



FORAGING ACTIVITY OF WAVED ALBATROSS (*Phoebastria irrorata*) DURING THE INDUSTRIAL PURSE SEINE FISHING TARGETING PERUVIAN ANCHOVETA IN PERU

Actividad alimenticia del Albatros de Galápagos (*Phoebastria irrorata*) durante la pesca industrial de cerco que tiene como pesca objetivo anchoveta peruana en Perú

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ABSTRACT: According to scientific literature, the Waved Albatross (*Phoebastria irrorata*) feeds on a wide array of prey species, such as squid, flying fish, carangid and clupeid fishes, and crustaceans such as euphausiids. However, most of this research was conducted near the Galápagos islands. In the present study, we document the consumption of Peruvian Anchoveta (*Engraulis ringens*), during the industrial purse seine fishing season. The albatrosses targeted these fish when the purse seine was closing, close to the corks in the superficial part of the fishing maneuver. This behaviour was found in Peruvian territorial waters, mainly in the north central zone (07°-14°S) over the continental shelf. This behavior has been continuously recorded since 2015 by the fishing industry (COPEINCA) and by the Peruvian Marine Research Institute (IMARPE).

KEYWORDS: anchovy, diet, Peru, purse seine fishing, Waved Albatross

RESUMEN: Según la literatura científica, el Albatros de Galápagos (*Phoebastria irrorata*) se alimenta de una amplia variedad de presas, tales como calamares, peces voladores, peces carángidos y clupeidos, y crustáceos euphausiidos. Sin embargo, todos estos hallazgos se han realizado cerca de Galápagos. En el presente estudio, se evidencia el consumo de Anchoveta Peruana (*Engraulis ringens*), durante la temporada de pesca industrial de cerco, los albatros consumían estos peces cuando se cerraba la red de cerco, cerca de los corchos en la parte superficial de la maniobra de pesca. Esta actividad se evidenció en aguas territoriales peruanas, principalmente en la zona norte centro del Perú (07°-14°S) sobre la plataforma continental. Este comportamiento se registró por la industria pesquera (COPEINCA) y por el Instituto del mar del Perú (IMARPE). Estos registros se han hecho evidentes desde el año 2015 hasta la actualidad.

PALABRAS CLAVE: Albatros de Galápagos, anchoveta, dieta, Perú, pesquería de cerco

The Waved Albatross (*Phoebastria irrorata*) is a critically endangered seabird species (BirdLife International 2018), nesting exclusively in la Española Island, Galápagos Archipelago (Anderson et al. 2002). There is information regarding their breeding biology

(Harris 1973), population status (Anderson et al. 2002, 2008), foraging activity close to their breeding grounds (Awkerman et al. 2005), range distributions after their breeding season and during El Niño years (Awkerman et al. 2014, Suazo et al. 2017, Moreno &

Quiñones 2022, among others). Little is known about their prey items, and all the available information is restricted to feeding areas near their nesting grounds in Galápagos, where in the early 1970's food samples were collected from young birds, which on being handled regurgitated the contents of their stomachs. However, no attempts were made to estimate the weights or proportions of the various foods' items within a sample as in most cases food was fragmentary (Harris 1973). Squid beaks were identified by Clarke (1966), showing that 80% of the 299 squid beaks collected corresponded to seven of the eight squid families occurring in the eastern Pacific, mainly represented by Histoteuthidae (47%), Octopodoteuthidae (34%), Enoploteuthidae (7%), Ommastrephidae (5%), among others. Regarding fish, they were reported in 40% of the regurgitations, where the most consumed were Flying-fish (Exocoetidae), Carangid (*Decapterus scombrinus*), and Clupeid (*Etrumeus cruentatus*), no proportions available. Finally, pelagic crustacea occurred in almost half the samples, the main item was *Benthophausia* sp., Krill (*Thysanopoda monacantha*), swimming crabs and isopods (Harris 1973).

Information from stable isotope ratios showed that males consumed slightly higher trophic level prey than females. Reflecting primarily pelagic foraging grounds for both sexes, in Galápagos islands

and in the Peruvian Northern Humboldt Upwelling Ecosystem (NHUE), providing evidence of trophic segregation (Awkerman et al. 2007).

