



Agreement on the Conservation  
of Albatrosses and Petrels

**Joint Thirteenth Meeting of the Seabird Bycatch  
Working Group and Ninth Meeting of the Population  
and Conservation Status Working Group**

*Swakopmund, Namibia, 26 May 2026*

**Spatial Overlap and Fisheries Interactions  
Between Artisanal Fisheries and Endangered  
Seabirds in Ecuador**

***Sebastian Cruz<sup>1</sup>, Olivia C. Rowley<sup>2</sup>, Giovanni Suarez<sup>1</sup>,  
Ivonne Becilla<sup>1</sup>, Francisca Hernández<sup>1</sup>, Carlos Pico<sup>1</sup>,  
Mónica Jaramillo<sup>1</sup>, Elizabeth Bell<sup>3</sup>, Sea McKeon<sup>1</sup>,  
Johannes H. Fischer<sup>2</sup>, Igor Debski<sup>2</sup>***

<sup>1</sup>American Bird Conservancy, Marine Program, Ecuador

<sup>2</sup>Aquatic Unit, Department of Conservation, Wellington, New  
Zealand.

<sup>3</sup> Wildlife Management International Ltd., Blenheim, New Zealand

**SUMMARY**

Artisanal longline fisheries along the Ecuadorian coast are considered an important but poorly quantified threat to ACAP-listed seabirds, particularly the Critically Endangered Waved Albatross (*Phoebastria irrorata*) and the Vulnerable Black Petrel (*Procellaria parkinsoni*). To address this knowledge gap, we combined high-resolution GPS tracking of artisanal fishing vessels with seabird tracking and systematic beach-survey data from coastal Ecuador. Between November 2024 and February 2026, we tracked 185 fishing trips from five ports in Santa Elena and Manabí provinces, encompassing demersal longline, pelagic longline, and handline fisheries. Seabird distributions were derived from GPS data for Waved Albatross and GLS data for Black Petrel. Both species overlapped with artisanal longline fisheries, with the strongest overlap associated with demersal longliners. Key hotspots occurred off the Santa Elena Peninsula for Waved Albatross and off Bahía de Caráquez for Black Petrel, primarily in shelf-edge waters within Ecuador's Exclusive Economic Zone. Beach surveys at Mar Bravo recorded 779 seabird carcasses, including hooked Waved Albatrosses. Hook size and type were consistent with gear used in both demersal and surface longline fisheries in the area. Collectively these findings identify priority areas, seasons, and gear types for targeted fisher engagement, bycatch mitigation and future monitoring in Ecuadorian artisanal fisheries.

## RECOMMENDATIONS

We recommend that SBWG13 and PaCSWG9

1. *Note* the overlap of Waved Albatross and Black Petrel with Ecuadorian longline fishing effort and the resultant bycatch risk, in particular from the Mahi Mahi fishery.
2. *Prioritise* further development of mitigation tools for artisanal longline fisheries.
3. *Recommend* that AC encourages parties and others with jurisdiction over relevant artisanal longline fisheries to implement mitigation measures to reduce bycatch risk.

## Superposición espacial e interacciones entre pesquerías artesanales y aves marinas en peligro de extinción en Ecuador

### RESUMEN

Las pesquerías artesanales de palangre a lo largo de la costa ecuatoriana se consideran una amenaza importante pero poco cuantificada para las aves marinas incluidas en la lista del ACAP, en particular las especies en peligro crítico *Phoebastria irrorata* y *Procellaria parkinsoni*. Para abordar esta laguna de conocimiento, combinamos el rastreo con GPS de alta resolución de embarcaciones pesqueras artesanales con el rastreo de aves marinas y datos sistemáticos de censos de playas desde la costa de Ecuador. Entre noviembre de 2024 y febrero de 2026, se realizó el rastreo de 185 expediciones de pesca desde cinco puertos de las provincias de Santa Elena y Manabí, que abarcan pesquerías de palangre demersal, palangre pelágico y línea de mano. Las distribuciones de aves marinas se derivaron de datos de GPS para *Phoebastria irrorata* y datos de GLS para *Procellaria parkinsoni*. Ambas especies se superponían con pesquerías artesanales de palangre; la superposición más fuerte se asoció con los palangres demersales. Se produjeron puntos críticos clave frente a la península de Santa Elena para *Phoebastria irrorata* y frente a Bahía de Caráquez para *Procellaria parkinsoni*, principalmente en aguas del borde de la plataforma dentro de la Zona Económica Exclusiva de Ecuador. Los censos de playa en Mar Bravo registraron 779 cadáveres de aves marinas, incluyendo *Phoebastria irrorata* enganchadas. El tamaño y el tipo de anzuelo eran consistentes con el equipo utilizado en pesquerías de palangre demersal y de superficie en la zona. En conjunto, estos hallazgos identifican áreas, temporadas y tipos de equipo prioritarios para la interacción con pescadores específicos, la mitigación de captura secundaria y el monitoreo futuro en las pesquerías artesanales ecuatorianas.

## RECOMENDACIONES

Recomendamos que la GdTCS13 y la GdTPEC9:

1. Tomen nota de la superposición de *Phoebastria irrorata* y *Procellaria parkinsoni* con el esfuerzo de pesca con palangre ecuatoriano y el riesgo de captura secundaria resultante, en particular de la pesquería de mahi-mahi.
2. Prioricen el desarrollo de herramientas de mitigación para las pesquerías artesanales de palangre.
3. Recomienden que el CA anime a las Partes y a otros con jurisdicción sobre las pesquerías artesanales de palangre pertinentes a implementar medidas de mitigación para reducir el riesgo de captura secundaria.

