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Conservation implications of pink-footed shearwater (*Puffinus creatopus*) movements and fishery interactions assessed using multiple methods

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SUMMARY

The pink-footed shearwater (PFSH) breeds on three islands off Chile and undertakes trans-equatorial migration to foraging grounds off the Pacific coast of Central and North America. The species is categorized as Vulnerable by the IUCN, with an estimated breeding population of approximately 28,000 pairs.

The purpose of this study was to review several existing data sets and implement one new project toward better clarifying and quantifying PFSH vulnerability to fisheries interactions in the southeastern Pacific Ocean. We determined the movements of satellite tracked PFSH in relation to geographic and political boundaries and movements through known fishing grounds. We also present results from onboard observer monitoring of small-scale fisheries in Peru and their interactions with PFSH. Finally, we present results from a series of rapid assessment surveys of fishing captains in Chile, Peru, and Ecuador designed to quantify

fishery interactions with seabirds, including PFSH.

The study provides evidence for PFSH interactions with fisheries in Chile, Peru and Ecuador and highlights the potential for bycatch in multiple fisheries given our measured distribution of satellite-tracked PFSH off South America. Rapid assessment surveys at 13 ports in Chile yielded an estimated annual bycatch of 1,384 PFSH, with an estimated annual mortality of ca. 1,000 PFSH - a previously unidentified source of mortality. Satellite tracking reveal fine-scale coastal movements of the species and its affinity with waters over the continental shelf and shelf-break. This distribution indicates spatial overlap and potential vulnerability to interactions with numerous fisheries that use gillnets, purse-seines, and longlines. The greatest overlap of PFSH with fishing zones was for the driftnet fishery from the port of Salaverry. Onboard observer effort in this fishery documented a PFSH bycatch rate of 0.004 PFSH set^{-1}. Given the size of the Peruvian gillnet fleet (ca. 3000 vessels, 80,000+ trips annually), this catch rate could result in considerable levels of total catch.

RECOMMENDATIONS

1. More intensive monitoring of fisheries identified through the rapid assessments that interact with PFSH
2. Assessment of the fisheries operating around the Juan Fernandez Archipelago
3. Increased observer effort along the central and northern Peru coast coinciding with high-use PFSH areas identified using satellite tracking,
4. Satellite tracking during the breeding season to examine foraging ranges and associated risks of fishery interactions,
5. Targeted assessments of the risks posed by purse-seine fisheries in Chile and Peru,
6. Assessments of the coastal fisheries operating in Pacific Central America and their potential for interactions,
7. Collection of age class information from bycatch individuals, and
8. Estimation of demographic parameters to best model resilience to perturbations, including fishery bycatch. In light of new fishery-related threats to PFSH, a reassessment by the appropriate institutions and agreements, of national, regional and international conservation status for the species may be warranted.

Implicaciones de la conservación de los movimientos del petrel de patas rosas (*Puffinus creatopus*) e interacciones de las pesquerías evaluadas mediante varios métodos

El petrel de patas rosas (PPR) se reproduce en tres islas frente a la costa de Chile y realiza una migración transecuatoriana rumbo a otras áreas en busca de alimento frente a la costa pacífica de América Central y América del Norte. La especie está clasificada como vulnerable por la UICN, con una población reproductora estimada de aproximadamente

28.000 parejas.

El propósito de este estudio fue revisar varios conjuntos de datos existentes e implementar un nuevo proyecto para aclarar y cuantificar mejor la vulnerabilidad del PPR frente a las interacciones de las pesquerías en el sudeste del Océano Pacífico. Determinamos los movimientos del PPR rastreado por medio de dispositivos satelitales en relación con los límites geográficos y políticos, y los movimientos a través de los caladeros de pesca conocidos. También presentamos los resultados del monitoreo por parte de observadores a bordo de las pesquerías de pequeña escala en Perú, y sus interacciones con el PPR. Por último, presentamos los resultados de una serie de estudios rápidos de evaluación de capitanes de pesca en Chile, Perú y Ecuador diseñados para cuantificar las interacciones de las pesquerías con las aves marinas, incluido el PPR.

El estudio proporciona evidencia de las interacciones del PPR con pesquerías en Chile, Perú y Ecuador, y destaca el potencial para la captura secundaria en varias pesquerías, teniendo en cuenta nuestra distribución medida de PPR rastreados por medio de dispositivos satelitales frente a las costas de América del Sur. Los estudios rápidos de evaluación en 13 puertos de Chile dieron como resultado una captura secundaria anual estimada de 1.384 PPR, con una mortalidad anual estimada de aproximadamente 1.000 PPR, una fuente de mortalidad no identificada previamente. El rastreo satelital revela los movimientos costeros en escala detallada de la especie y su afinidad por las aguas de la plataforma continental y el borde de la plataforma. Esta distribución indica una superposición espacial y la posible vulnerabilidad a las interacciones con varias pesquerías que usan redes de enmalle, cerqueros y palangres. La mayor superposición de PPR con las zonas pesqueras fue la pesquería con red a la deriva del puerto de Salaverry. La iniciativa de observadores a bordo de esta pesquería documentó una tasa de captura secundaria de PPR de 0,004 PPR por lance[1]. Teniendo en cuenta el tamaño de la flota de red de enmalle peruana (aproximadamente 3000 buques, 80.000+ expediciones anuales), esta tasa de captura podría dar como resultado niveles importantes en relación con la captura total.

RECOMENDACIONES

1. Un monitoreo más intensivo de las pesquerías identificadas mediante las evaluaciones rápidas que interactúan con el PPR.
2. Evaluación de las pesquerías que operan cerca del Archipiélago Juan Fernández
3. Mayor iniciativa de observadores a lo largo de la costa central y del norte de Perú, que coincide con las áreas de muy usadas por los PPR identificadas mediante el rastreo satelital.
4. Rastreo satelital durante la temporada de reproducción para estudiar las zonas de alimentación y los riesgos asociados de las interacciones con las pesquerías.
5. Evaluaciones dirigidas de los riesgos que representan las pesquerías con cerqueros en Chile y Perú.
6. Evaluaciones de las pesquerías costeras que operan en la costa pacífica de América Central y sus posibilidades de interacción.

7. Recolección de información sobre la clase de edad de los individuos capturados y
8. Estimación de los parámetros demográficos para modelar mejor la resiliencia a las perturbaciones, incluida la captura secundaria de las pesquerías. En vistas de nuevas amenazas relacionadas con las pesquerías para el PPR, quizás sea necesario realizar una reevaluación por parte de las instituciones y los acuerdos adecuados del estado de conservación nacional, regional e internacional de la especie.

Mouvements du puffin à pieds roses (*Puffinus creatopus*) et évaluation de son interaction avec les pêcheries en utilisant de multiples méthodes

Le puffin à pieds roses se reproduit sur trois îles au large du Chili et entreprend une migration trans-équatoriale vers des sites d'alimentation situés sur les côtes de l'océan Pacifique, en Amérique du Nord et en Amérique Centrale. L'espèce est considérée comme Vulnérable par l'IUCN et sa population reproductrice est estimée à 28,000 couples.

Notre objectif a été de réviser plusieurs des données existantes, et de lancer en outre un nouveau projet pour clarifier et quantifier la vulnérabilité du puffin à pieds roses au vu de son interaction avec les pêcheries du sud-ouest de l'océan Pacifique. Nous avons suivi les mouvements du puffin par voie satellitaire pour en déterminer les limites géographiques et politiques et aussi pour déterminer ses mouvements au travers de lieux de pêche connus. Nous présentons de surcroit les résultats provenant du contrôle des observateurs à bord de navires de pêche, sur des pêcheries à petite échelle au Pérou et sur leur interaction avec le puffin à pieds roses. Pour finir nous présentons les résultats qui proviennent d'évaluations et de sondages rapides effectués par des capitaines de flottilles du Chili, du Pérou et de l'Équateur visant à quantifier les interactions des pêcheries de ces pays avec des oiseaux de mer, y compris le puffin à pieds roses.

Suite à la distribution du puffin que nous avons pu mesurer grâce à notre système de marquage satellitaire à partir de l'Amérique du Sud, notre étude permet de confirmer l'interaction du puffin à pieds roses avec les pêcheries du Chili, du Pérou et de l'Équateur et elle souligne le potentiel évident de captures accessoires importantes du puffin dans de multiples pêcheries. Des estimations rapides effectuées au Chili dans 13 ports ont donné une capture accessoire du puffin à pieds roses de 1384 oiseaux, ainsi qu'une mortalité annuelle que l'on peut estimer à 1 000 puffins. Cette estimation de la mortalité annuelle du puffin due à sa capture accessoire est inédite, jusqu'à l'heure la capture accessoire ne figurait pas comme source de mortalité du puffin. Le marquage satellitaire révèle également des mouvements côtiers à échelle fine de la part de l'espèce, ainsi que son affinité avec les eaux du plateau continental et des rebords continentaux. Cette distribution indique qu'il existe bien un chevauchement spatial et une vulnérabilité potentielle du puffin aux interactions d'avec les pêcheries, car un nombre important de pêcheries de la région utilisent des filets maillants, des dispositifs de pêche à la seine et des palangres. Le chevauchement le plus important du puffin à pieds roses avec des zones de pêche porte sur la pêcherie de filet dérivant du port de Salaverry. La documentation des observateurs à bord de cette pêcherie témoigne d'un taux de capture accessoire du puffin de 0,004

oiseaux par pose^{-1}. Au vu de la taille des pêcheries du Pérou qui utilisent le filet dérivant (environ 3000 navires, 80 000+ campagnes chaque année), cela pourrait représenter un niveau considérablement élevé de la capture accessoire du puffin.

RECOMMANDATIONS

1. Travail de suivi sur les pêcheries que l'on a pu identifier avoir des interactions avec le puffin à pieds roses ;
2. Évaluation des pêcheries en opération autour de l'archipel Juan Fernandez ;
3. Renforcement de l'effort d'observation au long des côtes du Pérou du Nord et du Pérou central d'où des zones d'utilisation intense des puffins à pieds roses out pu être repérées par détection satellitaire ;
4. Focalisation de la détection satellitaire sur les sites d'alimentation utilisés surtout pendant la période de reproduction et sur les risques d'interaction avec des pêcheries ;
5. Évaluation des risques ciblée des pêcheries à la seine du Chili et du Pérou ;
6. Évaluations des pêcheries côtières de la zone Pacifique Amérique Centrale et de leur potentiel d'interaction avec les puffins ;
7. Collecte des informations sur la catégorie d'âge des oiseaux victimes des captures accessoires, et ;
8. Estimation des paramètres démographiques permettant le développement du meilleur modèle de résistance aux perturbations de la population, y compris l'impact des captures accessoires des pêcheries. Au vu de la découverte de menaces qui pèsent sur les puffins à pieds roses à partir de leur interaction avec des pêcheries, une réévaluation par les accords, institutions et instances appropriées du statut de conservation de l'espèce au niveau international, régional et national pourrait s'avérer nécessaire.

1. INTRODUCTION

1.1. Population

Pink-footed shearwaters (PFSH), *Puffinus creatopus*, breed on three islands off Chile in the southeastern Pacific Ocean: Isla Mocha (19,440 breeding pairs; Muñoz & Hodum pers. comm.), and in the Juan Fernández Archipelago (JFA) on Robinson Crusoe (5,075 breeding pairs; Hodum pers. comm.) and Santa Clara (3,525 breeding pairs; Hodum pers. comm.).

Although the colonies in the Juan Fernández Islands apparently are stable, the population on Isla Mocha is believed to be declining, mainly due to the annual consumption from March to May of an estimated 3,000 to 5,000 chicks by island residents (Guicking 1999). Other terrestrial threats to the Juan Fernández Archipelago and Isla Mocha populations include habitat degradation and depredation by introduced species including coatis, dogs, cats and rats (Hinojosa & Hodum 2007, COSEWIC 2004).

1.2 Conservation status

The PFSH is categorized by the IUCN as Vulnerable due to its very restricted area of occupancy that makes it susceptible to human activity or stochastic events (criterion D2). The species is also included in Appendix 1 of the Convention on the Conservation of Migratory Species (CMS). The species is categorized as Threatened in Canada and a recovery strategy was published in 2008 (Environment Canada 2008). The breeding areas of the species are listed as protected areas managed by CONAF in Chile (Hinojosa & Hodum 2007) which focuses primarily on habitat preservation (COSEWIC 2004). Current status of the PFSH in Chile is 'Endangered' (MINSEGPRES 2008). The Chilean government recently has expressed interest in nominating the species for inclusion on Annex 1 of the Agreement on the Conservation of Albatrosses and Petrels (ACAP), and this process is currently underway (ACAP link).

In Peru, where the species can be found at sea, the PFSH has been proposed for inclusion in the national list of protected species, managed by the Ministry of Agriculture (MINAG). In Canada, the United States, and Mexico, PFSH conservation activities are guided by the North American Conservation Action Plan (CEC 2005) and the Recovery Strategy for the Short-tailed Albatross (*Phoebastria albatrus*) and the Pink-footed Shearwater (*Puffinus creatopus*) in Canada (Environment Canada 2008).

1.3 At-sea distribution

PFSH are known to be present in all seasons off the coasts of Peru and Chile (Hinojosa & Hodum 2007, COSEWIC 2004). In Ecuador, the PFSH occurs coastally, with sightings from July and August in low numbers and increasing in October to December (Informe Pais Ecuador, 2012). Sightings in 2010 during 36 hours along 12 random days of a month, registered 220 birds by the Reserva Marina Costera Puntilla de Santa Elena (Informe Pais Ecuador, 2012). There is limited information of the species' occurrence in Central America. Off Costa Rica, PFSH are present from May to June and from September to October (Stiles and Skutch 1989). PFSH were observed during every survey transect conducted offshore of Isla Magdalena, Baja California Sur, Mexico in June-July 2008 (Hodum pers. comm.).

