Biological Conservation 252 (2020) 108817

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Policy analysis

Intentional killing and extensive aggressive handling of albatrosses and petrels at sea in the southwestern Atlantic Ocean

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ARTICLE INFO

Keywords:
Conservation
Hook removal
Intentional killing
Post-handling mortality
Seabird bycatch

ABSTRACT

Large Procellariiformes (albatrosses and petrels) constitute a highly threatened group of birds, for which bycatch in fisheries is the most prevalent threat. At-sea intentional killing and post-capture, handling-related injuries, remain poorly understood menaces. Here, we report fishermen off southern Brazil trying to reduce bait depredation in pole-and-line and handlining fisheries by hitting birds with a metal piece attached to a pole-and-line on four occasions. Fishermen also mutilated or killed birds caught alive on the lines (aggressive handling). In addition, we present a compilation of records of Procellariiformes with bill mutilations across the southwest Atlantic Ocean. Related to the intentional killing events, 16 birds of four species (two globally threatened) were recorded dead (n = 13) or injured (n = 3) with head trauma, broken limbs, wounds or bill mutilation. Observations spanning 1999–2019 across the waters of Brazil, Uruguay and Argentina totalize 46 Procellariiformes of eight species (four globally threatened) recorded with bill mutilations (29 alive and 17 dead). Mutilations were likely caused by aggressive handling of birds caught alive, potentially in Brazilian hook-and-line fisheries or in demersal and pelagic longline fisheries across the southwest Atlantic. Observations of deliberate killing from multiple vessels and the recurrent records of mutilated birds suggest those practices represent pervasive but largely undocumented threats to seabirds and could complicate the detection of fishery-related population effects. Coordinated actions by international bodies and national authorities are urgently needed to address this threat, including increasing at-sea observation, enforcement actions and campaigns targeting better handling practices among fishermen.

1. Introduction

Bycatch in fisheries is one of the main causes of global population declines of air-breathing marine megafauna such as marine mammals, sea turtles and seabirds (Lewison et al., 2014, 2004). Despite the improvement in the last decades in understanding and mitigating the direct bycatch mortality (Gilman et al., 2005; Jiménez et al., 2020; Moore et al., 2009; Senko et al., 2014), post-capture sublethal effects and mortalities have received less attention (Phillips and Wood, 2020; Wilson et al., 2014; Zollett and Swimmer, 2019). Likewise, at-sea

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https://doi.org/10.1016/j.biocon.2020.108817
Received 25 March 2020; Received in revised form 18 September 2020; Accepted 8 October 2020

intentional killing of air-breathing marine vertebrates for human consumption, for baiting or for reducing disturbance during fishing operations (Bugoni et al., 2008b; Kemper et al., 2005; Machado et al., 2016; Mintzer et al., 2018) remains largely undocumented and poorly understood threats.

Seabirds are a highly threatened group of birds particularly impacted by fisheries bycatch, notably large Procellariiformes such as albatrosses and large petrels (Phillips et al., 2016; Dias et al., 2019). However, like other marine megafauna, intentional killing and injuring of birds at sea and post-capture, handling-related, injuries and mortalities represent major knowledge gaps and current research priorities (Lewison et al., 2012; Phillips et al., 2016).

Historically, albatrosses and petrels were caught at sea for human consumption, or shot from vessels for sport, food, or scientific purposes (Phillips et al., 2016). More recently, information on intentional killing has been limited to catches for food, including waved albatrosses (*Phoebastria irrorata*) caught by Peruvian artisanal fishers (Alfaro-shigueto et al., 2016), white-chinned petrels (*Procellaria aequinoctialis*) by Angolan fishermen (Petersen et al., 2007), and black-browed albatrosses (*Thalassarche melanophris*) by the crew of jigging vessels operating on the southern Patagonian Shelf (Reid et al., 2006). In addition, intentional killing of seabirds to reduce depredation in hook-and-line fisheries has been observed off Brazil (Bugoni et al., 2008b). Seabirds can also die as result of severe injuries from poor handling practices or being deliberately killed after been caught alive on the lines (ACAP, 2013; Bugoni et al., 2008b; Moreno et al., 2006; Zollett and Swimmer, 2019), which we refer to as ‘aggressive handling’.