## **Chevauchement spatial et interactions entre les pêcheries artisanales et les oiseaux marins menacés en Équateur**

### **RÉSUMÉ**

La pêche artisanale à la palangre le long de la côte équatorienne est considérée comme une menace importante, mais mal quantifiée, pour les oiseaux marins inscrits à l'ACAP, en particulier l'albatros des Galápagos (*Phoebastria irrorata*), classé « en danger critique d'extinction », et le pétrel noir (*Procellaria parkinsoni*), classé « vulnérable ». Pour combler cette lacune, nous avons combiné les données de suivi GPS à haute résolution des bateaux de pêche artisanale avec celles issues du suivi des oiseaux marins et des relevés systématiques effectués sur les plages de l'Équateur côtier. Entre novembre 2024 et février 2026, nous avons suivi 185 sorties de pêche au départ de cinq ports des provinces de Santa Elena et de Manabí, couvrant les pêcheries à la palangre démersale, à la palangre pélagique et à la ligne à main. La répartition des oiseaux marins a été déterminée à partir des données GPS pour l'albatros des Galápagos et des données GLS pour le pétrel noir. Ces deux espèces présentaient un chevauchement avec les pêcheries artisanales à la palangre, le chevauchement le plus important étant observé avec les palangriers démersaux. Les principaux points chauds ont été recensés au large de la péninsule de Santa Elena pour l'albatros des Galápagos et au large de Bahía de Caráquez pour le pétrel noir, principalement dans les eaux situées à la lisière du plateau continental, au sein de la zone économique exclusive de l'Équateur. Les relevés effectués sur la plage de Mar Bravo ont permis de recenser 779 cadavres d'oiseaux marins, dont des albatros des Galápagos capturés par des hameçons. La taille et le type des hameçons correspondaient à ceux utilisés dans les pêcheries à la palangre, tant démersales qu'en surface, pratiquées dans la région. Dans leur ensemble, ces résultats permettent d'identifier les zones, les saisons et les types d'engins prioritaires pour une mobilisation ciblée des pêcheurs, la réduction des captures accessoires et le suivi futur dans les pêcheries artisanales en Équateur.

## RECOMMANDATIONS

Nous recommandons que le SBWG13 et le PaCSWG9

1. Prennent note du chevauchement entre les aires de répartition de l'albatros des Galápagos et du pétrel noir et l'effort de pêche à la palangre en Équateur, ainsi que du risque de captures accessoires qui en découle, notamment dans le cadre de la pêche au mahi-mahi.
2. Donnent la priorité à la poursuite du développement d'outils d'atténuation destinés aux pêcheries artisanales à la palangre.
3. Recommandent que le Comité consultatif encourage les Parties et les autres entités ayant compétence sur les pêcheries artisanales à la palangre concernées à mettre en œuvre des mesures d'atténuation visant à réduire le risque de captures accessoires.

## 1. INTRODUCTION

The eastern tropical Pacific supports diverse assemblages of pelagic seabirds, sustained by high marine productivity associated with the Humboldt upwelling system and the bathymetry formed by the Nazca and South American plates (Crawford *et al.* 2006; Gutiérrez *et al.* 2016). Waters within Ecuador's Exclusive Economic Zone are used by numerous wide-ranging species, including several listed as priority species under the Agreement on the Conservation of Albatrosses and Petrels (ACAP), which forage extensively within Ecuador's Exclusive Economic Zone (Reyes *et al.* 2024).

Ecuador supports a large artisanal fishing fleet distributed among coastal communities. Official registries report approximately 28,500 fishers as of 2021, although the true number is likely considerably higher (Delgado *et al.* 2021; Peñaherrera-Palma *et al.* 2025). Artisanal fisheries employ a range of gear types, including handlines, gill nets, spear fishing, and both pelagic and demersal longlines, the latter being the most prevalent (Peñaherrera-Palma *et al.* 2025). Globally, longline fisheries are recognised as a major source of seabird bycatch, with an estimated 160,000 seabird mortalities annually, primarily affecting albatrosses, petrels, and shearwaters (Anderson *et al.* 2011a; Brothers *et al.* 2010). Such levels of incidental capture are considered unsustainable for several populations and represent a significant conservation concern in the region (Awkerman *et al.* 2006).

Two pelagic seabird species frequent the Ecuadorian coast during breeding and postbreeding periods are the Waved Albatross (*Phoebastria irrorata*) and the Black Petrel (*Takotetai, Procellaria parkinsoni*) (Awkerman *et al.* 2014; Reyes *et al.* 2017). The Waved Albatross, listed as Critically Endangered (IUCN, 2025) and an ACAP species, breeds largely in the Galápagos Islands, nesting almost exclusively on Española Island, with a small number of pairs (<5) on Isla de la Plata. Its foraging range extends across the eastern tropical Pacific to the waters of the Humboldt upwelling system (Anderson *et al.* 2008; Jimenez-Uzategui & Mangel 2006). The Black Petrel is endemic to New Zealand, breeding on two islands (Aotea and Hauturu),

and undertakes extensive annual migrations that span the southwest Pacific and eastern South Pacific, including the coast of Ecuador (Freeman *et al.* 2010; Rowley *et al.* 2026).

Pelagic artisanal longline fisheries may exert significant but poorly quantified impacts on threatened seabird populations (Júnior *et al.* 2016; Votier *et al.* 2023). Incidental capture in longline fisheries is a principal threat to both Waved Albatrosses and Black Petrels, with a substantial proportion of bycatch occurring within Ecuador's artisanal fisheries (Awkerman *et al.* 2006; Delgado *et al.* 2021). Despite the importance of this threat, major knowledge gaps persist regarding the magnitude and spatial distribution of seabird bycatch in artisanal fleets operating within the Humboldt Current region (Anderson *et al.* 2011b; Beal *et al.* 2021). A critical limitation is the lack of information on the at-sea movements and spatial extent of artisanal fishing effort. These fleets typically operate without AIS or VMS systems, are therefore absent from Global Fishing Watch databases, and are generally undetectable in satellite imagery due to vessel size and construction materials. Consequently, existing data rely largely on fisher self-reporting, constraining robust assessments of spatial analyses of overlap between fisheries and seabirds.

To address these gaps, we conducted a GPS-based tracking program of artisanal fishing vessels operating in the provinces of Santa Elena and Manabí to characterise their at-sea movements and quantify spatial overlap with pelagic seabirds. In parallel, we carried out systematic beach-surveys (patrols) to assess and document seabird mortality and detect evidence of fishery interactions, including embedded hooks. Together, these approaches provide the first integrated assessment of artisanal fishing activity and seabird bycatch risk along the mainland coast of Ecuador.

## 2. METHODS

Fieldwork in Ecuador was carried out in the coastal fishing communities of Santa Elena and Manabí provinces, Ecuador, focusing on four major artisanal fishing ports: Santa Rosa (600 vessels) and Anconcito (238 vessels) in Santa Elena; and San Mateo (400) and Jaramijo (650) in Manabí. Activities included ports and landing site visits, direct observation of fishing operations, engagement with fishers, and systematic collection of spatial and operational data from fishing trips. GPS loggers (IgotU GT-120, 1 fix/sec) were deployed and retrieved to record vessel movements. GPS tracking data were collected from artisanal fishing vessels between November 2024 and February 2026. For each tracked trip, teams documented vessel details, target species, fishing gear and hook specifications, total hooks deployed, fishing zones, and any seabird encounters reported by fishers. All GPS data were consolidated into a single database and processed in R (R Core Team 2025). Data cleaning involved removing invalid and implausible fixes after visual inspections, with tracks reconstructed by vessel identity and timestamp. Spatial and movement analyses utilised R packages including dplyr (data wrangling), readr (file import), lubridate (date-time handling), geosphere (distance calculations), and leaflet (visualisation).