Previous satellite tracking has shown that post-breeding PFSH from Isla Mocha move north along the western coasts of South America into Central and North America (Fig. 1; Guicking et al. 2001). Tracking during the breeding season also revealed that PFSH from Isla Mocha regularly travelled within 1 km of the mainland coast and to a major inshore foraging area located 250-300 km north of the colony, and to another one, located a similar distance to the south, both coinciding with areas of sardine and anchovy concentrations (Guicking et al. 2001). Tracking studies from Santa Clara indicate inter-annual variation in PFSH foraging behavior but that the dominant pattern is for the birds to travel to the east-southeast from Santa Clara and forage predominantly over the shelf-shelf break, with a foraging hotspot in the Talcahuano region (Hodum and Wainstein 2002, 2003, 2004; Hinojosa & Hodum 2007). The proportion of the breeding populations from JFA and Isla Mocha that winter off South America, Mexico, the US and Canada remain unknown (Schlatter 2002). Ainley (1976) and Ainley et al. (1995), reported an annual variation in PFSH abundance and density off the California coast, however the species is generally associated with sea surface temperatures of 14°C to 19°C (Ainley 1976). Moving north from the Gulf of California to British Columbia, PFSH travel along the continental shelf from April into November, with a distribution associated with the outer edge of the continental shelf (COSEWIC 2004). From mid-September through late October birds move back towards the breeding grounds in Chile. The breeding season typically begins in Chile in October, with arrival of the first breeding

birds, and lasts until May with the fledging of chicks. Hyrenbach and Veit (2003) showed cross-correlations with near-surface (10 m) and subsurface (100 m) temperature anomalies off southern California.

1.4 Diet

In Chile, PFSH forage on sardine (*Sardinops sagax*) and anchovy (*Engraulis japonicus*) (Guicking et al. 2001). The same has been observed for over-wintering birds in Chile and Peru (Ainley 1976). Similarly, in Peru data from at-sea cruises reported that shearwater presence was associated with concentrations of anchovy (Jahncke et al. 1998a, 1998b). In Monterey Bay and off southern California, PFSH have been observed foraging on squid and Engraulid fishes (in COSEWIC 2004), which suggests a shift in diet from breeding to non-breeding distributions.

1.5 Density at sea

Information on at-sea numbers of PFSH is limited. In British Columbia, Canada, based upon the overall average density of PFSH observed from at-sea surveys it was estimated that ca. 21,000 birds used the region from June to October each year (CWS unpubl. data 2003 in COSEWIC 2004).

At-sea data from Peru in 1997/1998, covering 2,516 nautical miles (nm) observed, showed that the largest seabird groups registered were shearwaters (54.1%), with sooty shearwaters (*Puffinus griseus*) the most commonly sighted bird (33.9%). The greatest distance from shore of these transects was 105 nm. The average number of shearwaters sighted per nm was 33.7. PFSH were observed at latitudes 5°S, 8°S, and 11 to 12°S. (Jahncke et al. 1998a, Jahncke et al. 1998b). Off California between 1975 and 1983, maximum numbers occurred in May – September with ca. 130,000 birds off central California and 60,000 to >400,000 estimated off southern California (Briggs et al. 1987). Mason et al. (2007) recorded a maximum of 1.34 birds $(km^2)^{-1}$ off southern California during September (2000-2001).

1.6 Fisheries bycatch

There is limited information on fisheries interactions and bycatch of PFSH throughout its distribution. The species is, however, known to follow fishing vessels (Wahl and Heinemann, 1979), making it potentially vulnerable to fisheries interactions.

Onboard observer data of PFSH are available for small-scale fisheries in Ecuador and Peru (Mangel et al. 2011). In Central America, surveys in Guatemala show that PFSH are also incidentally caught when using sardine type (*Ophistonema* sp.) bait for sharks (Davila Perez et al. 2009).

While there is no PFSH bycatch reported in the northern hemisphere, their distribution associated with the continental shelf break overlaps spatially and temporally with industrial longline fleets operating in Canada and the United States (COSEWIC 2004).

1.7 Current study

Given the lack of information regarding potential at-sea threats to PFSH, the purpose of this study was to review several existing data sets and implement one new project toward evaluating PFSH vulnerability to fisheries interactions in the southeastern Pacific Ocean (Chile, Peru, Ecuador). More specifically, we quantified movements of satellite tracked PFSH

in relation to geographic and political boundaries and movements through known fishing grounds. We also present results from onboard observer monitoring of interactions with PFSH among small-scale fisheries in Peru. Finally, we present results from surveys of fishing captains in Chile, Peru, and Ecuador designed to rapidly evaluate their interactions with PFSH and all other seabirds.

2. METHODS

This report summarizes results from multiple studies, each of which improves our understanding of PFSH vulnerability to fishery threats in the southeastern Pacific Ocean region and north to their wintering grounds off the Pacific coast of North America. The studies described involve (1) rapid assessment surveys of marine fauna bycatch, (2) satellite tracking of PFSH, and (3) onboard observer monitoring of seabird bycatch in small-scale gillnet and longline fisheries in Peru.

2.1. Rapid assessment surveys

We report the results of three related studies that assessed the bycatch of seabirds, sea turtles and marine mammals by small-scale fisheries in Ecuador, Peru and Chile (Table 1). Building upon work by Moore et al. (2010), surveys forms were tested in the three countries prior to full-scale implementation to help avoid ambiguous terms and to ensure wording and meaning were consistent in the three countries. Surveys were undertaken by nationals from each country. Most questions used were closed questions with options that were read to the interviewees.

To avoid surveying multiple members of the same vessel (i.e. to avoid pseudo-replication of data), surveys were only conducted with fishing captains. In Ecuador and Chile, gillnets were separated into surface nets (nets of multifilament and monofilament material were not treated separately), mid-water nets, trammel nets and bottom set nets. In Peru, surveys addressed gillnets as a single consolidated category as this was part of a companion study addressing a wider range of fishery types.

2.1.1. Survey design and implementation

Surveys contained from 34 to 96 questions for fishermen and also included species identification guides to assist respondents in categorization (see Annex 2 for survey forms). Surveys were initiated by specifying the purpose of the surveys and the confidential nature of responses. Questions were designed to provide a general description of the fishermen (e.g., age, experience, if a boat owner) and the vessels (e.g., motor power, length). Bycatch questions were formatted to indicate the number of bycatch events in an annual time frame (e.g., number of seabirds caught per year), species composition (i.e., penguin, petrel, storm petrel, booby, albatross, cormorant, shearwater, pelican), and the final fate of bycatch, as described in Alfaro-Shigueto et al. (2011; i.e. released live, dead at capture, or retained to be commercialized, used as food, bait or for medicinal purposes). “Commercialized” refers to individuals retained to be sold as food, bait or other purposes. It is important to note that animals categorized as ‘released alive’ could still have some level of injury so it is reasonable to assume that some unknown percentage would also die as a result of being captured. While PFSH were not identified specifically on the survey forms, the species was pictured on the ID guide representing the “shearwater” category and there are few other

shearwater species in the region with which it could be confused. It is likely that responses confirming “shearwater” bycatch refer to PFSH. Other bycatch taxa, including marine mammals (sea lions and cetaceans) and sea turtles, were also included. As these surveys were designed to serve as a first assessment, bycatch species were generally identified to the level of categories (e.g. “sea lion” or “penguin”). This helps keep the survey to a manageable size and adds confidence to the species identifications. Questions also enquired as to the interviewee’s knowledge of legislation pertaining to seabirds. The final few questions were completed by the interviewer and were an assessment of the respondent’s degree of confidence and honesty during the interview.

The most recent of these three surveys was conducted specifically to query fishermen in Chile regarding their bycatch of seabirds generally and PFSH specifically. Therefore, in addition to the more general questions on seabird bycatch which all survey efforts had in common, for those fishermen who indicated a bycatch of PFSH, three additional questions were asked to explore in more detail the quantities, fates, and seasonality of this catch.

Surveys were completed in Ecuador and Chile from August 2010 to November 2010 and in Peru from November 2010 to March 2011 and again in Chile from June to August 2012 (Table 1). In total, 1515 fishing captains in 56 fishing ports and landing sites were interviewed (Table 2; Fig. 2).

2.1.2. Bycatch estimates

For each site and for the three countries, we calculated bycatch estimates by fishery, based on the median survey responses for bycatch per year for each port (e.g. 0 seabirds per year, 1-3 seabirds per year, 4-10 seabirds per year, etc.). These data were scaled according to the fleet size using the same gear for a given port to obtain the estimate of annual seabird bycatch. Using data gathered on the fate of seabirds, we were then able to estimate the total bycatch and fatal take. Total bycatch refers to the total number of reported interactions, including animals reported as released alive. Fatal take is defined as the number of seabirds killed as a consequence of fisheries and is obtained from captured dead individuals and those reported as retained to be sold, eaten or otherwise used.

2.2. Satellite tracking

2.2.1. Study site and transmitter deployment

In June-July 2009, we attached satellite tags to 5 PFSH captured at sea off Santa Barbara, CA within southern California Current waters (34°25′33″N 119°42′51″W). In April 2011, we tagged 9 breeding PFSH at the breeding colony on Isla Mocha (38°22′15″S 73°54′51″W), off the coast of south central Chile. To this set, we included one individual captured on Isla Mocha and tracked in 2006. These birds were tracked during the post-breeding dispersal (April - May) and non-breeding cycles (May - November).

We attached depth-reinforced, Microwave Solar PTTs (17 g) using the suture-tape-glue method (MacLeod et al. 2008, Adams et al. 2012). We could not assess detrimental tag effects by comparing the behaviour of tagged and control birds. The tags were programmed to follow two duty cycles designed to prolong battery life.

2.2.2. Filtering and processing of shearwater location data

We obtained individual bird locations using the ARGOS satellite-linked tracking system (CLS America, 2011) and archived the data via the Satellite Tracking and Analysis Tool (STAT; Coyne and Godley 2005). We used STAT to flag and manually correct "mirror" locations and to remove duplicate records (i.e., when ARGOS returned two records with same time), and retained those records with location class (LC) quality of higher accuracy or the greater number of satellite messages. Remaining ARGOS data (LC-3 through LC-B) were filtered using a speed-distance-angle (SDA) filter (modified *sdafilter* function, argosfilter package in R; Freitas et al. 2008). We specified a 16.7 m s^{-1} speed threshold and used default settings for distances and angles (Freitas et al. 2008). Our speed threshold is slightly greater than the mean + 1 SE allometric prediction for flight speed over ground (15.9 m s^{-1}) among diving shearwaters flying with a 5 m s^{-1} tailwind (see Table 2 in Spear and Ainley 1997). In 2009 and 2011, we retained 84.3 ± 4.3% locations and 81.3 ± 9.8% locations after SDA filtering, respectively. To estimate time spent per area (e.g., according to bathymetry, EEZ zones, and fishery areas) we used the SDA filtered data and generated hourly locations according to the linear method in Tremblay et al. (2006) for consecutive locations separated by <8 hrs. Thus, the total distances travelled by PFSH were calculated from these locations and should be considered a minimum, as they assume travel in a straight line from consecutive interpolated locations.

2.2.3. *Association of tracked shearwaters with management jurisdictions*

The data filtering and interpolation described above allowed us to produce maps of the time at sea for individual birds, at a spatial scale fine enough to describe their overlap with bathymetry and jurisdictions (e.g., EEZs). We followed a hierarchical approach to assess the overlap of PFSH movements and management jurisdictions. Over the basin-scale, we calculated the proportion of the total tracking time for all tracked PFSH combined within each national EEZ. Next, we addressed the proportion of time PFSH off South America (i.e., with in the combined EEZs of Colombia, Ecuador [including the Galápagos Islands EEZ], Peru, and Chile) spent within fishery zones off Ecuador, Peru, and Chile.

2.2.4. *Association of tracked shearwaters with bathymetric habitats*

In addition to mapping shearwater movements and time at-sea, we wanted to identify bathymetric habitats where these far-ranging seabirds spent time. To this end, we matched each of the interpolated locations with depth values from the ETOPO2 2-minute global relief grid (http://www.ngdc.noaa.gov/mgg/global/global.html).

2.3. Onboard observer monitoring

Seabird bycatch was monitored by trained onboard observers. All observers were biologists, fisheries technicians or fishermen trained in relevant data collection methods, including seabird identification. Data were gathered on the specific gear used (longline or gillnet), the timing and position (using GPS) of each set, and any bycatch occurring. Bycatch characteristics recorded included timing of event (set, soak, haul), species and quantity of bycatch, location of hooking or entanglement (beak, wing, etc.), and state (live, dead) and fate (released alive, discarded dead, etc.) of the seabird. All observers were equipped with cameras and photographed unusual or unidentifiable captures for later species identification. Observers did not participate in fishing activity and the crews and vessels that hosted observers were voluntary participants in the project. Except in cases when a fishery

operated seasonally, observers worked year-round to account for possible seasonal variations in fishing effort or seabird bycatch.

