

Fishermen's perceptions of interactions between seabirds and artisanal fisheries in the Chonos archipelago, Chilean Patagonia

CRISTIÁN G. SUAZO, ROBERTO P. SCHLATTER, ALDO M. ARRIAGADA
LUIS A. CABEZAS and JAIME OJEDA

Abstract Interactions between seabirds and commercial fishing activities have been well documented but little information is available regarding the impacts of more traditional fishing practices on seabird populations. We interviewed fishermen, administered questionnaires, and made field-based observations to determine the extent to which artisanal fisheries interact with and affect seabirds in the fjords and channels of the Chonos archipelago in southern Chile. Our surveys indicated a positive perception of seabirds as useful indicators of marine productivity and in their role scavenging fish waste and discards associated with fishing operations. However, the surveys also revealed that fishermen routinely establish seasonal camps for collecting seabird eggs and adults for food or bait and introduce feral predators to seabird breeding colonies on islands. Understanding the traditional practices of fishermen is critical for the future of community-based conservation of the region's marine resources and biodiversity.

Keywords Artisanal fishery, bycatch, Chile, conservation, feral predators, Patagonia, seabirds, South-east Pacific, subantarctic

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Introduction

Seabird bycatch has been widely documented in commercial fisheries but the extent to which traditional fishing activities affect seabirds has not been well studied (Anderson et al., 2011). In central Chile diving birds (e.g. penguins, cormorants, shearwaters) sometimes drown in artisanal gill-net or purse-seine fisheries (Simeone et al., 1999; Brito, 2002; Schlatter et al., 2009), and in southern Chile seabirds may be caught by the artisanal Patagonian toothfish *Dissostichus eleginoides* and Austral hake *Merluccius australis* fisheries (0.047 and 0.030 birds per 1,000 hooks, respectively, Moreno et al., 2006). However, the earliest records on bycatch rates, without mitigation measures, from the traditional long-line fleet for these waters (vessel size < 18 m) were generally low (white-chinned petrel *Procellaria aequinoctialis*: 0.068 birds per 1,000 hooks, exclusively during winter) compared to the industrial fleet (0.374–1.285 birds per 1,000 hooks, mainly during the breeding period of subantarctic birds, in summer; Moreno et al., 2003).

In addition to incidental capture, egg collection, hunting, and direct harvesting for food have been associated with traditional fishing activities and may also affect seabird populations (Schlatter & Simeone, 1999). Unregulated tourism (Simeone & Schlatter, 1998; Guicking et al., 1999) and for-profit trade may also be problematic (Ibarra-Vidal & Klesse, 1994), perturbing habitats and introducing invasive species or disease.

There is a significant artisanal fishing fleet targeting austral hake and ling *Genypterus blacodes* in the fjords and channels of the Chonos archipelago (between 44° and 46°S; Fig. 1), where artisanal activities are an important part of fishing (> 1 million hooks set since 2002; Moreno et al., 2006). Hake are caught on individual vertical lines suspended from a drifting buoy called *atorrante* (i.e. wandering). This gear is up to 200 m long, is equipped with 30–35 hooks, and has a 0.3–1.0 kg weight attached to the bottom of each *atorrante* (Moreno et al., 2006; Plate 1). Ling are caught using a line positioned horizontally on the seabed. Boats are 6–9 m long and have outboard motors; one boat can set a maximum of 2,000 hooks per day (Moreno et al., 2006). In this archipelago seabird species breed and forage in areas that overlap with the ling and hake fisheries. These long-line fisheries are a potential threat in

CRISTIÁN G. SUAZO* (Corresponding author) Department of Animal Ecology and Systematics, Justus Liebig University Giessen, Heinrich-Buff-Ring 38, 35392 Giessen, Germany. E-mail biosuazo@gmail.com

ROBERTO P. SCHLATTER Instituto de Ciencias Marinas y Limnológicas, Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile

ALDO M. ARRIAGADA Departamento de Zoología, Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile

LUIS A. CABEZAS Albatross Task Force, BirdLife International, Chile

JAIME OJEDA† Parque Etnobotánico Omora (Instituto de Ecología y Biodiversidad – Universidad de Magallanes), Puerto Williams, Chile

*Also at: Albatross Task Force, BirdLife International, Chile

†Also at: Departamento de Ciencias y Recursos Naturales, Facultad de Ciencias, Universidad de Magallanes, Punta Arenas, Chile

