SCRS/2008/032

SEABIRD BYCATCH ON BRAZILIAN PELAGIC LONGLINE FISHERY AND IMPLICATIONS FOR THE CONSERVATION IN SOUTH ATLANTIC

Leandro Bugoni[1, 2,*], Patricia Luciano Mancini[1], Danielle Silveira Monteiro[3, 4], Loretha Nascimento[1], Tatiana Silva Neves[1]

SUMMARY

The Southwestern Atlantic Ocean is an important foraging ground for several albatrosses and petrels during breeding and non-breeding seasons. In this region they meet longline fishing fleets, currently the main threat for this group of seabirds. Significant overlap between longline fishery and seabird distribution in southern Brazil, especially during winter, is the major cause for concern. Here we present information on bycatch rates of seabirds in the Brazilian domestic pelagic longline fleet from 2001 to 2007 on the Exclusive Economic Zone (EEZ) and adjacent international waters of the Southwestern Atlantic Ocean and a review of bycatch rates reported for the area. Overall seabird capture rates obtained during 63 cruises (656 sets and 788,446 hooks) was 0.229 birds/1000 hooks, varying from zero to 0.542 birds/1000 according to season. Capture rates were higher between June and November (cold season) and affected mainly black-browed albatross Thalassarche melanophris *(55% of birds captured), white-chinned petrel* Procellaria aequinoctialis*, spectacled petrel* Procellaria conspicillata *and Atlantic yellow-nosed albatross* Thalassarche chlororhynchos*. Capture rates previously reported in SW Atlantic varied from 0 to 5.03 birds/1000 hooks, with those based on logbooks or fishermen interview tending to underestimate capture rates, whereas those based on small number of hooks and/or seasonally biased tend to overestimated in both pelagic and demersal longline fisheries. Representative capture rates for the pelagic longline are in the range of 0.2 to 0.4 birds/1000 hooks. Detailed studies with large sample sizes are required for a comprehensive approach of causes determining the incidental capture.*

KEYWORDS

Albatrosses, petrels, longline, incidental capture, review, Brazil, fisheries.

[1] Projeto Albatroz, Av. dos Bancários 76/22, Ponta da Praia, CEP 11030-300, Santos-SP, Brazil. [2] Institute of Biomedical and Life Sciences, Graham Kerr Building, University of Glasgow, Glasgow G12 8QQ – UK. [3] Núcleo de Educação e Monitoramento Ambiental – NEMA, R. Maria Araújo 450, Cassino, CEP 96207-480, Rio Grande-RS, Brazil. [4] Fundação Universidade Federal do Rio Grande, Laboratório de Elasmobrânquios e Aves Marinhas, C.P. 474, CEP 96201-900, Rio Grande-RS, Brazil.

1. Introduction

The main reason for the current decline of albatross and petrel populations around the world is related to the negative interactions with fisheries, particularly the pelagic longline (Gales 1997, Montevecchi 2002, BirdLife International 2004). Currently, 19 out of 21 albatross species are under risk of extinction (BirdLife International 2004). In Southwestern (SW) Atlantic Ocean different fisheries are detrimental to albatrosses and petrels, as trawling (Sullivan *et al.* 2006), gillnetting (Perez & Wahrlich 2005, Neves *et al.* 2006a), a range of artisanal or semi-industrial hook-and-line fisheries (Bugoni *et al.* in press), bottom and pelagic longlines (Neves & Olmos 1997; Favero *et al.* 2003). The community of pelagic seabirds in SW Atlantic Ocean and particularly off Brazil is predominantly composed, in number of species and individuals, by albatrosses and petrels breeding in other areas such as Tristan da Cunha Archipelago, Malvinas/Falkland Islands, South Georgia, Antarctic and New Zealand, and feeding off Brazil during breeding and wintering periods (Olmos 1997, Neves *et al.* 2006a). This community shows seasonal variations, with low abundance in warm months and increasing abundance in cold months due to the arrival of Antarctic and sub-Antarctic migrants, which constitute the bulk of seabird on offshore waters (Olmos 1997, Neves *et al.* 2006a, b). In total, 10 albatrosses (Diomedeidae) and 31 petrels (Procellariidae, Hydrobatidae and Pelecanoididae) are recorded in Brazil (CBRO 2007).

In this study we present data on capture rates for the Brazilian pelagic longline fishery from 2001 to 2007. Gaps in our knowledge on seabird bycatch in the region, as well as conservation needs are discussed.

2. Study area and methods

Data on seabird interactions with longline fishery was collected in a large area over Brazilian Exclusive Economic Zone (EEZ) and adjacent international waters, from 22ºS to 38ºS and 26ºW to 53ºW (Figs. 1 & 2). Fishing grounds in SW Atlantic are under influence of the Subtropical Convergence, where cold waters of the Malvinas/Falkland Current flowing northward find the warm waters of the Brazilian Current flowing southward (Garcia 1998). The presence of high productive waters from the Malvinas/Falkland Current in winter (Castello 1998) sustains an important pelagic longline fishery in southern Brazil as well as the most abundant and diverse seabird community in Brazil (Neves *et al.* 2006b). Over the Patagonian shelf flows the Malvinas/Falkland Current where demersal longline fishery occurs.