From May 2005 to May 2011 a total of 309 fishing trips (2156 sets, 1990 fishing days) were monitored for seabird bycatch in Peru (Fig. 3). Trips monitored were on longline and driftnet fishing vessels operating from the port of Salaverry (08.23°S, 78.98°W) and longline vessels from the port of Ilo (17.65°S, 71.35°W). Driftnet vessels targeted primarily blue (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), thresher (*Alopias vulpinus*), and smooth hammerhead sharks (*Sphyrna zygaena*), and eagle rays (*Myliobatis* spp.). Longline vessels set their gear at the ocean surface and seasonally targeted either blue and mako sharks (March to November) or dolphinfish (*Coryphaena hippurus*; December to February). Longline gear configurations between shark and dolphinfish seasons differ (e.g. branchline spacing, leader material, hook size); therefore bycatch results for these fisheries are considered separately. Detailed specifications of these gear types and observer effort are given in Mangel et al. (2011) and in Alfaro-Shigueto (2010).

3. RESULTS

3.1. Surveys

3.1.1. Survey effort 2010 & 2011

A total of 793 surveys from 43 index fishing ports were obtained for the three countries (Ecuador: n = 407, 7 ports; Peru: n = 342, 30 ports; Chile: n = 44, 6 ports; Tables 1 & 2, Fig. 2). Survey coverage by gear across the ports varied between 3.8 to 100% but was on average 31.1% for Ecuador 37.0% for Peru and 62.7% for Chile. Most fishermen operated year-round, except in Chile where net fisheries were seasonal. The main employment of respondents was fishing for most ports although other employment was reported.

Seabird bycatch in Ecuador was reported in 42.9% of fishing ports (by 4.9% of respondents in those harbors; Table 2). In Peru, seabirds were reported as being caught at 86.7% of the Peruvian ports (by 28.4% respondents in those harbors; Table 2). In Chile 66.7% of ports (20.5% of respondents in those harbors) reported seabird bycatch (Table 2).

The reported seabird bycatch species composition varied from port to port (Table 3). From these species the most commonly caught were boobies, cormorants and penguins. PFSH bycatch was reported in Santa Rosa in Ecuador, several ports in Peru and in two ports in central Chile (Tables 2 & 3).

Seabird bycatch for the three countries was estimated as 8,271 seabirds (Table 4). The majority of them were reported released alive and their final fate is unknown. Approximately 43% were reported as dead or taken by the fisheries (3,537 seabirds), and the final fate of these birds was discarded dead, eaten or commercialized locally (Table 4).

3.1.2 PFSH surveys, 2012

A total of 157 surveys were completed in 13 ports in Chile (Tables 2 & 5). The majority of respondents (58%) used gillnets (surface, mid-water or bottom) but fishermen using purse-seines and longlines also constituted parts of the sample. Seventy percent of respondents reported having seabird bycatch, and seabird bycatch was reported in all the ports

assessed. This compares with 45% reporting small cetacean bycatch and 12% reporting sea turtle bycatch. The Humboldt penguin was the most frequently reported and most common bycatch species (27% of respondents) and was listed as one of several bycatch species by 31% of respondents (Table 5). Shearwaters were the species group least often listed as the primary bycatch species (7% of respondents) but were the second most common species overall in reported bycatch (16% of respondents). Forty-four percent of interviewed fishermen reported declines in seabird abundance since they began fishing (respondent's average number of years fishing: 31 ± 12 years; range: 1-69 years; Table 6). Overall, there was an even split (50%) between those fishermen who reported that seabirds were typically released alive versus discarded dead.

Diving birds, including boobies, cormorants and pelicans, were more likely to be listed as bycatch by respondents of purse-seine vessels whereas respondents from gillnet vessels were more likely to list other species – including penguins, shearwaters, petrels and albatrosses (Table 5).

Bycatch of PFSH was reported in eight of 13 ports (Table 7). This bycatch was almost exclusively reported by respondents operating gillnet vessels (surface, mid-water and bottom). Based on PFSH bycatch rates reported and estimates of fleet sizes in each port we were able to construct port-based estimates of PFSH bycatch and estimate annual mortality. Bycatch events were reported as fatal by 65.8% of respondents. Total bycatch of PFSH was estimated to be 1,384 birds year^{-1} of which 911 were estimated as fatal takes and 473 PFSH were released alive (Table 7). PFSH bycatch was reported as occurring during the months of August through May, with more than 25% of respondents indicating that bycatch was most common in the months of January and February, which coincides with pre-breeding and breeding season (Fig. 4).

Reported catch rates were greatest on Isla Mocha where all respondents reported bycatch of PFSH. The nearby coastal port of Tirua had the second greatest estimated annual bycatch, and estimates generally lessened with increasing distance northward from Isla Mocha (Table 7).

3.2. Satellite tracking

Track durations ranged from 100 days to 248 days, with distances travelled ranging from 9,393 km to 29,291 km (Table 8). Latitudes traversed ranged from 46.4 to -39.7. Tracked PFSH spent the majority of their time within EEZ waters and only 2% - 3% on the international high seas (Table 9, Fig. 5). In 2009, tracked PFSH occupied 9 EEZs and portions of the international high seas (Table 9, Fig. 5). In 2011, tracked PFSH occupied 13 EEZs (including Clipperton Island EEZ and Galapagos Islands EEZ), portions of the international high seas, and the EEZ Area en Controversia, currently disputed by Peru and Chile. With the exception of Canada and Mexico in 2006/11, in all years median bathymetric affiliation among shearwaters was centred over continental slope waters, beyond the 200 m isobath that delineates the outer reach of the continental shelf domain (Tables 9 & 10).

Combining all tracking data available for the South American EEZs (Colombia, Ecuador, Galapagos Islands, Peru, and Chile), tracked PFSH spent generally < 5% of their time within 13 fishery use areas (Table 11, Figs. 6 to 9). Greatest use by shearwaters occurred in the coastal fishing zone ("Salaverry 2") based out of Salaverry, Peru were shearwaters

aggregated for extended periods of time and were associated with the relatively broad continental shelf off northern Peru (Fig. 9).

3.2. Onboard observer monitoring

Bycatch of PFSH was reported in the surface driftnet fishery operating out of the port of Salaverry in northern Peru (Fig. 10). From May 2005 to May 2011 there was an observed bycatch of four PFSH in 914 sets (133 trips) resulting in a bycatch rate of 0.004 ± 0.105 birds set^{-1}. There were two sets with bycatch, one caught three PFSH and the other caught one. One PFSH was released alive while the other three drowned. These bycatch events occurred in the months of May and August.

No bycatch of PFSH has been reported during 1,842 observed sets (176 trips) of the surface longline fishery operating out of the ports of Salaverry and Ilo. Sightings of PFSH were occasionally reported by observers in the Ilo longline fishery (Fig. 10).

4. DISCUSSION

In this study, we have compiled information from multiple projects using diverse methods as a first effort to evaluate threats posed to PFSH by fisheries in the southeastern Pacific Ocean. This study provides evidence for PFSH interactions with fisheries in Chile, Peru, and Ecuador and highlights the potential for bycatch with multiple fisheries given the reported distribution of the species. This is the first large-scale study in the region and provides the first detailed, quantified estimates of PFSH bycatch.

Results of the rapid assessment surveys in Chile, Peru, and Ecuador make clear that seabird bycatch is common throughout the region. Respondents reporting bycatch of shearwaters were sporadic but were reported in each country. The 2012 rapid assessments conducted in Chile support these findings and also revealed evidence of PFSH bycatch specifically. PFSH bycatch was most commonly reported and greatest at the ports on and near Isla Mocha. It is interesting to note that some of these ports lie directly on one of the PFSH foraging zones reported by Guicking et al. (2001). The temporal distribution of bycatch reported by fishermen also strongly overlaps with the annual breeding cycle for the species and adds confidence in the study findings and in the ability of fishermen to correctly identify the species. Moreover, Region VIII (Bio-Bio) the region in which Isla Mocha is located hosts one of the highest levels of fishing activity in Chile. The estimated annual bycatch of 1,384 PFSH, with an annual mortality of ca. 1,000 PFSH, is a previously unidentified source of mortality and should be considered in future conservation action plans. About half of this total take was associated with gillnet fishermen from Isla Mocha, indicating that the identification and introduction of bycatch mitigation measures here could be particularly effective.

The results of the PFSH satellite tracking studies clearly reveal the coastal movements of the species and its affiliation with waters over the continental shelf and shelf-break. Perhaps most striking was the substantial amount of time spent by tracked PFSH off the central and northern coast of Peru. The broad continental shelf along this portion of the Peru coast is also home to the majority of the more than 3,000 small-scale gillnet vessels currently operating (Alfaro-Shigueto et al. 2010).

The overlap with most Peruvian fishing zones reported here was low (Table 11, Figs. 6 to 9), primarily because the majority of fisheries observed here were longline fisheries for sharks that typically operate beyond the continental shelf. There is still some potential for a more substantial overlap with the seasonal Peruvian small-scale longline fishery targeting dolphinfish which operates annually from December to March and which fishes nearer the shelf break (Fig. 4), but this fishery also coincides temporally with the PFSH breeding season when most birds would likely be at or near the Chilean nesting sites. Bycatch of PFSH was also reported in the 2012 rapid assessment surveys by demersal longline fishermen in the Chilean port of Lebu. And PFSH bycatch has been observed in the demersal longline fishery for South Pacific hake (*Merluccius gayi*) operating out of the port of Santa Rosa, Ecuador (Mangel et al. 2011).

The greatest overlap of PFSH and fishing zones reported here was for the driftnet fishery from the port of Salaverry. It is this same fishery in which bycatch of PFSH has been confirmed through onboard observations. While the reported bycatch rate was low (0.004 PFSH set^{-1}), with approximately 3,000 gillnet fishing vessels conducting an estimated 80,000 trips annually along the Peru coast (Alfaro-Shigueto et al. 2010), even low rates of bycatch by individual vessels can result in considerable total takes of seabirds. Given this observed catch rate and level of fishing effort it is reasonable to conclude that the annual bycatch mortality of PFSH by Peruvian gillnet vessels is on the order of 500 to 1000 birds.

Largely missing from the current assessment is information on the potential interactions of PFSH with the Peruvian and Chilean industrial purse-seine fisheries for anchovy and sardine. These fleets comprise approximately 1350 and 205 vessels in Peru and Chile, respectively (Bertrand et al. 2008, OECD 2009). In Peru, movements of the fishing fleet have been shown to be largely coastal and to track movements of the target fish stocks (Bertrand 2008). Given their reliance upon anchovy and sardine as prey, their feeding behaviour and their attraction to boats, it is reasonable to expect that PFSH may be vulnerable to interactions with these purse-seine fisheries. Representation of purse-seine vessel captains in our rapid assessment surveys was insufficient, however, and this is an area that needs further research.

Anthropogenic threats to PFSH have been identified both at their nesting sites and at their oceanic foraging grounds. These threats include direct take for human consumption, habitat loss, depredation by introduced species including coatis, dogs, cats and rats and fisheries bycatch. The annual take of PFSH chicks at Isla Mocha is estimated at 3,000 to 5,000 (Guicking 1999), although recent enforcement of the law prohibiting chick harvest by the Corporación Nacional Forestal has greatly reduced the annual take since 2011 (Hodum pers. comm.). Our estimate of PFSH bycatch mortality in Chilean net fisheries derived from rapid assessment surveys was of an additional ca. 1,000 birds. We have also provided a conservative estimate of annual bycatch mortality by Peruvian gillnet fisheries of another 500 to 1,000 PFSH. In addition to these values one must also consider the loss to the PFSH population at the nesting colonies due to depredation and habitat loss. Moreover, one needs to keep in mind that the number of fisheries monitored that fall within the range of the PFSH is exceedingly small. There are limited examples of fishery monitoring in Central America and Mexico which have shown interactions with threatened and endangered species, including sea turtles and small cetaceans (e.g. Peckham et al. 2007, Koch et al. 2006, Vidal et al. 1994).

Here we have attempted to clarify some of the threats from fisheries interactions facing the PFSH in the southeastern Pacific Ocean. Clearly though, additional efforts will be needed to more fully understand the population status of the species, the risks it faces and the steps that should be taken to help ensure species viability. Rapid assessment surveys serve as a useful first step in identifying those fisheries that have PFSH bycatch but to more accurately assess these interactions more intensive monitoring, including onboard observers, is recommended. Given the high rates of fishery interactions reported around Isla Mocha we recommend that similar assessments be conducted of the fisheries operating around the breeding colonies in the Juan Fernández Archipelago. Due to the relatively intensive use of habitat off central Peru, additional efforts to monitor gillnet fisheries are encouraged. Targeted assessments of the risks posed by purse-seine fisheries in Chile and Peru are also recommended. Satellite tracking studies during the breeding season could also help identify any changes in foraging ranges or strategies, and how they may impact their vulnerability to fishery interactions. There is also a clear need for assessments of the coastal fisheries operating in Pacific Central America and their potential for interactions with seabirds and other marine fauna. The demographic implications of the varying forms of mortality must also be considered, as the take of juvenile or adult PFSH through fisheries bycatch could have different population level effects than the take of chicks. The collection of age class information from bycaught birds would also help clarify the relative impacts to the population and would permit comparison to other mortality sources and to link mortality to population trends (Lewison et al. 2012). Modeling the PFSH population would help clarify these population parameters, its resilience to perturbations would help identify data gaps, and would help in setting targets for reductions in anthropogenic threats, including fisheries bycatch. In light of the identified threats to the species, a reassessment, by the appropriate institutions and agreements, of its national, regional and international conservation status may be warranted.

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ANNEX 1:

TABLES AND FIGURES

Table 1. Summary of rapid assessment surveys performed from 2010 to 2012.

