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Short Note

South American Fur Seals (*Arctocephalus australis*) Out of Range in Northern Peru

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The South American fur seal (*Arctocephalus australis*; SAFS) is one of the two resident species of pinnipeds inhabiting the Peruvian coast (Cárdenas-Alayza & Oliveira, 2015; Alava & Aurioles-Gamboa, 2017; Lopes et al., 2023). The SAFS historically suffered catastrophic declines in population size due to El Niño Southern Oscillation (ENSO) and direct and indirect anthropic activities such as poaching and competition with fisheries (Oliveira, 2011). The decrease in population numbers left breeding colonies abandoned and caused a reduction in the number of utilized haulouts (Arias-Schreiber, 1999). For example, a reduction of 72% of the SAFS population in Peru occurred due to the effects of the 1997/1998 ENSO (Oliveira et al., 2009). Nonetheless, the SAFS slowly recovered their population numbers in some breeding colonies along the Peruvian coast, due in part to government policies such as the categorization of the SAFS as an endangered species from 2004 until the present day (Supreme Decree No. 004-2014-MINAGRI; Ministerio de Desarrollo Agrario y Riego del Perú [MINAGRI], 2014), enforcement of marine coastal protected areas (Supreme Decree No. 024-2009-MINAM; Ministerio del Ambiente del Perú [MINAM], 2009), and the contribution of different organizations to the conservation efforts.

The taxonomic status of the SAFS is still under revision. Historically, the SAFS species was subdivided into two subspecies: (1) *Arctocephalus australis australis* for those animals living on the Falkland Islands and (2) *Arctocephalus australis gracilis* for the rest of the continental populations. However, with the incorporation of genetic evidence, the isolated populations of the SAFS inhabiting Peru and northern Chile were proposed as an entirely different evolutionarily significant unit (ESU) of the SAFS (Oliveira et al., 2008). A unique subspecies was proposed, namely the Peruvian fur seal (PFS), which suffered cyclic demographic variations and is geographically isolated for > 1,500 km to the north from the rest of the continental SAFS populations (Oliveira & Brownell, 2014; Rodrigues et al., 2018). Notably, it has been reported that the PFS populations in northern Chile have dispersed towards higher latitudes, which is believed to be due to a colonization process. This has resulted in a decrease in the distance between PFS distribution and the SAFS populations from southern Chile (Cárcamo et al., 2021).

The current distribution of the PFS ranges from Isla Mazorca, Peru (11° 20' S), to Rocas Abtao, Chile (23° 05' S) (Cárdenas-Alayza & Oliveira, 2015). Also, an isolated reproductive population of PFSs inhabits Isla Foca in northern Peru (5° 12' S, 81° 12' W). In the latter location, a preliminary genetic evaluation of individuals has revealed the existence of PFS hybrids with Galapagos fur seals (*Arctocephalus galapagoensis*; GFS) (Cárdenas-Alayza & Oliveira, 2015; Lopes et al., 2023). Notably, no other colonies or haulouts occur in the more than 780 km between Isla Mazorca and Isla Foca, and reports of the PFS in northern Peru, other than Isla Foca, have not been previously documented. In this short note, we briefly present different records of fur seals (FSs) in the northern Peruvian coastline, other than in Isla Foca.

Between 2012 and 2021, authors compiled information on FS reports along the northern coastline of Peru (latitude 3° 38' S to 8° 04' S). The evaluation included records obtained from volunteers, biologists, veterinarians, and other professionals from Peruvian NGOs conducting marine research-related activities during the study period. Mandatory information was collected through a questionnaire to obtain data such as the date and time of the observations, duration, location, number of individuals, sex, age, lesions, and audiovisual material. Authors and experienced pinniped researchers evaluated and discussed information and audiovisual materials to determine coherence with the data reported. The analysis did not consider reports that did not contain audiovisual material to keep rigorous control of the data presented in this short note.