Data for this study were collected by seabird observers during 63 longline fishing cruises between January 2001 and November 2007, departing from the main fishing ports of Santos, Itajaí and Rio Grande, in the Brazilian southern region. Cruises were usually 15-25 days long and observers collected data on seabird abundance, seabird bycatch and abiotic data. An overall coverage of 656 sets and 788,446 hooks was sampled. The number of hooks deployed in each set varied from 230 to 1,600 (mean = 1,110 hooks).

Search of published and unpublished references reporting seabird capture rates in pelagic and demersal (=bottom) longline fisheries was carried out (**Appendix 1**). It covers studies on Brazil, Uruguay, Patagonian shelf and adjacent international waters, but was not exhaustive, particularly where there were several peer reviewed publications on the topic, such as the demersal fishery on Patagonian area. Fishing effort was standardized as number of hooks deployed, and captures rates as birds/1000 hooks. Statistical analysis was performed using Minitab® software, v. 15. Capture rates and the number of hooks was transformed (ln x + 1), looking for normality of residuals and homoscedasticity. Because demersal and longline fisheries have different orders of magnitude in reported capture rates and fishing effort, statistical analysis was separated between these fisheries. Publications that failed to report overall capture rates by focusing in a single species (e.g. Laich & Favero 2007) were excluded from statistical analysis.

3. Results

3.1. The Brazilian pelagic longline fishing fleet

Longline settings and seabird censuses sampled in this study were widespread in a large area over Brazilian EEZ and adjacent international waters (Figs. 1 & 2), where most of the domestic Brazilian fleet target swordfish (*Xiphias gladius*), tuna (*Thunnus albacares, T. obesus* and *T. alalunga*) and sharks (*Prionace glauca* and others). The overlap between observer coverage reported here (Figs. 1 & 2) and the fishing effort and fishing grounds of the pelagic longline fleets reported to ICCAT is high, particularly for the domestic fleet.

3.2. Seabird capture in the Brazilian pelagic longline fishery

At least five seabird species were caught in fishing hooks during this study: black-browed albatross *Thalassarche melanophris*, Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*, Wandering albatross *Diomedea exulans*, white-chinned petrel *Procellaria aequinoctialis* and spectacled petrel *Procellaria conspicillata* (Table 1). A total of 178 birds were captured with a maximum of 40 birds in a single trip and 29 in a single set when 1225 hooks were deployed. Capture rates separated by season and year varied from 0 to 0.542 birds/1000 hooks with higher capture rates during the cold season (Table 2). The capture rate was variable between trips with half trips holding no captures (31 out of 63 trips), but only 61 out of 656 sets captured birds. Overall, a capture rate of 0.229 birds/1000 hooks was recorded, and black-browed albatross was the most common species with 55% of captured birds, followed by the white-chinned petrel with 26% (Table 1). Capture rates of spectacled petrel was ranked fourth in spite of being the most frequent and abundant species attending vessels. Birds are captured predominantly during cold months, when there is overlap in southern Brazil between species more prone to be captured, such as black-browed albatross and white-chinned petrels, with higher fishing effort of the pelagic longline fleet.

3.3. Seabird capture rates reported for the SW Atlantic

Seabird capture rates in the SW Atlantic have been reported in the literature from 1991 to 2007. At least 27 studies focused on incidental capture of albatrosses and petrels in demersal (16 studies) and pelagic (16 studies) longlines (**Appendix 1**). Sampling methods included analysis of logbooks, interview with fishing skippers or other fishermen, observers primarily dedicated to collect fishery data rather than seabird data making incidental observations of seabird bycatch, and seabird-dedicated onboard observers. The reliability of data obtained by each method is obviously variable, but biases associated with methods are difficult to evaluate, due to the difficulty of disentangling different factors and because some studies failed to provided sufficient accurate details. For the Brazilian pelagic longline fishery there is a trend for lower capture rates in the dataset provided by fishermen through logbooks or interview. Data obtained by logbooks or interview tended to have better nominal coverage (i.e. more hooks sampled), but their reliability is difficult to assess. Fishing effort reported was also very variable from a few thousands up to 150 million hooks. Demersal longline studies in general reported lower mean capture rates (0.005 to 0.41 birds/1000 hooks) and were more consistent in having less variation in capture rates and by relying on

samples with higher fishing effort. On the other hand, in the pelagic longline fishery the capture rates varied among studies from zero to 5.03 birds/1000 hooks.

Negative correlations between fishing effort (measured as number of hooks set) and capture rates were found for the demersal ($F=8.29$, $df=910$, $p=0.02$) and pelagic ($F=14.56$, $df=12$, $p=0.003$) fisheries in the SW Atlantic Ocean. Variation in number of hooks explained 42.2% of the variation in capture rates in the demersal fishery and 53% in the pelagic fishery. This result suggests that studies based on low numbers of hooks often greatly overestimate seabird capture rates.