### 2.1 Spatial Data

To assess spatial overlap between fisheries and the distributions of Waved Albatross and Black Petrel, seabird tracking data were obtained from the Movebank study *Galapagos*

*Albatrosses* (GPS, study 2911040; Dodge et al. 2013) and from the New Zealand Department of Conservation (GLS, Rowley et al. 2026). The Waved Albatross tracking data utilised in this study were gathered during the 2008 breeding season. For the Black Petrel, movement data were collected during 2018-2019 and records the post-breeding dispersal and migratory behaviour to the coast of South and Central America.

Given the high temporal resolution of the GPS data (1 fix s<sup>-1</sup>), it was possible to distinguish different phases of each fishing trip. Outbound and inbound transit segments were readily separated from active fishing segments, as vessels typically travelled at higher speed and along relatively straight trajectories during transit, but slowed and showed more localized movement during line setting and retrieval. Analyses of fishing effort were therefore restricted to track segments associated with fishing activity, excluding transit portions of trips. Fishing-related segments were identified based on expert interpretation of movement patterns. Fisheries effort was derived from GPS tracks of artisanal fishing vessels by evenly allocating the reported number of hooks for each trip across all GPS positions and rasterizing these values to a 0.1° × 0.1° grid in R. Seabird tracking data were rasterized to the same grid, with each location weighted by the proportion of a day represented by that fix according to dataset-specific sampling intervals. Waved Albatross GPS fixes collected every 15 min were assigned 0.0104 bird-days, whereas Black Petrel GLS fixes collected twice daily were assigned 0.5 bird-days. Summed values per grid cell were used as a measure of bird use intensity. The fisheries and seabird rasters were then aligned and merged to quantify spatial overlap (following methods by Rowley, 2026).

## **2.2 Beach patrols**

Monthly beach surveys were conducted on Mar Bravo Beach, Salinas, Santa Elena, Ecuador (2.245779°S, 80.920937°W), a south-westerly facing beach on the Santa Elena Peninsula extending approximately 12 km. Surveys covered a 3.5 km section between La Lobería (2.205041°S, 80.994861°W) and Pozas de Sal (2.224953°S, 80.970930°W). Each survey was carried out by a three-person team walking abreast with 5–10 m spacing, searching the area between the waterline and the upper tide line. The start and end time and GPS position of each survey were recorded. All seabird carcasses encountered were recorded and identified to species when possible. Each carcass was examined visually for evidence of entanglement in fishing gear and scanned with a handheld metal detector (Garrett Pro-Pointer AT) to detect embedded fishing hooks. When hooks were detected, they were removed and their size and location on the carcass were recorded. To avoid duplicate counts, examined carcasses were moved above the high-tide line after processing. Systematic surveys at Mar Bravo began in July 2024, and the dataset presented here includes surveys conducted through November 2025.

## **2.3 Ethical statement**

All research activities involving GPS tracking of artisanal fishing vessels were conducted in strict accordance with ethical guidelines for research involving human participants. Prior to the commencement of each tracking activity, fishers received a clear explanation of the study's aims, methods, and intended use of the data. Verbal informed consent was obtained from all participating fishers, ensuring they understood their involvement was entirely voluntary and

that they could withdraw at any point without consequence. No personal identifying information was collected, and vessel names were anonymised in all datasets, retained solely for internal data management and never disclosed publicly or to third parties. All procedures were designed to minimise disruption to fishing operations and respect the rights and privacy of the fishing community.

### 3. RESULTS

Between November 2024 and February 2026, we tracked 185 individual fishing trips of the artisanal fleet from 5 ports in Ecuador, in the provinces of Santa Elena and Manabi (Fig. 1a). The port with the most tracking occurred was Santa Rosa (n=125) followed by San Mateo (n = 32), Anconcito (n = 17), Jaramijo (n = 14), and San Clemente (n = 1). We tracked across gear types, demersal longline (n=117), pelagic longline (n=35) and handline (n=33) (Fig 1b). Pelagic longline trips were, on average, the longest in both duration and distance travelled, with a mean duration of 22.0 h (SD = 12.3, range = 2.7–47.1 h) and a mean trip length of 144.8 km (SD = 71.8, range = 57.7–330.3 km). Demersal longline trips were generally shorter and closer to port, with a mean duration of 11.2 h (SD = 9.4, range = 2.4–75.0 h) and a mean trip length of 81.3 km (SD = 47.4, range = 17.1–302.3 km). Handline fishing trips had a mean duration of 13.6 h (SD = 11.8, range = 1.0–43.2 h) and a mean trip length of 87.2 km (SD = 47.2, range = 4.6–219.1 km). Trips from Anconcito and Jaramijo showed the greatest average distance and duration among ports with complete distance estimates (63.8 km – 48.6 hrs; 113.4 km - 36.8hrs respectively). The shortest trips were from San Mateo whereas trips from Santa Rosa were more numerous and covered a broad range of durations and distances.

#### 3.1 Fishing gear and target species

Based on fisher-reported information for each tracked trip, artisanal pelagic and demersal longline fisheries in coastal Ecuador differed in both target species and gear configuration. Pelagic longlines primarily targeted mahi-mahi (*Coryphaena hippurus*, Coryphaenidae), whereas demersal longlines mainly targeted hake or “merluza” (*Merluccius gayi*, Merlucciidae) and a group of benthic and benthopelagic fishes, including seabass or “perela” (*Paralabrax humeralis*, Serranidae), tilefish or “cabezudo” (*Caulolatilus affinis*, Latilidae), and croaker or “corvina” (*Cynoscion squamipinnis*, Sciaenidae). Demersal longline trips deployed substantially more hooks on average than pelagic longline trips, although both gears showed high variability. Demersal longline sets used a mean of 1035 hooks per trip (n = 118, SD = 841, range = 100 – 3600) and typically consisted of mother lines bearing 400 – 600 hooks, with up to six mother lines connected in a single set. Demersal longlines used intermediate hooks sizes, specially 10 (n=44) and 9 (n=26). Pelagic longlines used a mean of 670 hooks per trip (n = 35, SD = 573, range = 240 – 3600) and used the largest hooks, sizes 4 (n=13) and 5 (n=16). Handline trips primarily targeted snapper or “pargo” (*Lutjanus guttatus*, Lutjanidae) and squid (*Dosiducus gigas*, Ommastrephidae); and used far fewer hooks, with a median of 20 hooks per trip (n=33) and used hook size 11 (n=27) exclusively. Compared with longline fisheries, handline effort was lower in magnitude (fewer hooks) and generally reflected a more selective mode of operation.

