Aquatic Mammals 2024, *50*(1), 1-7, DOI 10.1578/AM.50.1.2024.1

Short Note

First Records of Pinnipeds (Otariidae) Along the Pacific Coast of Nicaragua

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Pinniped populations in the Pacific Ocean inhabit a diverse range of ecosystems, straddling the boundary between the open ocean—where they engage in foraging activities—and terrestrial habitats along the North and South American coastlines—where they establish breeding colonies for mating and rearing their young (Bowen et al., 2009). The dynamic nature of pinniped population patterns and their geographical distribution is shaped by an intricate interplay of various factors. These include oceanographic conditions, prey availability, and human activities, all of which influence their movements and behaviors (Bowen et al., 2009).

Despite the considerable knowledge of these marine mammals in many locales, a conspicuous knowledge gap persists in our understanding of their presence along the Pacific coastlines of Central America, where pinniped records remain notably scarce. This scarcity poses a significant challenge to discerning the array of pinniped species that frequent this region, limiting the depth of our ecological understanding and impeding effective conservation planning efforts. Although Nicaragua is not typically recognized as part of the distribution range of pinnipeds due to the absence of documented breeding or non-reproductive colonies, several unpublished reports exist, indicating occasional visits or temporary inhabitation of pinnipeds along the Pacific coast. Assembling data on pinniped sightings and corroborating the presence of specific species represent critical initial steps towards assessing local biodiversity. This information will aid in establishing regional regulations, implementing species protection measures, and understanding the reasons these pinnipeds venture far from their typical habitats. For example, pinnipeds are generally non-migratory, yet certain individual "vagrants" have been known to disperse several hundreds of kilometers away from their customary breeding and feeding areas (Reeves et al., 1992). Past occurrences of these vagrants have been linked to shifts in sea surface temperature brought about by El Niño and La Niña phases of the El Niño-Southern Oscillation (ENSO) (Trillmich, 2015). However, further research is essential to definitively establish why pinnipeds frequent these atypical areas.

Reports of otariids off the Pacific coast of southern Mexico and Central America are common and include sightings of possible vagrants at sea (Acevedo-Gutiérrez, 1994; Aurioles-Gamboa et al., 2004; Montoya, 2008; Ortega-Ortiz et al., 2013; Ibarra-Portillo et al., 2016; Villegas-Zurita et al., 2016; Quintana-Rizzo et al., 2017). These sightings included Galapagos fur seals (*Arctocephalus galapagoensis*), Juan Fernández fur seals (*Arctocephalus philippii philippii*), Guadalupe fur seals (*Arctocephalus philippii townsendi*), Steller sea lions (*Eumetopias jubatus*), South American sea lions (*Otaria flavescens*), California sea lions (*Zalophus californianus*), and Galapagos sea lions (*Zalophus wollebaeki*). The nearest colonies of these species from Central America are located off the Galápagos Islands, northern Mexico, and along the Pacific coast of South America (Bowen et al., 2009). Thus, vagrant pinnipeds from Mexico and South America, usually adult males, have roamed relatively far from their colonies. Vagrant juveniles and subadults sometimes display exploratory foraging behaviors and enhance their traveling effort during food scarcity (Villegas-Zurita

et al., 2015; Elorriaga-Verplancken et al., 2016, 2020; D. Barragán-Barrera, unpub. data) and individuals may haul out in new habitats (Hoyos-Padilla & Gallo-Reynoso, 2015; Hoyos-Padilla et al., 2021; Barba-Acuña et al., 2022). Adult Guadalupe fur seals can travel 157 to 179 km in a day in search of food (Gallo-Reynoso et al., 2008).