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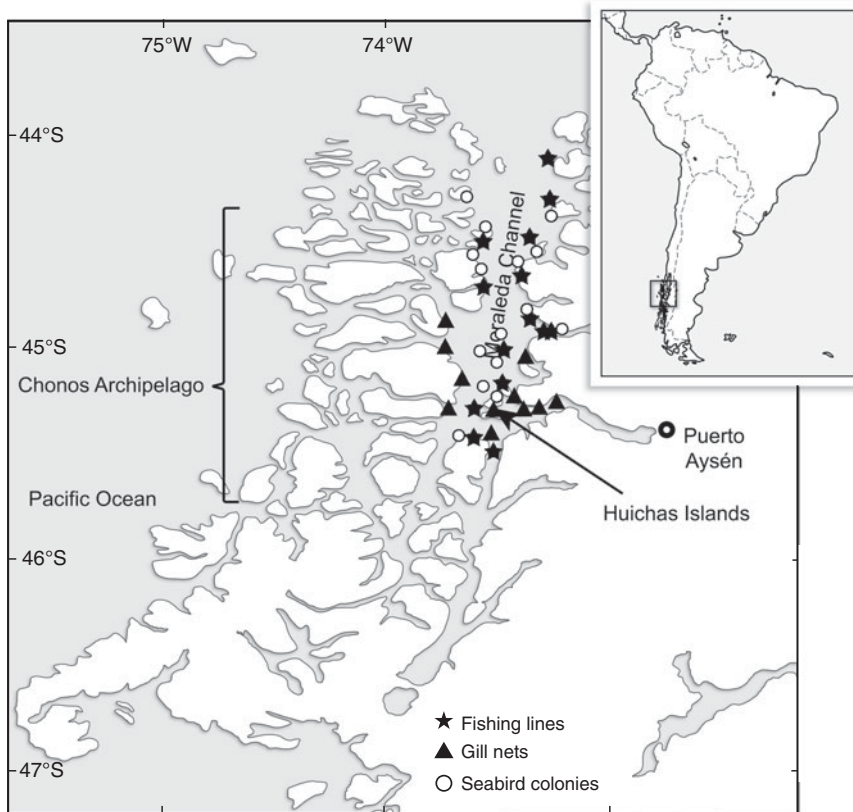


FIG. 1 The Chonos archipelago, Chilean Patagonia, showing the location of the Huichas islands, the areas preferred by fishermen for artisanal fishing (for fishing lines and gill nets) and the location of seabird breeding colonies in this area.



PLATE 1 Artisanal drift line known as *atorrante*. Left, settled line in shallow waters to show line's detail and its bottom weight. Upper right, buoy and flags. Bottom right, line and hooks.

what is considered to be a globally important breeding area for albatross species (Moreno & Robertson, 2008). Isolated fishing areas and extreme weather in this part of Patagonia encourage the creation of seasonal camps, where additional interactions between fishermen and seabirds could have detrimental effects on seabirds.

The goals of this study were to use questionnaires, interviews, and field-based research to: (1) understand the

perceptions of artisanal fishermen regarding their interactions with seabirds both at sea and on land, (2) determine the direct and indirect threats to seabirds resulting from artisanal fisheries in the region, (3) establish baseline information against which future conservation concerns can be assessed, and (4) explore the potential to promote and include artisanal fisheries in community-based conservation initiatives.

Methods

We used questionnaires to interview 60 hake and ling fishermen (18–65 years old) from the Chonos archipelago in Chile. To ensure that we could have confidence in the answers, trained university students related to the fishermen, and associated with the fishing activities of their relatives during the austral summer (January–March), administered all questionnaires. The questionnaires contained 13 open and closed questions (Supplementary Information 1).

We also interviewed 30 artisanal fishermen working in the region, using the same questionnaire, and made additional direct at-sea observations of fishing operations to acquire more detailed information. These observations were made of line and net fishing; ($n = 24$ boats with 60 setting lines and 10 nets, monitoring by CGS) during July–February (the austral winter and summer fishing

TABLE 1 Seabirds recognized by artisanal fishermen in the Chonos archipelago (Fig. 1), with prey recorded by fishermen, threats previously documented in Chile (Schlatter & Simeone, 1999), threats documented in this study, and the IUCN (2012) Red List category of the species.

