Evidence is required to address potential albatross mortality in the New South Wales Ocean Trawl fishery

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To examine the current management of trawl fisheries is important to ensure albatross mortality is not being overlooked. By-catch of albatrosses in trawl fisheries occurs cryptically, which has hindered the development of conservation policy. The implementation of tasked seabird observer programmes in trawl fisheries, nevertheless, has shown that albatross mortality can happen at threatening levels. Consequently, mitigation measures have been developed and adopted in some trawl fisheries. Despite this, some trawl fisheries lack clear policy in relation to albatross mortality. In this context, I investigated the management of potential albatross mortality in a state trawl fishery, the New South Wales Ocean Trawl, in Australia. I conducted a literature search and addressed a set of questions to the responsible management agency through questions on notice at the State Parliament of New South Wales to understand albatross interactions from a policy standpoint. My results indicate that current policy neither encompasses albatross mortality nor is evidence-based. However, the combination of characteristics of this fishery and its overlap with albatross occurrence, along with the reported albatross mortality from other trawl fisheries, may warrant the need to collect empirical evidence on potential albatross interactions. Hence, the responsible management agency should take action according to legal obligations. In this scenario, I recommend the implementation of a tasked seabird observer programme, collection of baseline data, and adoption of adaptive management by the examined fishery. As uncertainty can hamper conservation efforts because management actions require evidence, it is imperative to fill current information gaps in this fishery. Additionally, an improved understanding of albatross mortality from individual trawl fisheries across different fisheries management jurisdictions will enable the prioritization of conservation efforts of this avian taxon in an international and multi-gear fishing context.

Key words: albatross, trawl fisheries, seabird by-catch, Australia, evidence-based policy, threatened species

INTRODUCTION

DESPITE the mounting evidence that interactions with trawlers are a source of albatross (Aves: Diomedeidae) mortality, recognition of this issue by fisheries management has lagged. The detection of albatross mortality in longline fisheries (Brothers 1991) was contemporary to those of trawl fisheries (Bartle 1991); however fisheries management has traditionally devoted most attention to the former, neglecting the latter (Croxall 2008). This has been particularly evident in Australia (Department of Sustainability, Environment, Water, Population and Communities 2011a), where pelagic longline fisheries have been recognized as a key threat to seabirds at Commonwealth level since 1995 (Department of the Environment and Water Resources 2006), whereas trawl-related mortality of seabirds has been addressed only since 2011 by Commonwealth fisheries management (Woodhams and Vieira 2012). Any delay to address albatross by-catch in trawl fisheries is no longer justifiable when mortality rates from such fisheries may be comparable to those from longline fisheries (Baker *et al*. 2007; Watkins *et al*. 2008; Abraham and Thompson 2011) and mitigation measures have become available (e. g., Sullivan *et al*. 2006a; Bull 2009; Pierre *et al*. 2012a, b).

Trawl-related mortality has affected the disproportionate number of threatened species of albatross. Of the 22 species of albatross, 15 are currently listed under one category of threat at a global scale (IUCN 2013), of which at least seven are killed by trawl fishing gear worldwide (i. e., Argentina, Australia, Falkland/Malvinas Islands, New Zealand, and South Africa) at varying degrees (Bartle 1991; Sullivan *et al*. 2006b; González-Zevallos *et al*. 2007; Watkins *et al*. 2008; Waugh *et al*. 2008; Phillips *et al*. 2010; Favero *et al*. 2011). Fishing related mortality has had detrimental effects on albatross populations (Wanless *et al*. 2009); this is exacerbated by their life history, which is characterized by long life spans, delayed maturity, and low reproductive rates (Baker *et al*. 2002; Arnold *et al*. 2006). Therefore, even if mortality rates from individual fisheries are low, their cumulative effect over larger spatial and temporal scales may result in population declines (Baker *et al*. 2007).