4. Discussion

4.1. Seabird capture in the Brazilian pelagic longline fishery

Several albatrosses and petrels are captured by the Brazilian pelagic longline fishery and apart from those reported here (Table 1), Tristan albatross *Diomedea dabbenena*, southern royal *D. epomophora*, northern royal *D. sanfordi*, albatrosses, great shearwaters and southern fulmar are known to be affected (Neves & Olmos 1997, Olmos *et al.* 2001, Vaske-Jr 1991). An emerging pattern obtained from studies in SW Atlantic waters and confirmed here and is that black-browed albatross and white-chinned petrel are the main species affected by both pelagic and demersal longline fisheries along the whole area. Differently, Atlantic yellow-nosed albatross and spectacled petrel are captured in Uruguay and Brazil (This study, Jiménez & Domingo 2007), coinciding with a more northern distribution of these species in SW Atlantic. On the other hand, the high abundance of spectacled petrels attending fishing vessels contrast with its limited capture rate.

4.2. Overlap between fishery and seabirds and implications for conservation

The SW Atlantic Ocean is an important area for juvenile black-browed albatross from Malvinas/Falkland Islands, but also for adults of this and other populations (BirdLife International 2004, Phillips *et al.* 2005). Severe decline of the black-browed albatross global population is attributed to pelagic logline fisheries in the SW Atlantic, as well as a range of other fisheries (Sullivan *et al.* 2006, Neves *et al.* 2006a, 2007; Bugoni *et al.* in press).

The displacement of the leased fleet to northeast Brazil during summer months shows minor overlap with albatrosses and petrels distribution during this period, which could suggest negligible capture rates. However, the operation of some leased vessels in southern waters if of concern. Furthermore, preliminary data collected by onboard observers (non-seabird dedicated) in 2005 shows high number of great shearwaters, as well as lower number of threatened species, being captured and arise concern due to the high fishing effort in this area (Neves *et al.* 2007). There is no study on capture rates on the fleet based in northeastern Brazilian ports, which requires urgent studies. The dynamic of pelagic longline fleets in Brazil and elsewhere (Hyrenbach & Dotson 2003) suggest that continuous monitoring of the fleets is necessary. Non-negligible capture rates of spectacled petrel, Atlantic yellow-nosed, Tristan and wandering albatrosses (Jiménez & Domingo 2007, this study) in southern Brazil and Uruguay are a major concern due to their small global populations. Also abundant in summer, these species are affected for the longline fishing during this time of the year, when Brazilian fleet spread activities in a larger area along the southeastern Brazilian waters, but also over Rio Grande Plateau areas in summer.

Detailed analysis of environmental factors affecting the incidental capture of seabirds in Brazil is required in order to subsidize conservation strategies. In addition, the implementation of actions suggested in national plans of action (NPOA-Seabirds) available for all jurisdictional countries in SW Atlantic is urgently required. Improving data on capture rates in other fisheries is strongly recommended particularly those using hook-and-line methods in Brazil (Bugoni *et al.* in press) of for the northeastern leased fleet. Fishing fleets in the SW Atlantic have an important effect on several albatross and petrel populations from South Georgia, Malvinas/Falkland Islands, Tristan Cunha and New Zealand, and their conservation depends on mitigation measures in several worldwide fisheries.

5. Literature cited

BirdLife International (2004) Tracking ocean wanderers: the global distribution of albatrosses and petrels. Results from the Global Procellariiform Tracking Workshop, 1–5 September, 2003, Gordon's Bay, South Africa. BirdLife International: Cambridge, UK

Bugoni L, Neves TS, Leite-Jr NO, Carvalho D, Sales G, Furness RW, Stein CE, Peppes FV, Giffoni BB, Monteiro DS (in press) Potential bycatch of seabirds and

turtles in hook-and-line fisheries of the Itaipava Fleet, Brazil. Fish Res DOI: 10.1016/j.fishres.2007.10.013

Castello JP (1998) Teleósteos pelágicos. In: Os ecossistemas costeiro e marinho do extremo sul do Brasil. In: Seelinger U, Odebrecht C, Castello JP (eds). Rio Grande: Ed. Ecoscientia, p 137–143

CBRO (2007). Lista das aves do Brasil. 6th Ed. (16 de agosto de 2007). Comitê Brasileiro de Registros Ornitológicos, Sociedade Brasileira de Ornitologia. Available at http://www.cbro.org.br [02/12/07].