Survey effort	Countries	Fisheries addressed	Ports surveyed	Surveys completed	Survey dates	Focus of effort
1*	Ecuador Peru Chile	Open	15	488	Nov. 2010 to Feb. 2011	Fishery bycatch
2	Peru	Nets only	33	870	Oct. 2010 to Jan. 2011	Net fishery Bycatch
3	Chile	Open	13	157	Jun. to Aug. 2012	Seabird & PFSH bycatch

* Ecuador: 7 ports, 412 surveys. Peru: 1 port, 30 surveys. Chile: 7 ports, 46 surveys.

Table 2. Detailed summary of rapid assessment surveys, port where they were conducted and the degree to which seabird bycatch was reported. Ports in bold also have PFSH bycatch recorded by onboard observer monitoring. 'Registered vessels' refers to government reports of vessels operating in each port but the number of active fishing vessels is typically lower.

Country	Port	Registered Vessels	Surveys completed	Seabird bycatch?	% yes	PFSH bycatch?
Ecuador 2010-2011	Esmereldas	600	41	N	-	
	Manta	1800	71	Y	1	
	P. Lopez	280	52	N	-	
	Santa Rosa	**1200**	**118**	**Y**	**15**	**Y***
	Anconcito	370	34	N	-	
	Chanduy	210	30	N	-	
	P. Bolivar	650	66	Y	3	
Peru 2010-2011	P. Pizarro	No data	25	Y	24	
	Zorritos	150	24	Y	4	
	Cancas	127	8	Y	25	
	Mancora	96	21	Y	25	Y
	Talara	554	5	N	-	
	Paita	1980	3	N	-	
	Constante	50	10	Y	40	
	Delicias	25	2	Y	100	
	Parachique	1050	8	Y	75	
	Bayovar	No data	4	Y	75	
	Pimentel	18	12	Y	25	
	San Jose	160	50	Y	10	
	Chicama/Malabrigo	65	28	Y	4	
	Salaverry	**200**	**30 / 17**	**Y**	**53**	**Y**
	Chimbote	300	12	Y	33	
	Culebras	48	6	Y	50	
	Huarmey	55	3	N	-	
	Supe	42	6	Y	67	
	Huacho	279	10	Y	50	
	Ancon	200	4	Y	75	
	Callao	134	7	Y	29	
	Pucusana	400	11	Y	45	
	Tambo de Mora	35	16	Y	47	
	San Andres	214	17	Y	35	
	San Juan de Marcona	208	6	Y	67	
	Atico	130	1	Y	100	
	La Planchada	101	2	Y	100	
	Matarani	940	15	N	-	
	Ilo	744	6	Y	33	
	Morro Sama	284	3	Y	67	

*Mangel et al. 2011. ACAP Report.

Table 2. (continued)

Country	Port	Registered Vessels	Surveys completed	Seabird bycatch?	% yes	PFSH bycatch?
Chile 2010-2011	Caldera	11	5	N	-	
	San Antonio	11	8	Y	13	Y
	Coquimbo	6	2	N	-	
	Quintero	2	2	N	-	
	Valparaiso	11	10	Y	22	
	Tome	4	2	N	-	
	Lebu	41	17	Y	24	Y
Chile 2012	Coquimbo	95	27	Y	67	Y
	Guayacán	40	12	Y	75	N
	Peñuelas	15	15	Y	60	Y
	Guanaqueros	80	25	Y	82	N
	Tongoy	120	13	Y	85	N
	Tirua	71	5	Y	80	Y
	Isla Mocha	57	7	Y	100	Y
	Quidico	20	2	Y	100	N
	Coliumo	100	6	Y	83	Y
	Cocholgue	160	3	Y	100	Y
	Dichato	68	4	Y	75	Y
	San Vicente	214	4	Y	75	Y
	Lebu	416	32	Y	47	Y

Table 3. Seabird species composition reported by surveys to fishing captains from Ecuador to Peru, using net fisheries. Fishing gear types are surface (S), mid-water (M), trammelnet (T), and bottom (B). Seabird species groups are: alb=albatross, pel=pelican, pet=petrel, shear=shearwater, storm=storm petrel, corm=cormorant, boo=booby, pen= penguin. Some respondents grouped their responses and those are represented in the rightmost two columns. Grey shaded columns indicate shearwater bycatch.

Ports	Gear	Surveys	# Do Capture	% Capture	alb	pel	pet	shear	corm	storm	boo	pen	pet+pen	shear+oth
Ecuador														
Esmeraldas	S	29	0	0										
	M	6	0	0										
	T	1	0	0										
	B	5	0	0										
Manta	S	65	1	1.5						100				
	M	3	0	0										
	T	2	0	0										
	B*	1	0	0										
Pto.Lopez	S	39	0	0										
	M	10	0	0										
	T	2	0	0										
	B	3	0	0										
Sta.Rosa	S	92	17	18.5			47.1			35.3				17.6
	M	14	0	0										
	T	2	0	0										
	B	3	0	0										
	LL	3	0	0										
Anconcito	S	8	0	0										
	M	13	0	0										
	T	8	0	0										
	B	5	0	0										
Chanduy	S	2	0	0										
	M	19	0	0										
	T	4	0	0										
	B	5	0	0										
Pto.Bolivar	S	10	1	100							100			
	M	34	0	0										
	T	3	0	0										
	B	18	1	5.6			100							

Table 3. (continued)

Ports	Gear	Surveys	# Do Capture	% Capture	alb	pel	pet	shear	corm	storm	boo	Pen	pet+pen	shear+oth
Peru														
Pizarro	G	25	6	24.0	33.3				16.7					
Zorritos	G	23	1	4.4							100			
Cancas	G	8	2	25.0							100			
Mancora	G	20	5	25.0		20.0		20.0		40.0	20.0			
Talara	G	5	0	0										
Paita	G	3	0	0										
Constante	G	10	4	40.0					25.0		50.0			
Delicias	G	2	2	100							50.0			
Parachique	G	8	6	75.0		16.7			16.7		16.7			16.7
Bayovar	G	4	3	75.0										33.3
Pimentel	G	12	3	25.0							66.7	33.3		
San Jose	G	49	5	10.2							60.0	20.0		
Malabrigo	G	28	1	3.6					100					
Salaverry	G	17	9	52.9			11.1		22.2				11.1	11.1
Chimbote	G	12	4	33.3					75.0					
Culebras	G	6	3	50.0										
Supe	G	6	4	66.7					25.0					25
Huarmey	G	3	0	0.0										
Huacho	G	10	5	50.0		20.0			40.0					
Ancon	G	4	3	75.0			33.3				33.3			
Callao	G	7	2	28.6										
Pucusana	G	11	5	45.5	20.0		40.0							
Tbo.Mora	G	15	7	46.7					57.1			14.3		
Sn.Andres	G	17	6	35.3					83.3					
Marcona	G	6	4	66.7		25.0								25
Atico	G	1	1	100										
Planchada	G	2	2	100										
Matarani	G	15	0	0										
Ilo	G	6	2	33.3					50.0			50.0		
Morro	G	3	2	66.7					50.0					
Chile														
Caldera	S	5	0	0										
Coquimbo	S	2	0	0										
Quintero	S	2	0	0										
Valparaiso	S	10	2	20.0			50.0					50.0		
Sn.Antonio	S*	1	1	100				100						
	Md	7	0	0										
Lebu	S	17	4	23.5			50.0	50.0						
Tome	Trawl	2	0	0										

*Surface and midwater

Table 4. Estimates of seabird bycatch and seabirds take by gillnet fisheries. Final fate (released alive, discarded dead, sold or commercialized, eaten, or retained for medicinal purposes. Gear types are surface (S), mid-water (M), trammelnet (T), and bottom (B). Fate category "released" refers to bycaught birds released alive, "discarded" refers to drowned birds.

	Fishing	Total	Fate Categories					% Fatal	Total
Port	Gear	Bycatch	Released	Discarded	Sold	Eaten	Medicine	Take	Fatal take
Ecuador									
Esmeraldas	S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal		0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Manta	S	53.3	38.9	14.4	0.0	0.0	0.0	0.27	14.4
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Subtotal		53.3	38.9	14.4	0.0	0.0	0.0	0.27	14.4
Pto.Lopez	S	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Subtotal		0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Sta.Rosa	S	473.5	329.6	143.9	0.0	0.0	0.0	0.30	143.9
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	LL	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Subtotal		473.5	329.6	143.9	0.0	0.0	0.0	0.30	143.9
Anconcito	S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal		0.0	0.0	0.0		0.0		0.00	0.0
Chanduy	S	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	M	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Subtotal		0.0	0.0	0.0		0.0		0.00	0.0
Pto.Bolivar	S	2.0	1.4	0.6	0.0	0.0	0.0	0.40	0.6
	M	155.0	120.6	34.4	0.0	0.0	0.0	0.22	34.4
	T	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
	B	3.9	2.2	1.7	0.0	0.0	0.0	0.44	1.7
Subtotal		160.9	124.2	36.7	0.0	0.0	0.0	0.23	36.7
Subtotal Ec		687.7	492.6	195.1	0.0	0.0	0.0	0.28	195.1

Table 4. (continued). In Peru gillnets were not differentiated by type.

Port	Fishing Gear	Total Bycatch	Fate categories					% fatal take	Total Fatal take
			Released	Discarded	Sold	Eaten	Medicine		
Peru									
Pizarro	G	142.0	52.0	85.2	0.0	4.8	0.0	0.63	90.0
Zorritos	G	4.9	3.0	1.9	0.0	0.0	0.0	0.39	1.9
Cancas	G	56.3	42.2	14.1	0.0	0.0	0.0	0.25	14.1
Mancora	G	213.6	134.5	71.2	0.0	0.0	7.9	0.37	79.1
Talara	G	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Paita	G	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Constante	G	53.5	41.6	11.9	0.0	0.0	0.0	0.22	11.9
Delicias	G	116.0	0.0	116.0	0.0	0.0	0.0	1.00	116.0
Parachique	G	300.0	233.3	33.3	0.0	33.3	0.0	0.22	66.7
Bayovar	G	881.3	705.0	176.3	0.0	0.0	0.0	0.20	176.3
Pimentel	G	11.0	8.1	2.2	0.0	0.7	0.0	0.27	2.9
San Jose	G	36.0	30.4	4.9	0.0	0.7	0.0	0.16	5.6
Malabrigo	G	4.5	1.1	0.4	1.2	1.8	0.0	0.76	3.4
Salaverry	G	486.0	259.2	162.0	0.0	64.8	0.0	0.47	226.8
Chimbote	G	33.3	9.5	16.7	0.0	7.1	0.0	0.71	23.8
Culebras	G	137.0	68.5	34.3	11.4	22.8	0.0	0.50	68.5
Supe	G	593.3	195.8	195.8	0.0	195.8	0.0	0.66	391.6
Huarmey	G	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Huacho	G	407.0	232.6	58.2	29.1	87.2	0.0	0.43	174.4
Ancon	G	1275.0	637.5	637.5	0.0	0.0	0.0	0.50	637.5
Callao	G	204.0	102.0	25.5	0.0	76.5	0.0	0.50	102.0
Pucusana	G	559.1	279.5	248.5	0.0	31.1	0.0	0.50	279.5
Tbo.Mora	G	88.6	28.3	24.8	3.5	3.5	0.0	0.36	31.8
Sn.Andres	G	1144.0	624.1	312.0	0.0	205.9	0.0	0.45	517.9
Marcona	G	229.2	137.5	45.8	0.0	45.8	0.0	0.40	91.6
Atico	G	50.0	25.0	25.0	0.0	0.0	0.0	0.50	25.0
Planchada	G	175.0	58.3	0.0	0.0	116.6	0.0	0.67	116.6
Matarani	G	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Ilo	G	184.2	122.8	61.4	0.0	0.0	0.0	0.33	61.4
Morro	G	100.0	75.0	25.0	0.0	0.0	0.0	0.25	25.0
Subtotal Pe		7484.6	4106.7	2389.6	45.2	898.6	7.9	0.45	3341.3

Table 4. (continued)

Port	Fishing Gear	Total Bycatch	Fate categories					% fatal take	Total Fatal take
			Released	Discarded	Sold	Eaten	Medicine		
Chile									
Caldera	S	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Coquimbo	S	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Quintero	S	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Valparaiso	S	9.9	9.0	0.9	0.0	0.0	0.0	0.09	0.9
Sn.Antonio	S	22.0	22.0	0.0	0.0	0.0	0.0	0.00	0.0
	Md*	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Lebu	S	67.5	67.5	0.0	0.0	0.0	0.0	0.00	0.0
Tome	Tra*	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0
Subtotal Ch		99.4	98.5	0.9	0.0	0.0	0.0	0.01	0.9
Total SUM		8271.8	4697.8	2585.6	45.2	898.6	7.9	0.43	3537.3

*Md = midwater, Tra = trawl

Table 5. Seabird bycatch species composition as reported by rapid assessment survey to fishing captains in Chile, 2012, using net, trawl, purse-seine and longline fisheries. The grey shaded column highlights shearwater bycatch.

