Agreement on the Conservation of Albatrosses and Petrels

Eighth Meeting of the Seabird Bycatch Working Group

Wellington, New Zealand, 4 – 6 September 2017

Ecological risk assessment of the Itaipava fleet, ES, Brazil, on albatrosses and petrels in the southwest Atlantic

Marques, C., Sant'Ana, R., Gianuca, D. and Neves, T.

SUMMARY

Here, we performed a risk assessment of six albatross and petrel species to incidental mortality in fishing operations of the Itaipava fleet. This approach is urgently needed taking account (i) the spatial distribution of this fleet and its overlap with the distribution of endangered albatrosses and petrels, (ii) the utilization of a variety of fishing gear with the previous records of seabird bycatch, (iii) the inexistence of at-sea observation, and (iv) the lack of compliance with the current regulations obligating the use of seabird mitigation measures below 20° S. Five of the six studied species presented levels of vulnerability "intermediate-high" (>1.5) or "high" (>2) to pelagic longline and handline. This is worrying, taking into account that 600 vessels compose the Itaipava fleet and that endangered species were the most vulnerable, such as the *Diomedea dabennena*, *D exulans*, *Thalassarche chlororhynchos*, *Procellaria conspicillata* and *P. aequinoctialis*.

1. INTRODUCTION

The district of Itaipava, Espírito Santo, Brazil, is the harbor an important and emerging fleet operated by a traditional fishing community. At the end of the 1990s, the Itaipava fleet expanded significantly in number of vessels and operation areas, mostly due to the collapse of coastal fish stocks (Bugoni et al., 2008; Martins et al., 2014). In 2015, the Brazilian General Fishing Registry recorded 600 vessels. This fleet is known for its versatility and use of multi-gear strategies accordingly with the fishery target (Stein, 2006; Martins and Doxsey, 2006). For example, in a single fishing cruise, additionally to pelagic longline, a vessel can engages in secondary operations with different gear, such as demersal longline, handline, dropline and trolling (Stein, 2006; Bugoni et al., 2008; Martins et al., 2014). Although the fleet has typical characteristics of small-scale fisheries (13-17 m vessels, improvised fishing gear, no vessel monitoring system, no freezer, and limited or no use of electronic equipment, Figure 1), its capacity to perform long fishing trips (15-20 days) and operate in offshore waters is much like the industrial fisheries of the south and southeast of Brazil (Maldonado et al., 2014).

Seabird bycatch have been reported in the Itaipava fisheries, but data is anecdotal and there is increasing concern about the potential impact of this fleet on seabirds in Southwest Atlantic (Bugoni et al. 2008, Projeto Albatroz, 2015; 2016). The assessment of seabird interactions with this fleet is particularly difficult because (i) there is no observer coverage, (ii) boats have no VMS, and (iii) due to logistical limitations (vessel size and fish storage), the landing port in most cruises is different to the port of departure, and a vessel can complete several cruises before returning to the district of Itaipava. Although the existing legislation in Brazil requires mitigation measures for seabird bycatch in pelagic longline fisheries, compliance is rare and seldom monitored in pier inspections. Moreover, the multi-fishery operations of this fleet render an additional problem - there is no existing measures to mitigate seabird bycatch in most of the fisheries used by the Itaipava fleet (Bugoni et al. 2008).

Bycatch, including that of seabirds, have been incorporated in the management and risk assessment of the ecological impacts of fishing activities (Waugh et al., 2008; Tuck et al., 2011; Sharp et al., 2009; Waugh et al., 2009; Waugh et al., 2012). This type of analysis can also assess the effectiveness of different management approaches (e.g. adoption bycatch mitigation measures), especially for endangered or key species (Neat et al., 2010; Orsmeth and Spencer, 2011; Hobday et al., 2011; Dransfeld et al., 2013).

Here, we performed a risk assessment of six albatross and petrel species to incidental mortality in fishing operations of the Itaipava fleet. This approach is urgently needed taking account (i) the spatial distribution of this fleet and its overlap with the distribution of endangered albatrosses and petrels, (ii) the utilization of a variety of fishing gear with the previous records of seabird bycatch, (iii) the inexistence of at-sea observation, and (iv) the lack of compliance with the current regulations obligating the use of seabird mitigation measures below 20° S.

Figure 1. (A) Fishing vessels at the Itaipava harbor, (B) fisherman landing their catches on the beach, (C) deck of an Itaipava vessel showing the improvised fishing gear and (d) Itaipava fishermen during a pier interview.

2. MATERIALS AND METHODS

The bycatch vulnerability of albatrosses and petrels to the Itaipava fleet was accessed based on the productivity-susceptibility analysis (PSA) proposed by Hobday et al. (2007). All the analyses in this study were conducted and implemented in the statistical computing environment R 3.4.0 (R Core Team, 2017).

2.1. Itaipava fishery data collection

In order to characterize the fishing activities of the Itaipava fleet and its temporal and spatial distribution, data was obtained for 102 of the 600 registered vessels via pier interviews with skippers at Itaipava (20° 44' S, 040° 77' W). In each interview, we obtained information on the target species of each fishing gear, the most commonly used gear, the time of the year each fishing gear is used, and the fishing areas. Fishing areas were georeferenced in quadrants of 1 x 1. Total use of the area by the Itaipava fleet was estimated for each quadrant, along with the reported periods and the main fishing gear used by the fleet.

$$\widehat{U}_{jkl} = \frac{n_{ijkl}}{m} * N_t$$

where, $\widehat{U}_{jkl}$ is the estimated total number of vessels that used quadrant *j*, with fishing gear *k* in the *l*-the period of the year.

2.2. Exploratory analysis of fishery data

Data from the interviews with representatives of the 102 sampled vessels of the Itaipava fleet were subjected to a descriptive and exploratory assessment essentially to understand the response patterns, eliminate possible inconsistencies and anomalies in the responses, and standardise similar information obtained from the base. This exploratory phase included the estimation of temporal operation patterns, spatial distribution of trapping effort, main target species, and gear used by the Itaipava fishing fleet. This description allowed us to determine which variables could compose the susceptibility matrix that would be used in the productivity-susceptibility analysis (PSA).

2.3. Demographic parameters and species distribution

The vulnerability of bycatch by the Itaipava fleet was analyzed for the wandering (*Diomedea exulans*), Tristan (*D. dabbenena*), Atlantic yellow-nosed (*Thalassarche chlororhynchos*) and black-browned (*T. melanophris*) albatrosses, and for the spectacled (*Procellaria conspicillata*) and white-chinned (*P. aequinoctialis*) petrels. In order to parameterize the models, for each species, information on conservation status, population size, population trend, reproductive traits and survival was obtained from published articles and from the grey literature (Table 1). Table 2 shows the sources of each parameter used in the analyses. The information of global distributions of seabirds in the western South Atlantic were based on the BirdLife species utilization distribution and range maps, this data comprise contributions from many researchers and stored by BirdLife in a global database.