Although often cryptic, trawl interactions are a significant source of albatross mortality (Bartle 1991; Baker *et al*. 2002; Croxall 2008; Waugh *et al*. 2008; Abraham 2010). High mortality rates of albatrosses associated with trawlers were initially identified as a consequence of collisions with the net-sonde cable (Bartle 1991), the wire that transmits data from underwater acoustic devices to on-board monitors in order to inform the fishing process (Simmonds and MacLennan 2005). Nevertheless, subsequent studies have also identified the warps (i. e., the cables towing the

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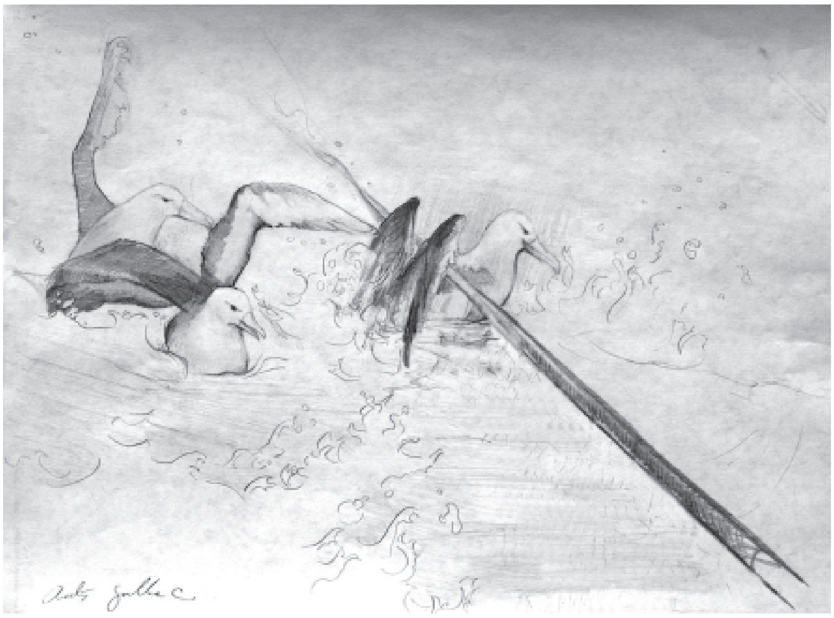

Fig. 1. Typical warp strike: albatrosses feeding on discards behind the vessel can be struck by the warps in the scapular region, which can drag them underwater as the net is towed along (illustration by Andrés Gallo).

net) as a major cause of mortality (Sullivan *et al*. 2006b; González-Zevallos *et al*. 2007; Watkins *et al*. 2008). Trawl-related mortality has been difficult to estimate quantitatively because detection of lethal interactions often requires tasked seabird observers, as only a proportion of killed birds are retrieved with the fishing gear (Watkins *et al*. 2008; Abraham 2010).

Trawl-related fatality rates of albatrosses vary in time and space due to differences in fisheries, environmental, and species-specific variables. Mortalities have been mostly recorded from demersal and pelagic trawl operations targeting fish and squid, particularly during discarding when albatrosses congregate behind the vessel's stern in response to foraging opportunities. Hence, birds are exposed to be struck by the warps either when on the water or flying, which can cause death due to collision or drowning (Sullivan *et al*. 2006b; González-Zevallos *et al*. 2007; Watkins *et al*. 2008; Abraham 2010; Favero *et al*. 2011; Fig. 1). Additionally, adverse weather conditions have been associated with higher mortality rates, possibly as a result of reduced visibility of warps and increased flex of them (Bartle 1991; Watkins *et al*. 2008). Levels of interaction also fluctuate seasonally because adult albatrosses migrate to breeding colonies during the Southern Hemisphere summer, temporally reducing overlap in some fisheries and increasing it in others (Watkins *et al*. 2008; Waugh *et al*. 2008; Favero *et al*. 2011).