For sexual differentiation, the classification of the individuals as male or female relied upon confirmation by photo or direct observation of genitalia. Age class was estimated according to the size of observed animals and with the help of the audiovisual material reviewed by the authors. The observers provided the FS records' location; if coordinates were not collected, it was assigned an estimated point to the most proximate known location mentioned. An FS event represents the occurrence of an FS record out of range that could involve one or more individuals at the same time. Our study did not involve direct manipulation of animals, and reports were voluntary; therefore, we did not count on the evaluation of the Institutional Animal Care and Use Committee.

Fourteen FS events involving 16 individuals occurred along the northern coastline of Peru during the study period (Figure 1). Twelve out of the fourteen events (~86%) were reported in the two most northern regions of the Peruvian coast, namely Piura and Tumbes. The distances between the location of these reports and the closest FS colony, Isla Foca, were from 110 to 390 km apart. All the individuals sighted are summarized in Table 1. We observed six females, two males, and eight individuals with undetermined sex (50%). The majority of reports included juveniles (56.3%; 9/16), and the beaches with the most reports were Punta Sal and Zorritos (each with 25%; 4/16).

In this short note, we acknowledge some limitations on species identification. The two fur seals observed at Huanchaco Beach were first identified as PFSs through photographs based on morphological features (i.e., body and head shape of the individuals) and taking into consideration distance to nearest FS colonies or haulouts. Huanchaco Beach is ~390 km away from the PFS haulouts in Isla Mazorca or Isla Foca (Figure 2). However, the accurate taxonomic classification of these individuals is difficult to interpret due to the existence of hybrids of PFSs with GFSs in Isla Foca. A small and stable number of records north of Isla Foca, with a range of 17 to 52 individuals between 2016 and 2019 (Aguilar-Arakaki, 2021), harbored at least one individual of pure GFS ascendence and two hybrids with PFS identified after a phylogenetic assessment (Lopes et al., 2023). These findings lead to more questions about the genetic diversity of FS species in this geographic location, denoting that these differences cannot be distinguishable based on distant observation and audiovisual material alone.

Notably, most of these new records involved juvenile animals, an age group that tends to disperse more widely than breeding adults as has been observed in other pinnipeds (Zeppelin et al., 2019). In the Pacific Ocean, records of *A. australis* up to Mexico show the range of juvenile dispersal (Villegas-Zurita et al., 2016). In contrast, adult females engaged in reproductive activity are characterized by strong site fidelity, returning to the same sites to breed interannually (Harcourt, 1992). In southern Peru, maximum trip distances carried out by adult female PFSs range between 75 to 300 km offshore from the breeding colonies (Cárdenas-Alayza et al., 2022).

The pup documented in Zorritos Beach on 11 January 2019 corresponded to a newborn due to the presence of an umbilical cord (E. García-Collave, pers. obs., 11 January 2019). Some studies have found the presence of an umbilical cord attached to a newborn up to 48 h after birth (Majluf Chiok, 1988), which strongly suggests that the female might have given birth on this beach. The GFS breeding season occurs from late August to the beginning of November in the Galápagos Islands (0° 28' 11" S; Trillmich & Wolf, 2008); conversely, the PFS breeding season occurs from the end of October to the end of December (Cárdenas-Alayza & Oliveira, 2015). Thus, the timing of the birth supports the hypothesis that the female and pup reported in Zorritos Beach were more likely related to a PFS. Nevertheless, latitude might influence this birth timing assumption, posing extra difficulty in the identification of the species.