The genus *Arctocephalus* is composed of eight different fur seal species, of which three were reported as vagrant off the Pacific coast of Mexico and Central America: (1) South American fur seal (*Arctocephalus australis*), (2) Galapagos fur seal, and (3) Guadalupe fur seal (Reeves et al., 1992; Villegas-Zurita et al., 2016). Breeding colonies of South American fur seals are found along the Chilean coast to central-northern Peru (Cárdenas-Alayza et al., 2016). Galapagos fur seals are residents of the Galápagos Islands in Ecuador, but vagrants are regularly sighted along the mainland coast of Ecuador, Guatemala, El Salvador, Mexico (Trillmich, 2015, 2020), Costa Rica (Montoya, 2008), and Colombia (Capella et al., 2002; Flórez-González & Capella-Alzueta, 2006; D. Barragán-Barrera, unpub. data). This species is typically found on rocky beaches where they haul out to rest and breed, and, in warm climates, search for shade (Heckel & Schramm, 2021). Guadalupe fur seals breed mainly on Guadalupe Island in the Mexican Pacific Ocean and are known to haul out as far south as El Farallon de San Ignacio Island in the Gulf of California (Gutiérrez-Osuna et al., 2022). The genus *Zalophus* observed in the Eastern Tropical Pacific (ETP) is composed of two species that were both reported in Mexico and Central America: (1) the Galapagos sea lion and (2) the California sea lion. Reports of vagrant pinnipeds are important to estimate distances traveled and direction of dispersal, which is information that helps clarify the species' ecology and distribution patterns. Documenting the occurrence of pinnipeds in Central American waters helps us understand if animals are vagrant or occupying new habitats (Barba-Acuña et al., 2022); this information is needed to develop management strategies for possible fishery interactions and to assess public health risks. Otariids have not previously been reported along the Pacific coast of Nicaragua. Herein, we present a summary of opportunistic sightings of pinnipeds observed along this region.

The Pacific coast of Nicaragua is composed of a series of sandy beaches and bays, with some rocky beaches. The continental slope extends over 100 km from shore. The Costa Rican Thermocline Dome (CRD)—a distinct feature in the tropical waters of the ETP found off the coast of Central America, including Nicaragua—is marked by a shallow thermocline, at a depth of approximately 35 m, and its nutrient-rich aquatic environment (Fiedler, 2002). From February to April, the CRD progresses towards the southern coasts of Nicaragua. During this transit, the thermocline's coastal shoaling metamorphosizes into upwellings due to the influence of the Papagayo winds (Fiedler, 2002). These upwellings bring nutrient-dense waters from the depths to the surface, creating areas of high biological productivity which attract a diverse array of marine organisms and significantly contribute to the region's biodiversity.

To identify occurrences of pinnipeds in Nicaragua, data were obtained from 2007 to 2020 through a citizen science network involving fishermen and local communities, and online searches using search engines (Google and Lilo) and social media platforms (Instagram, Facebook, and YouTube) (Table 1). Key words for online searches were identified as the most relevant terminology for finding records of pinnipeds in the region—for example, *Nicaragua*, *lobos marinos*, *sea lions*, *pinnipeds*, *pinipedos*, and *focas*. Only sightings that included location data and pictures and/or videos were included. Sightings were mapped with *QGIS*, Version 3.17, to measure the distance between pinniped sightings and the location of their possible population/rookery of origin.

Species identifications were undertaken by T. Acosta-Pachón, utilizing available information about the animals' behavior from anecdotal reports, as well as from images that facilitated a detailed examination of the animal morphology. The process also relied on the use of authoritative marine mammal guides (e.g., Reeves et al., 1992, 2002; Würsig & Perrin, 2009; Allen et al., 2011).

Genus Arctocephalus: Arctocephalus sp.—The genus *Arctocephalus* is characterized by the presence of large ears, a small and thick muzzle, a pointy nose, and extra cartilage on their flippers, posterior to the bone (Berta, 2018). Their body size is generally smaller than genus *Zalophus*, reaching a total length of 1.8 m for males and 1.4 m for females (Gallo-Reynoso & Figueroa-Carranza 1996). The six cases listed below involved fur seals, including four Galapagos fur seals and two animals that could not be identified to the species level (Figure 1); they traveled a minimum distance of 1,330 km from the Galápagos Archipelago to the coast of Nicaragua:

(1) On 19 July 2015, an individual live-stranded on the rocky beach of Playa Hermosa in Nagarote, Léon state (El 19 Digital, 2015; Nicaragua Today, 2015; Figure 1; Table 1, Case 1). Navy personnel protected the animal, and it presumably was in good health condition since it was swimming and moving around.