#### 3.2 Seabird encounters reported by fishers

Of the 185 GPS-tracked fishing trips, seabird encounters at sea were reported by fishers on 41 occasions (22.2%), involving both Waved Albatross and Black Petrel. Albatross sightings occurred on 39 trips, typically comprising 1 – 8 individuals, with occasional observations of larger groups up to 20 birds. Black Petrels were reported on 5 trips, including two instances with groups of 50 – 80 individuals. Most encounters were recorded between May and September, peaking in September. Most reports originated from Santa Rosa, Santa Elena, and were associated with demersal longline trips targeting perela and merluza. Only two sightings were reported from San Mateo, Manabí.

### 3.3 Overlap hotspots and priority areas

Overall, the movements of foraging Waved Albatrosses and non-breeding Black Petrels overlapped with artisanal longline fisheries (combined demersal and pelagic longline effort) operating from Santa Elena and Manabí (Fig. 2). For Waved Albatross, the area of highest overlap intensity was located ~25 km northwest of the Santa Elena Peninsula. Additional overlap was evident farther north, off Manta at ~25 km from the coast, and farther south in the Gulf of Guayaquil, around ~70 km from Puná Island (Fig 2a). For Black Petrels, the spatial pattern of overlap differed from that of Waved Albatross. The highest overlap intensity occurred approximately 15 km off Bahía de Caráquez, although overlap extended along the coasts of Manta and the Santa Elena Peninsula and south to the mouth of the Gulf of Guayaquil (Fig. 2b). Overall, for both species, overlap with artisanal fisheries occurs on the Ecuadorian coast, generally between ~50 – 5 km of land, and entirely within Ecuador's Exclusive Economic Zone. These overlap areas were associated with the outer continental shelf and shelf break, where depths transition from approximately 100 – 200 m to >1000 m along the Ecuadorian Trench.

Overlap between seabirds and fisheries differed among gear types and between species. In both species, the highest overlap values were associated with demersal longline, whereas overlap with pelagic longline effort was lower (Fig. 3). Black Petrel showed the strongest overlap overall, particularly with demersal longline. For Black Petrel, overlap with demersal longline was highest off Bahía de Caráquez, while overlap with pelagic longline effort was concentrated farther south, particularly off the Santa Elena Peninsula. For Waved Albatross, the highest overlap with both demersal and pelagic longline effort occurred off the Santa Elena Peninsula. Overall, Black Petrel overlap with artisanal fisheries was more spatially dispersed, whereas Waved Albatross overlap was more concentrated in a smaller number of focal areas.

### 3.4 Species composition and hook occurrence of beached birds at Mar Bravo

During surveys at Mar Bravo Beach, 779 beached birds were documented. The assemblage was predominantly composed of Sooty Shearwater (*Ardenna grisea*), representing 705 individuals (90.5% of records). Blue-footed Booby (*Sula nebouxii*) was the second most common species (n = 31, 4.0%), while all other taxa were observed in fewer than 10 individuals each. These included Neotropic Cormorant (*Nannopterum brasilianum*, n = 9), Magnificent Frigatebird (*Fregata magnificens*, n = 7), Waved Albatross (*Phoebastria irrorata*, n = 4), White-chinned Petrel (*Procellaria aequinoctialis*, n = 4), and Pink-footed Shearwater (*Ardenna creatopus*, n = 1). Artisanal fisheries along the Ecuadorian coast use J-hooks, with hook size

varying by gear type and target species. Demersal longlines typically use size 9 and 10 hooks, pelagic longlines size 4, and handlines size 11. Fishing hooks were found in 14 carcasses (1.8% of birds), with hook size 10 being most prevalent (n = 10). Most hooks were detected in Sooty Shearwaters of sizes 10 and 9 (n = 8). Of the four Waved Albatross carcasses, three contained hooks, one size 4 and two size 10. Additionally, a Blue-footed Booby and a Pink-footed Shearwater were found with hooks size 9.

#### **4. DISCUSSION**

This study provides the first assessment of spatial overlap between artisanal longline fisheries in coastal Ecuador and the at-sea distributions of Waved Albatross and Black Petrel. It also represents the first high-resolution description of the movements and operational patterns of artisanal fishing vessels in Ecuador. Both threatened seabird species overlapped with artisanal longline fisheries, but the magnitude and spatial pattern of overlap differed between species and gear types. In both cases, overlap was consistently greater with demersal longline fishing effort than with pelagic longline, although this pattern may partly reflect the greater number of demersal longline trips represented in the dataset. Waved Albatross overlap was concentrated in several distinct areas, particularly off the Santa Elena Peninsula, whereas Black Petrel overlap was more spatially dispersed along the Ecuadorian coast. These species-specific patterns likely reflect differences in movement ecology and space use. For Waved Albatross, overlap was concentrated in relatively discrete areas, suggesting that certain coastal and shelf-edge zones are particularly important for foraging. In contrast, Black Petrel overlap was more scattered along the coast, with a marked hotspot off Bahía de Caráquez and additional overlap extending along other coastal sectors.

The observed differences between gear types were likely related to the spatial distribution of the fisheries. Demersal longline effort was generally concentrated closer to the coast, particularly over the continental shelf and shelf edge, where fishers target known fishing grounds with relatively shallow bathymetry. Pelagic longline, by contrast, extended farther offshore. Nevertheless, overlap between pelagic longline and both seabird species indicates that interaction risk is not restricted to a single gear type. Bathymetry appears to be a key feature linking seabird use and fishing activity, as the main overlap areas identified in this study were associated with the outer continental shelf, shelf break, and adjacent deep waters.

Our results are broadly consistent with recent information derived from fishers. Peñaherrera (2026) reported that nearly all interviewed fishers perceived strong declines in yields, an increase in the number of species targeted, and an expansion or shift of fishing grounds farther from the coast. However, the main fishing grounds used by most fishers remained concentrated relatively close to shore, within the first 8 nautical miles. Our GPS results show that, particularly for demersal longline, fishing activity occurs nearshore. The seabird tracking datasets used in this study also show that both species used waters within this zone, indicating potential for interaction between seabirds and artisanal fisheries in coastal Ecuador.