Table 1: Descriptive summary of the surveyed parameters for each species. DE- *Diomedea exulans,* DB - *D. dabbenena,* TC - *Thalassarche chlororhynchos,* TM - *T. melanophris,* PC - *Procellaria conspicillat* and PA - *P. aequinoctialis*.

	Species					
Parameters	**DE**	**DB**	**TC**	**TM**	**PC**	**PA**
Conservation status	3	5	4	2	3	3
Annual breeding	2	2	1	1	1	1
Breeding age	9	10	9.7	10	-	6
Breeding age (range)	(7-X)	(4-20)	(6-13)	(8-13)	-	(4-9)
Success range (%)	30	-	69	75	-	-
Atlantic population	9,900	7,100 – 11,000	65,000	1,659,000	38,000	>2,250,000
Total population	55,000	7,100 – 11,000	65,000	2,100,000	38,000	>3,000,000
Mature Individuals	20,100 – 28,000	4,700	27,800	1,400,000	20,000	3,000,000
Annual breeding pairs (Atlantic)	1,420 – 1,553	1,698 – 1,763	13,900 – 34,000	473,712	10,000	773,205
Annual breeding pairs (Total)	6,107 – 8,050	1,698 – 1,763	13,900 – 34,000	601,686	10,000	1,030,205 – 1,200,000
Mean breeding success (%)	71	32.6	66.5	39.2	-	44.4
Mean juvenile survival (%)	50.65	-	31	32.8	-	39.3
Mean adult survival (%)	92.6	91	88	92.8	-	89.5
Population trends	-1	-1	-1	-1	1	-1

Table 2: Bibliographical references* of the population parameters used in the analyses of this study. DE- *Diomedea exulans,* DB - *D. dabbenena,* TC - *Thalassarche chlororhynchos,* TM - *T. melanophris,* PC - *Procellaria conspicillat* and PA - *P. aequinoctialis*.

	Species					
Parameters	**DE**	**DB**	**TC**	**TM**	**PC**	**PA**
Conservation Status	1	1	1	1	1	1
Annually breeding	4	15	18	4	36	38
Breeding age	4	16	19	11	-	(2)
Breeding age (range)	4-7	16	19	30	-	(2)
Success range (%)	4	-	19	4	-	-
Atlantic population	(2)	3, 16	20	(2)	3	(2)
Total population	8	3, 16	20	3	3	-
Mature Individuals	3, 8	3	3	3	3, 37	3
Annual breeding pairs (Atlantic population)	(2), 3, 9	(2), 3, 16	3, 21-23	9, 25, 26	37	39, 40
Annual breeding pairs (Total)	3, 8-12	(2), 3, 16	3, 21-23	8-11, 26-34	37	3, 39-41
Mean breeding success (%)	(2)	16	19	(2), 4	-	42
Mean juvenile survival (%)	13	-	19	4, 35	-	41
Mean adult survival (%)	(2)	16	19	(2), 4	-	41
Population trends	1, 9, 14	1, 17	1, 19, 23, 24	1, 4, 8, 9, 26	1	1, 13

* (1) IUCN 2017, (2) ACAP 2009, (3) BirdLife International 2017, (4) Croxall et al 1998, (5) Pickering 1989, (6) Weimerskirch & Jouventin 1987, (7) Weimerskirch 1992, (8) Gales 1998, (9) Poncet et al 2006, (10) Jouventin et al 1984, (11) Weimerskirch et al 1989, (12) Ryan et al 2003, (13) Falkland Islands Government 1999[1], (14) Pannekoek & Strien 2006, (15) Cuthbert et al 2004, (16) Wanless 2007, (17) Wanless et al 2009, (18) Rowan 1951, (19) Cuthbert 2003, (20) Richardson 1984, (21) Fraser 1988, (22) Cuthbert & Sommer 2004, (23) Ryan & Moloney 2000, (24) Ryan 2005, (25) Strange 2008, (26) Huin & Reid 2007, (27) Marin & Oehler 2007, (28) Woehler et al 2002, (29) Lawton et al 2003, (30) Arata et al 2003, (31) Robertson et al 2007, (32) Robertson et al 2008, (33) Godoy et al 2007, (34) Tennyson et al 1998, (35) Arnold et al 2006, (36) Hagen 1952, (37) Ryan et al 2006, (38) Jouventin et al 1985, (39) Martin et al 2009, (40) Reid et al 2007, (41) Barbraud et al 2008, (42) Berrow et al 2000.

2.4. Productivity-susceptibility analysis

The attributes of productivity (p) alludes to the resilience of each species, used as reference to choose the parameters, available data, and ecological risk assessments previously applied to seabirds (Waugh et al., 2008; Tuck et al., 2011; Sharp et al., 2009; Waugh et al., 2009; Waugh et al., 2012). For each parameter in the productivity matrix, we attributed three qualification levels (Table 3), defined after compiling the information on each attribute for each species. Whenever a parameter of productivity for a given species from a given colony was

[1] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas.

not found, published data of the same species, but from another colony was used. Table 4 shows the final matrix containing the mean final productivity (p) used to calculate vulnerability.

The attributes of susceptibility (s) is a measures of the potential risk of a species or set of species to be killed in any fishing activity operations, independent of the fishing gear, considering the overlap between each seabird species and the spatial distribution of the fishing effort of the fleet. Thus, information such as effort, production, and financial yield are usually important to determine how susceptible a species can be to the fisheries of a fleet in a given region. For the seabirds, production and yield are not relevant information.

Table 3: Description of the qualification levels of the productivity parameters used in this study.

	Levels		
Parameters	**LOW (1)**	**MEDIUM (2)**	**HIGH (3)**
Conservation Status	5	3-4	1-2
Annual breeding	2	-	1
Breeding age (year) AVE	>= 8	4-8	<= 4
Breeding age (range) MIN	>= 8	4-8	<= 4
Success range (%)	<= 30	30-60	>= 60
Total Individuals (Atlantic pop.)	< 50,000	50,000-250,000	> 250,000
Total Individuals (Total pop.)	< 100,000	100,000-500,000	> 500,000
Endemism (Total-Atlantic)	0	-	>0
Mature Individuals (Total pop.)	< 5,0000	50,000-100,000	> 100,000
Annual breeding pairs (Atlantic)	<15,000	15,000-30,000	> 30,000
Annual breeding pairs (Total)	< 25,000	25,000-50,000	> 50,000
Mean breeding success (%)	< 40	40-60	> 60
Mean juvenile survival (%)	< 40	40-60	> 60
Mean adult survival (%)	< 40	40-60	> 60
Population trends	-1	0	1

Table 4: Matrix of productivity scores and final mean used to calculate vulnerability. DE- *Diomedea exulans,* DB - *D. dabbenena,* TC - *Thalassarche chlororhynchos,* TM - *T. melanophris,* PC - *Procellaria conspicillat* and PA - *P. aequinoctialis*.