	Fishing	#	Catch	%	seabird group (% respondents)							
Port	**gear**	**surveys**	**seabirds**	**yes**	**Albatross**	**Pelican**	**Petrel**	**Shearwater**	**Cormorant**	**Storm Petrel**	**Booby**	**Penguin**
	Gillnet	5	3	60			40.0		40.0			20.0
Guayacán	Purse-seine	1	1	100							100.0	
	Longline	7	5	71	12.5	25.0	12.5		25.0			25.0
	Gillnet	19	13	68		9.5			33.3		4.8	52.4
Coquimbo	Purse-seine	2	2	100		20.0			40.0			40.0
	Longline	1	1	100			50.0				50.0	
	Gillnet	10	8	80		11.8	11.8	5.9	17.6		11.8	41.2
Peñuelas	Purse-seine	0	0									
	Longline	5	1	20			100.0					
	Gillnet	4	3	75		16.7			33.3			50.0
Guanaqueros	Purse-seine	15	12	80					15.0		45.0	40.0
	Longline	3	3	100	33.3		33.3				33.3	
	Gillnet	7	6	86			9.1		27.3		9.1	54.5
Tongoy	Purse-seine	0	0									
	Longline	6	5	83	9.1	18.2	9.1		27.3			36.4
	Gillnet	3	2	67		25.0	25.0	25.0	25.0			
Dichato	Purse-seine	1	1	100	33.3	33.3		33.3				
	Longline	0	0									
	Gillnet	2	2	100	25.0	25.0	25.0	25.0				
San Vicente	Purse-seine	0	0									
	Longline	2	1	50	50.0		50.0					
	Gillnet	3	3	100	25.0	25.0	12.5	37.5				
Cocholgue	Purse-seine	0	0									
	Longline	0	0									
	Gillnet	3	3	100	18.2	18.2		27.3	9.1			27.3
Coliumo	Purse-seine	2	2	100	20.0	20.0		20.0	10.0		20.0	10.0
	Longline	1	0	0								

Table 5. (continued)

Port	Fishing gear	# surveys	Catch seabirds	% yes	seabird group (% respondents)							
					Albatross	**Pelican**	**Petrel**	**Shearwater**	**Cormorant**	**Storm Petrel**	**Booby**	**Penguin**
Lebu	Gillnet	19	8	42	10.5		31.6	36.8				21.1
	Purse-seine	0	0									
	Longline	13	7	54	23.1		46.2	30.8				
Quidico	Gillnet	2	2	100								100.0
	Purse-seine	0	0									
	Longline	0	0									
Tirua	Gillnet	5	4	80				37.5	12.5			50.0
	Purse-seine	0	0									
	Longline	0	0									
Isla Mocha	Gillnet	7	7	100				53.8				46.2
	Purse-seine	0	0									
	Longline	0	0									

Table 6. Summary of some key respondent characteristics, PFSH survey, Chile 2012.

Question	Response
Age	$\bar{x}$ = 46 (Range: 23-77)
Years fishing	$\bar{x}$ = 31 (Range: 1-69)
Fishing is sole occupation?	99% yes
Fish year-round?	47% yes
Vessel owner?	64% yes
Days fishing per month	> 15 days = 61%

Table 7. Estimates of PFSH bycatch and mortality for 13 Chilean fishing ports based upon rapid assessment surveys to fishing captains.

Port	Fishing gear	Total bycatch	Condition		% dead
			Alive	Dead	
Guayacán	Gillnet	0	0	0	0
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Coquimbo	Gillnet	0	0	0	0
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Peñuelas	**Gillnet**	**14**	**7**	**7**	**50**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Guanaqueros	Gillnet	0	0	0	0
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Tongoy	Gillnet	0	0	0	0
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Dichato	**Gillnet**	**21**	**21**	**0**	**0**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
San Vicente	**Gillnet**	**16**	**16**	**0**	**0**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Cochalgue	**Gillnet**	**97**	**97**	**0**	**0**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Coliumo	**Gillnet**	**128**	**128**	**0**	**0**
	Purse-seine	6	6	0	0
	Longline	0	0	0	0
Lebu	**Gillnet**	**171**	**73**	**98**	**57**
	Purse-seine	0	0	0	0
	Longline	**60**	**30**	**30**	**50**
Quidico	Gillnet	0	0	0	0
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Tirua	**Gillnet**	**285**	**95**	**190**	**66.7**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
Isla Mocha	**Gillnet**	**586**	**0**	**586**	**100**
	Purse-seine	0	0	0	0
	Longline	0	0	0	0
TOTAL		**1384**	**473**	**911**	

Table 8. Summary of Pink-footed Shearwater satellite tracking data during 2006, 2009, and 2011 including, year and PTT ID, duty cycle (hours on:off), start and end dates, tracking duration (days), total number ARGOS locations, total number locations post-filtering, minimum cumulative distance travelled (km), and minimum and maximum individual latitudinal extent.

Year-PTT	Duty Cycle	Start	End	Duration (days)	Total Locs	SDA-Filtered Locs	Distance (km)	Min Lat	Max Lat
06-64378	10:48	4/21	7/30	100.8	330	279	10525	-36.4	27.9
09-39138	10:48	6/30/09	2/2/10	216.7	1118	903	29291	-39.5	46.4
09-39140	10:48	6/30	10/22	114.2	521	411	12277	-30.9	34.7
09-39141	10:48	6/30	12/9	162.1	772	687	18192	-34.1	47.4
09-39142	10:48	7/1	10/30	121.1	552	478	12837	-32.3	34.3
09-39144	10:48	6/30	12/17	169.6	752	649	16097	-39.5	34.5
11-96060	6:8	5/1	11/3	186.7	1803	1439	20409	-38.4	-3.7
11-96061	6:8	5/2	11/11	193.3	1928	1670	28593	-38.4	7.6
11-99579	6:8	5/1	9/7	130.0	1337	1232	10086	-36.1	-7.9
11-99580	6:8	5/1	8/27	119.0	1054	965	11272	-38.3	-7.4
11-99581	6:8	5/1	10/24	176.3	1858	1624	27946	-38.2	31.3
11-99582	6:8	5/1	9/21	144.0	2142	1686	19610	-38.3	49.5
11-102530	6:8	5/2	8/13	103.3	966	604	16696	-38.3	29.4
11-102531	6:8	5/2/11	1/5/12	248.3	2139	1765	28690	-39.7	31.5
11-102532	6:8	5/2	9/3	125.0	1083	766	9393	-38.4	-6.9

Table 9. Proportion of total PFSH tracking use of bathymetric habitat within each Marine Exclusive Economic Zone during 2009. Data summarized include total hours transmitted, mean water depth (m), median water depth, and percent time located over the continental shelf (i.e., water <201 m depth).

Marine Economic Zone	Hours	Mean Depth (m)	Median Depth (m)	% Shelf
Chilean EEZ (disputed - Peruvian point of view)	451	-1897	-677	35%
Colombian EEZ	51	-2629	-3016	4%
Costa Rican EEZ	22	-3045	-3103	0
Ecuadorean EEZ	56	-995	-1041	25%
Galapagos EEZ	6	-3059	-3117	0
International High Seas	152	-3459	-3569	-
Mexican EEZ	98	-2120	-2911	19%
Panamanian EEZ	23	-3072	-2969	0
Peruvian EEZ (disputed - Peruvian point of view)	361	-1268	-699	27%
United States EEZ	1641	-604	-523	28%

Table 10. Proportion of total PFSH tracking use of bathymetric habitat within each Marine Exclusive Economic Zone during 2006 and 2011 combined. Data summarized include total hours transmitted, mean water depth (m), median water depth, and percent time located over the continental shelf (i.e., water <201 m depth).

Marine Economic Zone	Hours	Mean Depth (m)	Median Depth (m)	% Shelf
Area en controversia (disputed - Peruvian point of view)	40	-4516	-4381	0
Canadian EEZ	250	-110	-110	98%
Chilean EEZ (disputed - Peruvian point of view)	910	-1934	-1055	34%
Clipperton Island EEZ (France)	13	-3671	-3626	0
Colombian EEZ	18	-2861	-2995	0
Costa Rican EEZ	81	-2308	-2393	0
Ecuadorean EEZ	40	-1340	-1005	18%
El Salvador EEZ	1	-3740		0
Galapagos EEZ	29	-2366	-2222	0
Guatemalan EEZ	10	-3878	-3819	0
International High Seas	323	-3184	-3568	-
Mexican EEZ	2899	-563	-124	63%
Panamanian EEZ	2	-2766		0
Peruvian EEZ (disputed - Peruvian point of view)	4722	-951	-270	39%
United States EEZ	1623	-909	-238	44%

Table 11. Proportion of total PFSH tracking time off South America associated with 13 port-based fishery zones (minimum convex polygon [MCP]) including the national EEZs spanned by the fishery zones, and the combined hours located within each zone as well as the total percent time off South America within each zone.

Port-based MCP	National EEZ(s)	Hours (% of PFSH time w/in South America)
Ilo-Sharks (sets_MCPs)	Peru/Chile	289 (4.3%)
Ilo-Mahi (sets_MCPs)	Peru/Chile	300 (4.5%)
Salaverry 2(sets_MCPs)	Peru	2146 (32.1%)
Constante (sets_MCPs)	Peru	0
Paita (all_II_REDO)	Peru	11 (0.2%)
San Juan Marcon (all_II_REDO)	Peru	25 (0.4%)
Ancon (all_II_REDO)	Peru	0
Chimbote (all_II_REDO)	Peru	88 (1.3%)
Callao (all_II_REDO)	Peru	125 (1.9%)
Salaverry 1 (all_II_REDO)	Peru	153 (2.3%)
Pucusana (all_II_REDO)	Peru	85 (1.3%)
Ilo (all_II_REDO)	Peru/Chile	327 (4.9%)
Tuna_sets_MCP	Ecuador/Peru	16 (0.2%)

FIGURES

Figure 1. Generalized range map of the PFSH. Isla Mocha is located at the southernmost limit of the distribution approximately 35 km from the Chilean coast.

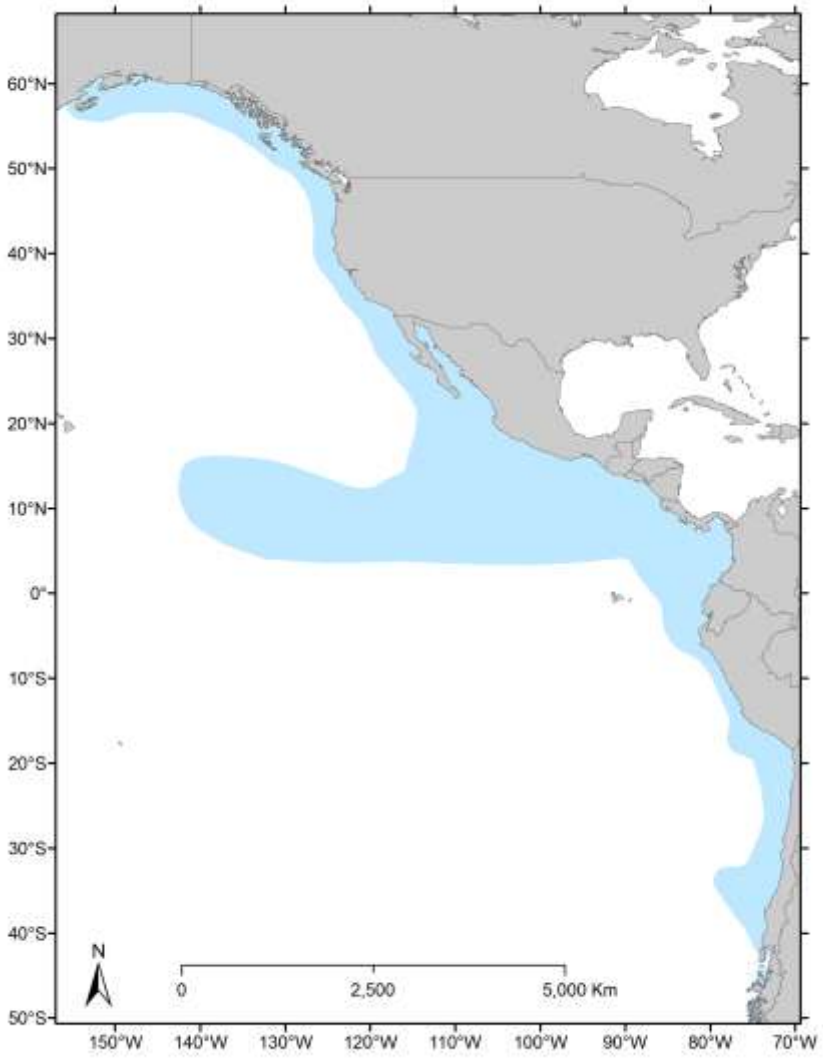
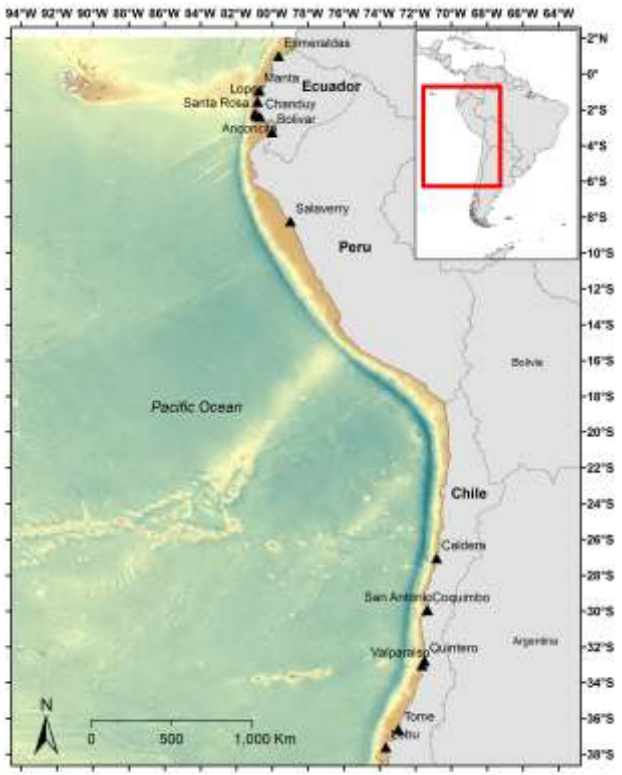
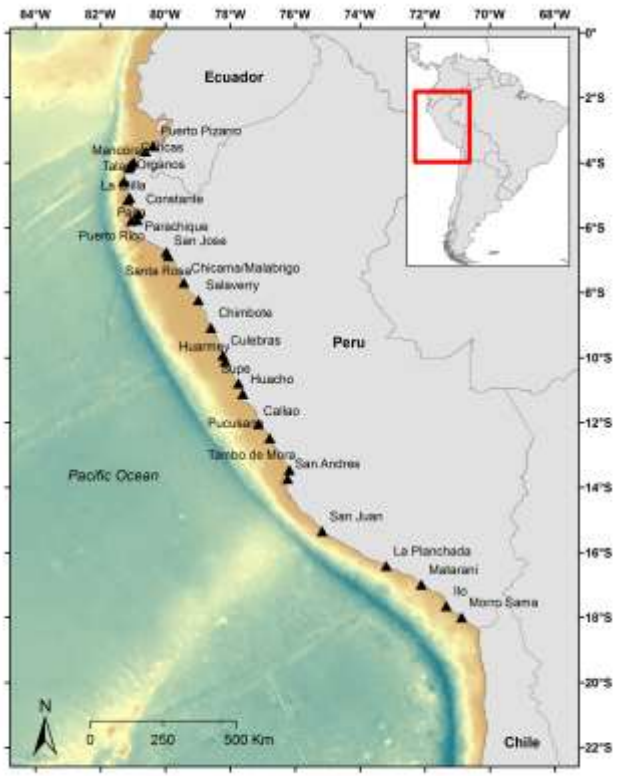


Figure 2. Survey locations for rapid assessment surveys conducted between 2010 and 2012. Maps coincide with the survey efforts 1, 2 and 3 described in Tables 1 and 2.