The measures developed to mitigate albatross mortality in trawl fisheries have been focused on two main strategies: (i) reduction of vessel attractiveness to birds, and (ii) keeping birds away from the fishing gear. As trawl fishing operations usually discharge offal while the gear is deployed, the first strategy comprises the reduction of feeding opportunities for albatrosses by managing discards, as follows: (i) batching discharge at given time intervals (Pierre *et al*. 2012a), (ii) mincing discards before discharging (Pierre *et al*. 2010, 2012b), and (iii) total retention of discards whilst fishing gear is deployed (Middleton and Abraham 2007, Abraham *et al*. 2009). Unfortunately, discard management is often constrained by logistics depending on each vessel's configuration; hence reducing the attractiveness of vessels to birds is not always feasible. The second mitigation strategy includes bird scaring devices that deter albatrosses from entering the danger zone, the area between the warps and the stern of the vessel (Sullivan *et al*. 2006a; González-Zevallos *et al*. 2007). As there is no one-size-fits-all solution, mitigation of seabird interactions requires tailored strategies according to each fishery and vessel configuration (Bull 2007).

Fisheries management often passes through three stages in relation to seabird by-catch: (i) denial, (ii) assessment, and (iii) implementation of mitigation measures (Croxall 2008). In this context, notwithstanding a major trawl fishery, the Ocean Trawl Fishery (OTF), overlaps with albatross species occurrence within New South Wales (Australia) fisheries management jurisdiction, no analysis has been carried out to establish the current management perspective in relation to potential albatross mortality. Therefore, the aim of this work was to determine at which stage the management of the OTF currently stands and to make recommendations for further research and policy development to ensure potential deleterious demographic effects on albatrosses are addressed.

THE OTF AND ALBATROSSES

The fishing grounds of the OTF encompass the entire length of the New South Wales (Australia) coast from Tweed Heads (28°09" S) to Cape Howe (37°30" S). Along the south coast, the fishing area extends three nautical miles offshore north to Barrenjoey Point (33°34" S), Sydney. From Barranjoey Point, the OTF extends north towards the border with Queensland and from the coast eastwards to 60–80 nautical miles following the 4 000 m depth contour. Two sectors make up the OTF: fish trawling occurs south from Smoky Cape (30°55" S), whereas prawn trawling is conducted northwards from Barrenjoey Point (33°34" S) (NSW Department of Primary Industries 2004).

The OTF is state-managed, multi-sector, multi-species, and single-gear with a diverse fleet. The management of this fishery is the responsibility of the New South Wales Department of Primary Industries (DPI). This fishery operates year round with the exception of some closures for juvenile prawns. The fish trawl sector was initiated in the 1920s whereas the prawn trawl sector was established in the 1940s. This fishery peaked in the 1980s, both in production and fleet size, with a decrease in both ever since (NSW Department of Primary Industries 2004). Nowadays the fishery's landing is about 3 376 tonnes per annum (fish sector: 1 539 tonnes; prawn sector: 1 837 tonnes in 2010–2011. DPI unpublished data) and the fleet size comprised usually 125 vessels (fish sector: 25; prawn sector: 100. DPI unpublished data). This fishery does not use net-sonde cables and its fishing gear consists of demersal otter trawl with specifications related to target species, namely single-rigged for fish trawling and multiple-rigged for prawn trawling (Fig. 2). All vessels in this fishery are wheel-housed and decked ranging in length from 9 m to 27 m (NSW Department of Primary Industries 2004).

Twelve species of albatross, of which all are of conservation concern, have been identified to potentially overlap with the OTF presenting clinal abundance (Wood 1992; Ganassin and Gibbs 2005; Table 1). Five species are listed under at least one category of threat by the New South Wales Threatened Species Conservation Act 1995 (TSC Act), twelve under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), and eight under the IUCN red list. All these species are listed under the Agreement on the Conservation of Albatrosses and Petrels (ACAP), to which Australia is a signatory party (ACAP 2004). The abundance of albatross species along the New South Wales coast tends to increase southwards (Wood 1992).