At-sea intentional killing and aggressive handling of birds caught alive remains largely undocumented because when observers are on board such practices are likely to cease (Phillips et al., 2016). Consequently, this unaccounted mortality can complicate both the assessment of population effects of these impacts and linking them to fisheries (Komoroske and Lewison, 2015). Furthermore, the lack of evidence for this potential threat is a barrier for identifying target fleets to improve monitoring and implementation of management actions (Zollett and Swimmer, 2019).

Here, we present evidence of at-sea intentional killing and extensive aggressive handling of albatrosses and petrels in hook and line fisheries in the southwestern Atlantic Ocean, a foraging hotspot for globally threatened albatrosses and petrels (Carneiro et al., 2020). We discuss the potential extent and the conservation implications of this largely undocumented threat, and suggest measures to tackle it in the southwestern Atlantic Ocean and elsewhere.

2. Methods

2.1. On-board observations of intentional killing and aggressive handling

In February 2006, direct observations of intentional killing and aggressive handling of albatrosses and petrels were conducted opportunistically on four different days along a ~2-weeks fishing trip. Observations were conducted by a scientific observer, from the deck of a 26 m pelagic longline vessel that approached pole-and-line and handline fishing vessels next to a moored buoy off southern Brazil (33°57′S; 52°26′W). The number of vessels simultaneously fishing next to the moored buoy during the period of direct observations varied from 4 to 10. The vessels used live bait to target tuna species and attracted large numbers of seabirds, mostly Cory’s shearwaters (*Calonectris borealis*), Cape Verde shearwaters (*Calonectris edwardsii*) and great shearwaters (*Ardenna gravis*), and also spectacled petrels (*Procellaria conspicillata*) and Atlantic yellow-nosed albatrosses (*Thalassarche chlororhynchos*). Fishermen were repeatedly observed trying to reduce live bait depredation by hitting the birds with a metal piece attached to a pole-and-line, or other poles (e.g. bamboo sticks) also used for fishing, and also killing birds caught alive in the lines (aggressive handling). All observations were conducted with the aid of a 10 × 50 binocular, under calm seas and good weather conditions (Fig. 1), opportunistically, whenever fishing activities occurred in nearby vessels. Aggressive handling was also recorded on the vessel on which the observer was working. Injured or dead seabirds seen in the vicinity of those vessels were hauled on-board using a cast net (Bugoni et al., 2008c) or dipnet. Injured birds were also recorded among albatrosses and petrels (foraging around the vessel) hauled on board for research on three occasions in February and one in June 2006 in the same area. Each bird was identified, photographed, and notations were made on the description of the injuries and condition of the bird.

The vessels belong to southeastern Brazilian small-scale fisheries, so called ‘Itaipava fleet’, composed by around 500 vessels, poorly regulated, which deploy a variety of hooks-and-line gears in pelagic water of the southwest Atlantic Ocean, from 18°S to 35°S. Further details about this fleet, including gear configurations, operational standards and bycatch rates are provided by Bugoni et al. (2008c).

2.2. Review of observations of bill-mutilated Procellariiformes

We compiled information gathered by Albatross Task Force instructors, distributed across seven countries (Namibia, South Africa, Brazil, Uruguay, Argentina, Chile, and Peru), which had comparable seabird expertise and at-sea effort over the last 10 years (BirdLife International, 2017), for records of albatrosses and petrels with mutilated bills. In addition, we contacted researchers working on seabirds in those same regions for complementary records. We recorded the species observed, age class (immature or adult) based on plumage and bill colouration from photographs when available, whether it was alive or dead, observed at sea or beached, date, location, and whether the record was documented (photographed).