In addition, PFS births occur almost exclusively in reproductive colonies, and female foraging trips showed maximum distances of ~50 to 100 km from the coast (Espinoza et al., 2017). The occurrence of a parturition event outside of a reproductive colony is extremely rare but has been reported in other FS species (Félix et al., 2007), and this may be the case of the female and pup at Zorritos Beach. This event occurred ~200 km from the nearest reproductive colony of PFSs at Isla Foca and ~1,100 km from the GFS colony in the Galápagos Islands. GFS births were reported nearby on the coastline of mainland Ecuador (Félix et al., 2007). However, these events

Figure 1. Compiled photographic evidence of fur seals in beaches from northern Peru: juveniles of undetermined sex observed in Cancas (A) and Punta Veleros (B); individuals observed in Huanchaco: a juvenile male (C) and a juvenile female (D); individuals reported from Zorritos: an adult female (E), an adult female and her pup (F & G), and a juvenile female (H); individuals reported from Punta Sal: two juveniles of undetermined sex (I & J), an adult female (K), and a fetus (L); a juvenile of undetermined sex in Playa del Amor-Mancora (M); a female yearling in La Cruz (N); a juvenile of undetermined sex in Cabo Blanco (O); and an adult of undetermined sex in Las Pocitas-Mancora (P). (*Photo credits:* (A) Yuri Hooker/UPCH, (B) Shaleyla Kelez/ecOceánica, (C & D) Selene Diaz/ONG ConservAccion, (E) ecOceánica, (F & G) Evelin García-Collave/ Universidad Nacional de Tumbes, (H, M, N, & O) Grupo de Rescate de Animales Marinos (GRAM)/ONG ConservAccion, (I & J) Marilu Wilhelmi, (K & L) Juan León, and (P) Adriana Zavala/ecOceánica)

occurred within the reproductive season of GFSs in September and October. Since the case described in Zorritos Beach occurred in January, it would be difficult to consider this birth to be a GFS parturition event under the influence of latitude in the Southern Hemisphere.

Furthermore, the report of a fur seal abortion in Punta Sal Beach is an anecdotal event that should be evaluated with caution. Different etiologic agents could cause or be related to abortions in FSs, ranging from infectious diseases (e.g., *Brucella* sp., *Mycoplasma* sp., *Toxoplasma gondii*, *Coxiella burnetti*) to toxic contaminants (e.g., domoic acid) (Gulland et al., 2018). Abortion events have been described in PFSs breeding in southern Peru, presenting an annual occurrence of abortions between

Table 1. Location, date, and additional information of fur seal reports along the shore borders in northern Peru from 2012 to 2022 (see Figure 1 for corresponding photographs)

Figure 1	Date	Location	Age	Sex	Additional commentaries
A	11 Aug. 2012	Cancas, Tumbes (3° 56' 41" S, 80° 56' 30" W)	Juvenile	Undet.	Observed escaping from local people that were disturbing the animal.
B	29 July 2013	Punta Veleros, Piura (4° 10' 45" S, 81° 8' 24" W)	Juvenile	Undet.	Found resting close to a touristic beach.
C	22 March 2016	Huanchaco, La Libertad (8° 4' 43" S, 79° 7' 17" W)	Juvenile	Male	Captured, moved temporarily to a local small animal clinic, and released to the beach by unauthorized personnel.
D	30 April 2017	Huanchaco, La Libertad (8° 4' 43" S, 79° 7' 17" W)	Juvenile	Female	Spotted for a short period of time; good body condition.
E	8 Dec. 2018	Zorritos, Tumbes (3° 40' 35" S, 80° 40' 3" W)	Adult	Female	No additional information
F	11 Jan. 2019	Zorritos, Tumbes (3° 40' 35" S, 80° 40' 3" W)	Adult	Female	Found next to a hotel facility displaying nursing behavior to newborn pup; emaciated body condition.
G	11 Jan. 2019	Zorritos, Tumbes (3° 40' 35" S, 80° 40' 3" W)	Pup	Undet.	Presence of umbilical cord was observed. Animal died on the beach on 17 January 2019.
H	3 March 2021	Zorritos, Tumbes (3° 41' 45" S, 80° 42' 20" W)	Juvenile	Female	Found next to a hotel facility resting; returned to the beach 2 d later.
I	9 March 2021	Punta Sal, Tumbes (3° 58' 50.3" S, 80° 58' 49.7" W)	Juvenile	Undet.	Found in a rocky beach area.
J	13 April 2021	Punta Sal, Tumbes (3° 57' 21.8" S, 80° 57' 18.4" W)	Juvenile	Undet.	Entered a local beachfront house on its own, presented a calm behavior, and was encouraged to return to the sea by local people.
K	30 April 2021	Punta Sal, Tumbes (3° 57' 21.8" S, 80° 57' 18.4" W)	Adult	Female	Found resting in beach in front of a hotel facility; spontaneous abortion occurred the next day.
L	1 May 2021	Punta Sal, Tumbes (3° 57' 21.8" S, 80° 57' 18.4" W)	Fetus	Male	No additional information
M	26 May 2021	Playa del Amor – Mancora, Piura (4° 05' 51.9" S, 81° 03' 01.5" W)	Juvenile	Undet.	Found with emaciated body condition and putative ophthalmic lesion ("cataract eye"). An image of the same animal located in Punta Sal Beach a day before was sent through social media to local Rescue Marine Animal Group (GRAM).
N	18 July 2021	La Cruz, Tumbes (3° 38' 7" S, 80° 35' 17" W)	Yearling	Female	Manipulated by local people.
O	16 Nov. 2021	Cabo Blanco, Piura (4° 15' 01.5" S, 81° 13' 54.8" W)	Juvenile	Undet.	Sighted resting for the first time 2 d earlier on the same beach.
P	12 June 2022	Las Pocitas – Mancora, Piura (4° 06' 40" S, 81° 04' 23" W)	Adult	Undet.	Reported resting for 2 d on a rock in front of the touristic beach. A round injury was observed in the lateral flank of the animal.