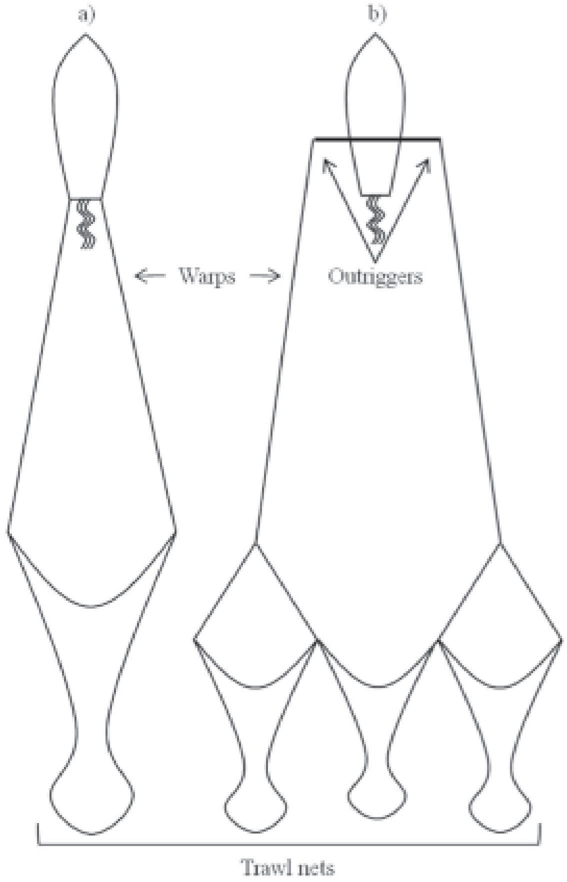

Fig. 2. Fishing gear configuration of the New South Wales Ocean Trawl Fishery according to each sector: a) fish trawl (single-rigged gear) and b) prawn trawl (multiple-rigged gear) (based on NSW Department of Primary Industries 2004 and Macbeth *et al*. 2008). (Diagram neither shows otter boards nor is drawn to scale.)

CURRENT POLICY AND EVIDENCE OF ALBATROSS INTERACTIONS IN THE OTF

Policy perspective of the OTF regarding albatross interactions

The current policy perspective of the OTF in relation to seabird interactions was investigated through direct inquiry. A set of six questions about the understanding and management of seabird interactions in the OTF was addressed to the DPI through a "questions on notice" session at the State Parliament of New South Wales on 15 November 2012 (Parliament of New South Wales 2013). This is a formal procedure where written requests for information concerning government administration are asked by members of parliament to ministers, in this case the Minister for Primary Industries. The questions and answers received on 20 December 2012 (Parliament of New South Wales 2013) are summarized as follows:

1. Have seabird interactions been reported through logbooks or observer data in the OTF?

Table 1. Species of albatross potentially overlapping with the New South Wales Ocean Trawl Fishery (Ganassin and Gibbs 2005), evidence of trawl-related mortality elsewhere, and conservation status at state (New South Wales Threatened Species Conservation Act 1995), national (Environment Protection and Biodiversity Conservation Act 1999), and global level (International Union for Conservation of Nature red list 2013). Taxonomy follows that officially adopted by the Agreement on the Conservation of Albatrosses and Petrels (ACAP 2009).