Based on information provided by fishers, demersal and pelagic longlines differed not only in spatial distribution but also in target species, hook size, and the number of hooks deployed. Demersal longline typically targeted hake and other demersal or benthopelagic fishes and used more hooks on average, whereas pelagic longline targeted mahi-mahi and generally

used larger hooks. These differences are likely to influence both the probability and nature of seabird interactions. For example, nearshore demersal effort may lead to repeated overlap with birds using shelf waters, whereas offshore pelagic longlines may create interaction opportunities in more pelagic areas. Handline fisheries appeared more selective and used fewer hooks, which may imply lower interaction risk, although this requires further evaluation.

Although overlap identifies areas of potential interaction, it does not by itself demonstrate bycatch. Spatial coincidence between fisheries and seabirds should therefore be interpreted as a proxy of potential risk rather than direct evidence of mortality. However, the beach patrol data indicate that interactions with artisanal fisheries do occur. Hooks recovered from seabird carcasses provide direct evidence of lethal fishery interactions, and hook size may help identify the fishery involved. Information provided by tracked fishers indicated that demersal longlines mainly used hook sizes 9 and 10, pelagic longlines commonly used larger hooks such as size 4, and handline fisheries predominantly used size 11 hooks. Of the four dead Waved Albatrosses recorded on Mar Bravo Beach, three contained embedded hooks: one size 4 hook, consistent with pelagic longline, and two size 10 hooks, consistent with demersal longline. These records suggest that both fisheries can result in seabird mortality.

Self-reported encounters at sea were most frequent between July and September for Waved Albatross. This period coincides with the breeding season, when adults are rearing chicks and foraging regularly off the coasts of Ecuador and Peru (Anderson *et al.* 2003; Awkerman *et al.* 2005, 2014). This suggests that interaction risk may increase when breeding birds are repeatedly commuting through coastal fishing areas.

Future work should build on these findings by increasing sample size across ports and gear types, especially for pelagic longline. Seasonal analyses would also be valuable, as overlap may vary through time in response to seabird phenology, fish availability, and shifts in fishing grounds. Further integration of GPS tracking with direct bycatch records, onboard observation, and fisher interviews would help determine whether areas of high overlap also correspond to elevated mortality risk. It would also be useful to examine environmental predictors of overlap, including bathymetry, distance to shore, and oceanographic conditions, to assess whether hotspots are persistent and predictable across years.

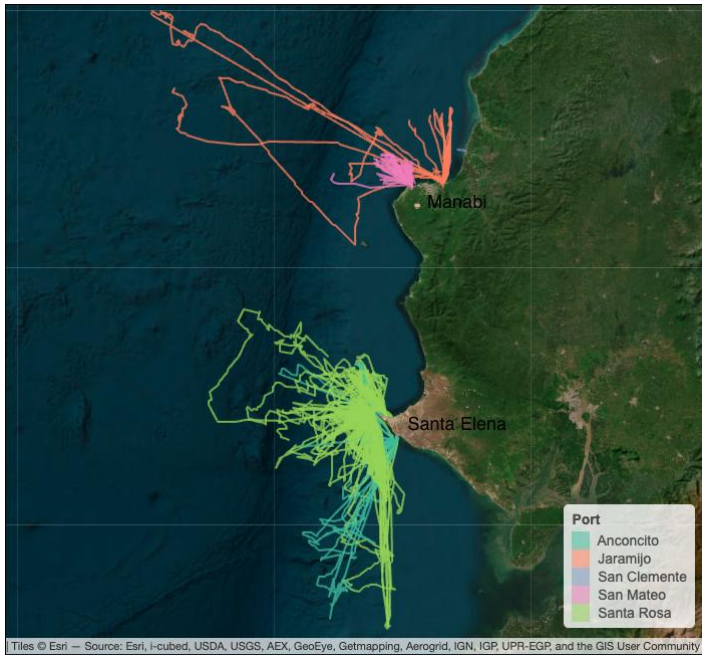
## 5. ACKNOWLEDGEMENTS

National Fish and Wildlife Foundation, Packard Foundation, Ball Family, White Family. We thank all those who assisted with the Black Petrel and Waved Albatross fieldwork which enabled these tracking data. Black Petrel GLS tags and associated fieldwork were funded by Fisheries New Zealand, analyses of the subsequent data processing were funded by the Department of Conservation. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation and its funding sources. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government, or the National Fish and Wildlife Foundation or its funding sources.

**Table 1.** Trip duration and mean distance of artisanal fishing trips, according to gear type.

<b>Gear type</b>	<b>n trips</b>	<b>Mean duration (h)</b>	<b>SD</b>	<b>Range (h)</b>	<b>Mean distance (km)</b>	<b>SD</b>	<b>Range (km)</b>
Demersal longline	117	11.2	9.4	2.4–75.0	81.3	47.4	17.1–302.3
Pelagic longline	35	22	12.3	2.7–47.1	144.8	71.8	57.7–330.3
Handline	33	13.6	11.8	1.0–43.2	87.2	47.2	4.6–219.1

1. a. 6. FIGURES



2. b.

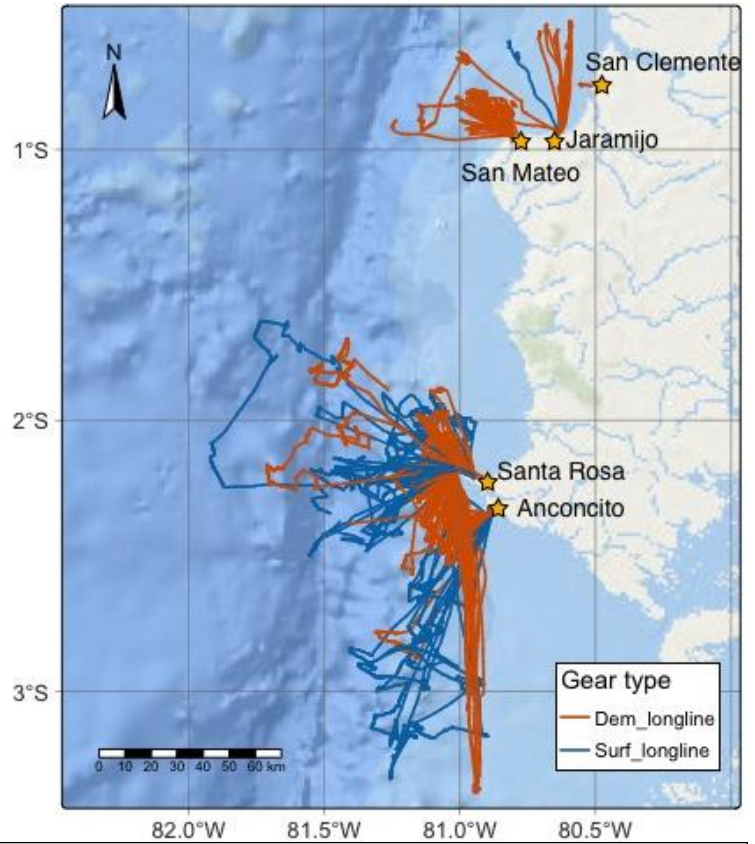


Figure 1a. GPS tracks of artisanal fishing trips in coastal Ecuador from 5 ports in the provinces of Santa Elena and Manabi.  
Figure 1b. GPS tracks of artisanal fishing trips coloured by gear type, demersal longline (red) and pelagic longline (blue).