We categorized mutilations into three categories: upper mandible only, lower mandible only, or both mandibles. The difference in the frequency of mutilations of the upper mandible compared to mutilations of lower or both mandibles was tested using a χ^2 test with Yates correction with 95% significance level, using the software BioEstat (Ayres et al., 2007). From photographs, when available, we estimated the degree of mutilation as percentage of bill length based on the known culmen length for each species (Fig. A1 and Table A1) using the software ImageJ (Schneider et al., 2012). For methodological details, see Appendix A.

3. Results

3.1. Observations of intentional killing and aggressive handling

Sixteen seabirds of four species, including two that are formally threatened were found dead ($n = 13$) or injured ($n = 3$) as result of intentional killing or aggressive handling, of which 13 were hauled on-board near the pole-and-line and handlining vessels and three were killed or injured on the vessel on which the observer was working. Those killed included three great shearwaters, three spectacled petrels (Vulnerable), two Atlantic yellow-nosed albatrosses (Endangered) and one Cory’s shearwater. In addition, four dead unidentified shearwaters were observed floating on the sea surface but could not be retrieved for examination. Dead birds showed signs of head trauma, broken necks, bill mutilations and body wounds, including multiple injuries; and the three great shearwaters that were still alive had broken legs, body/wing wounds or scars (Fig. 2 and Table B1).

3.2. Records of albatrosses and petrels with bill mutilations

From 1999 to 2019, 46 seabirds of eight species were recorded with bill mutilations, including four species that are formally listed as threatened. These comprised four albatross species, including 33 black-browed albatrosses, three northern royal albatrosses (*Diomedea sanfordi*, Endangered), two southern royal albatrosses (*D. epomophora*,

Fig. 1. Three pole-and-line (two indicated by arrows, behind the vessel in first plan) and two handlining vessels fishing next to a moored buoy off southern Brazil (33°57′S; 52°26′W) in one of the occasions when intentional killing of seabirds to reduce bait depredation was observed. Photo: Leandro Bugoni.

Vulnerable), one Atlantic yellow-nosed albatross (Endangered) and one unidentified mollymawk (*Thalassarche* sp.). In addition, were also recorded four petrel species, comprising three southern giant petrels (*Macronectes giganteus*), one spectacled petrel (Endangered), one Manx shearwater (*Puffinus puffinus*) and one Cory's shearwater.

A total of 39 of these (85%) were documented with photographs (Fig. B1 and Table B2). Of the total, 29 were recorded alive (63%), both at-sea ($n = 24$; 52%) and rescued on-shore after being stranded ($n = 5$; 11%) and 17 (37%) were found dead on a beach (Fig. 3). All the mutilated birds rescued onshore died within a few days at rehabilitation centres. Although seabird researchers and scientific observers from the southeast Atlantic (South Africa and Namibia) and southeast Pacific (Chile and Peru) were also contacted, all collected records of albatrosses and petrels with bill mutilation originated from the southwestern Atlantic Ocean, 30 (65%) of which were from Brazil, 13 from Uruguay (28%) and three from Argentina (6%) (Fig. 4 and Table B2). Most of reported cases were in the recent years (44 during 2009–2019, versus 4 over the previous decade 1999–2008).

Most injuries (98%) were flat cuts perpendicular to the length of the bill (Figs. 3 and B1), likely caused by a cutting tool (e.g., knife or saw), and similar to the intentionally mutilated albatross observed in 2006 (Fig. 2A). Mutilations of the upper mandible were significantly more frequent (85%, $\chi^2_{\text{Yates}} = 20.89$, $p < 0.001$) than observed for the lower or both mandibles (one and six birds, respectively). The mean degree of mutilation in relation to bill linear length was 58% ($n = 36$), varying from 3% to 100% of the bill removed (Table B2).

4. Discussion

This is the first review of fishery-related at sea intentional killing and aggressive handling of albatrosses and petrels, showing that such practices represent a pervasive at-sea threat in the southwest Atlantic Ocean and have potential major implications for assessing impact of fisheries on seabirds.