The waved albatrosses, during their breeding cycle forages in the NHUE in Peruvian waters, at approximately 1350 km to the southeast (Awkerman et al. 2014). To date, there is no conclusive evidence of prey consumption in Waved Albatross in the NHUE. There is some anecdotal information regarding Panama Lightfish (*Vinciguerria lucetia*) and juvenile Jack Mackerel (*Trachurus picturatus*) consumption during the Humboldt Squid (*Dosidicus gigas*) fishery in offshore waters of southern Peru; however, without photographic evidence (Moreno & Quiñones 2022). In addition, according to the IMARPE stranding program, during 2023, a total of 31 carcasses of waved albatrosses were registered, necropsies were performed in the Peruvian north central coasts. Though, due to a high decomposition of the carcasses no clear results were obtained, however one individual was registered with a Mahi-mahi (*Coryphaena hippurus*) hook on the neck (Chauca-Huánuco et al. 2024).

Fishing interactions and anchoveta consumption

During the purse seine industrial fishery targeting Peruvian Anchoveta (*Engraulis ringens*) in northern central Peru, seabirds' observations were carried out four times per season during spring 2023, summer 2024 and early autumn 2024, on board the fishing vessel Andes 53. Observations were carried out by one person during daylight in every fishing operation, each fishing trip lasted between one and two days, there is an ongoing training program to fisherman to register these events. Four groups of waved albatrosses were observed, three of them over the continental shelf, and one over the continental slope in the NHUE (Fig. 1). The first group (G1, $n = 210$ individuals) was registered on November 28th, 2023 ($09^{\circ}52'S$, $79^{\circ}W$) at 80 km off Culebras, the second group (G2, $n = 35$) on January 3rd, 2024 ($09^{\circ}05'S$, $78^{\circ}55'W$) at 30 km off Chimbote, the third group (G3, $n = 8$) on April 20th, 2024 ($08^{\circ}38'S$, $79^{\circ}49'W$) at 105 km off Chao, and the fourth group (G4, $n = 25$) on 20th April 2024 ($09^{\circ}42'S$; $79^{\circ}58'W$) at 167 km off La Gramita (Fig. 1), this last one haul was the only one over the continental slope (Table 1). In all cases, the waved albatrosses were actively feeding in anchoveta trapped inside the seine net on the water surface, and also on anchoveta leaping to the surface, on the external edge of the net, by the floats. G1 was feeding on medium size anchoveta (mean: 12.5 cm, range: 11 – 15 cm); G2, and the

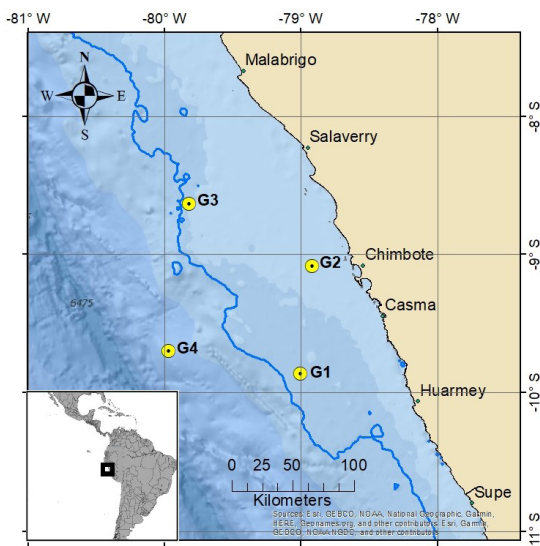


Figure 1. Map showing the hauls where the Waved Albatross (*Phoebastria irrorata*) were actively feeding on Peruvian Anchoveta (*Engraulis ringens*), yellow circles for the industrial enterprise COPEINCA, and green ones from the anecdotal information taken by IMARPE. Occurring during the Purse seine industrial fishery in 2015 and 2022 – 2024. The continental shelf break is represented by the continuous blue line, and the diameter of the icons represent the abundance as specified in the legend. For specific details please see Table 1.

other hauls with similar anchoveta size structure: G2 (mean: 12 cm, range: 10.5 – 13 cm); G3 (mean: 12.5 cm, range: 11.5 – 14.5 cm), and G4 (mean: 12 cm, range: 11 – 14.5 cm), the anchoveta size structure was precise since a subsample of at least 120 individuals was measured in each haul (for specific details, please see Table 1).

