

MARINE RECORD

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First record of a Galapagos fur seal (*Arctocephalus galapagoensis*) in Guatemala

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Abstract

Background: Galapagos fur seals, *Arctocephalus galapagoensis*, inhabit the Galapagos Archipelago. The species is considered to be non-migratory, remaining in the Galapagos year-round. On 9 June 2016, a live fur seal stranded on the Pacific coast of Guatemala.

Results: Morphological characteristics (slightly rounded crown, short pointed muzzle with a lighter colored pelage extending into the face and over the eyes forming a small pale mask, tan ventrum contrasting with grizzled gray-brown fur on the back and sides) were used to identify the pinniped as a Galapagos fur seal, *Arctocephalus galapagoensis*. Additionally, the fur seal was estimated to be a subadult male based on body size and the presence of testicles. Total body length was estimated to be 140 cm and the weight was estimated to be 90 lb. For comparison, adult males of *A. galapagoensis* measured to date are slightly larger with an average length and weight equal to 150–160 cm and 132–150 lb., respectively. The species identification and age-class determination were confirmed by pinniped specialists.

Conclusion: This is the first record of Galapagos fur seal in the Pacific coast of Guatemala and in the Central America region.

Keywords: *Arctocephalus galapagoensis*, Galapagos fur seal, Guatemala, Stranding

Background

The marine mammal fauna of Guatemala is comprised of tropical and subtropical species. One sirenian species (*Trichechus manatus*; Quintana-Rizzo and Reynolds 2010) and 17 cetacean species have been identified in the Atlantic and Pacific Oceans, respectively; the latter group comprises three rorquals, two ziphids, one physeterid, one kogiidae and 10 delphinids (Quintana-Rizzo and Gerrodette 2009) (Table 1). Pinnipeds are not endemic to Guatemala but occasional sightings of single individuals have been reported sporadically; however, written records of such sightings do not exist in Guatemala. Individuals that stranded in the early 90's included species with northern distribution such as the California sea lion (*Zalophus californianus*; E. Quintana-Rizzo, pers. comm.). No known records of pinnipeds with southern distribution have been reported in the country.

In the Americas, the distribution of *Arctocephalus* is limited to four species inhabiting localized areas: *A. galapagoensis* inhabits the Galapagos Islands (Clark 1975; Alava and Salazar 2006; Alava et al. 2017); *A. philippii* inhabits the Juan Fernandez Archipelago in the eastern South Pacific Ocean off Chile; *A. australis* inhabits the coasts of South America, from central Peru in the Pacific Ocean, around the southern tip of the continent, and up to southern coast of Brazil in the Atlantic Ocean; and *A. townsendi* inhabits the San Benito Archipelago and Guadalupe Island off central Baja California in Mexico (Reeves et al. 1992; Jefferson et al. 1993, 2007).

We present the first known report of a Galapagos fur seal in Guatemala. The fur seal stranded alive in the Pacific coast and morphological characteristics were used to identify the species, its gender, and estimate the age class (Clark 1975; Reeves et al. 1992; Jefferson et al. 1993, 2007). The initial species identification and characteristics were confirmed separately by five specialists after inspecting multiple photographs of the individual. This species is considered endangered on the International Union for Conservation of Nature 2009 Red List (Trillmich

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Table 1 Marine mammal species naturally occurring in Guatemala (Sirenia: Quintana-Rizzo and Reynolds 2010; cetacea: Quintana-Rizzo and Gerrodette 2009)

Orden	Family	Species
Sirenia:	Trichechidae	<i>Trichechus manatus</i>
Cetacea:	Balaenopteridae	<i>Balaenoptera edeni</i>
		<i>Balaenoptera musculus</i>
		<i>Megaptera novaeangliae</i>
	Delphinidae	<i>Delphinus delphis</i>
		<i>Feresa attenuata</i>
		<i>Globicephala macrorhynchus</i>
		<i>Grampus griseus</i>
		<i>Orcinus orca</i>
		<i>Pseudorca crassidens</i>
		<i>Stenella attenuata</i>
		<i>Stenella longirostris</i>
		<i>Steno bredanensis</i>
	<i>Tursiops truncatus</i>	
	Kogiidae	<i>Kogia sima</i>
	Physeteridae	<i>Physeter macrocephalus</i>
Ziphiidae	<i>Mesoplodon peruvianus</i>	
	<i>Ziphius cavirostris</i>	