4.1. Potential extent of fishery-related intentional killing of seabirds

Since the observations of intentional killing from 2006 reported here, there have been no further at-sea assessments of interactions between seabirds and those fleets. However, there is no reason to expect that the observed killings were events restricted to that period and area. Four elements support that these events may in fact occur recurrently: (1) fishermen were killing birds during all the days when observations were conducted, (2) they even had adapted poles designed to kill birds, (3) those fisheries are unmonitored and poorly regulated (Bugoni et al., 2008b; Pimenta et al., 2020), and (4) no management action was adopted and implemented to mitigate this threat. In addition, there is an emerging, poorly regulated, pole-and-line/handline fishery off southern Brazil that uses fish aggregation devices (Pinheiro, 2013; Schroeder and Castello, 2008), often fishing around moored buoys and using live or dead bait (Bugoni et al., 2008b; Schroeder and Castello, 2008), which therefore has the potential to constitute a supplementary source of negative interactions such as those reported here. It is important to mention that these hook and line fishing gears are extensively used in Brazil, but they are not used in Uruguay and Argentina.

4.2. Potential source of mutilated birds and extent of aggressive handling

Records of birds with bill mutilation are likely to underestimate the level of aggressive handling, since those are only the birds that survived long enough to be recorded, in addition to the possibly many other unseen cases. The observed injuries, if not killing the bird in the short term, can cause blood loss and infections, and certainly impair their foraging efficiency and likely survival (Komoroske and Lewison, 2015; Wilson et al., 2014; Zollett and Swimmer, 2019), which is supported by the fact that all mutilated birds rescued alive died within a few days at rehabilitation centres. Mandibles were likely cut by fishermen handling birds hooked alive (aggressive handling), as observed at sea. This is supported by the strong bias towards large birds that scavenge behind vessels, which have a higher risk of getting caught (Jiménez et al., 2012; Phillips et al., 2016).

All mutilated birds observed alive (63% of the records) were unlikely caught during longline setting because any birds hooked during this phase are dragged underwater and drown (Anderson et al., 2011). Therefore, these birds were either caught during hauling in demersal or pelagic fisheries, which are widespread across the southwestern Atlantic Ocean (Anderson et al., 2011), or by a different "hook and line" gear that does not drag the birds underwater, like tuna handline and the Brazilian surface longline for dolphinfish (*Coryphaena hyppurus*), which have high hooking rates of albatrosses and petrels (Bugoni et al., 2008b; Gianuca