The observed waved albatrosses approached (<50 m) more actively when the purse seine began to be reduced at the starboard of the vessel, due to the action of the vessel net stacker. Firstly, they approach to

the outer edges of the float lines to be able to feed of anchoveta. Then, some individuals entered the inner part of the purse seine, since anchoveta density is always higher in that area (Fig. 2). During the November 28th, 2023 haul, 20% of the waved albatrosses entered in the inner area of the purse seine. In contrast, in the January 3rd, 2024 haul, none of the observed waved albatrosses entered since they were feeding in the outer part of the float lines. In the April 20th, 2024 hauls, the waved albatrosses approached to the outer edges of the purse seine and feds on anchoveta jumping out of the surface by the floats.

Table 1. Interactions of Waved Albatross (*Phoebastria irrorata*) with the industrial purse seine fishery (2023 – 2024) targeting Peruvian Anchoveta (*Engraulis ringens*) in northern central Peru. SST: Sea Surface Temperature (vessel sensor).

Haul date	Time of sighting	Position	Ecological domain	Sea depth (m)	DC (km)	<i>n</i>	Anchoveta mean length (cm)	SST (°C)
11/28/2023 (G1)	08:05	09°52'S; 79°00'W	Continental Shelf	-142	80	210	12.5 (11 – 15)	20.6
01/03/2024 (G2)	14:38	09°05'S; 78°55'W	Continental Shelf	-92	30	35	12 (10.5 – 13)	25.6
04/20/2024 (G3)	09:14	08°38'S; 79°49'W	Continental Shelf	-124	105	8	12.5 (11.5-14.5)	19
04/20/2024 (G4)	15:40	09°42'S; 79°58'W	Continental Slope	-2097	167	25	12 (11-14.5)	19

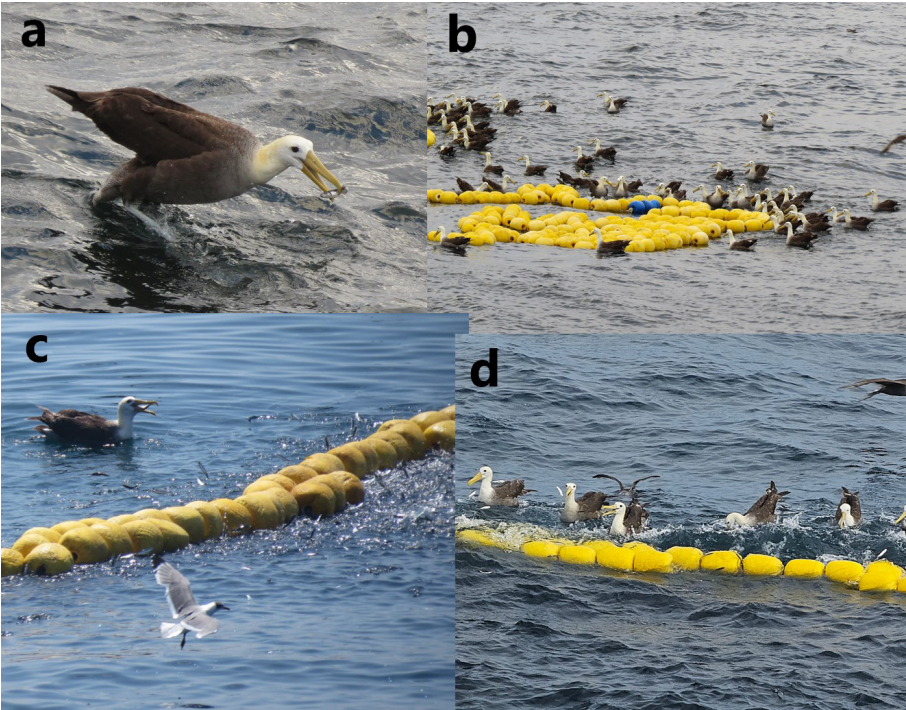


Figure 2. Waved Albatross (*Phoebastria irrorata*) actively feeding on Peruvian Anchoveta (*Engraulis ringens*) during the industrial purse seine fishery in northern central Peru (07°-10°S). Photographies: a, b, c) Calderon Vigil J (from IMARPE), d) Vazquez C (from COPEINCA)

Associated species

The sightings were made from a fixed point on the port side of the boat, during the entire time of operation of the cove that lasts about an hour, seabird species identification was determined using Howell & Zufelt (2019). G1 were accompanied by other species such as Arctic Jaeger (*Stercorarius* sp.; $n = 6$), Pomarine Jaeger (*Stercorarius pomarinus*; $n = 2$), Swallow-tailed Gull (*Creagrus furcatus*; $n = 8$), Pink-footed Shearwater (*Ardena creatopus*; $n = 3$) and Sooty Shearwater (*Ardena grisea*; $n = 12$). G2's seabirds composition was less diverse, only represented by Artic Jaeger ($n = 1$) and Swallow-tailed Gull ($n = 2$). In G3 and G4, the video recordings only allow us to identify a few swallow-tailed gulls. All the mentioned associated seabirds were feeding as well on Peruvian Anchoveta: albatrosses and seagulls at the surface, while pink-footed and sooty shearwaters on the surface and in the water column as well, since they are diver specialist species (Fig. 2).