2015). The population declined by 77–80% from 1977/78 to 2001. Recent abundance of Galapagos fur seals has been roughly estimated to be approximately 10,000 to 15,000 mature individuals (Alava and Salazar 2006; Trillmich 2015). Severe ENSO events have had a drastic impact on the species population (Trillmich and Limberger 1985) as well as on other pinniped populations in the eastern tropical and temperate Pacific Oceans (Trillmich and Limberger 1985; Capella et al. 2001; Salazar and Denking 2010; Elorriaga-Verplancken et al. 2016a,b; Villegas-Zurita et al. 2016). For example, in the 1982–83 ENSO event, the population of Galapagos fur seal lost the four youngest year classes almost entirely (Trillmich and Limberger 1985; Alava and Salazar 2006). Therefore, atypical dispersion events such as the one reported here may provide insight into the effects of recent ENSO events on the species.

Methods

The fur seal was first sighted on 9 June 2016 at the Barra El Jiote community, Jutiapa (13° 47' 29.19" N, 90° 14' 29.59" W; Fig. 1). Members of the community attempted to push the fur seal back into the ocean on several occasions but each time it returned to shore a few hours later and a couple of kilometers further north, moving a total distance of about 6.5–8 km. In the last attempt, members of the community reported that stray dogs harassed the fur seal and that in response the fur seal attacked and wounded one of the dogs, likely in self-defense. To prevent

further harassment, members of the community enclosed the pinniped in a large industrial cooler (180 × 70 cm) with approximately 20 cm of seawater. The fur seal spent the night and the following morning in those conditions.

On 10 June, a team of biologists and a veterinarian visited the location and observed the behavior of the fur seal and performed a visual external examination. Morphological characteristics were used to identify the species of fur seal, its gender, and estimate the age class according to Clark (1975), Reeves et al. (1992) and Jefferson et al. (1993, 2007). Furthermore, multiple photographs of the fur seal were sent to five independent pinniped specialists including a specialist on Galapagos fur seals (D. Bárcenas, Universidad Autónoma de Baja California Sur, Mexico; F. Elorriaga-Verplancken, Centro Interdisciplinario de Ciencias Marinas, Mexico; D. Páez-Rosas, Universidad San Francisco de Quito, Ecuador; S. Villegas, University of California, Santa Cruz, U.S.; C. Yaipén-Llanos, Organización Científica para la Conservación de Animales Acuáticos, Peru) to confirm the initial identification.

The four species of *Arctocephalus* found in the Americas are morphologically different. *A. galapagoensis* is the smallest otariid species; it has a compact body and adult males are stocky in build. Additionally, the size and shape of the muzzle are key taxonomical characteristics use in dichotomous keys to distinguish *A. galapagoensis* from the other three species (see taxonomical key by Jefferson et al. 1993). *A. galapagoensis* has a short and straight muzzle that rapidly tapers in width and thickness to the small nose. Also, the muzzle is pale tan and the color extends onto the face and forehead over the eyes, forming a small pale mask. In contrast, the other three species do not have a short muzzle. Instead, they have either 1) a moderately long muzzle that tapers in width and thickness to the nose, slightly enlarged rhinarium and upward-angled nostrils (e.g. *A. australis*) or 2) a long muzzle with a bulbous, enlarged rhinarium and significantly downward-angled nares (e.g. *A. philippii* or *A. townsendi*). Further, *A. philippii* and *A. townsendi* have a variable amount of buff to reddish-brown color on the muzzle that may extend into the face. In *A. australis*, the face is dark and the sides of the muzzle may be gray to yellow (Reeves et al. 1992; Jefferson et al. 1993, 2007).

There are also some differences in the head's shape and fur coloration, especially among males. In *A. galapagoensis*, males have a slightly rounded crown and a short sloping forehead. They do not have the characteristic sagittal crest of other male otariids. Nevertheless, males of *A. australis* have a rounded crown and prominent forehead, of *A. philippii* have a rounded crown with the apex above the ear pinnae and a slight rounded forehead, and of *A. townsendi* have a long, narrow and fairly flat head. Males of *A. galapagoensis* are dark brown on the back