Species	Evidence of trawl-related mortality	NSW TSC Act	EPBC Act	IUCN red list
Wandering (snowy) Albatross (*Diomedea exulans*)		EN	VU	VU/A4bd
Antipodean Albatross (*Diomedea antipodensis*)	Waugh *et al.* (2008)	VU	VU	VU/D2
Northern Royal Albatross (*Diomedea sanfordi*)	Waugh *et al.* (2008), Favero *et al.* (2011)		EN	EN/A4bc; B2ab (iii,v)
Southern Royal Albatross (*Diomedea epomophora*)	Bartle (1991), Sullivan *et al.* (2006b), Waugh *et al.* (2008), Favero *et al.* (2011)		VU	VU/D2
Black-browed Albatross (*Thalassarche melanophris*)	Sullivan *et al.* (2006b), González-Zevallos *et al.* (2007), Watkins *et al.* (2008), Waugh *et al.* (2008), Phillips *et al.* (2010), Favero *et al.* (2011)	VU	VU	NT
Campbell Albatross (*Thalassarche impavida*)	Waugh *et al.* (2008)		VU	VU/D2
Shy Albatross (*Thalassarche cauta*)	Watkins *et al.* (2008), Phillips *et al.* (2010)	VU	VU	NT
White-capped Albatross (*Thalassarche steadi*)	Bartle (1991), Waugh *et al.* (2008)		VU	NT
Salvin's Albatross (*Thalassarche salvini*)	Waugh *et al.* (2008)		VU	VU/D2
Indian Yellow-nosed Albatross (*Thalassarche carteri*)			VU	EN/A4bde
Buller's Albatross (*Thalassarche bulleri*)	Bartle (1991), Waugh *et al.* (2008)		VU	NT
Sooty Albatross (*Phoebetria fusca*)		VU	VU	EN/A4bd

Reply (R)/ There are no data of seabird interactions from observer programmes or logbooks.

2. Has any research been undertaken to determine the extent of seabird interactions in the OTF and the impact on different seabird populations?

R/ Two studies have been conducted relevant to seabird interactions in the OTF (Ganassin and Gibbs 2005; Macbeth *et al.* 2008).

3. Are there any plans to undertake further research on seabird interaction in the OTF?

R/ Seabird interactions will be documented as part of proposed observer work.

4. What actions have been taken to address the potential mortality of seabirds in the OTF?

R/ An Environmental Impact Assessment of the fishery has been conducted and logbook reporting of interactions with threatened and protected seabirds is compulsory.

5. Are there any management measures to prevent potential seabird interactions in the OTF?

R/ No specific measures have been implemented to address potential seabird mortality as it is considered to be negligible.

6. What is the latest Environmental Impact Assessment of the OTF?

R/ The latest Environmental Impact Assessment was produced in 2004 (NSW Department of Primary Industries 2004).

What is known about albatross interactions with the OTF?

Whilst there is no evidence to support that fatal albatross interactions are occurring in the OTF, there is also a lack of data to support the opposite. The negligible mortality of seabirds claimed by the DPI in response to question five is not supported by any of the documents referred to (NSW Department of Primary Industries 2004; Ganassin and Gibbs 2005; Macbeth *et al.* 2008) in response to questions two and four (Parliament of New South Wales 2013). The study by Ganassin and Gibbs (2005) is inconclusive in relation to seabird mortality in the OTF. Moreover, this study is a qualitative assessment of the risk of wildlife interactions with the OTF based on a literature review with no data collection to address the particular issue. Similarly, the study conducted by Macbeth *et al.* (2008) may have little relevance for this issue because it focused on the prawn sector, which has lower albatross mortality risk (González-Zevallos *et al.* 2011; Marinao and Yorio 2011). By contrast, the Environmental Impact Assessment of the OTF (NSW Department of Primary Industries 2004) concluded that albatross mortality arising from fishing gear interactions should likely be low as net-sonde cables are not used in this fishery. This assertion is not well supported though, as neither empirical evidence is presented nor the potential significance of warp strikes considered (e. g., Watkins *et al*. 2008; Abraham 2010). This flaw, nevertheless, may be understandable due to the chronology of publication of research on the topic. Trawl mortality from warp strikes, not just net-sonde cable collisions (Bartle 1991), became widely recognized after the seminal work of Sullivan *et al*. (2006b). However, as new evidence has become available, update of management is urgently required. Albatross mortality in trawl fisheries can only be reliably assessed through a well designed and implemented tasked seabird observer programme (Baker *et al*. 2002), which has not been implemented in the OTF. Therefore, no study to date can be used to support conclusions of insignificant levels of albatross mortality in the OTF.