June and September every year (Vilchez-Delgado et al., 2018). Therefore, our record of an abortion event in May, although earlier than expected, can be related to the PFS abortion season. However, different latitude and other environmental factors that have not yet been evaluated might be influencing the timing of these abortion events.

Phylogenetic analysis has provided robust evidence of the ancient hybridization of the SAFS and GFS, resulting in the current PFS populations (Lopes et al., 2023). In Isla Foca, phylogenetic analyses found a pure GFS and a likely PFS individual with a higher proportion of GFS ancestry (Lopes et al., 2023). All reports provided in this short note, particularly the individuals described in Huanchaco, support the hypothesis that northern populations of fur seals (which may possess a hybrid genetic composition of the GFS) exhibit the capacity to reach higher distances toward southern geographic areas. This raises a question about whether there is potential for gene flow with PFS populations situated in southern Peru. Under

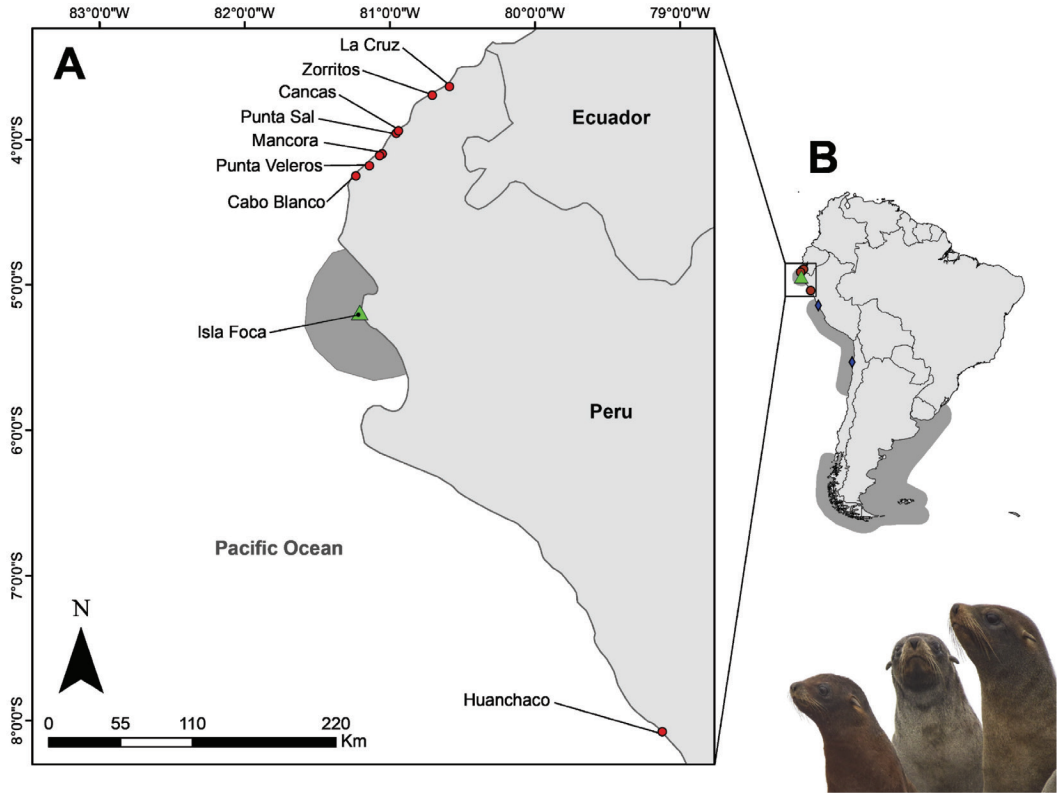

Figure 2. Localization of reports of fur seals along the shore borders in northern Peru. Distribution of South American and Peruvian fur seals (*Arctocephalus australis*) are highlighted in grey along South American coasts (B), including Isla Foca (A). Sites where fur seals were reported in northern Peru are represented in circles. Isla Foca is represented in a triangle. Blue diamonds in (B) mark the current accepted upper (Isla Mazorca) and lower (Roca Abtao) limit for Peruvian fur seal colonies. (*Map credit:* Felix Ayala Torres)

this idea, the genotypes of northern FSs might be introduced into southern PFS populations by a few migrating individuals with a potential impact on genetic diversity and conservation. Migrating individuals reported herein provide evidence of the dispersal of individuals of different age groups into new areas. The Eastern Tropical Pacific presents distinct climatic and oceanographic features, including significant seasonal fluctuation and cyclic variations in the nutricline. Currently, it is unclear whether these factors may affect the spread of FSs along