Survey effort 1



Survey effort 2



Survey effort 3

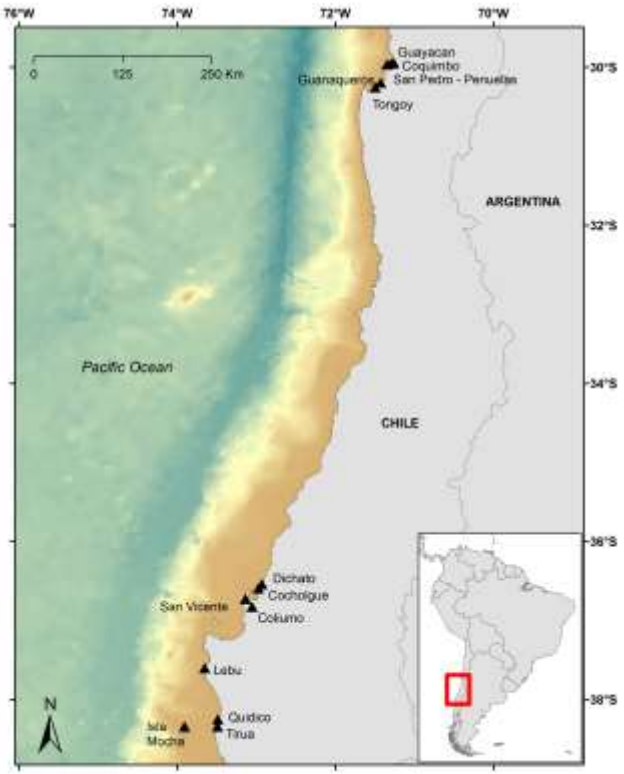


Figure 3. Locations of observed fishing sets by vessel type.

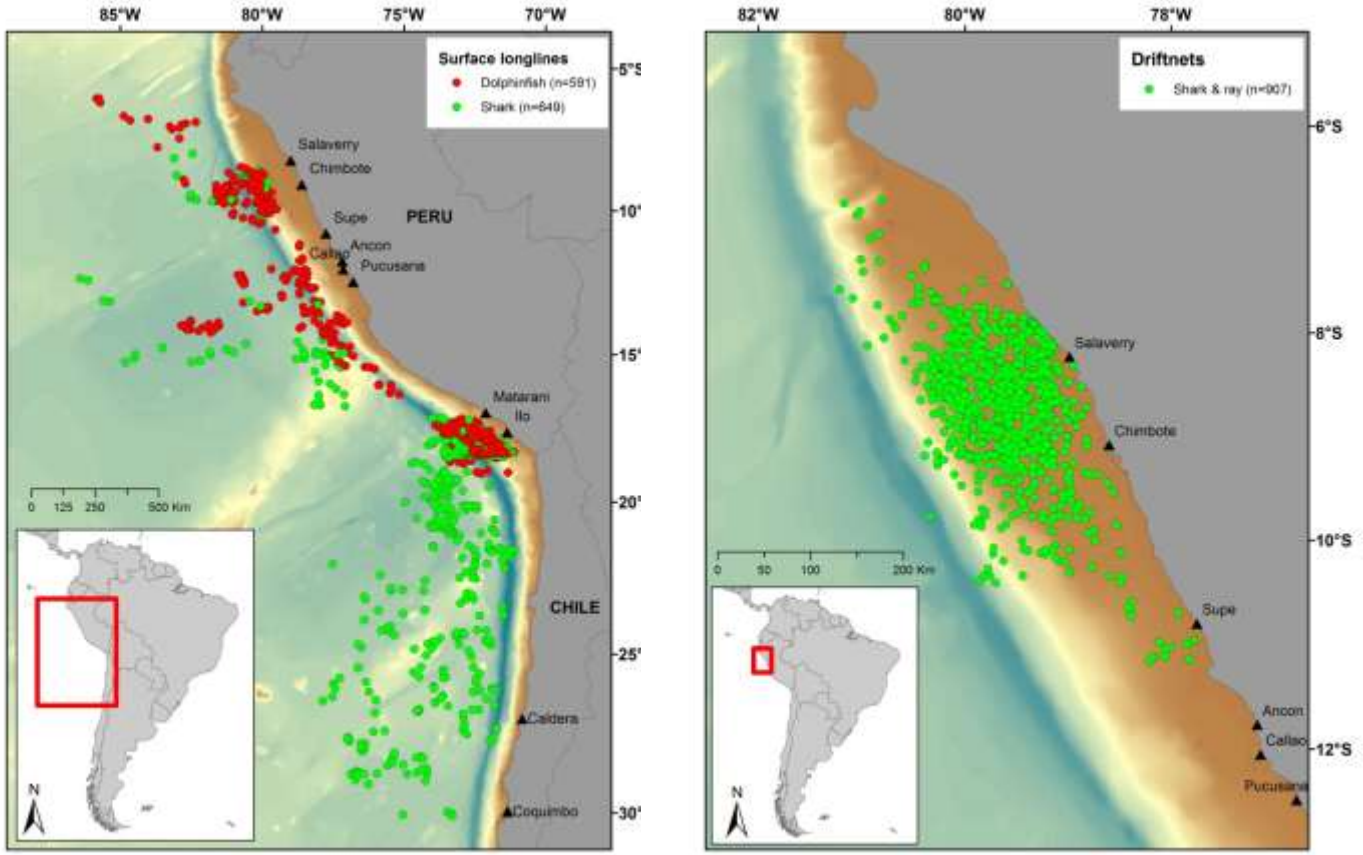


Figure 4. Months during which PFSH bycatch occurs as reported by survey respondents. The PFSH breeding season occurs annually from approximately November to May.

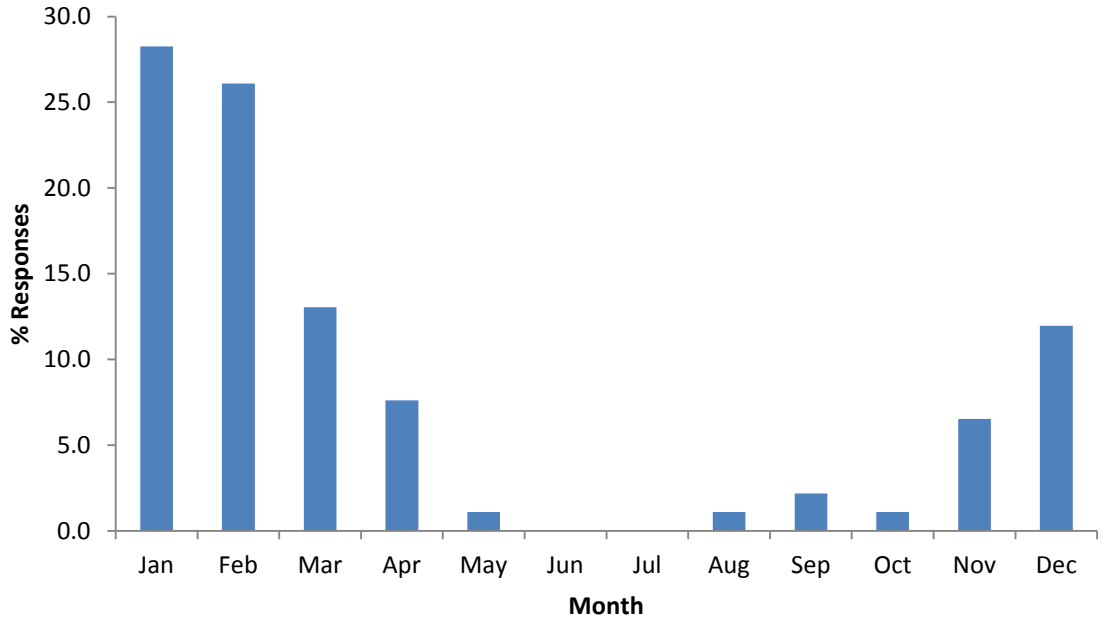


Figure 5. Proportion of total PFSH tracking time during 2009 (right panel) and 2006, 2011, combined (left panel) within national Exclusive Economic Zones (EEZs) and International High seas of the eastern Pacific Ocean off the Americas. PFSH in 2009 were captured and outfitted with satellite transmitters in June-July off Santa Barbara, CA and PFSH in 2006 and 2011 were captured in April at their colony on Isla Mocha, Chile.

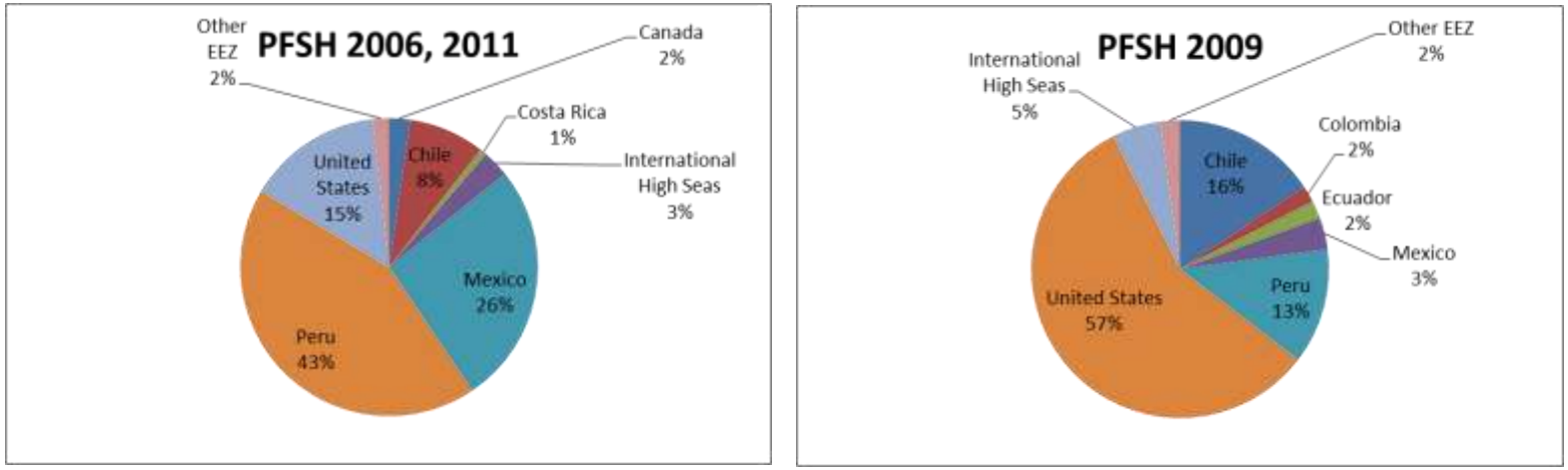


Figure 6. Kernel utilization distribution for all PFSH within South American EEZs showing regions of concentrated use in space and time (left panel). Right panel shows PFSH kernel distribution and hourly locations (black dots) within portions of the northern Peruvian and Ecuadorian EEZ. The “Tuna Sets MCP” is delineated by the orange-hashed polygon. Thin grey line delineates the 200-m isobaths marking the outer reaches of the Continental Shelf domain.