Species	% recognized by fishermen	Bird's main food item recognized by fishermen (type of prey)	Previous threats in Chile (area mentioned)	Main threats (this study) ¹	IUCN category ²
Magellanic penguin <i>Spheniscus magellanicus</i>	100	Little fish (sprat)	Egg collection & hunting for bait (central & southern Chile)	Gill nets, fishing lines, egg collection, hunting for food & bait, introduction of feral predators, oil spills	NT
Southern giant petrel <i>Macronectes giganteus</i>	82.5	Bait from fishing lines & offal	No information (subantarctic islands)	Fishing lines	LC
Southern fulmar <i>Fulmarus glacialoides</i>	80	Little fish (sprat)	No information	Fishing lines, hunting for bait	LC
Black-browed albatross <i>Thalassarche melanophrys</i>	67.5	Bait from fishing lines & offal	Future shrimp fishery (distant south)	Fishing lines, plastic debris	EN
Sooty shearwater <i>Puffinus griseus</i>	55	Little fish (sprat)	No information (distant southern islands)	Fishing lines, gill nets	NT
Wilson's storm petrel <i>Oceanites oceanicus</i>	10	No information	No information (distant southern islands)	Plastic debris, oil spills	LC
Diving petrel <i>Pelecanoides</i> spp. ³	2.5	No information	No information (inner sea & distant southern islands)	Plastic debris, oil spills	LC
Kelp gull <i>Larus dominicanus</i>	100	Mainly offal	Egg collection (along Chilean coast)	Egg collection, hunting for bait, introduction of feral predators, plastic debris	LC

¹These threats don't consider the invasion and predation on the islands by American mink, which was introduced into Patagonia for the pelt industry in the 1960s

²NT, Near Threatened; VU, Vulnerable; LC, Least Concern; EN, Endangered

³We considered both Magellanic *Pelecanoides magellani* and common *Pelecanoides urinatrix* diving petrels as potentially present in the Chonos archipelago but the fishermen have difficulty in differentiating them

seasons) during 2005–2008. We visited 14 seabird breeding islands and islets to assess the impacts of fishing camps on seabird colonies. The total number of interviewed fishermen comprised almost 50% of settled families in the town of Caleta Andrade in the northern Huichas Islands.

Results

Austral hake and ling were the most commonly targeted catch species in the region. These were typically caught using vertical and horizontal fishing lines, respectively. Other species of interest to fishermen included Fuegian sprat *Sprattus fuegensis* (for use as bait or in the fishmeal industry) and Patagonian blennie *Eleginops maclovinus*, which are caught by purse seining and with monofilament gill nets, respectively. Preferred fishing areas are associated with the coastal borders of islands in the inner sea of this archipelago and between 44°S and 45°30'S (Fig. 1).

The seabird species most recognized by the fishermen were Magellanic penguins *Spheniscus magellanicus*,

southern giant petrels *Macronectes giganteus* and southern fulmars *Fulmarus glacialoides*, which were seen throughout the year. Less commonly recognized species included Wilson's storm petrels *Oceanites oceanicus* (seen during January–March) and diving petrels (genus *Pelecanoides*; only recorded during July; Table 1). Fishermen reported that bait from fishing lines and offal from fishing operations is the main food of black-browed albatrosses *Thalassarche melanophrys* and noted that southern giant petrels also fed on these sources. Small pelagic fishes (e.g. Fuegian sprat) were reported as the main food for sooty shearwaters *Puffinus griseus*, southern fulmars, and Magellanic penguins (Table 1).

Fishermen most commonly reported breeding activities among Magellanic penguins and imperial cormorants *Phalacrocorax atriceps*. Responses also revealed that fishermen were familiar with several seabird breeding colonies on small islands far from human settlements (e.g. Huichas islands, Fig. 1) as well as on some islets near human settlements, where eggs are regularly harvested for food.



PLATE 2 Skeleton of a Magellanic penguin *Spheniscus magellanicus* found at a landfill associated with fishing camps. Penguins are often hunted by fishermen for food or bait.

Fishermen perceived more birds (67%), the same number (23%) or fewer birds (10%) compared to 10 years ago. Fishermen who reported more birds associated the trend with increased food abundance, decreased human predation, the absence of the invasive American mink *Neovison vison*, and increased food availability from salmon farming. Fishermen who perceived a decrease in the abundance of seabirds attributed the decline to dispersion to other areas with greater food availability, or to pollution, oil spills and red tides. A c. 350 m³ oil spill along Moraleda Channel, in 2001, was responsible for seabird mortalities and other unquantified ecosystem effects.

Fishermen held both positive and negative views of seabirds and their relationships to fishing activities. Negative attitudes were associated with the disruption of fishing activities. For example, birds sometimes steal bait, damage the catch before it is taken on-board, and attract unwanted species (e.g. South American sea lion *Otaria flavescens*), which may further damage the fishing gear and catch. Many fishermen valued the birds as indicators of good fishing areas and for their consumption of waste discarded from vessels during fish processing. Only 3.3% of fishermen considered seabirds to be an important component of the scenic beauty of the region.