Table 1. Overview of fur seal and sea lion observations made in Nicaragua with their sources

Case	Species	Date(s)	Link
Case 1	*Arctocephalus* sp.	19 July 2015	https://pinoleronic.blogspot.com/2015/07/lobo-marino-encalla-en-playa-hermosa.html
Case 2	*Arctocephalus galapagoensis*	18 Oct. 2018	https://www.facebook.com/ComunidadTN8/photos/pcb.1112761775568520/1112761672235197
Case 3	*A. galapagoensis*	3 May 2019	https://www.tn8.tv/departamentos/475127-avistamiento-de-lobo-marino-en-playas-de-el-transito-leon https://www.facebook.com/ComunidadTN8/photos/pcb.1247008735477156/1247008645477165
Case 4	*A. galapagoensis*	30 July 2019 31 July 2019	https://m.facebook.com/chinandeganewslive/posts/1331957850315578?locale2=ne_NP
Case 5	*A. galapagoensis*	12 March 2020	https://tn8.tv/departamentos/499755-visita-insolita-leon-marino-aparece-balneario-las-penitas
Case 6	*Arctocephalus* sp.	10 April 2007	https://mundo.sputniknews.com/noticias/2007041363584536
Case 7	*Zalophus* sp.	1 Aug. 2013	--
Case 8	*Zalophus* sp.	22 Feb. 2017	https://www.elnuevodiario.com.ni/nacionales/419864-ballenas-delfines-focas-pacifico-nicaragua
Case 9	*Zalophus* sp.	4 April 2017	--