the northern coast of Peru. During 2021, half of the records (n = 8) of the study were described. Although environmental factors could not be ruled out, we associate the increase in reports with a higher effort in the diffusion activities and the incorporation of new researchers in the study, improving our proximity to coastal communities in northern Peru.

Results emphasize the need for local authorities' efforts to protect the resting sites of migrating marine mammals since colonization processes are essential for ecosystem development. The creation of the Reserva Nacional Sistema de Islas, Islotes y Puntas Guaneras (RNSIIPG) in 2009, a system of multiple sites along the Peruvian coastline, was a positive achievement protecting the biodiversity of coastal marine ecosystems in 22 islands and 11 guano capes of Peru (Supreme Decree No. 024-2009-MINAM; MINAM, 2009). However, protection of areas that could serve as natural corridors among populations of marine animals is still lacking. Only a few protected areas of the RNSIIPG system exist in northern Peru, and there is not a single National Protected Area in the Peruvian tropical marine ecosystem, which seems to serve as a location where migrating animals disperse to Ecuador's mainland coast (Félix et al., 2007; Lopes et al., 2023).

The participation of citizen science in the notification of the events described in this short note was decisive. Nonetheless, an interconnected national stranding network is urgently

needed to adequately monitor and compile information on strandings and sightings of species, especially those occurring out of their reported range. Herein, we presented evidence of potential endangered marine mammal species under Peruvian legislation, in locations out of reported range distribution, and suggested the mobilization of individuals involving long distances. These data should raise awareness for implementing additional resources to perform monitoring programs and protect new coastal marine sites in northern Peru. Also, further studies should evaluate the importance of Isla Foca and other areas on the northern Peruvian coast to the diversity of the PFS.

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