Our observations indicated that the main threats to seabirds were bird hunting, egg collection, and introduction of feral predators at breeding sites of threatened species (Table 1). We recorded the death of one black-browed albatross tangled in a line. We also observed bycatch of Magellanic penguins in gill nets (and 56% of the interviewed fishermen reported them in this kind of gear). Penguins also became entangled in the *atorrante* lines when they were attracted to the Fuegian sprat used as bait in the fishery.

The questionnaires indicated that fishermen sometimes hunted Magellanic penguins for bait (45%) or food (16%) and collected their eggs for consumption (39%). Kelp gulls



PLATE 3 Transport of dogs by artisanal fishermen.

Larus dominicanus were also exploited for their eggs (98%) and for use as bait (2%). Several fishermen described the use of hooks and dogs to hunt birds (Plate 2, Plate 3). We also heard of one hunting event at sea in which a southern fulmar was captured with a hook-pole device while it was feeding on bait from a fishing line. Justification for this act was that bird's meat was more durable than fish when used as bait.

We confirmed the presence of dogs on at least 10 islands, with a maximum of three adults and two pups on a single islet. Inspection of dog faeces ($n = 10$) and seabird remains on invaded islets indicated that dogs were feeding on seabirds, and may have been responsible for the local extirpation of at least one colony of Magellanic penguins.

Discussion

As this region of Patagonia moves forward with conservation planning and the identification of biodiversity resources it is important to consider the traditional and current activities of fishermen on land and at sea. By identifying the perceptions of fishermen and their practices it may be possible to eliminate or reduce negative impacts such as the intentional or incidental killing of seabirds (Moore & Battam, 2000). Similarly, understanding traditional interests may enable local communities to actively participate in the design and development of management decisions. Traditional fishing communities are currently only invited to participate in decisions related to the assignment of marine exploitation areas (e.g. areas for exploitation of benthic resources). Including artisanal fisherman in discussions may improve conservation efforts by including their knowledge in policy decisions.

Fishermen provided useful perceptions of marine phenomena such as the routine presence of diving and carrion-feeding birds around fish farms, which did not exist in the region 20 years ago (Carss, 1990, 1993; Buschmann et al., 2006). The concerns of fishermen may be

well-founded; although no seabird mortalities have been documented following red tides (Schlatter, 1984) these blooms can have detrimental effects on foraging activity, fecundity and survival of vertebrates (Shumway et al., 2003). Some of the fishermen's perceptions concord with documented interactions between wildlife and fisheries. For example, the presence of seabirds often attracts South American sea lions to fishing boats.

South American sea lions are known to steal fishermen's catch and cause damage to artisanal fishing gear (Sepúlveda et al., 2007), and there is demand from this sector for government authorities to allow hunting of this legally protected mammal for its meat and oil.

The temporary use of islands, on which there are seabird colonies, as fishing camps has resulted in extirpations of seabirds because of habitat destruction, pollution and introduction of predators (Tasker et al., 2000; Wanless et al., 2007). Therefore, if transport of dogs or cats is a common practice among fishermen (Plate 3) we may expect more serious impacts to this insular environment.

It may be important to encourage active local participation in conservation activities (Novacek, 2008) in this region. For example, by taking advantage of traditional knowledge, small-scale fishing tourism initiatives (Skewgar et al., 2009) can be designed to increase sustainable harvesting of fish while reducing threats to birds in this region. In addition, there has been transfer of useful ideas from artisanal to industrial fisheries: the faster sink rates of artisanal lines, which reduce seabird mortalities (Moreno et al., 2006), and devices designed to avoid damage by mammals to artisanal catch of Patagonian toothfish have been successfully used to reduce seabird mortalities (Moreno et al., 2008).

Artisanal fishermen are an important source of experiences of and perceptions on the current and future status of the environment in which they work, and ecological approaches in conservation must be related to how people interact with their environment, especially when considering the local effects of global environmental changes (Mansilla et al., 2012). In Chile salmon farming is expanding in the southern archipelagos and programmes to mitigate any effects on seabirds will need to engage with local knowledge.

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Biographical sketches

CRISTIÁN G. SUAZO studies seabird ecology in the fjords and subantarctic islands of Chile. His primary interest is the interaction of birds with human activities such as fishing and aquaculture. ROBERTO P. SCHLATTER is one of the pioneers in the study of Chilean seabirds. ALDO M. ARRIAGADA studies seabird trophic and breeding ecology in Chilean Patagonia. LUIS A. CABEZAS works on the development of mitigation methods and adoption strategies for fishermen, to reduce bycatch of albatrosses and other seabirds that interact with Chilean fisheries. JAIME OJEDA studies the biodiversity of the subantarctic channels in southern South America, integrating ecological, social and philosophical components.