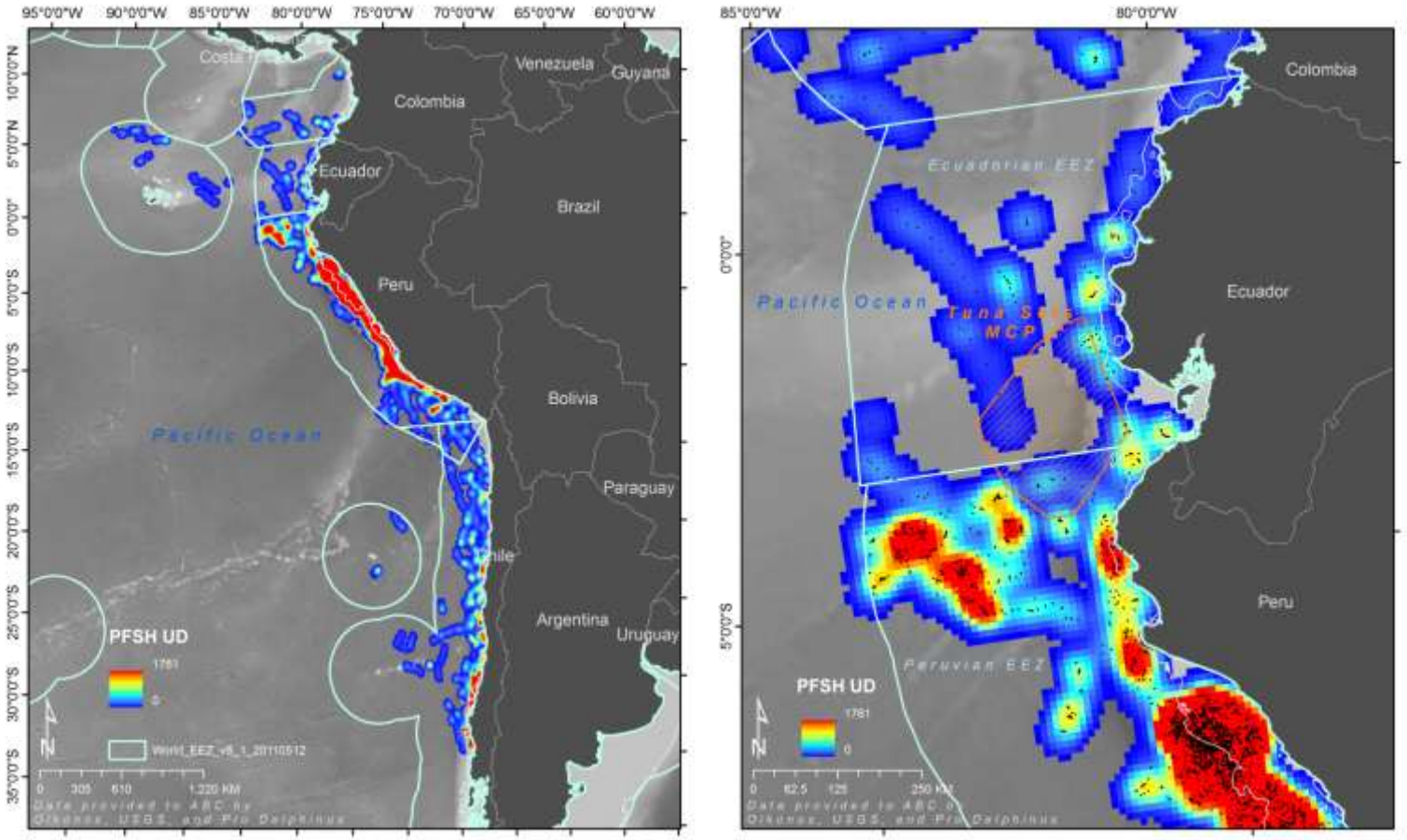


Figure 7. Kernel utilization distribution and hourly locations (black dots) for all PFSH within South American EEZs showing regions of concentrated use in space and time associated with 5 Peruvian fishery zones (left panel). Right panel shows PFSH kernel distribution and hourly locations (black dots) within the large Callao fishing zone. Thin grey line delineates the 200-m isobaths marking the outer reaches of the Continental Shelf domain.

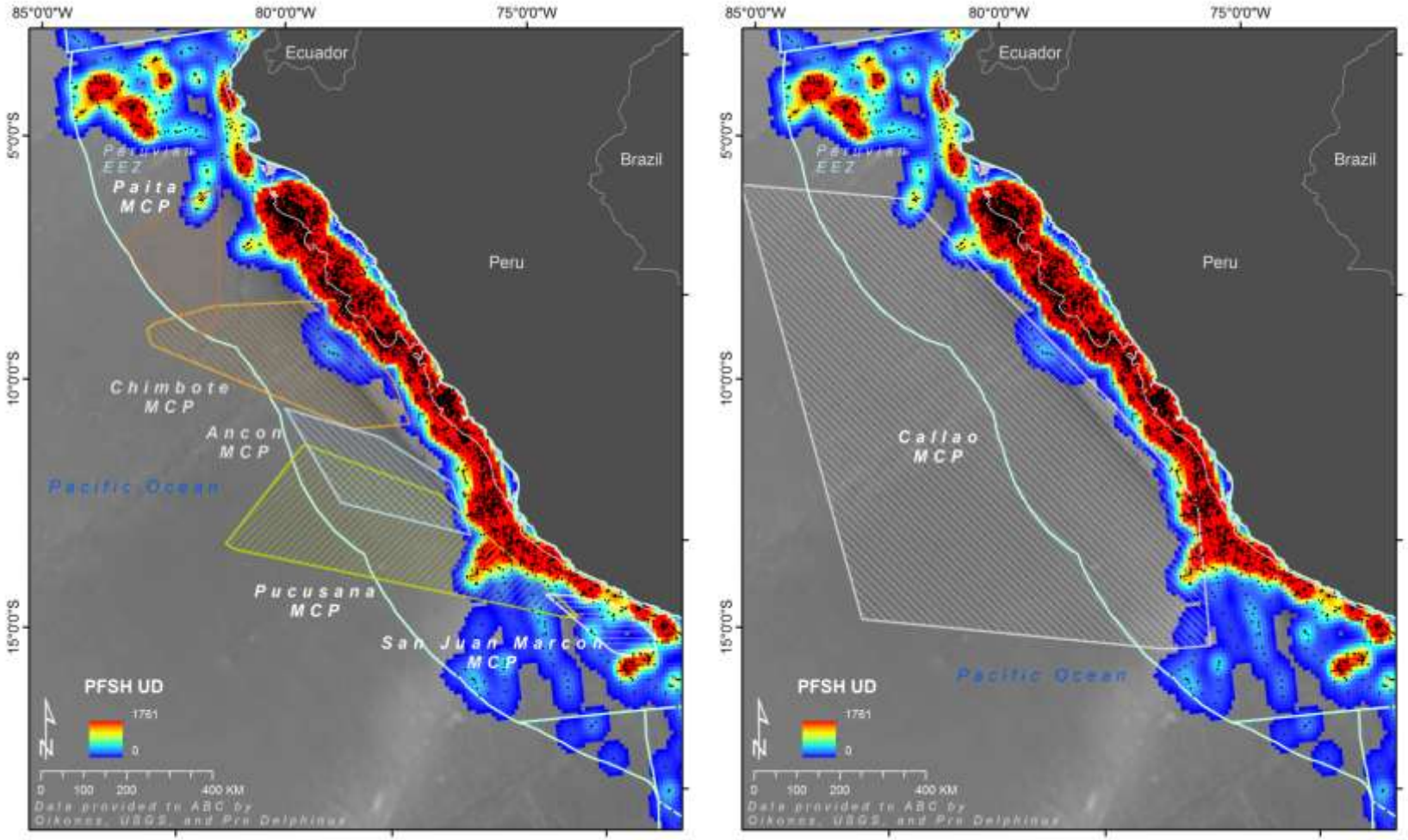


Figure 8. Kernel utilization distribution and hourly locations (black dots) for all PFSH within South American EEZs showing regions of concentrated use in space and time associated with the Ilo dolphinfish fishery zone (left panel). Right panel shows PFSH kernel distribution and hourly locations (black dots) within the Ilo shark fishing zone. Thin grey line delineates the 200-m isobaths marking the outer reaches of the Continental Shelf domain.

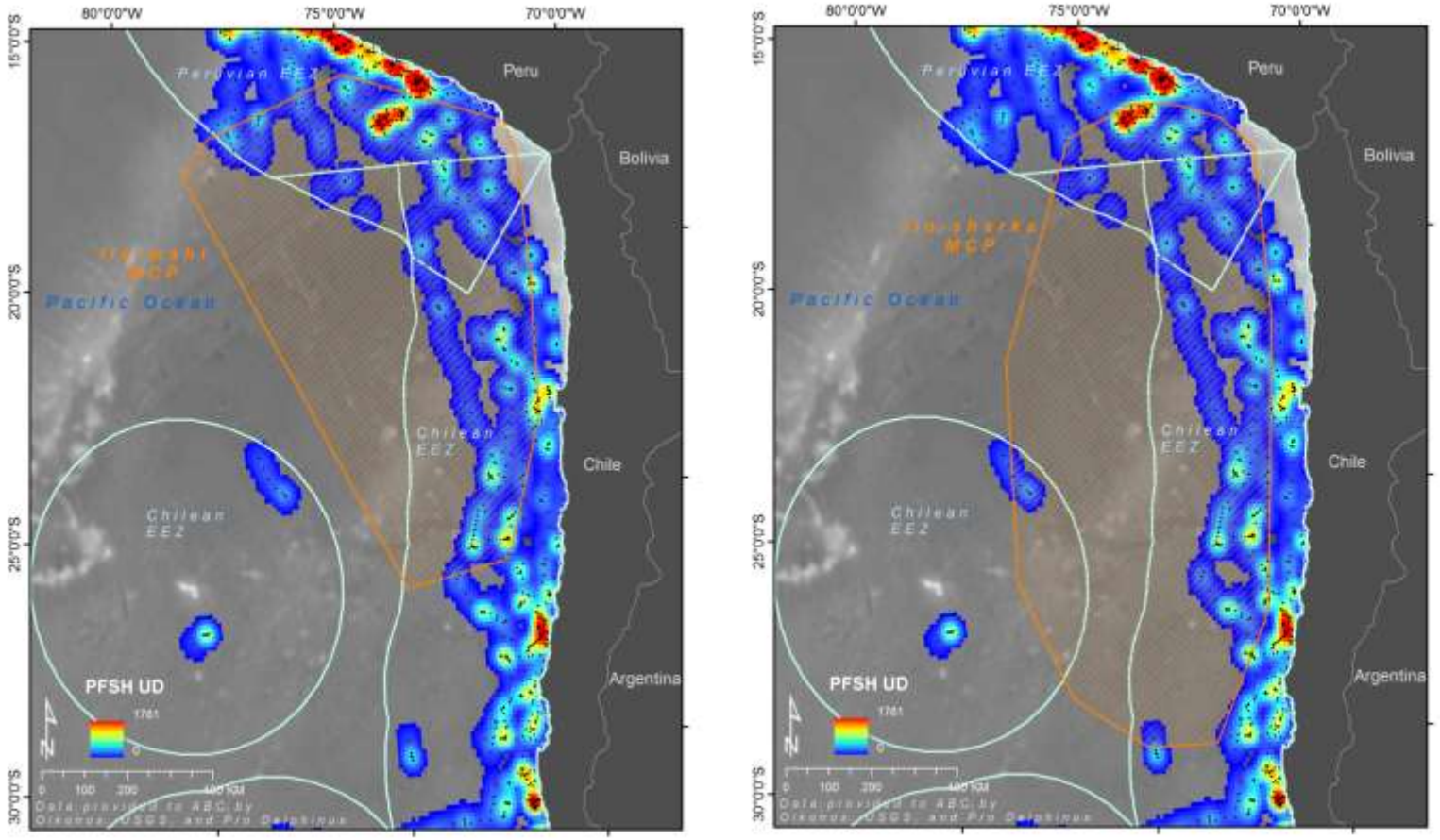


Figure 9. Kernel utilization distribution and hourly locations (black dots) for all PFSH within South American EEZs showing regions of concentrated use in space and time associated with three Peruvian fishery zones. Thin grey line delineates the 200-m isobaths marking the outer reaches of the Continental Shelf domain.

