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Northernmost Record of the Galapagos Sea Lion (*Zalophus wollebaeki*): Sightings Along the Mexican Central Pacific and the Gulf of California During La Niña Conditions

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Most organisms within the trophic web are affected by significant fluctuations in sea surface temperature (SST)—from phytoplankton (Fischer et al., 2020) to top predators such as pinnipeds (Elorriaga-Verplancken et al., 2016; Páez-Rosas et al., 2018; Gálvez et al., 2020). The global distribution of these marine carnivores depends on SST because of its effects on the input of nutrients, primary productivity, and subsequent prey availability (Guinet et al., 2001; McClatchie et al., 2016; Adame et al., 2020).

El Niño-Southern Oscillation (ENSO) has been defined as "an unstable interaction between sea surface temperature and atmospheric pressure that results in variations in oceanographic conditions in the central and eastern tropical Pacific Ocean" (Fiedler, 2002). "El Niño" is the warm phase of ENSO, which is characterized by an unusual increase in SST, weak trade winds, a reduction in nutrient advection, and a deeper mixed layer. Furthermore, this type of event has been linked to negative impacts on different pinniped populations (Trillmich et al., 1991), mainly due to low prey availability (Iriarte & González, 2004; McClatchie et al., 2016).

These positive thermal anomalies in the marine environment may cause abnormal dispersion of solitary individuals due to the extension of their regular foraging ranges. The temporal and spatial knowledge of how organisms respond to abnormal oceanographic shifts provides insights into the trophic ecology of the species (Weise et al., 2006). This has been the case for several otariids such as the Guadalupe fur seal (*Arctocephalus townsendi*; Páez-Rosas et al., 2020a), the South American fur seal (*Arctocephalus australis*; Villegas-Zurita et al., 2016), the Galapagos fur seal (*Arctocephalus galapagoensis*; Páez-Rosas et al., 2017), and the only previous record in Mexico for the Galapagos sea lion (*Zalophus wollebaeki*; Ceballos et al., 2010) in Chiapas, along the southern coast of the Mexican Pacific. This non-migrant otariid from the Galapagos Archipelago has been strongly affected by El Niño events in the past. During 2018, its overall abundance was estimated at 18,000 to 24,000 individuals; however, there was a population decline of 23.8% after the 2015-2016 El Niño (Páez-Rosas et al., 2021). Studies regarding its ecology regain relevance for this reason, as well as because of its "endangered" classification according to the International Union for Conservation of Nature (IUCN) (Trillmich, 2015).

Moreover, there are negative anomalies related to the cold phase of ENSO events, known as "La Niña." This event is characterized by an unusual decrease in SST, stronger-than-usual trade winds, nutrient-rich waters close to the ocean surface, and a decreased depth of the mixed layer (Philander, 1990). Since these cold conditions expand typical foraging areas, there can be positive outcomes, such as increased body mass of neonates (e.g., in the Guadalupe fur seal; Gálvez et al., 2020). Abnormal dispersal events, however, can also occur in some pinnipeds as a consequence of these extended foraging areas. These vagrant records have so far included the arrival of southern elephant seals (*Mirounga leonina*) to the Gulf of Panama and to Ecuador at the end of 2016 and 2017 (Páez-Rosas et al., 2018; Redwood & Félix, 2018) and a Steller sea lion (*Eumetopias jubatus* [described as a South American sea lion (*Otaria flavescens*) by Gallo-Reynoso et al., 2020]), which arrived at Colima in the Mexican Central Pacific during 2008 (Ceballos et al., 2010).

In the present paper, we provide evidence of several sightings of a single male adult Galapagos sea lion, referred to as "*Zw*-LN21," from 25 January 2021 to 4 June 2021, from the Mexican Central Pacific to the entrance of the Gulf of California (Figure 1). There were eight confirmed sightings along a path of ~720 km during this period. The southernmost location was Maruata Beach in the state of Michoacán, and the northernmost location was Mazatlán in the state of Sinaloa, separated by ~700 km (Table 1; Figure 2).