Favero M, Khatchikian CE, Arias A, Rodriguez MPS, Cañete G, Mariano-Jelicich R (2003) Estimates of seabird by-catch along the Patagonian shelf by Argentine longline fishing vessels, 1999-2001. Bird Conserv Internat 13:273–281

Gales R (1997) Albatross populations: status and threats. In: Robertson G, Gales R (eds) Albatross biology and conservation. Chipping Norton: Surrey Beatty & Sons, p 20–45

Garcia CAE (1998) Oceanografia Física. In: Os ecossistemas costeiro e marinho do extremo sul do Brasil. In: Seelinger U, Odebrecht C, Castello JP (eds) Rio Grande: Ed. Ecoscientia, p 104–106

Hyrenbach KD, Dotson RC (2003) Assessing the susceptibility of female black-footed albatross (*Phoebastria nigripes*) to longline fisheries during their post-breeding dispersal: an integrated approach. Biol Conserv 112:391–404

Jiménez S, Domingo A (2007) Albatros y petreles: su interacción con la flota de palangre pelágico uruguaya en el Atlántico Sudoccidental. Col Vol Sci Pap, ICCAT 60:2110–2117

Mayer FP, Andrade HA (2005) Swordfish (*Xiphias gladius*) and blue shark (*Prionace glauca*) fishery and the dynamics of the fleet off the southeastern Brazilian coast. Col Vol Sci Pap, ICCAT 58:1204–1214

Montevecchi WA (2002) Interactions between fisheries and seabirds. In: Schreiber EA, Burger J (eds) Biology of Marine Birds. Boca Raton: CRC Press, p 527–557

Neves T, Olmos F (1997) Albatross mortality in fisheries off the coast of Brazil. In: Robertson G, Gales R (eds) Albatross biology and conservation. Chipping Norton: Surrey Beatty & Sons, p 214–219

Neves TS, Olmos F, Peppes, FV, Mohr LV (2006a) National Plan of Action for the Conservation of Albatrosses and Petrels – NPOA-Brazil. – Brasília: Ibama, 124 p.

Neves T, Vooren CM, Bugoni L, Olmos F, Nascimento L (2006b) Distribuição e abundância de aves marinhas no sudeste-sul do Brasil. In: Neves T, Bugoni L, Rossi-Wongtschowski CLB (eds). Aves oceânicas e suas interações com a pesca na região Sudeste-Sul do Brasil. São Paulo – USP, REVIZEE: Score Sul, p 11–35

Neves T, Mancini PL, Nascimento L, Miguéis AMB, Bugoni L (2007) Overview of seabird bycatch by Brazilian fisheries in the South Atlantic Ocean. Col Vol Sci Pap, ICCAT. 60:2085–2093p.

Olmos F (1997) Seabirds attending bottom long-line fishing off southeastern Brazil. Ibis 139:685–691

Olmos F, Neves TS, Bastos GC (2001) A pesca com espinhéis e a mortalidade de aves marinhas no Brasil. In: Albuquerque JLB, Cândido-Jr JF, Straube FC, Roos AL (eds) Ornitologia e conservação, da ciência às estratégias. Tubarão, SC, Editora Unisul, p 327–337

Perez JAA, Wahrlich R (2005) A bycatch assessment of the gillnet monkfish *Lophius gastrophysus* fishery off southern Brazil. Fish Res 72:81–95

Phillips RA, Silk JRD, Croxall JP, Afanasyev V, Bennett VJ (2005) Summer distribution and migration of nonbreeding albatrosses: individual consistencies and implications for conservation. Ecology 86:2386–2396

Stagi A, Vaz-Ferreira R, Marín Y, Joseph L (1997) The conservation of albatrosses in Uruguayan waters. In: Robertson G, Gales R (eds) Albatross, biology and conservation. Surrey Beatty & Sons, Chipping Norton, p 220–224

Sullivan BJ, Reid TA, Bugoni L (2006) Seabird mortality on factory trawlers in the Falkland Islands and beyond. Biol Conserv 131:495–504

Vaske-Jr T (1991) Seabirds mortality on longline fishing for tuna in Southern Brazil. Ciência e Cultura 43:388–390

Table 1. Capture rate of seabird species in the pelagic longline fishery in Brazil from 2001 to 2007 (n=788,446 hooks)

Species	Capture Rate (birds/1000 hooks)
Black-browed albatross *Thalassarche melanophris*	0.126
Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*	0.011
Unidentified *Thalassarche* albatrosses	0.018
Wandering albatross *Diomedea exulans*	0.001
Unidentified *Diomedea* albatrosses	0.005
White-chinned petrel *Procellaria aequinoctialis*	0.059
Spectacled petrel *Procellaria conspicillata*	0.008
Overall capture rate	0.229

Table 2. Seasonal and inter-annual variation in capture rates of seabirds (birds/1000 hooks) in the pelagic longline fishery of Brazil, from 2001 to 2007. Overall capture rate = 0.229 birds/1000 hooks and number of hooks deployed = 788,446 hooks. --- Not sampled.