Species	Conservation Status	Annual breeding	Breeding age (year) AVE	Breeding age (range) MIN	Success range (%)	Total Individuals (Atlantic pop.)	Total Individuals (Total pop.)	Endemism (Total-Atlantic)	Mature Individuals (Total pop.)	Annual breeding pairs (Atlantic)	Annual breeding pairs (Total)	Mean breeding success (%)	Mean juvenile survival (%)	Mean adult survival (%)	Population trends	Mean
DE	2	1	1	2	1	1	1	3	1	1	1	3	2	3	1	1.60
DB	1	1	1	2	-	1	1	1	1	2	1	1	-	3	1	1.31
TC	2	3	1	2	3	2	1	1	1	2	1	3	1	3	1	1.80
TM	3	3	1	1	3	3	3	3	3	3	3	1	1	3	1	2.33
PC	2	3	-	-	-	1	1	1	1	1	1	-	-	-	3	1.56
PA	2	3	2	3	-	3	3	3	3	3	3	2	1	3	1	2.50

For the susceptibility factor, three levels of qualification were generally used for the attributes to represent the different impacts of the fleet on the bird species. When the representatives (species) proved too susceptible in a given attribute, they were given a score 3 of high susceptibility, while categories with average susceptibility were given a score 2, and categories with low susceptibility were given a score 1 for each attribute.

The parameters considered to compose the susceptibility matrix were fishing intensity or fishing effort (in number of vessels), time of the year when fisheries are most frequent, and the preferred fishing gear. Of the six types of fishing gear identified (associated shoal (vessel as FAD), gill net, bottom longline, surface longline, handline and 'pole and line') in the sample survey, only two (surface longline and handline) were considered for the final risk assessments. The susceptibility matrix take into account the information associated to each quadrant, which provides a measure of the spatial distribution of the vulnerability of each species. The criteria for qualifying the susceptibility levels were based on the following:

a) Fishing intensity (effort in number of vessels by quadrants):
    a. Score 1 (low) - quadrants with 1 to 10 vessels;
    b. Score 2 (medium) - quadrants with 10 to 70 vessels;
    c. Score 3 (high) - quadrants with 70 to 150 vessels;
b) Time of the year:
    a. Score 1 (low) - fisheries that did not occur in the autumn or winter months;
    b. Score 3 (high) - fisheries that occurred in the autumn or winter months;

c) Overlapping of fishing and bird use areas:
   a. Score 1 (low) - quadrants with 1 to 33% use of seabirds;
   b. Score 2 (medium) - quadrants with 33 to 66% use of seabirds;
   c. Score 3 (high) - quadrants with 66 to 100% use of seabirds;
   d. Score 0 (absent) - quadrants with no overlap between the reported fishing areas and the areas used by the seabirds.

Vulnerability (v) or risk is a single measure of a species susceptibility (s) to a given fishery according to the productivity (p) of this species. Consequently, the quantifications of vulnerability of each species were estimated in two ways, namely total species vulnerability to gear (2) and spatial vulnerability of each species to each fishery (3).

$$v_t = \sqrt{((p-3)^2 + (s-2)^2)} \qquad (2)$$

Where, v_t is total vulnerability, *p* is mean productivity of the species and *s* is mean susceptibility. This equation represents the Euclidean distance from the points to the origin of the axes (the distance in a straight line from the point to the origin). This equation is useful because it provides the number values of vulnerability for the species, so the different positions of the analysis components in the graph can have equal values of vulnerability.

$$v_{ti} = \sqrt{((p-3)^2 + (s_i-2)^2)} \qquad (3)$$

where, v_{ti} is the estimated vulnerability for the *i*-th quadrant of the fishing activity for the analyzed gear and s_i is no longer the global susceptibility mean, but the mean susceptibility of quadrant i.

3. RESULTS

3.1. Fishing season, fishing gear and target species

The vast majority (76%) of the Itaipava fleet operates throughout the year (Figure 2A), and the most commonly used fishing gear were the pelagic longline (including the modified gear for dolphinfish, see details in Bugoni et al. 2008) and the handline, which were reported as main fishing gear by 50% and 44% of the sampled vessels, respectively. Other fishing gear utilized by the fleet included ‘associated school’ (vessel as FAD), demersal longline, gillnet, and ‘pole and line’ (Figure 2B). The main target species of the Itaipava fleet were the dolphinfish (*Coryphaena hippurus*, 34%), followed by the tuna (*Thunnus* spp., 32%) and swordfish (*Xiphias gladius*, 15%). A variety of miscellaneous pelagic species were target by 13% of the vessels, and demersal fish by 6% (Figure 2C).

3.2. Distribution of fishing effort

Although most of the landings occurs in areas near Itaipava or Cabo Frio (Rio de Janeiro), the fleet operated between 4° S and 34° S of latidute, through most of the Brazilian EEZ and adjacent international waters, as far as 700 miles offshore. However, the Itaipava operates with greater effort between latitudes 19° S and 27º S, manly across the submarine volcanic chain Vitória-Trindade, including the Trindade and Martin Vaz archipelago (20º 31 'S, 029º 19' W), but with particularly high fishing effort between latitudes 23° S and 27° S, from outer shelf to offshore waters (Figure 4).