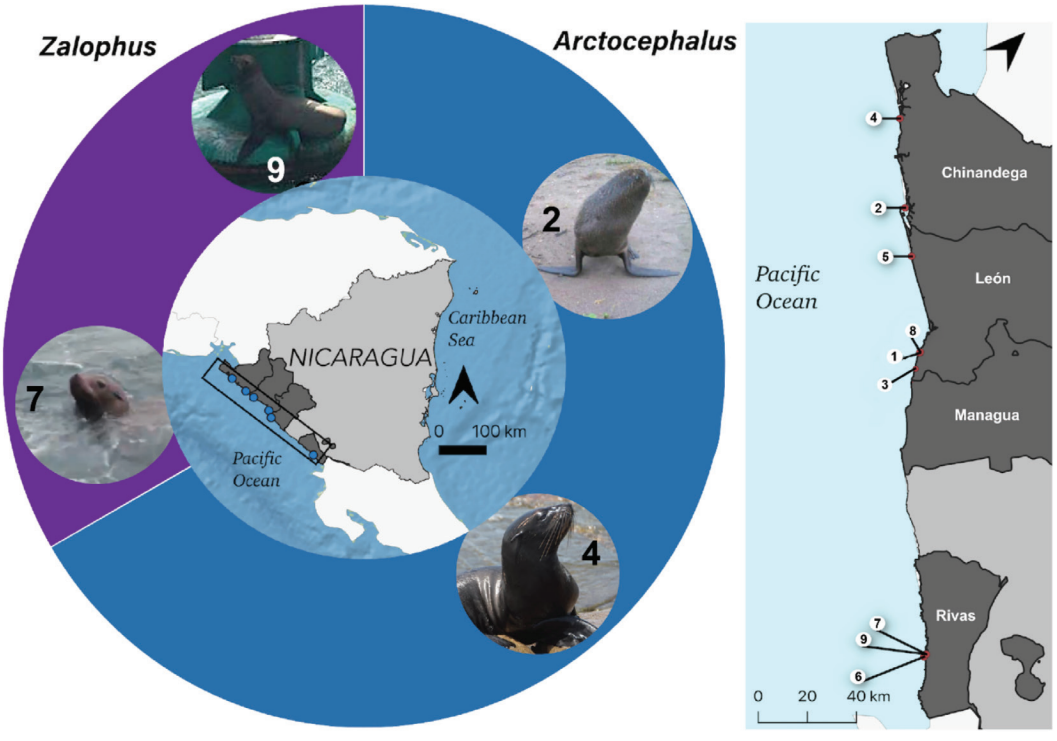

Figure 1. Images of the pinnipeds (Otariidae) observed along the Pacific coast of Nicaragua and sighting locations plotted in a map (*Photo credits:* Case 2, Eddy Maradiaga; Case 4, Rosa Lisseth Umanzor Diaz; Case 7, Norlan Javier Granados Leal; and Case 9, José Dionisio Vivas Mora)

(2) On 18 October 2018, a Galapagos fur seal was observed entering the mangroves and moving around the sandy beaches of Corinto in Chinandega state (TN8 News, 2018; Figure 1; Table 1, Case 2). The animal did not remain stationary for long and returned to the ocean.

(3) On 3 May 2019, a male Galapagos fur seal was observed for several days on the rocks of Playa Del Transito in León state (TN8 News, 2019; Figure 1; Table 1, Case 3).

(4) On 30 July 2019, a juvenile Galapagos fur seal was resting for 5 d between rocks located on Jiquilillo Beach in the state of Chinandega and was visually estimated to be approximately 50 cm long (Chinandega News Live, 2017; Figure 1; Table 1, Case 4).

(5) On 12 March 2020, a Galapagos fur seal was recorded in Las Peñitas in the state of León (TN8 News, 2020; Figure 1; Table 1, Case 5). It entered a restaurant located on a sandy beach and ran away to the ocean straight afterwards. The individual was not observed again.

(6) On 10 April 2007, a live individual was first sighted in the bay of San Juan del Sur in the state of Rivas (Sputnik Mundo News, 2007; Figure 1; Table 1, Case 6). It was caught by local authorities and was provided with vitamins and antibiotics to ensure its survival. It then rested for 3 d until the morning of 12 April 2007 when it left the area. This was confirmed by search efforts on the afternoon of 12 April 2007 and on the following day, 13 April 2007.

Genus Zalophus—Sea lion species of the genus *Zalophus* are characterized by having short ears, a robust body, and shorter muzzles, with elongated and narrow rostrums and large nares which have a slender opening that expands anteriorly. Body length reaches up to 2.5 m in males and 2 m in females. In male California sea lions, the sagittal crest is prominent, curved, rises abruptly at the supraorbital processes, and forms a high convex ridge along the dorsal surface of the frontal bone through to the occipital bone. For adult females, sagittal and occipital crests are also present, although greatly reduced and not easily observed (Brunner, 2018). The three cases of sea lions that we report on below were accompanied by imagery of insufficient quality to conclusively confirm the species identity:

(1) In the second week of August 2013, one individual was recorded near the lighthouse of San Juan del Sur in the Rivas state (The little frog tours Fishing, 2013; Figure 1; Table 1, Case 7). It was resting on the rocks and then jumped in the water and started vocalizing when the fishermen came close. This individual was likely a male based on the occipital crest and vocalizing behavior.

(2) On 22 February 2017, an individual was observed resting on a yellow buoy in Puerto Sandino, Nagarote, Leon state (Canal 4, 2017; Figure 1; Table 1, Case 8). This animal was probably a subadult male due to the external characteristics of the rostrum.

(3) On 4 April 2017, a single individual was reported sitting on a signaling buoy at the entrance of the bay of San Juan del Sur in the Rivas state (TN8 News, 2020; Figure 1; Table 1, Case 9). It swam towards the buoy, where it rested for a few days.

