf which provides rich year-round foraging grounds for a number of marine top predators (Reid *et al.* 2004, Favero & Silva 2005), which conservation status are currently compromised.

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