Despite logbook reporting potentially providing data on interactions between albatrosses and the OTF, some practical considerations may preclude this from occurring. Reporting of harmful interactions between fishing gear and threatened and protected species by fishermen is a legal requirement of the DPI. However, obtaining this information is not necessarily a reliable data source (Phillips *et al*. 2010). On one hand, bodies of albatross killed by trawlers are seldom retrieved (Watkins *et al*. 2008) and, even, when birds are landed, the bodies are not always retained by fishing crews for observer programmes (Bartle 1991). On the other hand, logbook reporting of interactions with threatened and protected species does not attract individual liabilities to fishermen, which could in principle discourage underreporting. Nevertheless, there may be a concern among fishing crews that reporting such interactions could prompt new management measures with associated burdens for the fishing industry within the OTF, such as fines, gear modifications, and fishing ground closures (see NSW Department of Primary Industries 2007).

Are albatross interactions likely to be occurring in the OTF?

Not all trawl fisheries pose the same risk to albatrosses because fishing gear configuration differs according to target species. For instance, trawl operations targeting fish use single-rigged gear, while those targeting prawn use multiple-rigged gear (Fig. 2). Albatross mortality has been recorded for single-rigged gear, because the warps tow the net in line with the trail of water flow that carries discards from the stern of the vessel (e. g., Watkins *et al*. 2008). By contrast, multiple-rigged equipment usually uses outriggers to tow the nets, which generally stretch the warps outside the trail of discards that attract albatrosses (e. g., González-Zevallos *et al*. 2011; Marinao and Yorio 2011). As the OTF has two sectors, fish and prawn, with single and multiple-rigged gear configuration respectively, the most likely risk is derived from the fish sector, which operates from the Victorian border to the mid-north coast.

Potential lethal interactions between albatrosses and the OTF fish sector are uncertain, however, indirect evidence may indicate the need to collect empirical evidence. The OTF uses demersal fishing gear, the same type of trawl for which albatross mortality has been documented elsewhere (Sullivan *et al*. 2006b; Watkins *et al*. 2008; Abraham 2010; Favero *et al*. 2011). Albatross mortality has additionally been recorded in other inshore trawl fisheries with vessels within the same length range as the OTF (Abraham 2010). In comparison and in contrast to the OTF, the Commonwealth Trawl sector of the Southern and Eastern Scalefish and Shark fishery, which is adjacent to the OTF in southern New South Wales, has mandatory seabird management plans in response to recorded albatross fatalities (Phillips *et al*. 2010; Woodhams and Vieira 2012). Moreover, nine of the twelve albatross species potentially overlapping with the OTF have experienced trawl-related fatalities elsewhere (Table 1) and, at least, one of them (Black-browed Albatross *Thalassarche melanophris*) is actually known to feed on fishing discards from trawlers within the OTF (Milledge 1977). In conclusion, even though uncertainty remains, the available indirect evidence may warrant the need to collect data on potential interactions between albatrosses and the OTF. Hence, according to the responses provided by the DPI, the management of the OTF may be still in the stage of denial in relation to albatross by-catch (Croxall 2008), as there are neither data available nor management actions to address potential mortality.

A WAY FORWARD

Why should the DPI care about albatross interactions?

Different legislative and policy frameworks make the DPI responsible for ensuring threats to albatrosses are managed within the OTF. Under the New South Wales Fisheries Management Act 1994, the TSC Act and the EPBC Act, the DPI is required to conserve threatened species within its jurisdiction. Additionally, as Australia is a party to the ACAP, the DPI is obligated to address mortality of albatrosses from trawl fisheries (ACAP 2009). There are also policy instruments under which the DPI should undertake actions to address potential trawl-related mortality of albatrosses. For instance, the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (Department of Sustainability, Environment, Water, Population and Communities 2011b) recommends extending the seabird by-catch mitigation plans currently implemented in Australian Commonwealth trawl fisheries to Australian State trawl fisheries. Likewise, the OTF Management Strategy (NSW Department of Primary Industries 2007) and the National Fishing and Aquaculture Research, Development and Extension Strategy (Commonwealth of Australia 2010) state the need to understand the impacts of fishing on threatened species.