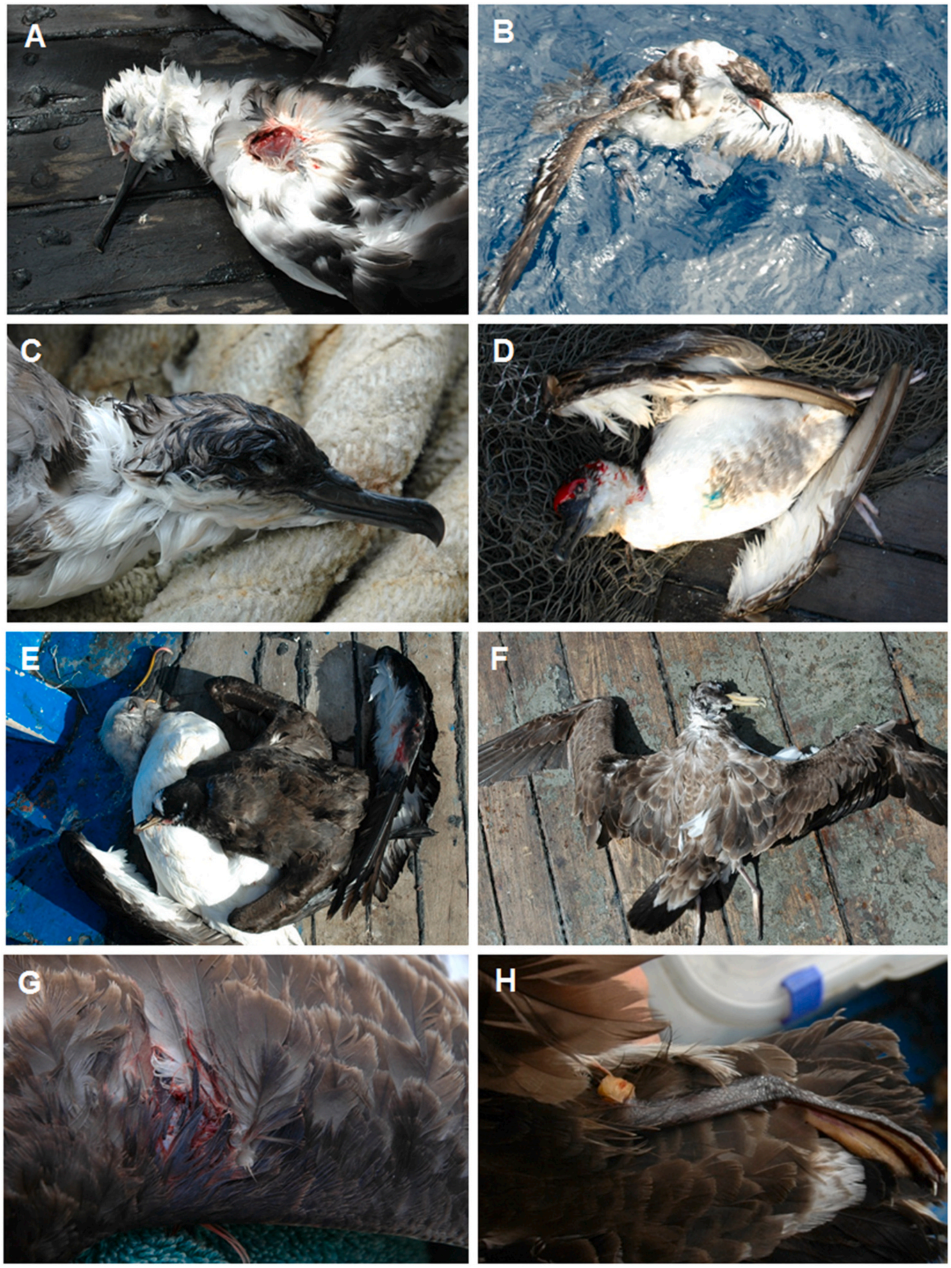

Fig. 2. Albatrosses and petrels deliberately killed (A–F) or injured (G–H) by pole-and-line and handline/troll fisheries targeting tuna species off Brazil, included an Atlantic yellow-nosed albatross with large would and upper mandible amputated (A), great shearwaters (B–D), and an Atlantic yellow-nosed albatross and a spectacled petrel (E) killed by head trauma, a Cory's shearwater killed with a broken neck (F), and alive great shearwaters showing wounded wing (G) or leg exposed fracture (H). Photos: Leandro Bugoni.

et al., 2019). Though seabird researchers with comparable experience and effort at sea from the southeastern Atlantic and southeastern Pacific Oceans were also contacted, all records of albatrosses and petrels with bill mutilations were from the southwestern Atlantic Ocean, suggesting the phenomenon is prevailing in this area.

The higher number of reported cases in the recent years (44 during 2009–2019, versus 4 over the previous decade 1999–2008) can be explained by the higher observation effort at-sea and on stranded carcasses on the shores, coinciding with the implementation of the Albatross Task Force program (BirdLife International, 2017), in addition to different long-term and large-scale beach monitoring programs in Brazil (Barreto et al., 2019; Faria et al., 2014; Tavares et al., 2020).