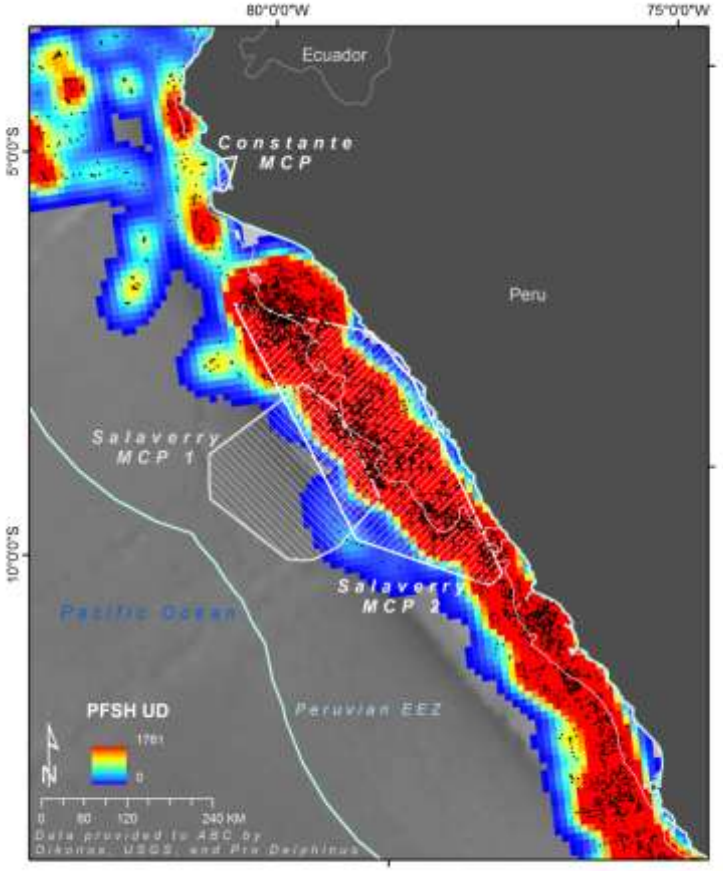
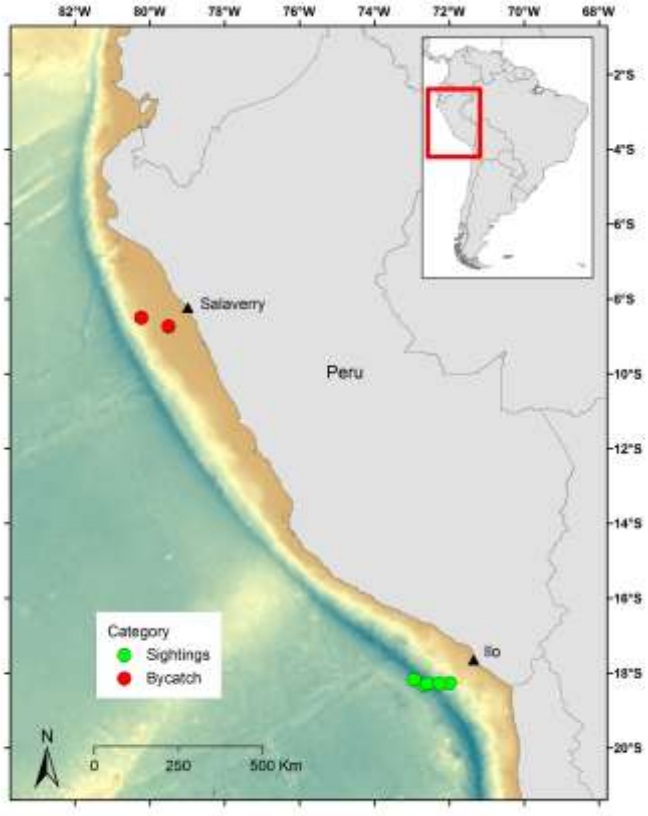


Figure 10. Locations of PFSH bycatch and sightings by onboard observers based out of the ports of Salaverry (driftnet) and Ilo (longline), Peru.



ANNEX 2

Rapid assessment form to assess PFSH bycatch

Numero de ficha:

Nombre de entrevistador:_____ **Fecha:**_____ **Lugar:**_____

PARA LOS PESCADORES

Al inicio se menciona a los entrevistados:

Me llamo _____. Hago un estudio en pesca artesanal. Esta es una entrevista voluntaria y anónima. No necesitamos su nombre o ninguna información de contacto personal ni compartiremos su respuesta personal con alguna persona fuera del equipo de investigación. Usted no tiene que responder alguna pregunta que no quiera.

El objetivo principal es aprender sobre las tortugas, delfines y aves marinas en la pesca costera artesanal. Estamos agradecidos por su participación en este estudio, y confiamos que nos ayudará a aprender más sobre el tema.

ANTECEDENTES

1. ¿Ha participado previamente en entrevistas o investigaciones relacionadas a (marque):
   ☐ Pesca? ☐ Tortugas marinas? ☐ Mamíferos marinos? ☐ Aves marinas? ☐ Nunca participe
   Describa: _____
2. ¿Qué edad tiene? _____
3. ¿Que edad tenia cuando comenzó a pescar? _____
4. ¿La pesca es su principal ocupación? ☐ Si ☐ No
5. ¿Es usted dueño de un bote? ☐ Si ☐ No
6. ¿Cuál es su puerto de matrícula? _____
7. De que puerto operó principalmente en el último año? _____

DESCRIPCIÓN DEL BOTE

8. ¿Qué tan largo (en metros) es el bote donde pesca? _____
9. ¿Es el bote: ☐ Motor interior? ☐ Fuera de borda? ☐ Sin motor?
10. ¿Cuántos caballos de fuerza tiene el motor?: _____

APAREJOS: PREGUNTAS DE PESCA Y CAPTURA

(Responda las preguntas describiendo **su experiencia personal**, no de la comunidad.)

11. ¿Qué tipo de aparejo (u arte) de pesca usa **más seguido** durante el curso de un año? **Marque UNO**:
    - ☐ Red de superficie
    - ☐ Red de media agua
    - ☐ Red de fondo
    - ☐ Redes de trasmallo
    - ☐ Arrastre
    - ☐ Cerco
    - ☐ Espinel
    - ☐ Otra (describa): _____

12. ¿Cuántos pescadores, incluyéndose, van en el bote a pescar con ese tipo de arte? _____

13. ¿Durante cuáles meses del año utiliza este arte? [E] [F] [M] [A] [M] [J] [J] [A] [S] [O] [N] [D] / [TODO]

14. ¿Cuál es tu principal especie objetivo con este arte? _____

15. ¿Cuántos días al mes pesca cuando está usando este arte?
    ☐ 1-7 ☐ 8-14 ☐ 15-21 ☐ 22-31

16. ¿Ocasionalmente le caen tortugas cuando utiliza este arte? ☐ Sí ☐ No

    Si la respuesta es Sí:

17. ¿Qué especies de **tortugas** le caen cuando utiliza este arte? (***use ilustraciones***)? Liste las especies de mayor a menor frecuencia que le caen en su aparejo.
    1. _____ 2. _____ 3. _____
    4. _____ 5. _____

18. ¿Durante qué meses del año le caen más tortugas con este arte?
    [E] [F] [M] [A] [M] [J] [J] [A] [S] [O] [N] [D] / [TODO]

19. ¿Cuántas tortugas cree que le cayeron **en el último año**, con este arte?
    Marque una: ☐ 0 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ >50

20. ¿Ocasionalmente le caen delfín/lobo/ballena cuando utiliza este arte? ☐ Sí ☐ No

    Si la respuesta es Sí:

21. ¿Qué especies de **delfín/lobo/ballena** le caen cuando utiliza este arte (***use ilustraciones***)? Liste las especies de mayor a menor frecuencia que le caen en su aparejo.
    1. _____ 2. _____
    3. _____ 4. _____

22. ¿Durante qué meses del año le caen más delfín/lobo/ballena con este arte?
    [E] [F] [M] [A] [M] [J] [J] [A] [S] [O] [N] [D] / [TODO]

23. ¿Cuántos delfín/lobo/ballena cree que le cayeron **en el último año**, con este arte?
    Marque una: ☐ 0 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ >50

24. ¿Ocasionalmente le caen aves cuando utiliza este arte? ☐ Sí ☐ No

    Si la respuesta es Sí:

25. ¿Qué especies de **aves** le caen cuando utiliza este arte (***use ilustraciones***)? Liste las especies de mayor a menor frecuencia que le caen en su aparejo.
    1. _____ 2. _____ 3. _____
    4. _____ 5. _____

26. ¿Durante qué meses del año le caen más aves con este arte?
    [E] [F] [M] [A] [M] [J] [J] [A] [S] [O] [N] [D] / [TODO]

27. ¿Cuántos aves cree que le cayeron **en el último año**, con este arte?
    Marque una: ☐ 0 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ >50

PREGUNTAS HISTÓRICAS Y DE PROTECCIÓN

28. ¿Comparado a cuando usted comenzó a pescar, ¿la abundancia de aves marinas es ahora...?
☐ Mayor ☐ Menor ☐ Igual ☐ No sé

29. ¿Qué hace normalmente usted si le caen aves?
☐ Comer ☐ Vender ☐ Carnada ☐ Botar (muertas) ☐ Liberar (vivas) ☐ No caen

30. ¿Sabe usted si las aves marinas están legalmente protegidas? ☐ Sí ☐ No ☐ No sé

31. ¿Sabes si las aves tienen otro uso? (carnada, señuelo, otro) ☐ Sí: _____ ☐ No

Si en la pregunta 25 señalan el grupo de fardelas (opción 4), entonces completar esta sección.

PREGUNTAS SOBRE LAS FARDELAS

32. ¿Durante qué meses del año le caen más fardelas con este arte?
E F M A M J J A S O N D / TODO

33. ¿Cuántas fardelas cree que le cayeron **en el último año**, con este arte?
Marque una: ☐ 0 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ >50

34. ¿Cómo encuentra a las fardelas cuando le caen en el aparejo?
☐ En buena condición ☐ Moribundo ☐ Muerto ☐ Herido ☐ Otro _____

SÓLO PARA LOS ENCUESTADORES

35. ¿Qué tan abierto y honesto parecía el pescador contestando las preguntas de pesca incidental?
☐ Muy abierto/honesto ☐ Parcialmente abierto/honesto ☐ Nada honesto

36. **Otros comentarios**: _____

_____

_____

_____

_____

UNO POR PUERTO: FORMULARIO DE DESCRIPCIÓN DEL LUGAR DE DESEMBARQUE

(incluir algunas fotos del puerto, embarcaciones y a Usted trabajando en entrevistas)

Fecha: _____ Nombre del investigador: _____
Hora: _____

Información sobre la ubicación:
Puerto: _____
Latitud: _____
Longitud: _____

¿Cuántos lugares de desembarque hay en el puerto? _____

Total del número de botes en este lugar de desembarque: _____

Longitud mínima (m): _____
Longitud más común (m): _____
Longitud máxima (m): _____

Proporción del total de botes motorizados en este lugar: _____

Desintegre la información acerca de los botes por el tipo de botes (ej. Canoas pequeñas, largas, etc.)

Tipo de bote	Número de botes	Rango de tamaño (m)	Proporción motorizada	Descripción
A				
B				
C				
D				
E				

FICHA DE IDENTIFICACION DE AVES MARINAS

1= Albatros o pajarotes

2=Pelicanos

3=Petreles

4=Pardelas

5=Cormoranes

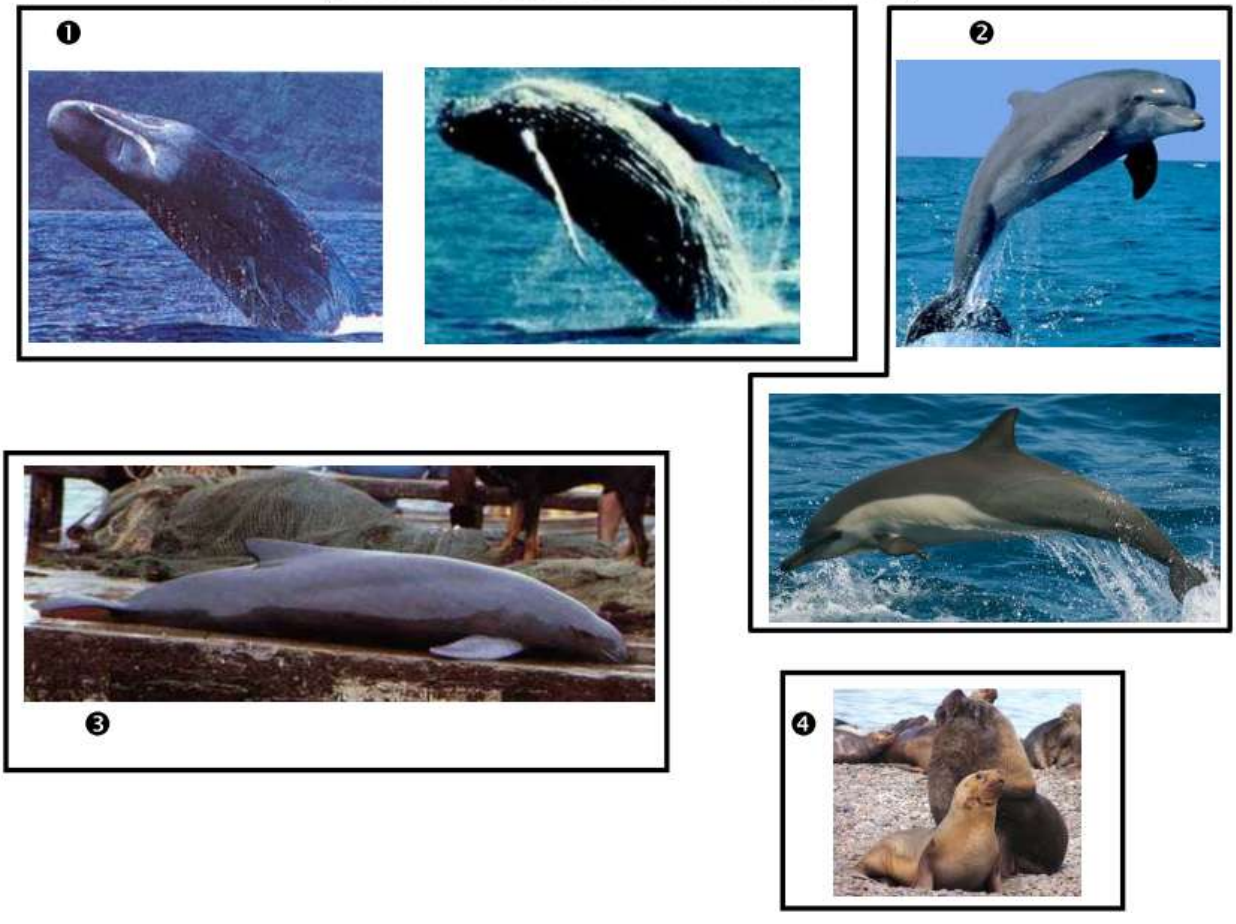
6=Golondrina de tempestad, paiño

7=Piqueros

8=Pinguinos

FICHA DE IDENTIFICACION: FARDELA BLANCA

FICHA DE IDENTIFICACION DE MAMIFEROS MARINOS



FICHA DE IDENTIFICACION DE TORTUGAS MARINAS

❶

❷

❸

❹

❺ =Carey