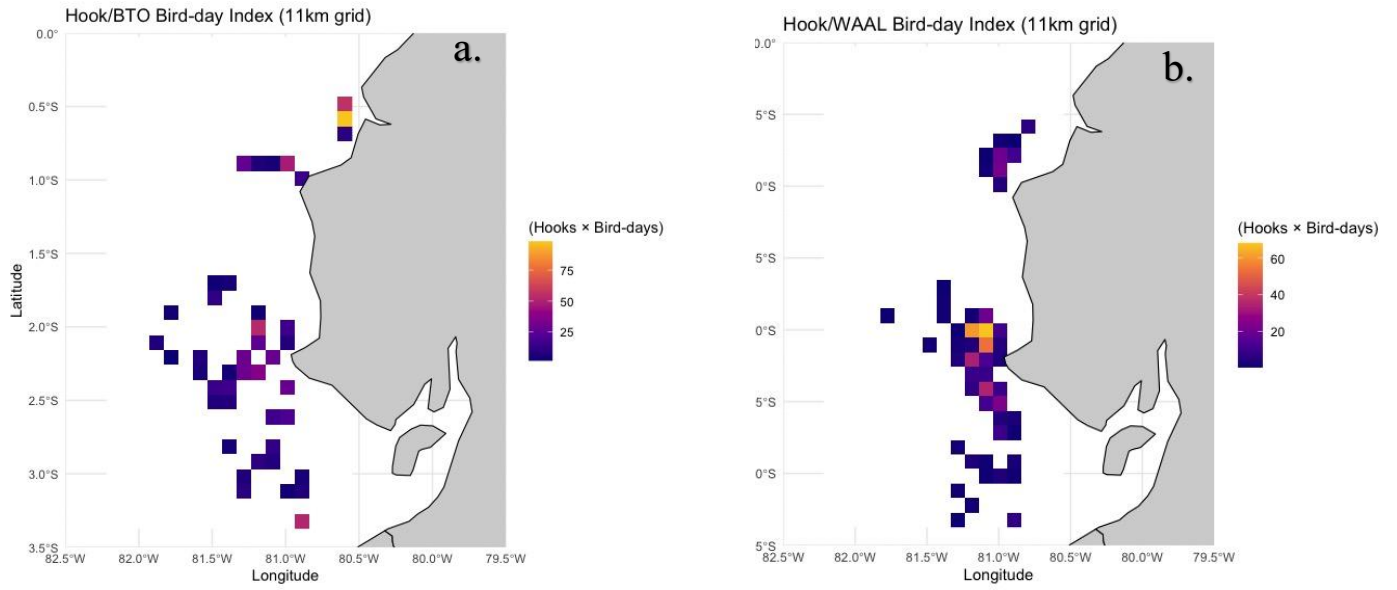


Figure 2a and 2b. Overlap between seabirds (BTO = Black Petrel; WAAL = Waved Albatross) and fisheries (demersal and pelagic combined) in coastal Ecuador.