The identification of *Zw*-LN21 was based on characteristic morphological traits for its age and sex class. Adult male Galapagos sea lions are smaller or more compact relative to adult male California sea lions (*Zalophus californianus*; CSLs). The former measure up to 2 m and weigh approximately 200 kg (Eibl-Eibesfeldt, 1984). Adult male Galapagos sea lions generally have a blackish-gray pelage and a sagittal crest that is fully developed, which is a significant trait relative to subadult male CSLs; however, their neck is thinner compared to an adult male CSL (Trillmich, 1979).

These records are the northernmost for this species to date, with distances to the Galapagos Archipelago of ~2,460 km from Maruata Beach; ~2,600 to 2,700 km from Manzanillo and Melaque; ~2,800 km from Bahía de Banderas; and ~3,200 km from Mazatlán. The latter is considered to be within the entrance of the Gulf of California. Several photographs and characteristics of *Zw*-LN21 allowed us to correctly identify it as the same *Zalophus wollebaeki* individual (Figure 3).

Our observations took place during the 2021 La Niña cold conditions for the 3.4 region in the Eastern Pacific (El Niño Index or NOI = -1.2 [January], -1.0 [February], -0.9 [March], -0.8 [April], -0.7 [May], and -0.5 [June]; National Oceanic and Atmospheric Administration [NOAA], 2021). Overall, these abnormally cold conditions prevailed from September 2020 to June 2021. As briefly mentioned before, the low SST can cause an unusual dispersal of different taxa that feed over

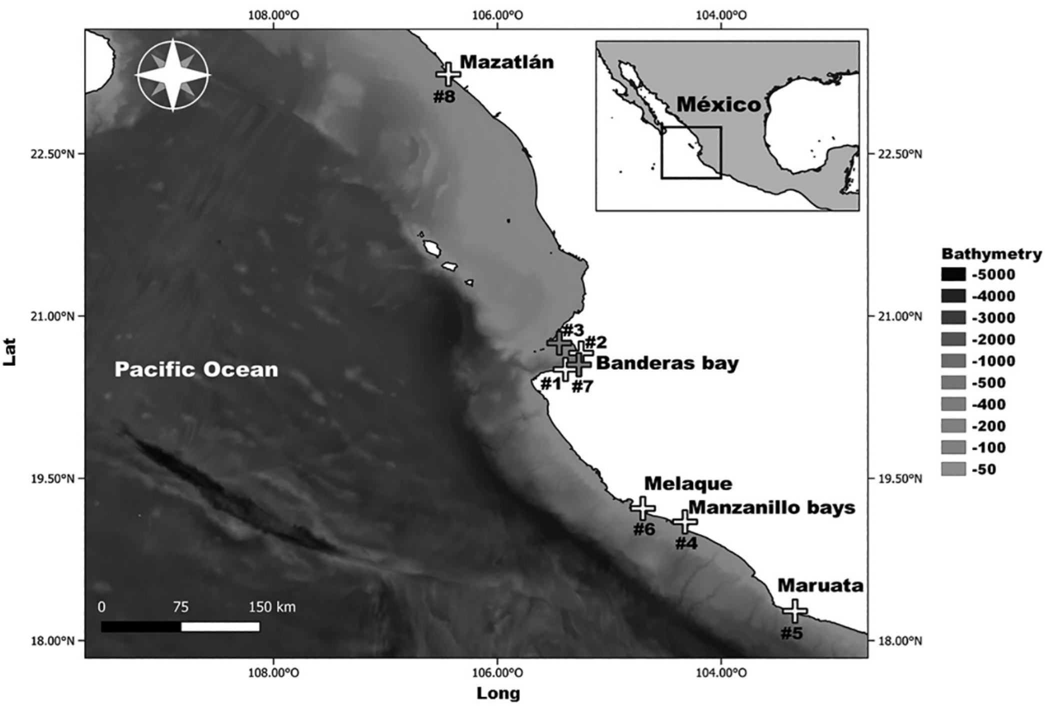

Figure 1. Geographical position of *Zw*-LN21, a Galapagos sea lion (*Zalophus wollebaeki*). Sightings from January to June 2021: (#1) Majahuitas Beach, Jalisco; (#2) Mayan Vidanta Beach, Puerto Vallarta, Jalisco; (#3) Punta Burro, Nayarit; (#4) Azul Beach, Manzanillo, Colima; (#5) Maruata Beach, Michoacán; (#6) Melaque Beach, Jalisco; (#7) Las Gemelas Beach, Puerto Vallarta, Jalisco; and (#8) in front of Universidad Autónoma de Occidente, Mazatlán, Sinaloa.