	Warm months (December-May)		Cold Months (June-November)	
	Capture Rate	No. hooks	Capture Rate	No. hooks
2001	0.000	23,893	0.000	36,900
2002	0.217	55,400	0.177	50,900
2003	---	---	0.124	48,400
2004	0.000	5,400	0.036	82,958
2005	0.000	39,190	0.129	123,940
2006	0.073	27,390	0.415	53,045
2007	0.142	56,460	0.542	184,570

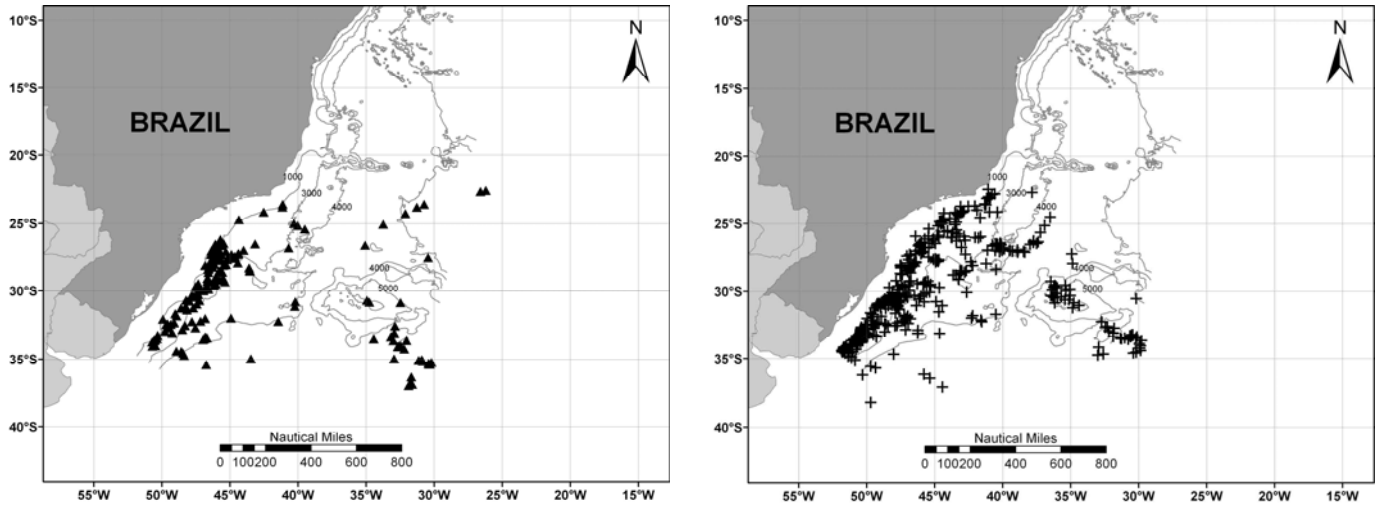

Figure 1. Location of 656 pelagic longline settings off Brazilian coast sampled by onboard seabird observers from 2001 to 2007. Warm months are from December to May (left; n=176 sets) and cold months are from June to November (right; n=480 sets).

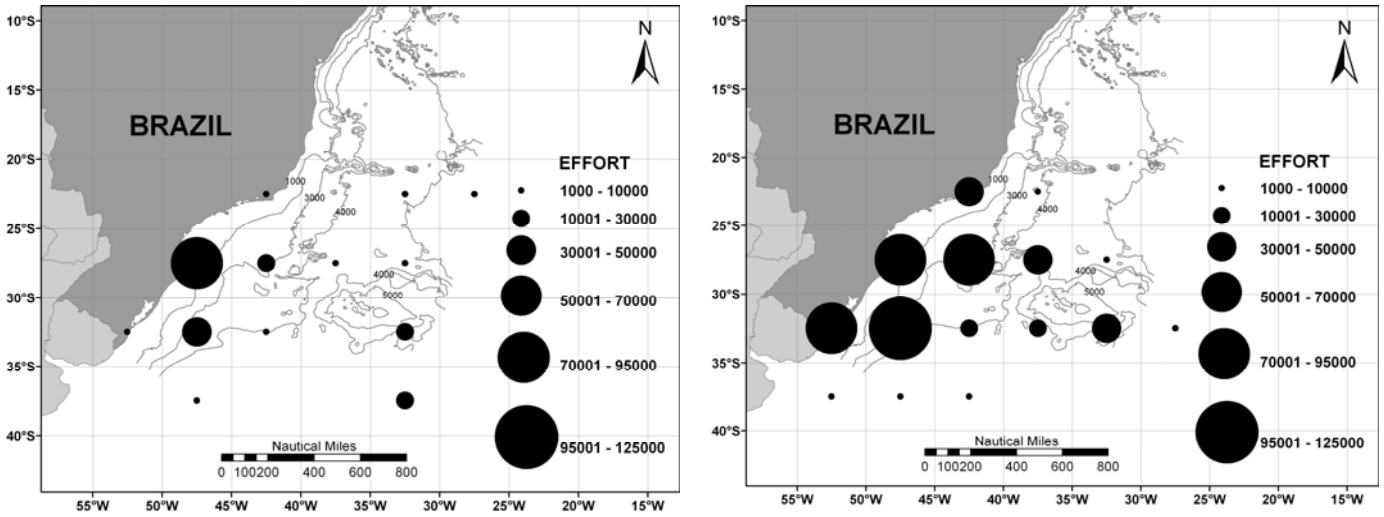

Figure 2. Pelagic longline effort in number of hooks (total=788,446 hooks) sampled in this study by onboard observers off Brazilian coast from 2001 to 2007 in December-May (left; n=176 sets) and June-November (right; n=480).