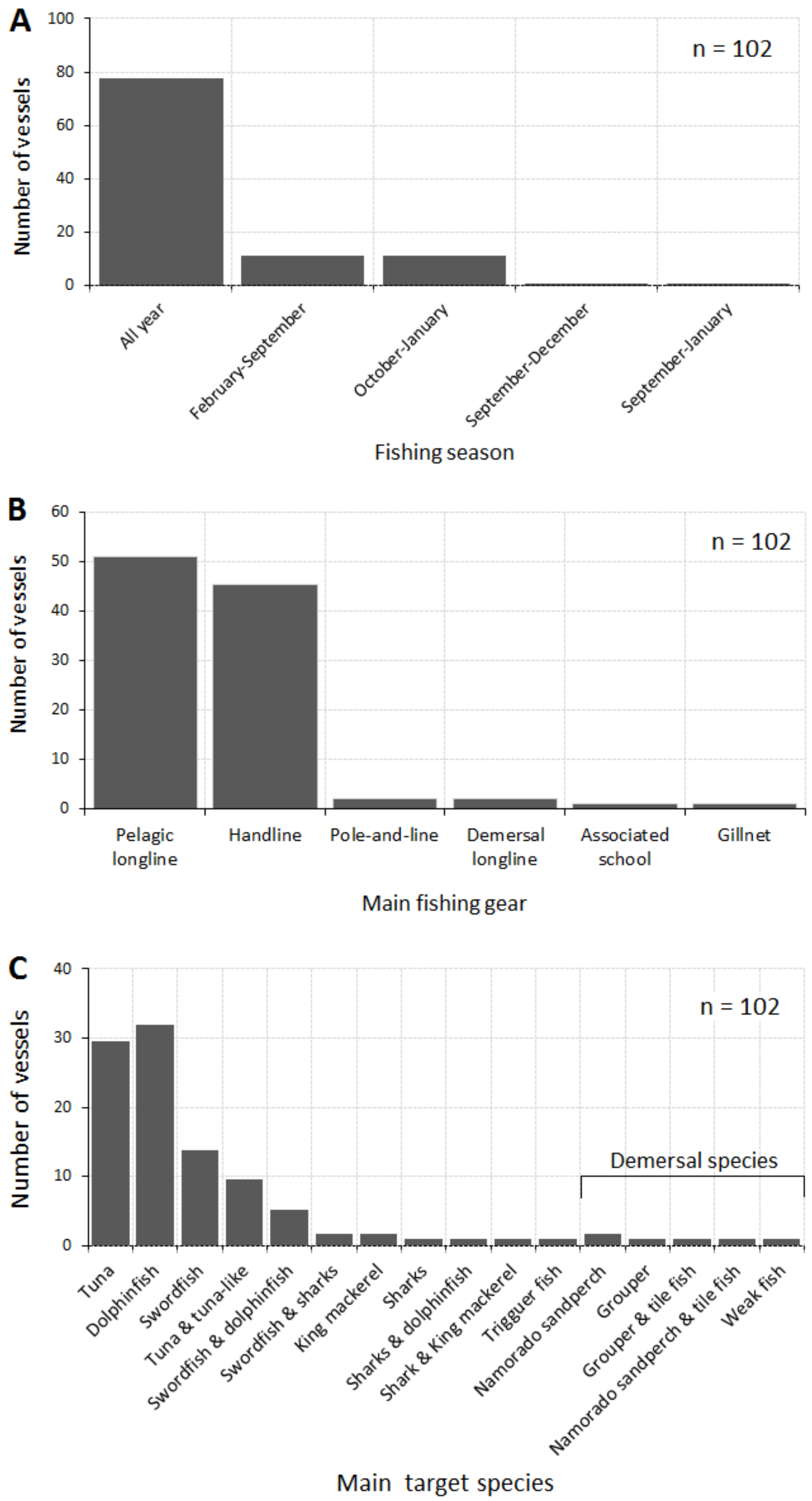


Figure 2. Frequency of vessels operating throughout the year or during a specific fishing season (A), main fishing gear (B) and main target species (C) of the Itaipava fleet based in a sample of 102 vessels.

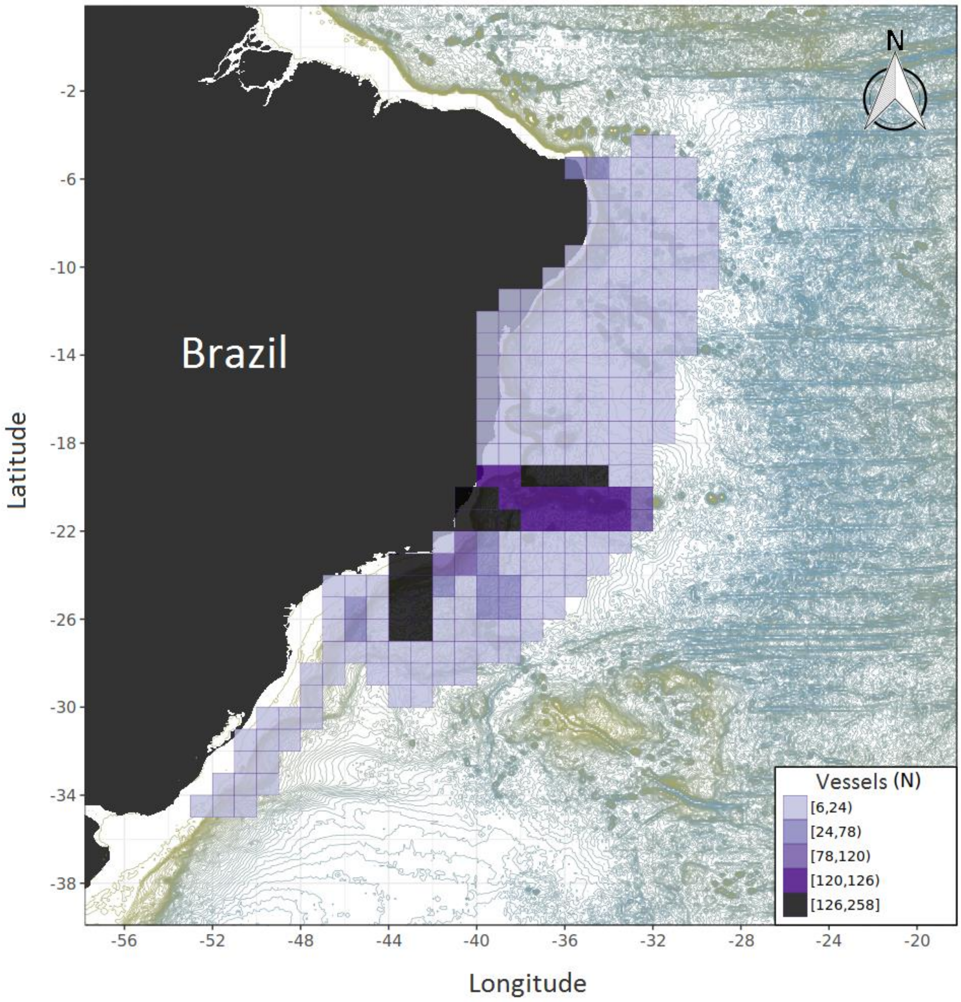


Figure 3: Over year spatial distribution of the fishing effort of Itaipava fleet, expressed as the number of vessels per quadrant of 1º x 1º.

3.3. Vulnerability of albatrosses and petrels to the Itaipava fleet

Vulnerability of albatrosses and petrels was analysed only for the two most representative fishing gears of the Itaipava fleet, the pelagic longline and handline, which presented similar threats to the studied seabird assemblage. Five of the six studied species presented levels of vulnerability "intermediate-high" (>1.5) or "high" (>2). The most vulnerable species to mortality in fishing gear from Itaipava fleet were *P. conspicillata* and *D dabbenena*, followed by *D. exulans*, while the lesser vulnerable was *T. melanophris* (Figure 4). The spatial vulnerability of each species to pelagic longline or handline is presented on Figure 5.