All individuals of both genera appeared to be active and alert, with no evident indicators of health concerns (e.g., emaciation). Animals were identified as male in three cases, but the lack of information from the other cases prevented any sex determination or broader interpretation in dispersal patterns of these species. The similarities between species of the genus *Zalophus* and poor image quality limited accurate species identification, making it difficult to identify the colonies from which they were coming. It is likely that they traveled from colonies off South America (Bowen et al., 2009).

It is unclear what drove these individual pinnipeds to visit the coast of Nicaragua or if there were similar drivers for the different species we documented. For example, several California sea lions reported off the central and southern coast of Mexico were suggested to have traveled more than 700 km (Gallo-Reynoso & Ortega, 1986; Gallo-Reynoso & Solórzano-Velasco, 1991; Hoyos-Padilla & Gallo-Reynoso, 2015; Hoyos-Padilla et al., 2021). ENSO events associated with large-scale inter-annual variations in the ETP are potentially a driver of behavioral changes in California sea lion populations (Shirasago-Gérman et al., 2015). Alternatively, Guadalupe fur seals can travel long distances in search of food (Gallo-Reynoso et al., 2008). Long-distance traveling may have been the result of prey depletion at their original rookeries and/or opportunistic pursuit of new prey sources possibly associated with sea surface temperature changes (Gallo-Reynoso et al., 2008). Collectively, these reports suggest that long-distance travel to Central America may be part of the normal movement patterns of some individuals. Even if Central America is not part of the home range of the Galapagos fur seal, we cannot exclude the possibility that these movements are historically common for a small subset

of populations or that juvenile vagrants dispersed from their original colonies to new habitats due to density-dependent factors (Hoyos-Padilla & Gallo-Reynoso, 2015; Hoyos-Padilla et al., 2021; Barba-Acuña et al., 2022).

Four out of the nine pinniped sightings reported in this study coincided with the period when the CRD approaches the Central American coast, specifically between February and April. This timing is significant because the CRD's arrival generates upwellings that bring nutrient-rich waters to the surface, which, in turn, can lead to an increased abundance of prey, potentially providing enhanced feeding opportunities for these marine mammals. However, while this correlation suggests a possible link between the arrival of the CRD and the sightings of pinnipeds, it remains unclear whether the potential for augmented feeding opportunities presented by the CRD's arrival is the primary driver behind the long-distance travel of these animals. It is also plausible that other factors, such as changes in sea surface temperature, prey distribution, or reproductive needs, may also play a role. Given this ambiguity, there is a clear need for further research to better understand the motivations behind the pinnipeds' long-distance movements. Future studies should continue monitoring and recording pinniped sightings in the region, ideally integrating data collection with detailed analysis of local oceanographic conditions, behavioral studies, and other relevant biological information. Such an integrative approach will help elucidate whether there is a causal relationship between the CRD, its potential feeding opportunities, and the occurrences of pinnipeds along the Central American coast.

Documenting the occurrences of vagrant individuals is crucial for comprehending the population dynamics of the species and for monitoring potential shifts associated with climate change-induced oceanographic factors (Shirasago-Gérman et al., 2015; Trillmich, 2015). These include localized oceanographic conditions such as the CRD. Additionally, considering the susceptibility of pinniped species to anthropogenic threats (e.g., habitat destruction, harassment, pollution, overfishing, disease), it is imperative to accurately ascertain their current distribution and formulate management strategies for their protection. This resonates with recent research on cetaceans in Nicaragua, which has offered significant baseline data underpinning the advocacy for marine mammal protection in the country (De Weerdt & Ramos, 2019; De Weerdt et al., 2021, 2022). These findings are critical for identifying and mitigating risks to these coastal habitats and for enhancing conservation initiatives for pinnipeds in Nicaragua.

Acknowledgments

The authors thank all the citizens who shared their photographic contributions from the Padre Ramos and San Juan del Sur communities (Eddy, Rosa, Norlan, and Nicho). Special thanks to Susana Cárdenas-Alayza for species identification, and to PC and KAC for proofreading the original manuscript. We thank the reviewers of this manuscript for their insightful comments and suggested revisions that improved the quality of the work.

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