Appendix 1. Summary of studies reporting capture rates (birds/1000 hooks) of seabirds in demersal and pelagic longline in Southwestern Atlantic Ocean from 1991 to 2007. (---) Data not provided.

Longline Type	Location	Mean Capture Rate	Range Capture Rate*	Year(s)	No. of Hooks	Sampling Method	Comments	References
Demersal for Toothfish and Hake	Argentina	---	---	1993-1995	25,386,000	Log books and interview	Anecdotal data on bycatch.	Schiavini et al. (1997)
Demersal for Toothfish and Kingclip	Argentina - Patagonian shelf	0.04	0-0.2	1999-2000	~14.8 millions	Non dedicated onboard observers	Steep decline in capture rate during years of the study; 99% of sets with mitigation measures.	Favero et al. (2003)
Demersal for Kingclip, Patagonian toothfish and	Argentina - Patagonian shelf and shelf break	0.03	0.001-0.18 (sd=0.39)	1999-2003	19,067,100	Non dedicated onboard observers		Laich et al. (2006)

Yellownosed skate								
Demersal for Kingclip, Patagonian toothfish and Yellownosed skate	Argentina - Patagonian shelf and shelf break	0.014[1]	(sd=0.090)	1999-2003	Not explicit, but mentioned to be 30 millions per year, thus ~150 millions	Non dedicated onboard observers	[1] Only analyzed for white-chinned petrel. Environmental variables affecting captures were detected.	Laich & Favero (2007)
Demersal for Kingclip	Argentina - Patagonian shelf	0.071	0.034-1.53	2005	1,033,900	Onboard observers?	Single vessel, summer.	Seco-Pon et al. (2007)
Demersal for Toothfish	Malvinas/ Falkland Is. - Patagonian shelf	0.019	0-0.032	2001-2002	1,523,155	Dedicated and non-dedicated onboard observers	2 to 4 torilines used.	Reid et al. (2004) Reid & Sullivan (2004)
Demersal for Toothfish	Malvinas/ Falkland Is. - Patagonian	0.010	0.-8.504	2202-2204	~17.1 millions	Dedicated onboard observers	2 to 3 torilines used; injury and delayed mortality by lost hooks	Otley et al. (2007)

	shelf						reported.	
Pelagic for Tuna	Uruguay – off Brazil & Uruguay	5.03	---	1994	55,624	---		Barea et al. (1994)
Pelagic for Tuna	Uruguay	4.7	0-481.3	1994	26,364	Onboard observers	Capture rate of 481.3 birds/1000 hooks was based in a set of only 320 hooks.	Stagi et al. (1997)
Demersal for Rays and other spp.	Uruguay	0.41	0.075-0.575	1995	202,650	Onboard observers	Only two cruises sampled.	Stagi et al. (1997)
Not provided - Probably pelagic	Uruguay	1.7	---	---	1.5 million	---	Anecdotal data (no methods, fleet or birds caught reported).	Stagi & Vaz-Ferreira (2000)
Pelagic for Tuna, Swordfish and Sharks	Uruguay and International waters	---	0.05-5.57[2]	1993-1996	155,040	Onboard observers	[2] Capture rate calculated for non-fish (birds, mammals and sea turtles).	Marín et al. (1998)

Semi-pelagic (=demersal) for Wreckfish	Uruguayan EEZ	3.0	---	2001	---	Onboard observers		Marín et al. (2004)
Pelagic for Swordfish, Tuna and Sharks	Uruguay and International waters	0.42	0.04-1.65	1998-2004	647,722	Dedicated and non-dedicated onboard observers		Jiménez (2005) & Jiménez et al. (2005)
Pelagic for Swordfish, Tuna and Sharks	Uruguay and International waters	0.26		1998-2006	2,242,026	Dedicated and non-dedicated onboard observers	Monthly capture rates provided. Higher in southern area and winter.	Jiménez & Domingo (2007)
Pelagic for Tuna	Southern Brazil	1.35	0-97.9	1987-1990	52,593	Onboard observers	Winter months; high capture rates during stormy weather; capture rate of 97.9 calculated from a set of only 1,205 hooks;	Vaske-Jr (1991), and pers. comm. on total number of hooks.

							several authors erroneously derived capture rates from Vaske's paper based only on sets with bird captures.	
Pelagic for Tuna, Swordfish and Sharks	Brazil and adjacent international waters	0.12	---	1994-1995	*c.* 983,333	Log books	Capture rate considered underestimate and highly variable.	Neves & Olmos (1997)
Demersal for Tilefish, Namorado and Groupers	Brazil	0.3	---	1994-1995	280,197	Log books	Research vessel; Capture rate included 49 unidentified birds.	Neves & Olmos (1997)
Demersal	Brazil	---	0.1-0.32	---	---	Onboard observers	Review of two other studies.	Olmos et al. (2000)
Pelagic for	Brazil	---	0.09-1.35	---	---	Onboard	Data is from three	Olmos et al.