We have also no published anecdotal information, obtained by Jimy Calderon in the industrial purse seine on board observer program, carried out by IMARPE in north central Peru. In nine sighting events, waved albatrosses were registered feeding on anchoveta, three in spring 2015, two in autumn 2022, and four on spring 2022. The average number per

sighting event was 68.6 ± 57.7 individuals (range: 3 – 230; Fig. 1, Table 2). Waved albatrosses were actively feeding on Peruvian anchoveta by the floats, particularly when the purse seine was closing, they fed in Peruvian anchoveta in two ways, when the fish jumped out of the water they were caught by the waved albatrosses, and sometimes albatrosses introduce their heads in the water and also got Peruvian anchoveta from the water surface. The associated species were represented by Sooty and Pink-footed Shearwaters, South Polar Skua (*Stercorarius maccormicki*), Pomarine Jaeger, Parasitic Jaeger (*Stercorarius parasiticus*), Peruvian Pelican (*Pelecanus thagus*), Peruvian Booby (*Sula variegata*), Franklin's Gull (*Leucophaeus pipixcan*), and South American Sea Lion (*Otaria flavescens*; Fig. 2).

CONCLUSIONS

This note constitutes the first documented evidence report showing critically endangered Waved Albatross actively feeding on Peruvian Anchoveta by taking advantage of Peruvian industrial fishery during spring 2015, and in the time period 2022 – 2024. No bycatch was reported in the purse seine fishery during the present work. However, some bycatch events were reported in the artisanal longline fishery in Ecuador and Peru (Awkerman et al. 2006, Mangel

Table 2. Interactions of Waved Albatross (*Phoebastria irrorata*) with the industrial purse seine fishery (2015 and 2022) targeting Peruvian Anchoveta (*Engraulis ringens*) in northern central Peru. Anecdotal information taken by IMARPE, no Peruvian anchoveta measures were performed.

Date	Time of Sighting	Position	Ecological domain	Depth (m)	DC (km)	Place	n
11/21/2015	13:30:00	13°20'S 76°57'W	Continental Slope	-595	72	Tambo de Mora	51
12/01/2015	07:19	14°49'S 76°41'W	Peruvian Trench	-4810	83	Morro Quemado	3
12/05/2015	06:25	15°01'S 76°08'W	Continental Slope	-2306	46	Punta Lomitas	82
06/06/2022	06:47 06:51	08°53'S 79°34'W	Continental Shelf	-103	87	Punta Guañaape	45
06/06/2022	10:20 10:21 10:25	08°51'S 79°36'W	Continental Shelf	-108	89	Punta Guañaape	46
12/02/2022	07:36	09°01'S 79°53'W	Continental Slope	-289	123	Punta Guañaape	61
12/07/2022	11:23	09°37'S 78°29'W	Continental Shelf	-94	12	Punta El Huaro	94
12/10/2022	13:38	07°25'S 79°53'W	Continental Shelf	-80	34	Punta Pacasmayo	230
12/11/2022	10:46	07°05'S 79°56'W	Continental Shelf	-53	18	Punta Eten	5

2012). Waved albatrosses have been reported feeding on several species of unidentified squid in the shelf break zone off the north coast - central Peru, about 30 nautical miles from the coast (Quiñones, pers. obs.); however, the waved albatrosses also take advantage of the Peruvian anchoveta captured in the Industrial purse seine fishery, since they become more accessible in the surface in the fishing maneuver. In this scenario is easier to consume it than when there are not fishing vessels associated. The number of waved albatrosses recorded per haul in the present work far exceeds the sightings reported on fisheries-independent assessment cruises. Showing that the greater availability and accessibility of Peruvian anchoveta during purse seine fishery in Peru, is a factor that is obviously taken advantage of by the Waved Albatross. The information generated in this work can be used as input into management and conservation plans for this critically endangered species.

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