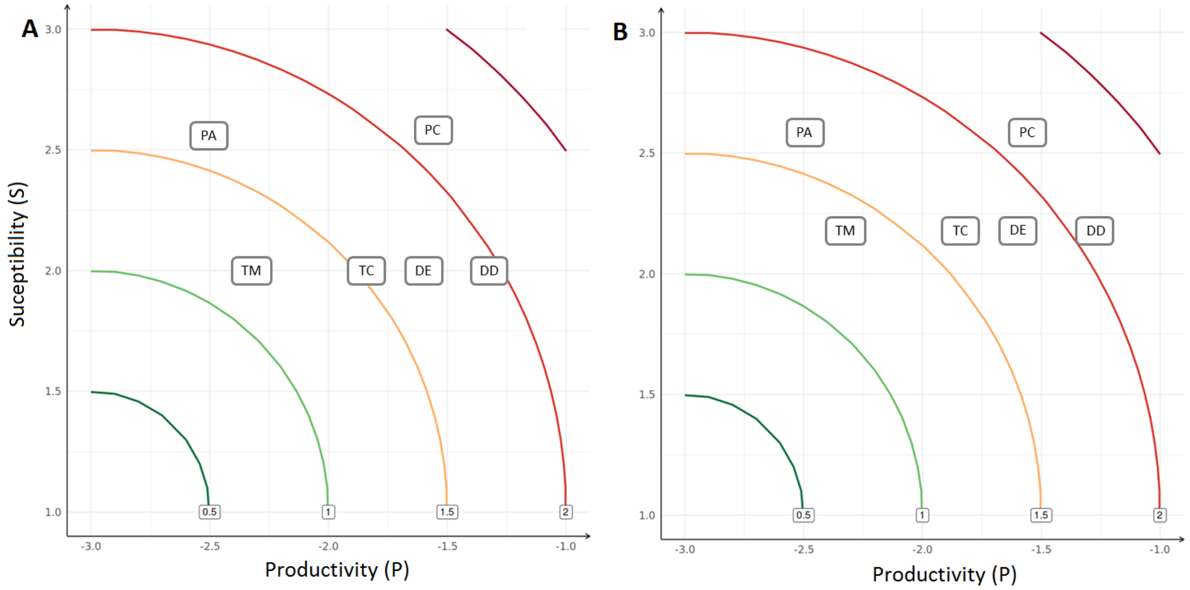
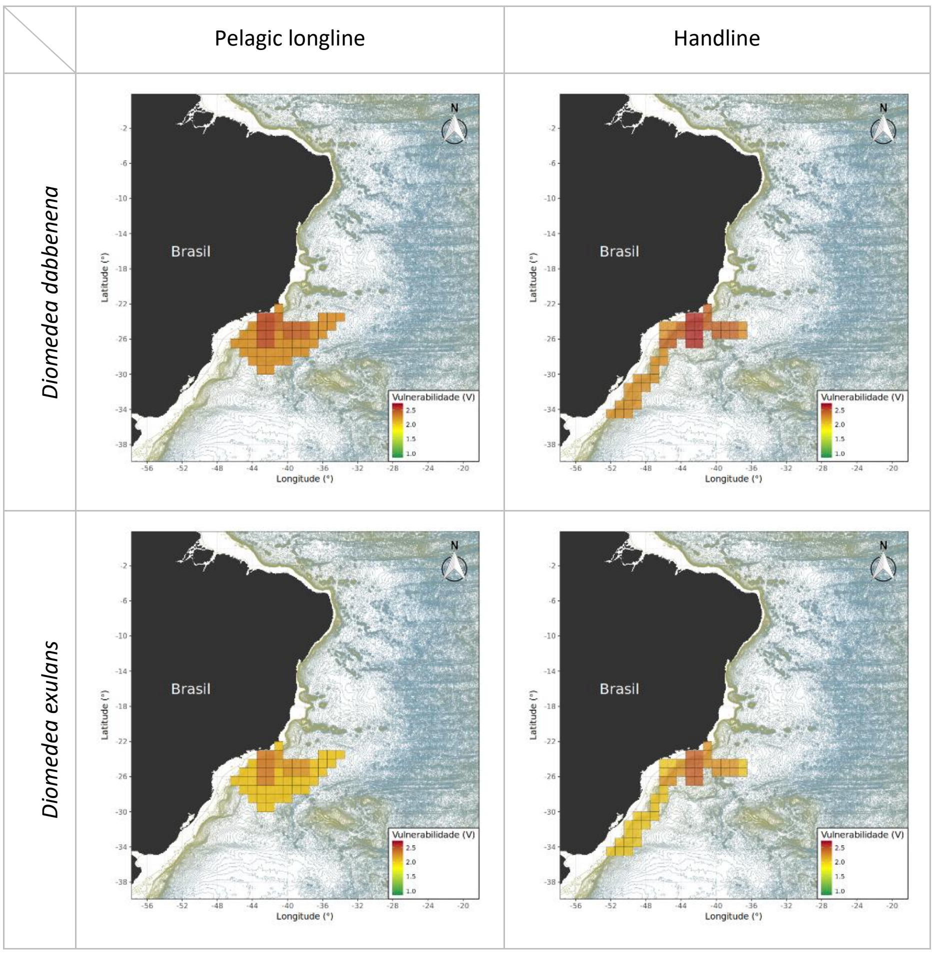


Figure 4: Vulnerability of albatrosses and petrels to pelagic longline (A) and handline (B). DE - *Diomedea exulans,* DD - *Diomedea dabbenena,* TC - *Thalassarche chlororhynchos,* TM - *Thalassarche melanophris,* PC - *Procellaria conspicillata,* PA - *Procellaria aequinoctialis.*