Table 1. Chronology of the sightings of the recorded Galapagos sea lion (*Zalophus wollebaeki*) from January to June 2021 along the Mexican Central Pacific

Date	Time	Site	Observations
25 January	1000 h	Majahuitas Beach, Jalisco	First report of the individual resting on southernmost beach of Banderas Bay. It entered the sea at sunset.
26 January	1230 to 1730 h	Mayan Vidanta Beach, Puerto Vallarta, Jalisco	Displacement of ~21.5 km to the northeast of the bay. Photographs corroborated that it was the same individual. Municipal civil protection cordoned the area. It entered the sea in the afternoon.
28 January-6 February	1238 to 0836 h	Punta Burro, Nayarit	Displacement of ~20.9 km to the north of the bay. Municipal civil protection arrived and cordoned the area. It entered the sea a couple of times during the afternoon of the first day. It swam near a school of fish. It rested on the beach during the second day. One of its eyes was observed closed. During the following days, it was observed swimming near a fishing net. It was observed swimming in the same area on the last day.
2 March	1700 to 2000 h	Azul Beach, Manzanillo, Colima	Displacement of ~282 km out of the Banderas Bay and to the south. It was resting on the beach. The area was cordoned to avoid an incident with people. It reacted to sounds around it. Both eyes were closed and had a yellowish secretion (Figure 2). It entered the sea after sunset. It was not observed again.
5 March	0830 h	Maruata Beach, Michoacán	Displacement of ~152 km out of the Manzanillo Bay and to the south. It was identified as the same individual based on photographs published on social media. It was noticeable that both eyes were closed (Figure 2). There was no further news.
20 April	1400 h	Melaque Beach, Jalisco	Displacement of ~193 km to the north of Maruata. It was resting on the beach. Both eyes were closed (Figure 2). It was no longer observed in the afternoon.
2-15 May	0900 to 0720 h	Las Gemelas Beach, Puerto Vallarta, Jalisco	Displacement of ~252 km to the north of Melaque. It was resting on the beach, and it entered the sea sometimes. It was confirmed that it was the same individual based on photographs. A very considerable weight gain was noticed in relation to its sightings in January and February. The left eye was open, as well as, slightly, the right one. It still showed a yellowish secretion. Some people tried to feed it, and others disturbed it.
4 June	0800 to 1800 h	Mazatlán, Sinaloa, in front of Universidad Autónoma de Occidente	Displacement of ~347 km to the north of Las Gemelas Beach. First, it was observed resting on the Norte Beach. It was moving around this site when it was captured by personnel from an aquarium, municipal civil protection, and an aquatic squadron to assess its condition. The left eye was observed open in photographs taken inside the aquarium. This was the northernmost record.

larger nutrient-rich areas related to cold conditions. Therefore, their coverage increases and reaches atypical northern latitudes. A valuable aspect of this record is that, even though it was only one individual, several sustained reports from January to June allowed us to determine its presence for almost half a year at different Mexican locations. Sightings were separated by up to 720 km between Maruata and Mazatlán.

The other extant record of this nature of a Galapagos sea lion took place during the warm conditions of the 1997-1998 El Niño in the La Encrucijada Biosphere Reserve (15º 41' 15" N, 92º 01' 23" W), 25 km south of Acapetahua, Chiapas, located 1,800 km northeast of the Galapagos Archipelago, Ecuador. This record included two dead males and an emaciated female that eventually died (Ceballos et al., 2010). Despite the well-known negative effects of El Niño on Galapagos sea lions (Páez-Rosas et al., 2021), this species has exhibited trophic flexibility during these abnormal conditions. Páez-Rosas et al. (2020b) evidenced a response to anomalous warm conditions that included reduction of the foraging niche and a higher consumption of prey found in deeper waters. Although this flexibility was described during abnormally warm conditions, it suggests that some individuals, such as *Zw*-LN21, could also display foraging variations under cold scenarios.