Swordfish						observers	previous studies.	(2000)
Demersal for Tilefish, Namorado and Groupers	Brazil	0.32	---	1994-1995	340,777	Log books and onboard observers	Research vessel; data partially reported in Neves & Olmos (1997).	Olmos et al. (2001)
Demersal for Tilefish, Namorado and Groupers	Brazil	0.1	---	1996-1997	187,908	Log books	Research vessel.	Olmos et al. (2001)
Pelagic for Tuna, Sharks and Swordfish	Brazil	---	0.095-0.73	1994-1999	1,529,312	Interview and onboard observers	Data partially reported in Neves & Olmos (2001); include data from research vessel.	Olmos et al. (2001)
Demersal for Tilefish, Namorado, Groupers, etc.	Brazil	0.26	0.1-0.32	1994-1997	528,685	Fishermen interview		Neves et al. (2001)
Pelagic for Tuna,	Brazil	0.095	---	1994-	1,529,312	Fishermen		Neves et al.

Swordfish and Sharks				1999		interview		(2001)
Demersal Tilefish, Namorado, Groupers, etc.	Brazil	0.298	---	1994-1995	338,812	Onboard observers	Research cruises.	Tutui et al. (2000)
Pelagic for Tuna, Swordfish and Sharks	Brazil	0.27	0-6	2002-2003	64,150	---	Only five cruises; use of mitigation measures; cite other three previous cruises with higher capture rates without details, and no cruise with 'zero' capture rate reported.	Soto et al. (2003)
Demersal	Brazil	0.101	---	1996-1997	188,000	Onboard observers	Research cruises.	Vooren & Coelho (2004)
Pelagic for Swordfish, tunas,	Brazil	0.102	---	2000-2005	499,978	Onboard observers	Capture rates for demersal longline	Neves et al. (2007)

sharks							based in previous studies	
Pelagic for Swordfish and Dorlphinfish	Brazil	0.114	0-0.15	2001-2006	52,691	Onboard observers	Small vessels from Itaipava fleet; focused on the description of other fisheries.	Bugoni et al. (in press)
Pelagic for Tuna, Swordfish and Sharks	Brazil and international waters	0.128	0-0.542	2001-2006	547,416	Onboard observers	No mitigation measure.	This study

* Range of capture rates was reported in several ways, e.g. between sets, cruises, season or areas.

Common names: Namorado (*Pseudopercis numida*), Tilefish (*Lopholatilus villarii*), Groupers (*Epinephelus* spp.), Toothfish (*Dissostichus eleginoides*), Hake (*Merluccius hubbsii*), Kingclip (*Genipterus blacodes*), tuna (*Thunnus* spp.), Swordfish (*Xiphias gladius*), Sharks (several spp, including *Prionace glauca*, *Sphyrna* spp., *Carcharhinus* spp., and *Alopias* spp.), Wreckfish (*Polyprion americanus*), Yellownosed skate (*Dipturus chilensis*), Dolphinfish (*Coryphaena hippurus*).

REFERENCES FOR THE APPENDIX 1

Barea L, Loinaz I, Marin Y, Ríos C, Saralegui A, Stagi A, Vaz-Ferreira R, Wilson N (1994) Mortality of albatrosses and other seabirds produced by tuna longline fisheries in Uruguay. CCAMLR, Scientific Abstracts WG-IMALF-94/17 (http://www.ccamlr.org/pu/e/e_pubs/sa/abs94.pdf & http://www.ccamlr.org/pu/e/e_pubs/sr/94/all.pdf)

Bugoni L, Neves TS, Leite-Jr NO, Carvalho D, Sales G, Furness RW, Stein CE, Peppes FV, Giffoni BB Monteiro DS (in press) Potential bycatch of seabirds and turtles in hook-and-line fisheries of the Itaipava Fleet, Brazil. Fish Res DOI*:* 10.1016/j.fishres.2007.10.013

Favero M, Khatchikian CE, Arias A, Rodriguez MPS, Cañete G, Mariano-Jelicich R (2003) Estimates of seabird by-catch along the Patagonian shelf by Argentine longline fishing vessels, 1999-2001. Bird Conserv Internat 13:273–281

Jiménez S (2005) Captura incidental de aves marinas en el Océano Atlántico Sudoccidental: interacción con la flota uruguaya de palangre pelágico. Facultad de Ciencias, Universidad de la República. Montevideo, Unpub. Bachelor Thesis, 30 p

Jiménez S, Domingo A, Brazeiro A (2005) Captural incidental de aves marinas en el Océano Atlántico Sudoccidental: interacción con la flota uruguaya de palangre pelágico. Actas de las VIII Jornadas de Zoologia del Uruguay, p 147