Research needs and recommendations

Since the current policy related to albatross interactions in the OTF has not been evidence-based, thorough research needs to be conducted to fill information gaps. Any observer programme to address albatross mortality in the OTF needs to focus on this issue (Baker *et al*. 2002), primarily on the fish sector. Data must be collected by tasked seabird observers (Watkins *et al*. 2008) and an effort should be made to identify albatrosses to species level (Yeh *et al*. 2013). In this context, baseline data on interactions should be collected before the potential implementation of mitigation measures to enable appraisal of management performance. Experimental design of the observer programme should include key variables, such as season, time, weather, latitude, distance offshore, gear configuration, fishing effort, offal discharge, and target species, so that results are representative of the entire fishery (South Africa's Department of Environmental Affairs and Tourism 2008). Estimates of interactions should be calculated at a fishery level considering the clinal and seasonal abundance of albatross species along the New South Wales coast (Barton 1979; Wood 1992), as well as the spatio-temporal variation of fishing effort. Statistical modelling could additionally be used to account for deceptively low interaction rates from individual vessels and unfeasible 100% observer coverage. Finally, research should be published in peer-reviewed journals to ensure transparency and scientific robustness (Argyrous 2011).

Considering the complexity of the problem and the financial resources required to address it, research may be undertaken cooperatively. Addressing albatross mortality in trawl fisheries requires effort across different fisheries management jurisdictions because these species occur over large spatial scales beyond political borders. Therefore, any observer programme aimed at appraising seabird interactions in the OTF could be fostered through collaboration from the Australian Fisheries Management Authority and research institutions. This could create opportunities to reduce associated costs (e.g., training of tasked observers, data analyses), standardize data collection protocols to have comparable datasets, streamline reporting processes to meet policy obligations, as well as assess the effectiveness of, and improve, seabird management plans (González-Zevallos *et al*. in press).

Should the empirical evidence indicate the need for mitigation, more robust management outcomes would be likely through collaboration between researchers, fisheries management, and the fishing industry. Cooperative development of mitigation strategies, alongside the fishing industry, that are not just effective for albatrosses but practical and safe to fishing crews, are likely to result in higher compliance levels (Huang and Yeh 2013). Additionally, in comparison to seabird by-catch in longline fisheries, addressing this issue in trawl fisheries represents little incentive to fishermen to trigger voluntary uptake of solutions. Seabird by-catch in longline fisheries is typically perceived as reducing fishing potential. Hence, addressing seabird by-catch by fishing crews in longline fisheries bears not only environmental connotations but economic too (Anderson *et al*. 2011). By contrast, seabird mortality in trawl fisheries is economically innocuous to fishermen, as it does not reduce fishing potential. Therefore, the implementation of a process to address possible albatross by-catch in the OTF should empower the fishing industry by increasing its social license to operate through public recognition of its environmental stewardship. Gaining public endorsement in this context is likely to result in more secured resource access to the fishing industry and, thus, possibly becoming an incentive to address albatross by-catch (Hall *et al*. 2000; Hundloe *et al*. 2011).

FINAL REMARKS

Fisheries management is now challenged to address trawl fisheries as much as longline fisheries as a source of potential albatross mortality (Moore and Zydelis 2008). As uncertainty can hinder conservation efforts because management actions require evidence (Lewison *et al*. 2004), it is imperative to fill current information gaps in the OTF. To date, the level of interactions between the OTF and albatross species remains unquantified, which renders the current management of the fishery insufficient to ensure the DPI is meeting its obligations under various legislative and policy frameworks. This state of affairs suggests that policy should be evidence-based following an adaptive management framework through research taking into account seabird mortality mitigation measures for trawl fisheries (FAO 2009). The improved understanding of albatross mortality from individual trawl fisheries will additionally enable appraisal of the issue at a global scale, as has already been done with longline fisheries (Anderson *et al*. 2011), which is a prerequisite to set conservation priorities for albatross species in an international and multi-gear fishing context.

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