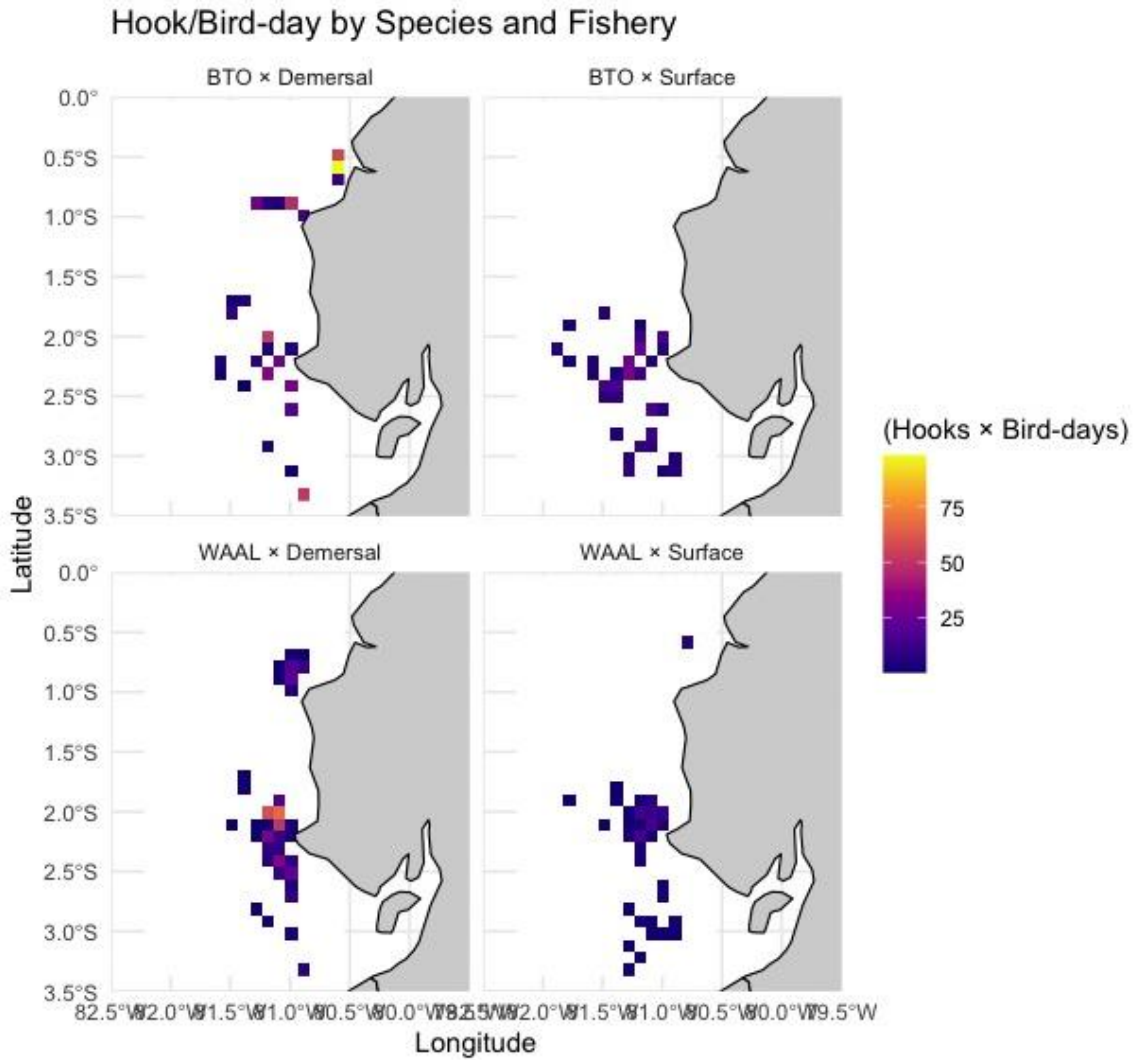
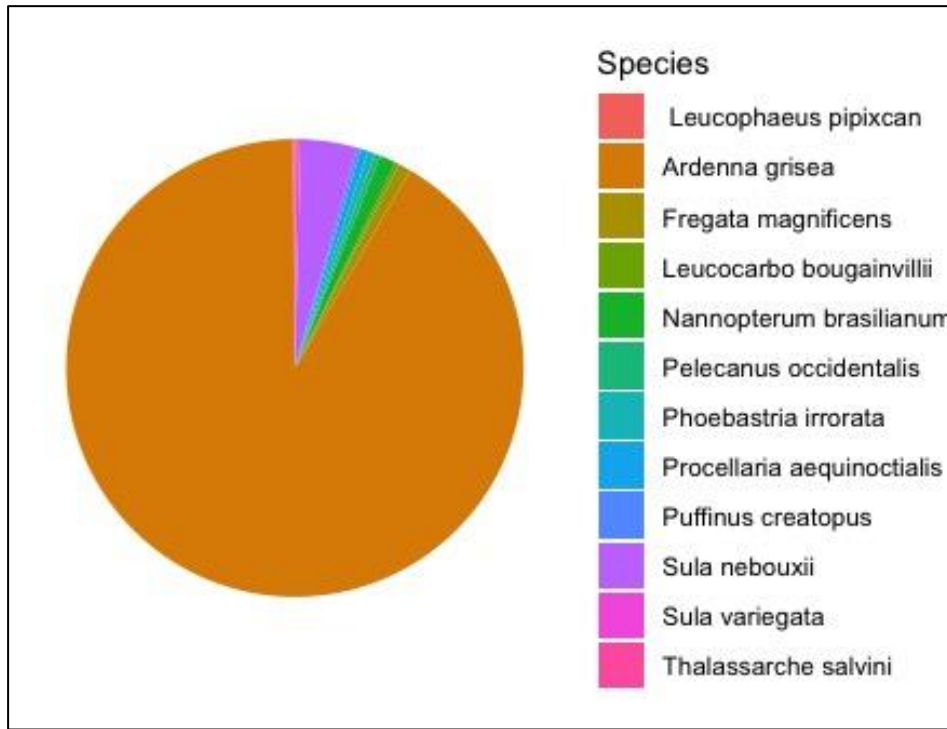


Figure 3. Overlap between Black Petrel (BTO and Waved Albatross (WAAL) and fisheries, separated by gear type: demersal longline and pelagic longline (surface).



Figures 4. Pie chart of the species composition of beached birds found on Mar Bravo Beach, Santa Elena.