4.3. Conservation implications

Considering the cumulative effort of the "hook-and-line" fleets across the southwestern Atlantic and their overlap with foraging areas of globally threatened albatrosses and petrels (Carneiro et al., 2020), even low or moderate levels of intentional killing and aggressive handling practices pose a cryptic menace to species already impacted by bycatch in this area (Anderson et al., 2011; Bugoni et al., 2008a; Sullivan et al., 2006). Furthermore, the recurring observations of mutilated birds over the last 20 years demonstrate that aggressive handling represents a pervasive but largely undocumented threat. It is a potential factor contributing to the already large numbers of dead albatrosses and petrels washed-up on beaches across south and southeast Brazil (Barreto et al., 2019).

This largely unreported and unaccounted mortality can complicate the spatial evaluation of fishery-related mortality risk (Carneiro et al., 2020; Clay et al., 2019) and can make the detection of relationships between seabird demography and fisheries difficult (Komoroske and Lewison, 2015; Pardo et al., 2017; Wilson et al., 2014), since those analysis are largely based on reported bycatch mortalities and the overlap between seabirds foraging areas and reported fishing effort of major concerning fleets.

Fig. 3. Examples of albatrosses and petrels documented with bill mutilation alive, at sea (A–C) or stranded (D–F), or dead on the shores (G–I), including black-browed (A–D, F and H), northern royal (G) and southern royal (I) albatrosses and a southern giant petrel (E). Detailed information of each record is presented in the supplementary information (Table B2, Fig. B1). Photos: Gabriel Canani (A), Nicholas W. Daudt (B), PMP-BS (D, F), Tatiana Neves (E), Dimas Gianuca (G), Fernando A. Faria (H) and MUCIN collection (I).

4.4. Management challenges and recommendations

The main management challenge for mitigating the potential impact of intentional killing and lethal handling is that such practices remain largely undocumented, and are likely to cease in the presence of on-board observers (Phillips et al., 2016). Consequently, there is no basic information to justify or guide specific policies or support research to tackle this poorly understood threat (Lewison et al., 2011).

The deliberate killing of seabirds to avoid bait depredation could be reduced by using harmless deterrents, like water curtains, jets or sprayers (Reid et al., 2010). In the case of lethal handling, the first step is to avoid the bycatch of live birds in first place. Although several measures have been successfully developed to mitigate seabird bycatch during pelagic and demersal longline hauling (Gilman et al., 2014; Reid et al., 2010), hooking of seabirds in handline and Brazilian dolphinfish longline fisheries, both of which operate during daylight and using unweight lines, is difficult to avoid. For handline gear, line weighting could increase fishing depths of baited hooks, and the use of sliding leads would prevent the risk of accident to the crew due to flight-backs (Santos et al., 2019; Sullivan et al., 2012). The seabird bycatch in Brazilian dolphinfish longline, which is set at 2 m depth (Bugoni et al., 2008b), could be reduced by increasing set depth to 10 m, like in Costa Rican dolphinfish longline fisheries (Swimmer et al., 2005), and by night setting (ACAP, 2019, 2017). However, for all the potential measures aforementioned, on-board research on efficiency, practical feasibility and potential effects on fish catches is needed. In addition, operational, socio-economics and management particularities of each fisheries requires fishery-specific approaches to tackle this problem (Komoroske and Lewison, 2015; Lewison et al., 2011).

Once a seabird is hooked alive, both its survival likelihood and fishermen safety depend upon correct handling and hook removal techniques, which are available through manuals and fisherman-directed fact-sheets produced by several organizations (ACAP, 2013; Zollett and Swimmer, 2019). The widely documented non-lethal handling of albatrosses caught alive on the lines provides further support that aggressive handling practices are avoidable (Gilman et al., 2014; Phillips and Wood, 2020; Thiebot et al., 2015). Therefore, investing in education, awareness and training campaigns for fishermen could play an important role for reducing the utilization of aggressive handling practices of birds caught alive (Lewison et al., 2011; Zollett and Swimmer, 2019). Concerted and coordinated action by national and international stakeholders can include (1) production and distribution of manuals on seabird handling and hook removal for target hook and line fisheries, (2) requirements by national fishery authorities and Regional Fishery Management Organizations (RFMOs) for vessels to carry such manuals and (3) the inclusion of safe handling and hook removal techniques in professional fishermen courses.