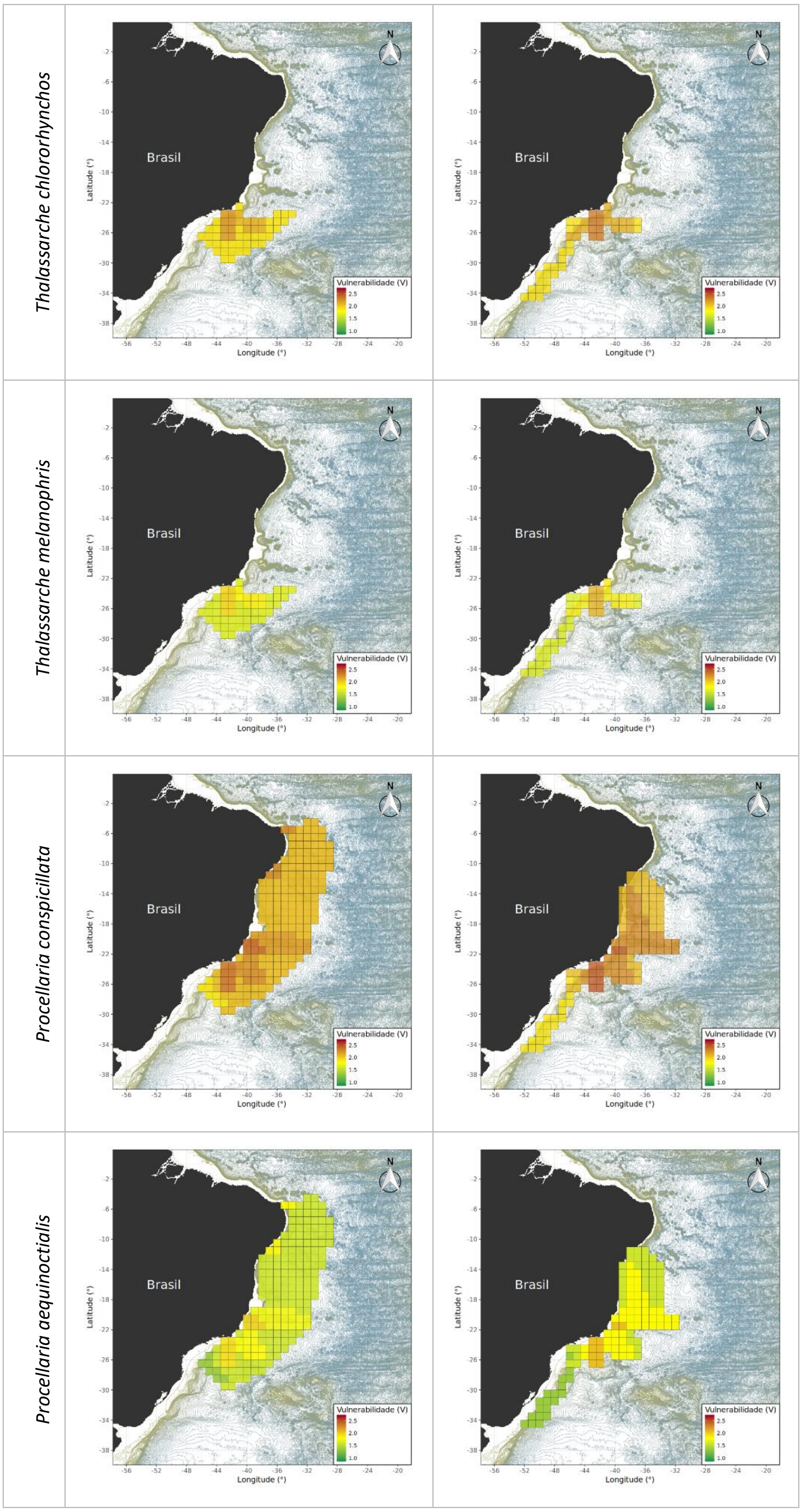


Figure 5: Maps of the vulnerability of each species to the two fishing gears, right column (handline) and left column (longline).

4. DISCUSSION

This study represent the first analysis of the relative risk of albatrosses and petrels to bycatch in fisheries of the Itaipava fleet, which was urgently needed taking into account about potentially high impact on seabirds and turtles in the southwest Atlantic (Martins and Doxsey, 2006, Bugoni et al. 2008, Projeto Albatroz, 2015; 2016).

Although vessels from Itaipava can utilize a range of fishing gear in a single trip, and often change target species throughout the year (Martins and Doxsey, 2005, 2006, Stein, 2006), pelagic longline or handline comprised the main fishing gear of 94% of the surveyed vessels, which target primarily large pelagic fish offshore, including international waters. These results reinforce the changing pattern of Itaipava fleet from predominantly coastal operations to highly pelagic fisheries (Martins and Doxsey, 2005; Stein, 2006; Dallagnolo and Andrade, 2008). The area of activity of the fleet operating with pelagic longline (including the surface longline for dolphinfish) or handling were similar, with increased vulnerability of seabirds from the North to the South, influenced by the distribution of the studied species (Bugoni et al. 2008a).

Handlines are used to catch different species of tunas, frequently around fish aggregating devices (FADs), and considered to be a selective fishing method (Majkowski, 2003). However, in Brazil, high seabird bycatch rates have been reported, from 0.61 birds/day (Bugoni et al. 2008) to 6 birds/day (Projeto Albatroz unpublished data). However, the traditional pelagic longline captures seabirds during winter months (Neves et al., 2006), while the surface longline for Dolphinfish takes place during summer. In the surface longline for Dolphinfish all the baited hooks remain 2 m depth during soak time, are deployed during daylight and use smaller hooks compared to traditional pelagic longline, resulting in extreme high risk of seabird bycatch. Surface longline for Dolphinfish had a bycatch of seabirds of 0.147 birds/1000 hooks (Bugoni et al., 2008) in Itaipava vessels during summer, and a modified version of this gear deployed simultaneously with the traditional pelagic longline by an industrial vessel in southern Brazil (33° S) had a bycath rate of 31 birds/1000 hooks (Projeto Albatroz unpublished data), bycatch rate for in the pelagic longline in Brazil was 0.09 birds/1000 hooks (Neves et al., 2006). This is worrying, taking into account that 600 vessels compose the Itaipava fleet and that endangered species intermediate-high or high vulnerability, such as the *D. dabennena*, *D. exulan*, *T. chlororhynchos*, *P. conspicillata* and *P. aequinoctialis*. These aggravated when considering the difficulties in properly monitoring this fleet (Dallagnolo and Andrade, 2008) and the small or almost non-existent legal structure to control this fleet (Bugoni et al., 2008).
`

REFERENCES

ACAP - Agreement on the Conservation of Albatrosses and Petrels. 2009. ACAP Species assessment: Wandering Albatross Diomedea exulans. Downloaded from http://www.acap.aq on 10 September 2009.

Arata, J., Robertson, G., Valencia, J., and Lawton, K. 2003. The Evangelistas Islets, Chile: a new breeding site for black-browed albatrosses. Polar Biology 26: 687-690.

Arnold, J.M., Brault, S., and Croxall, J.P. 2006. Albatross populations in peril: A population trajectory for black-browed albatrosses at South Georgia[2]. *Ecological Applications* 16: 419-432

Barbraud, C., Marteau, C., Ridoux, V., Delord, K., and Weimerskirch, H. 2008. Demographic response of a population of white-chinned petrels *Procellaria aequinoctialis* to climate and longline fishery bycatch. Journal of Applied Ecology 45: 1460-1467.

Berrow, S.D., Croxall, J.P., and Grant, S.D. 2000. Status of white-chinned petrels *Procellaria aequinoctialis* Linnaeus 1758, at Bird Island, South Georgia. Antarctic Science 12: 399-405.

BirdLife International. 2017. Species factsheet: Diomedea exulans. Downloaded from http://www.birdlife.org on 18/04/2017. Recommended citation for factsheets for more than one species: BirdLife International (2017) IUCN Red List for birds. Downloaded from http://www.birdlife.org on 18/04/2017.

Bugoni L., Mancini P.L., Monteiro D.S., Nascimento L., Neves T.S. 2008. Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. Endangered Species Res. 5: 137–147.

Bugoni L., Neves T.S., Leite N.O.Jr, Carvalho D. et al. 2008. Potential bycatch of seabirds and turtles in hookand-line fisheries of the Itaipava Fleet, Brazil. Fish Res 90: 217–224

Croxall, J.P., Prince, P.A., Rothery, P., and Wood, A.G., 1998. Population changes in albatrosses at South Georgia, in Albatross Biology and Conservation, G. Robertson and R. Gales (Eds). Surrey Beatty & Sons: Chipping Norton. 69-83.

Cuthbert, R. and Sommer, E.S. 2004. Population size and trends of four globally threatened seabirds at Gough Island, South Atlantic Ocean. Marine Ornithology 32: 97-103.

Cuthbert, R., Ryan, P.G., Cooper, J., and Hilton, G. 2003. Demography and population trends of the Atlantic Yellow-Nosed albatross. The Condor 105: 439-452.

Cuthbert, R., Sommer, E., Ryan, P., Cooper, J., and Hilton, G. 2004. Demography and conservation of the Tristan albatross *Diomedea [exulans] dabbenena*. Biological Conservation 117: 471-481.

Dallagnolo R. and Andrade H.A., 2008. Observações a respeito da pescaria sazonal de dourado (Coryphaena hippurus) com espinhel pelágico-de-superfície no sul do Brasil. Bol. Inst. Pesca, v. 34, n.2, p.331-335.