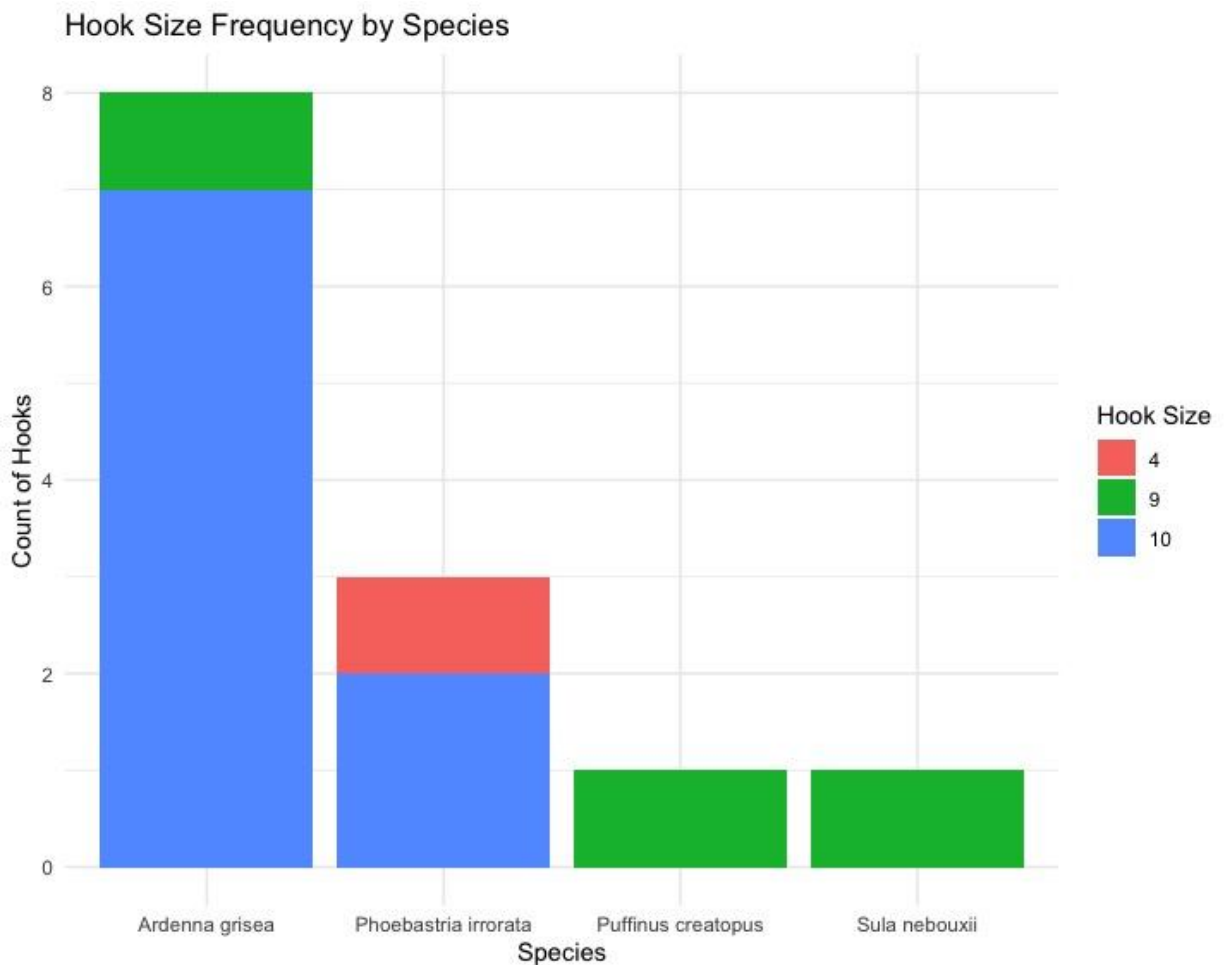


Figure 5. Histogram of beached birds found with fishing gear, i.e hooks on Mar Bravo beach, Santa Elena, and the hook sizes found on those beached birds. Size 9 and 10 associated with demersal longline. Size 4 associated with pelagic longline.



Photo 1. Waved Albatross carcass found on Mar Bravo beach, Santa Elena during a beach patrol. Hook, size 10, was found on the underside of the wing with nylon still attached. Hook was located using the pin pointer metal detector (orange object).

## 7. REFERENCES

- Anderson, D., Huyvaert, K., Wood, D., Gillikin, C., Frost, B., & Mouritsen, H. (2003). At-sea distribution of waved albatrosses and the Galapagos Marine Reserve. *Biological Conservation*, **110**(3), 367–373.
- Anderson, D. J., Huyvaert, K. P., Awkerman, J. A., Grace, J. K. (2008). Population status of the Critically Endangered waved albatross *Phoebastria irrorata*, 1999 to 2007. *Endangered Species Research*, **5**, 185–192.
- Anderson, O., Small, C., Croxall, J., Black, A. (2011a). Global seabird bycatch in longline fisheries. *Endangered Species Research*, **14**(2), 91–106.
- Anderson, O., Small, C. J., Croxall, J. P., & Dunn, E. K. (2011b). Global seabird bycatch in longline fisheries. *Endangered Species* ....
- Awkerman, J. A., Cruz, S., Proaño, C., Anderson, D. J. (2014). Small range and distinct distribution in a satellite breeding colony of the critically endangered Waved Albatross. *Journal of Ornithology*, **155**(2), 367–378.
- Awkerman, J. A., Huyvaert, K. P., Mangel, J., Shigueto, J. A., & Anderson, D. J. (2006). Incidental and intentional catch threatens Galápagos waved albatross. *Biological Conservation*, **133**(4), 483–489.
- Awkerman, J., Fukuda, A., Higuchi, H., & Anderson, D. (2005). Foraging activity and submesoscale habitat use of waved albatrosses *Phoebastria irrorata* during chick-brooding period, *Marine Ecology Progress Series*, **291**, 289-300.
- Beal, M., Dias, M. P., Phillips, R. A., Catry, P. (2021). Global political responsibility for the conservation of albatrosses and large petrels. *Science Advances*, **7**(10), eabd7225.
- Brothers, N., Duckworth, A. R., Safina, C., & Gilman, E. L. (2010). Seabird Bycatch in Pelagic Longline Fisheries Is Grossly Underestimated when Using Only Haul Data. *PLoS ONE*, **5**(8), e12491.
- Crawford, R., Goya, E., Roux, J.-P., & Zavalaga, C. (2006). Comparison of assemblages and some life-history traits of seabirds in the Humboldt and Benguela systems. *African Journal of Marine Science*, **28**(3–4), 553–560.
- Delgado, E. R. M., Ríos, E. B. R., Casasola, D. B., & Jiménez, M. del M. C. (2021). Artisanal fishery in Ecuador. A case study of Manta city and its economic policies to improve competitiveness of the sector. *Marine Policy*, **124**, 104313.
- Freeman, R., Dennis, T., Landers, T., ... Guilford, T. (2010). Black Petrels (*Procellaria parkinsoni*) Patrol the Ocean Shelf-Break: GPS Tracking of a Vulnerable Procellariiform Seabird.
- Gutiérrez, D., Akester, M., & Naranjo, L. (2016). Productivity and Sustainable Management of the Humboldt Current Large Marine Ecosystem under Climate Change. *Environmental Development*, **17**, 126–144.
- Jimenez-Uzategui, G., & Mangel, J. (2006). Fishery bycatch of the Waved Albatross *Phoebastria irrorata*, a need for implementation of agreements. *Noticias de* ....

- Júnior, J. G. C. O., Silva, L. P. S., Malhado, A. C. M., Batista, V. S., Fabr e, N. N., & Ladle, R. J. (2016). Artisanal Fisheries Research: A Need for Globalization? *PLoS ONE*, **11**(3), e0150689.
- Pe aherrera-Palma, C. R., Chinacalle-Mart nez, N. S., Zamora, W. G., Bravo-Ormaza, M. E. (2025). Reconstructing the spatial and temporal dynamics of Ecuador's artisanal small-scale fisheries from fishers' perspective. *PLOS One*, **20**(12), e0338495.
- Reyes, E. M. R., Giovanardi, S., Suarez-Espin, G., ... Fischer, J., H. (2024). Where do some Aotearoa New Zealand seabirds go? Records of *Thalassarche albatrosses* and *Procellaria petrels* in Ecuadorian waters. *Notornis*, **71**(3), 69.
- Reyes, E. M. R., Suarez-Spin, G., & Bell, E. A. (2017). La Ni a signal? Unusual inshore sightings of black petrel (*Procellaria parkinsoni*) in Santa Elena Province, Ecuador. *Notornis*, **64**(1), 24.
- Rowley, O., Qui ones, J., Fisher, J., & Debski, I. (2026.). Range-wide black petrel distribution and overlap with pelagic longline fisheries: insights from AIS and domestic vessel data. Joint SBWG13 and PaCSWG9, ACAP, Swakopmund, Namibia.
- Votier, S. C., Sherley, R. B., Scales, K. L., Camphuysen, K., & Phillips, R. A. (2023). An overview of the impacts of fishing on seabirds, including identifying future research directions. *ICES Journal of Marine Science*, **80**(9), 2380–2392.