Finally, despite technical recommendations and legal requirements for mitigating the impact of fisheries on seabirds and other marine vertebrates, most concerning fishing fleets are unmonitored or the observer programmes cover a low proportion of the fishing effort. In the absence of observers, the compliance with conservation and management measures is thought to be low (Gilman and Kingma, 2013; Haas et al., 2020; Phillips, 2013). Furthermore, in some small-scale fisheries, restrictions imposed by boat size limits the possibilities to accommodate observers on board (Bartholomew et al., 2018; Bugoni et al., 2008b; Moreno et al., 2006). Therefore, in addition of increasing independent observer coverage, remote electronic monitoring (REM) could be used to monitor illegal fishing practices against protected marine megafauna, such as intentional killing, bycatch retention, aggressive handling or

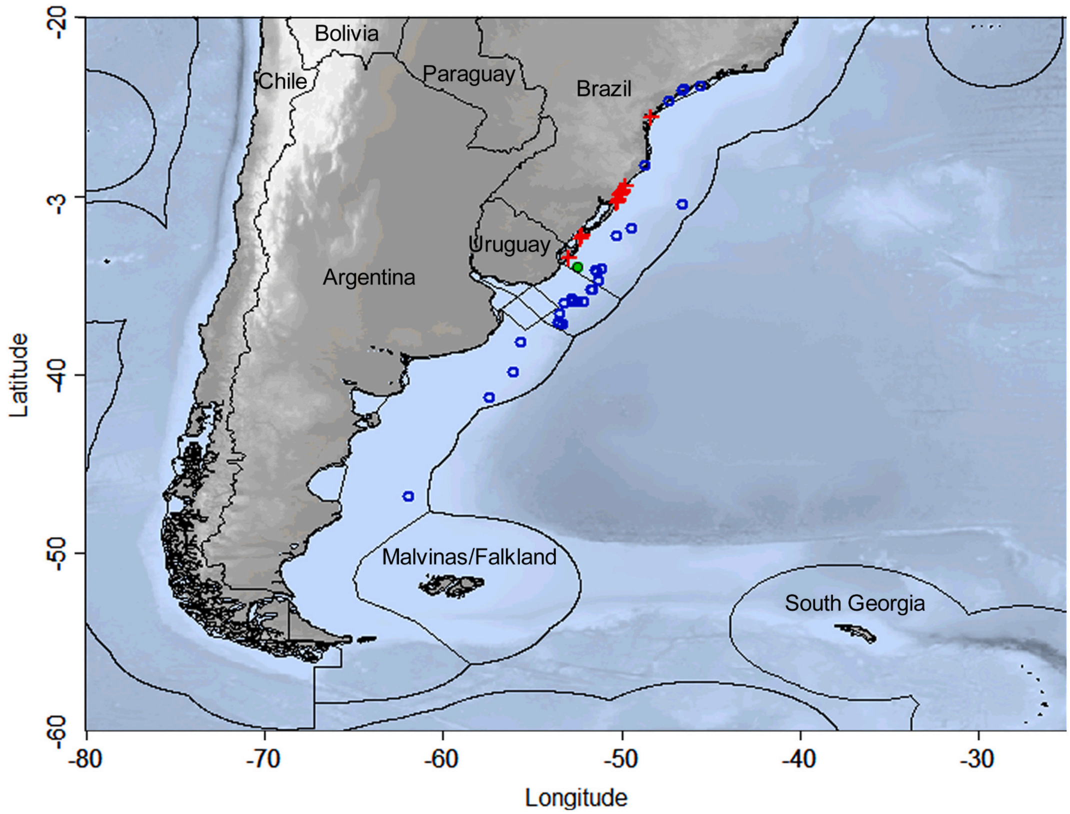

Fig. 4. Geographical distribution of the records of albatrosses and petrels with bill mutilation recorded alive (blue open circles) or dead (red crosses), and the position of the moored buoy (light green solid circle) where handline and pole-and-line vessel's crew members were observed intentionally killing birds to reduce bait depredation or to remove hooks off birds caught alive. The solid dark line represents country's borders and respective Economic Exclusive Zones. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