Dransfeld, L., Gerritsen, H., Hareide, N., & Lorance, P. 2013. Assessing the risk of vulnerable species exposure to deepwater trawl fisheries: The case of orange roughy Hoplostethus atlanticus to the west of Ireland and Britain. *Aquatic Living Resources, 26*(4), 307-318.

[2] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas.

Falkland Islands Government. 1999. Conservation of Wildlife and Nature Bill 1999. The Falkland Islands Gazette. Supplement 10(13). http://www.falklandconservation.com/wildlife/conbill.html.

Fraser, M.W., Ryan, P.G., and Watkins, B.P. 1988. The seabirds at Inaccessible Island, South Atlantic Ocean. Cormorant 16: 7-13.

Gales, R., 1998. Albatross populations: status and threats, in Albatross Biology and Conservation, G. Robertson and R. Gales (Eds). Surrey Beatty & Sons: Chipping Norton. 20-45.

Godoy, N., Bahamondes, J., and Castilla, J.C. 2007. Expedición al Seno Almirantazgo, Tierra del Fuego, Chile. Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile. Unpublished Report to the Wildlife Conservation Society.

Hagen, Y. 1952. Birds of Tristan da Cunha. Results of the Norwegian Scientific Expedition to Tristan da Cunha, 1937-38. 20: 1-248

Haimovici M., 1998. Present state and perspectives for the southern Brazil shelf demersal fisheries. Fisheries Management and Ecology 5 (4), 277-289.

Hobday, A. J., Smith, A., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M., and Walker, T. 2007. Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

Hobday A.J., Smith A.D.M., Stobutzki I., Bulman C., Daley R., Dambacher J, et al. 2011. Ecological risk assessment for the effects of fishing. Fish. Res. 2011; 108: 372–384.

Huin, N. and Reid, T. 2007. *Census of the Black-browed Albatross Population of the Falkland Islands.* Falklands Conservation[3]. 44.

IUCN - Red List of Threatened Species. Version 2016-3. <www.iucnredlist.org>. Downloaded on 25 March 2017.

Jimenez S., Domingo A., Brazeiro A. 2009. Seabird bycatch in the Southwest Atlantic: interaction with the Uruguayan pelagic longline fishery. Polar Biol 32:187–196.

Jiménez S., Phillips R.A., Brazeiro A., Defeo O., Domingo A., 2014. Bycatch of great albatrosses in pelagic longline fisheries in the southwest Atlantic: Contributing factors and implications for management. Biological Conservation. 171: 9-20.

Jouventin, P., Stahl, J.C., Weimerskirch, H., and Mougin, J.L., 1984. The seabirds of French Subantarctic Islands & Adélie Land, their status and conservation, in Status and conservation

[3] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas.

of the world's seabirds, J.P. Croxall, P.G.H. Evans, and R.W. Screiber (Eds). ICBP Technical Publication.

Jouventin, O., Mougin, J.L., Stahl, J.C., and Weimerskirch, H. 1985. Comparative breeding biology of the burrowing petrels at the Crozet Islands. Notornis 32: 157- 220.

Lawton, K., Robertson, G., Valencia, J., Weinecke, B., and Kirkwood, R. 2003. The status of black-browed albatrosses *Thalassarche melanophrys* at Diego de Almagro Island, Chile. Ibis 145: 502-505.

Majkowski, J., 2003. Tuna trolling lines. Tuna fishing techniques. Fishing Techniques Fact Sheets FAO – FIGIS.

Marin, M. and Oehler, D. 2007. A new breeding colony of black-browed albatross (*Thalassarche melanophys*) for Chile. Anales Instituto Patagonia (Chile) 35: 29-33.

Martin, A.R., Poncet, S., Barbraud, C., Foster, E., Fretwell, P., and Rothery, P. 2009. The white-chinned petrel (*Procellaria aequinoctialis*) on South Georgia[4]: population size, distribution and global significance. Polar Biology 32: 655-661.

Martins, A.S. Olavo, G., Costa, P.A.S., 2005. A pesca de linha de alto mar realizada por frotas sediadas no Espírito Santo, Brasil. In: P. A. S., Martins, A.S., Olavo, G. (Eds.), Pesca e potenciais de exploração de recursos vivos na região central da Zona Econômica Exclusiva brasileira. Costa, Museu Nacional, Rio de Janeiro, Série Livros No. 13, pp. 35–55.

Martins, A.S., Doxsey, J.R., 2006. Diagnóstico da pesca no litoral do estado do Espírito Santo. In: Isaac, V.J., Martins, A.S., Haimovici, M., Andriguetto, J.M. (Eds.), A pesca marinha e estuarina do Brasil no início do século XXI: recursos, tecnologias, aspectos socioeconômicos e institucionais. Ed. Universitária UFPA, Belém, pp. 93-116.

Martins, A.S.; Santos, L.B.; Silva, M.P.C.; Doxsey, J.R.; Sousa, C.R.; Meireles, A.F.; Rodrigues, C.M.; Pizetta, G.T.; Araújo, J.S.; Zambon, M.C. e Rabelo, L.B. 2014. The Rapid Recent Development of Fisheries in Itaipava, Its Causes and Consequences: A Case Study. *In:* A pesca marinha e estuarina no Brasil : estudos de caso multidisciplinares / organizadores Manuel Haimovici, José Milton Andriguetto Filho, Patricia Sfair Sunye. Rio Grande: Editora da FURG. 135-146.

Neat, F., Kyne, P., Baker, K., Figueiredo, L., Perez, J.A.A., Revenga, C. 2010. Applying a Base Productivity-Susceptibility Analysis to a Complex Deepwater Mixed Trawl Fishery In The Northeast Atlantic. In: Can Ecossistem-Based Deep-Sea Fishing Be Sustained?, 2010, Neuville-Bosc, França. Report. The University of Maine. p.35-51.

Neves, T., Olmos, F., Peppes, F., Mohr, L.V., 2006. National Plan of Action for the Conservation of Albatrosses and Petrels. Ibama, Brasília.

[4] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas.

Ormseth, O.A. and Spencer, P.D. 2011. An assessment of vulnerability in Alaska groundfish. Fisheries Research. 112(3): 127-133.

Pannekoek, J. and van Strien, A. 2006. TRIM 3.53 (TRends & Indices for Monitoring data). Statistics Netherlands, Voorburg. http://www.cbs.nl/en- GB/menu/themas/natuur-milieu/methoden/trim/default.htm.

Patrick, W. S., Spencer P., Ormseth O., Cope J., Field J., Kobayashi D., Gedamke T., Cortés E., Bigelow K., Over-holtz W., Link J., and Lawson P. 2009. Use of productivity and susceptibly indices to determine stock vulnerability, with example applica- tions to six U.S. fisheries. NOAA Tech. Memo. NMFS- F/SPO-101, 90 p.

Patrick, W.S., Spencer, P., Link, J., Cope, J., Field, J., Kobayashi, D., Lawson, P., Gedamke, T., Cortés, E., Ormseth, O., Bigelow, K., Overholtz, W. 2010. Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. Fishery Bulletin, 108(3), pp. 305-322.