Jiménez S, Domingo A (2007) Albatros y petreles: su interacción con la flota de palangre pelágico uruguaya en el Atlántico Sudoccidental. Coll Vol Sci Pap, ICCAT 60:2110–2117

Laich AG, Favero M (2007) Spatio-temporal variation in mortality rates of white-chinned petrels *Procellaria aequinoctialis* interacting with longliners in the south-west Atlantic. Bird Conserv Internat 17:359–366

Laich AG, Favero M, Mariano-Jelicich R, Blanco G, Cañete G, Arias A, Silva-Rodriguez P, Brachetta H (2006) Environmental and operational variability affecting the mortality of black-browed albatrosses associated with long-liners in Argentina. Emu 106:21–28

Marín YH, Brum F, Barea LC, Chocca JF (1998) Incidental catch associated with swordfish longline fisheries in the south-west Atlantic Ocean. Mar & Freshw Res 49:633–639

Marín YH, Stagi A, Chocca J (2004) Incidental mortality of marine birds during fishing operations directed to wreckfish with semi-pelagic longlines CCAMLR Scientific Abstracts. CCAMLR, Hobart, p 10

Neves T, Olmos F (1997) Albatross mortality in fisheries off the coast of Brazil. In: Robertson G, Gales R (eds) Albatross, biology and conservation. Surrey Beatty & Sons, Chipping Norton, p 214–219

Neves FOC, Bastos GCC, Neves TS (2001) Pesca no céu, a morte de aves em espinhéis no Brasil. Ciência Hoje 29:24–32

Neves T, Mancini PL, Nascimento L, Miguéis AMB, Bugoni L (2007) Overview of seabird bycatch by Brazilian fisheries in the South Atlantic Ocean. Coll Vol Sci Pap, ICCAT 60:2085–2093

Olmos F, Bastos GCC, Neves TS (2000) Estimating seabird bycatch in Brazil. Mar Ornithol 28:141

Olmos F, Neves TS, Bastos GC (2001) A pesca com espinhéis e a mortalidade de aves marinhas no Brasil. In: Albuquerque JLB, Cândido-Jr JF, Straube FC, Roos AL (eds) Ornitologia e conservação, da ciência às estratégias. Editora Unisul, Tubarão, SC, p 327–337

Otley HM, Reid TA, Pompert J (2007) Trends in seabird and Patagonian toothfish *Dissostichus eleginoides* longliner interactions in Falkland Island waters, 2002/03 and 2003/2004. Mar Ornithol 35:47–55

Reid, TA, Sullivan BJ (2004) Longliners, black-browed albatross mortality and bait scavenging in Falkland Island waters: what is the relationship? Polar Biol 27:131–139

Reid TA, Sullivan BJ, Pompert J, Enticott JW, Black AD (2004) Seabird mortality associated with Patagonian toothfish (*Dissostichus eleginoides*) longliners in Falkland Islands waters. Emu 104:317–325

Schiavini A, Frere E, Gandini P, García N, Crespo E (1997) Albatross-fisheries interactions in Patagonian shelf waters. In: Robertson G, Gales R (eds) Albatross, biology and conservation. Surrey Beatty & Sons, Chipping Norton, p 208–213

Seco-Pon JP, Gandini PA, Favero M (2007) Effect of longline configuration on seabird mortality in the Argentine semi-pelagic kingclip *Genypterus blacodes* fishery. Fish Res 85:101–105

Soto JMR, Colabuono FI, Filippini A (2003) Análise das capturas de albatrozes e petréis (Procellariiformes) no espinhel pelágico operante na costa sul do Brasil e ao largo, utilizando medidas mitigadoras. Abstracts of the XI Congresso Brasileiro de Ornitologia, Universidade Estadual de Feira de Santana. Feira de Santana. CR–ROM.

Stagi A, Vaz-Ferreira R, Marín Y, Joseph L (1997) The conservation of albatrosses in Uruguayan waters. In: Robertson G, Gales R (eds) Albatross, biology and conservation. Surrey Beatty & Sons, Chipping Norton, p 220–224

Stagi A, Vaz-Ferreira R (2000) Seabird mortality in the waters of the Atlantic Ocean off Uruguay. Mar Ornithol 28:148

Tutui SLS, Bastos GCC, Tomás ARG, Tiago GG, Zavala-Camin LA (2000) Species composition of the exploratory fisheries with bottom longline off southeastern Brazil. Ciência e Cultura 52:55–58

Vaske-Jr T (1991) Seabirds mortality on longline fishing for tuna in Southern Brazil. Ciência e Cultura 43:388–390

Vooren CM, Coelho L (2004) Captura incidental de aves oceânicas na pesca com espinhel-de-fundo. In: Haimovici M, Ávila-da-Silva AO, Rossi-Wongtschowski CLDB (eds) Prospecção pesqueira de espécies demersais com espinhel-de-fundo na Zona Econômica Exclusiva da Região Sudeste-Sul do Brasil. REVIZEE, São Paulo, p 85–91