Figure 2. Photographic catalog of *Zw*-LN21, observed from January to June 2021 on beaches in the Mexican Central Pacific and the entrance to the Gulf of California, from which it was possible to distinguish morphological characteristics for its identification and follow-up: (#1) Majahuitas Beach, Jalisco; (#2) Mayan Vidanta Beach, Puerto Vallarta, Jalisco; (#3) Punta Burro, Nayarit; (#4) Azul Beach, Manzanillo, Colima; (#5) Maruata Beach, Michoacán; (#6) Melaque Beach, Jalisco; (#7) Las Gemelas Beach, Puerto Vallarta, Jalisco; and (#8) in front of Universidad Autónoma de Occidente, Mazatlán, Sinaloa. (*Photo credits:* JEM-V [#1 & 3]; Protección Civil Puerto Vallarta [#2]; ML-G [#4]; social net [#5]; Estela Carretero, Universidad de Guadalajara [#6]; Frank McCann [#7]; and https://www.noroeste.com.mx/mazatlan/encalla-lobo-marino-en-playa-de-mazatlan-XD1027743 [#8])

Figure 3. Image comparison between the recorded adult male Galapagos sea lion (*Zw*-LN21) sighted in the Mexican Central Pacific (top left) and another adult male of the same species (*Zw*A) photographed on the Galapagos Islands (top right), an adult male California sea lion (*Zalophus californianus*; *Zc*A) (bottom left), and a subadult male CSL (*Zc*SA) (bottom right). The protrusion of the subadult CSL's neck is thinner compared to that of the adult male *Zc*A. (*Photo credits:* DP-R [Galapagos sea lions from the Galapagos Islands] and FRE-V [two California sea lions])

Zw-LN21 exhibited an apparent disease related to at least one of its eyes. During most of its sightings, the individual had his eyes consistently closed. This individual could have been blind; however, there is no certainty about its exact health condition. Completely blind CSLs have stranded and eventually seemed to survive—most likely their feeding was aided by their highly sensitive vibrissae (Elorriaga-Verplancken et al., 2018), which have been demonstrated to facilitate a high detection capability in absence of light (Dehnhardt, 1994). Blind sea lions may be able to survive in the wild by switching their regular diet to benthic prey, using their vibrissae to detect food close to the sea floor (Thomas & Kastelein, 1990). If *Zw*-LN21 was partially blind, it could have taken advantage of shallow waters along the geographic regions where it was recorded. Additionally, the individual apparently gained weight from January to May (Table 1; Figure 2).

On 4 June 2021, *Zw*-LN21 appeared stranded, and organizations/institutions from Mazatlán (an aquarium, municipal authorities, civil protection, and the aquatic squadron) captured it with the aim of treating its apparently wounded eye and its general condition. It died 3 days later due to several probable factors, including age or health conditions that were not possible to identify. The necropsy report drafted by the collecting organizations was shared on social media (https://tvpacifico.mx/noticias/264506-fallecio-lobo-marino-rescatado-en-playas-de-mazatlan), which described several internal traumas, including fractured ribs and other lesions. Given the lack of official information on this necropsy, the cause of death of *Zw*-LN21 must be taken with caution. Further inferences cannot be made in relation to the magnitude of these injuries or their origin.

It is not possible to determine how abnormal environmental conditions and the health condition of *Zw*-LN21 were related to its extralimital record and death. Based on previous references that involve both warm and cold abnormal conditions and their connection to unusual dispersal events in pinnipeds, the effect of oceanographic factors is underlined as one of the most probable triggers of its long trip from Galapagos. On 17 March 2021 (within our analyzed period), a live Galapagos fur seal (*Arctocephalus galapagoensis*) was sighted in Marquelia (state of Guerrero, Mexico), 2,000 km north of the Galapagos Archipelago (https://guerrero.quadratin.com.mx/arriba-lobo-marino-a-playa-las-penitas-de-marquelia). However, this record has not been formally analyzed.

Extreme events involving Galapagos sea lions, and other aquatic species, should be monitored closely. These types of records will likely continue to occur due to more frequent and intense oceanographic anomalies as seen in recent decades related to ongoing climate change (Freund et al., 2019). These constant individual records and their environmental context constitute valuable information for a better ecological understanding of species, especially those that are endangered and declining, such as the Galapagos sea lion (Trillmich, 2015). Furthermore, they provide scenarios for enhanced long-term research, as well as more rigorous conservation plans.

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