Pickering, S.P.C. 1989. Attendance Patterns and Behavior in Relation to Experience and Pair-Bond Formation in the Wandering Albatross (*Diomedea exulans)* at South Georgia. Ibis 131: 183-195.

Poncet, S., Robertson, G., Phillips, R.A., Lawton, K., Phalan, B., Trathan, P.N., and Croxall, J.P. 2006. Status and distribution of wandering, black-browed and grey-headed albatrosses breeding at South Georgia. Polar Biology 29: 772-781.

Projeto Albatroz, 2015. Boletim Técnico Científico do Projeto Albatroz Nº2. http://projetoalbatroz.org.br/sobre-o-projeto-albatroz/biblioteca/boletim-tecnico-cientifico-2015

Projeto Albatroz, 2016. Boletim Técnico Científico do Projeto Albatroz Nº3. http://projetoalbatroz.org.br/pesquisas/biblioteca-de-pesquisas/boletim-tecnico-cientifico-2016.

R Development Core Team, 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Reid, T., Lecoq, M., and Catry, P. 2007. The White-chinned petrel *Procellaria aequinoctialis* population of the Falkland Islands[5]. Marine Ornithology 35: 57-60.

Richardson, M.E. 1984. Aspects of the ornithology of the Tristan da Cunha group and Gough Island, 1972-1974. Cormorant 12: 122-201.

Robertson, G., Moreno, C.A., Lawton, K., Arata, J., Valencia, J., and Kirkwood, R. 2007. An estimate of the population sizes of black-browed (*Thalassarche melanophrys*) and grey-

[5] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas.

headed (*T. chrysostoma*) albatrosses breeding in the Diego Ramirez Archipelago, Chile. Emu 107: 239-244.

Robertson, G., Moreno, C.A., Lawton, K., Kirkwood, R., and Valencia, J. 2008. Comparison of census methods for black-browed albatrosses breeding at the Ildefonso Archipelago, Chile. Polar Biology 31: 153-162.

Rowan, M.K. 1951. The Yellow-nosed albatross *Diomedea chlororhynchos* Gmelin, at its breeding grounds in the Tristan da Cunha group. Ostrich 22: 139-155.

Ryan, P.G. and Moloney, C.L. 2000. The status of Spectacled Petrels *Procellaria conspicillata* and other seabirds at Inaccessible Island. Marine Ornithology 28: 93-100.

Ryan, P.G., 2005. Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*, in Roberts Birds of Southern Africa VII Edition, P.A.R. Hockey, P.G. Ryan, and W.R.J. Dean (Eds). John Voelker Bird Book Fund: Cape Town.

Ryan, P.G., Cooper, J., Dyer, B.M., Underhill, L.G., Crawford, R.J.M., and Bester, M.N. 2003. Counts of surface-nesting seabirds breeding at Prince Edward Island, summer 2001/02. African Journal of Marine Science 25: 441-451.

Ryan, P.G., Dorse, C., and Hilton, G.M. 2006. The conservation status of the spectacled petrel *Procellaria conspicillata*. Biological Conservation 131: 575-583

Sharp, B. R., Parker, S. J., and Smith, N. 2009. An impact assessment framework for bottom fishing methods in the CCAMLR area. CCAMLR Science, 16: 195-210.

Sharp, B. R., Waugh, S. M., and Walker, N. A. 2011. A risk assessment framework for incidental seabird mortality associated with commercial fishing in the New Zealand EEZ. Unpublished report held by the Ministry for Primary Industries, Wellington.

Sharp B.R.; Cryer M.; Richard Y.; Abraham E.R. 2013. New Zealand's Approach to Assessment of Risk to Seabirds Associated with Fishing-Related Mortality. Fifth Meeting of the Seabird Bycatch Working Group.

Stein, C. E. 2006. Dinâmica da Frota Linheira de Itaipava-ES. Monografia do curso de graduação em Oceanografia. Vitoória: Universidade Federal do Espírito Santo.

Stobutzki, I., Miller, M., & Brewer, D. (2001). Sustainability of fishery bycatch: A process for assessing highly diverse and numerous bycatch. *Environmental Conservation, 28*(2), 167-181.

Strange, I.J. 2008. Aerial surveys of Black-browed Albatross *Thalassarche melanophris* breeding colonies in the Falkland Islands: the methodology employed and comparisons with surveys carried out in 1986-2005 and 2007. Design in Nature. Falkland Islands. 60 pp.

Tennyson, A., Imber, M., and Taylor, R. 1998. Numbers of black-browed mollymawks (*Diomedea m. melanophrys*) and white-capped mollymawks (*D. cauta steadi*) at the Antipodes Islands in 1994-95 and their population trends in the New Zealand region. Notornis 45: 157-166.

Tuck G.N., Phillips R.A., Small C., Thomson R.B., Klaer N.L., Taylor F., Wanless R.M., Arrizabalaga H. An assessment of seabird—fishery interactions in the Atlantic Ocean. ICESJMarSci 2011; 68: 1628–37.

Wanless, R.M. 2007. Impacts of the introduced house mouse on the seabirds of Gough Island. Ph.D. Thesis. Percy FitzPatrick Institute. University of Cape Town: Cape Town.

Wanless, R., Peter G. Ryan, P., Altwegg, R., Angel, A., Cooper, J., Cuthbert, R., and Hilton, G. 2009. From both sides: Dire demographic consequences of carnivorous mice and longlining for the Critically Endangered Tristan albatrosses on Gough Island. Biological Conservation 142: 1710-1718.

Waugh S.M., Baker G.B., Gales R., Croxall J.P. 2008. CCAMLR process of risk assessment to minimize the effects of longline fishing mortality on seabirds. Mar Policy; 23: 442–54.

Waugh S.M., Filippi D.P., Kirby D.S., Abraham E., Walker N. 2012. Ecological Risk Assessment for seabird interactions in Western and Central Pacific longline fisheries. Marine Policy; 36: 933–946.

Waugh SM, Filippi DP, Abraham E. 2009. Ecological Risk Assessment for seabirds in New Zealand fisheries. Final report of project PRO200801 to the Ministry of Fisheries. Wellington: Sextant Technology Ltd.

Weimerskirch, H. 1992. Reproductive Effort in Long-Lived Birds - Age-Specific Patterns of Condition, Reproduction and Survival in the Wandering Albatross. Oikos 64: 464-473.

Weimerskirch, H. and Jouventin, P. 1987. Population-Dynamics of the Wandering Albatross, *Diomedea exulans*, of the Crozet Islands - Causes and Consequences of the Population Decline. Oikos 49: 315-322.

Weimerskirch, H., Zotier, R., and Jouventin, P. 1989. The avifauna of the Kerguelen Islands. Emu 89: 15-29.

Woehler, E.J., Auman, H.J., and Riddle, M.J. 2002. Long-term population increase of black-browed albatrosses *Thalassarche melanophrys* at Heard Island, 1947/1948-2000/2001. Polar Biology 25: 921-927.