non-compliance with the utilization of mandatory bycatch mitigation measures (Kritzer, 2020; Probst, 2020; van Helmond et al., 2020). This would improve compliance with legal requirements over a broad-scale and, ultimately, reduce the unsustainable mortality of seabirds and other marine megafauna in global fisheries (Phillips et al., 2016; Probst, 2020; van Helmond et al., 2020). However, though REM is an emerging powerful tool, its application for large-scale monitoring of fishing practices still face many challenges, including equipment maintenance, hidden activity outside the camera's field of view, structural diversity among vessels, data storage and transference, and capacity for analysing large amount of image data (Probst, 2020; van Helmond et al., 2020). Despite its current challenges, which are expected to be overcome due to the rapidly increasing technology, implementing REM on vessels could simply deter fishermen from intentionally killing or aggressively handling threatened species at sea (Kritzer, 2020; van Helmond et al., 2020).

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2020.108817.

CRediT authorship contribution statement

Dimas Gianuca: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft; Visualization. **Leandro Bugoni**: Conceptualization, Methodology, Investigation, Writing - reviewing and editing. **Sebastián Jimenez**: Investigation, Writing - reviewing and editing. **Nicholas W. Daudt**: Investigation, Writing - reviewing and editing. **Philip Miller**: Investigation, Writing - reviewing and editing. **Gabriel Canani**: Investigation, Writing - reviewing and editing; Visualization. **Augusto Silva-Costa**: Investigation, Writing - reviewing and editing. **Fernando A. Faria**: Investigation, Writing - reviewing and editing. **Julián Bastida**: Investigation, Writing - reviewing and editing. **Juan Pablo Seco Pon**: Investigation, Writing - reviewing and editing. **Oli Yates**: Conceptualization, Writing - reviewing and editing. **Patricia P. Serafini**: Investigation, Writing - reviewing and editing. **Alexander L. Bond**: Conceptualization; Writing - reviewing and editing; Supervision.

Author statement

This study is all original research carried out by the authors, who all agree with the contents of the manuscript and its submission to Biological Conservation. This paper has not been previously submitted to Biological Conservation or any other journal, and no part of this study has been published or is being considered for publication elsewhere. However, the direct observation of intentional killing, presented in detail here, where broadly mentioned in Bugoni et al. (2008b; Fish. Res. 90, 217–224). Cases from this study are a sort of validation of injuries detected on the beach and at sea, as they were visualized in situ. Any contribution not carried out by the authors is fully acknowledged in the manuscript, and we have no ethical issues or conflicts of interest to disclose.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Brazilian data was largely collected by *Projeto Albatroz*, sponsored by *Petrobras* through the *Programa Petrobrás Socioambiental* and supported by BirdLife International and Royal Society for the Protection of Birds (RSPB) through the Albatross Task Force Programme. Four records included in this study were publicly available in the online data platform maintained by the '*Projeto de Monitoramento de Praias* – PMP' (Beach Monitoring Program), a monitoring program required by the Brazilian Environmental Agency (IBAMA), for licensing oil production and transportation at the pre-salt province. We are thankful to Richard A. Phillips, for kindly reviewing the manuscript and contributing with constructive comments. N.W.D. and F.A.F. received respectively, MSc. and PhD. Scholarships from 'Conselho Nacional de Desenvolvimento Científico e Tecnológico' (CNPq) through the 'Programa de Pós-Graduação em Oceanografia Biológica' (FURG). L.B. is research fellow 1D of CNPq #311409/2018-0. This study is dedicated to the memory of captain Celso Oliveira, who left us recently, and whose vessels served as platforms for several data reported here.

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