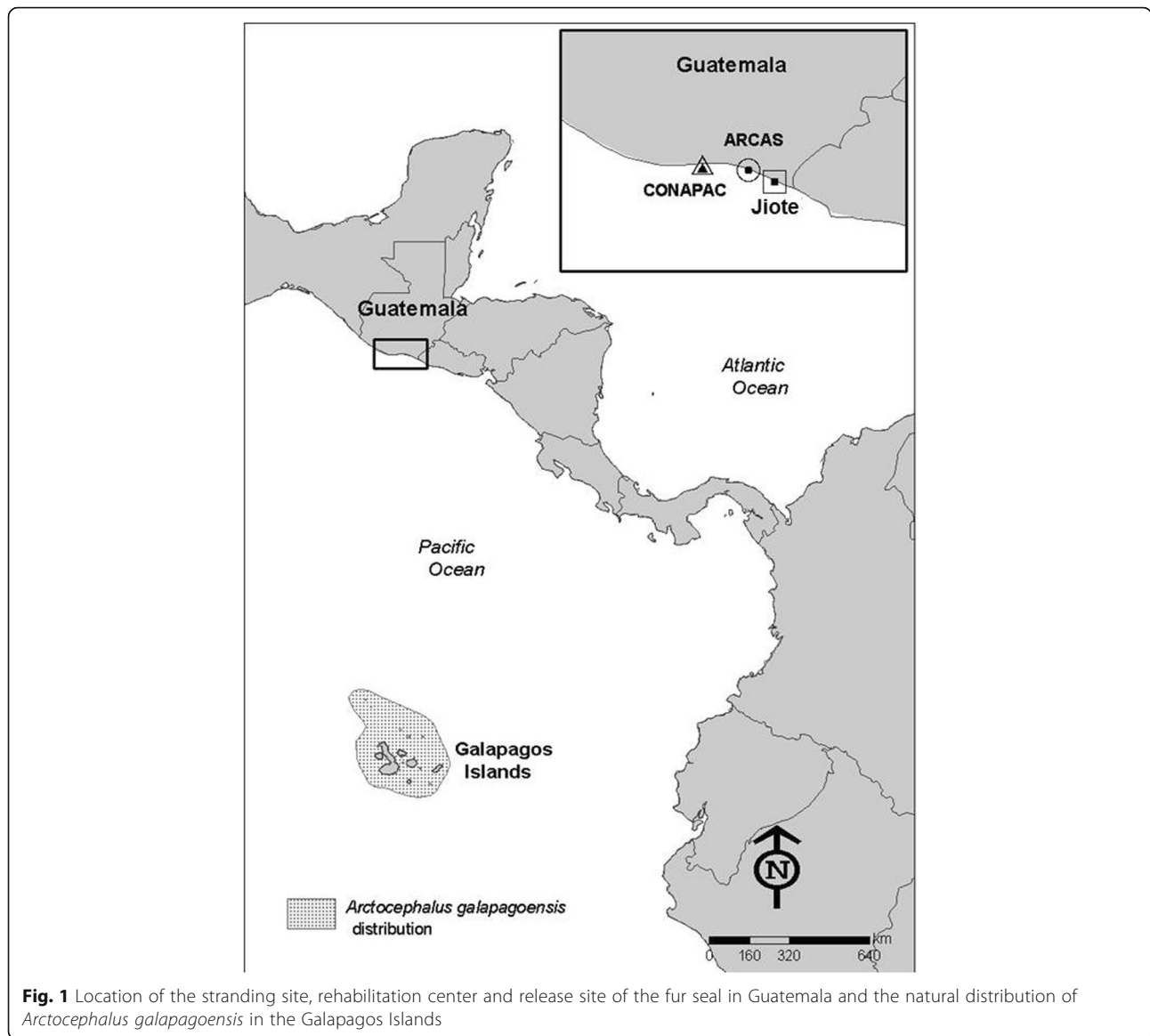


Fig. 1 Location of the stranding site, rehabilitation center and release site of the fur seal in Guatemala and the natural distribution of *Arctocephalus galapagoensis* in the Galapagos Islands

and sides, with pale tan heads and bellies. Yet, in *A. australis* and *A. philippii*, males are dark brown to black and in *A. townsendi*, both sexes can be uniform dark brown to black (Reeves et al. 1992; Jefferson et al. 2007).

The fur seal did not have any apparent wounds, nasal or ocular secretions, was calm and exhibited regular breathing patterns; however, the fur seal was emaciated and some bone structures (e.g., vertebral spine, hips, pelvic and scapular bones) were visible during the external examination of the animal in situ. A release was attempted near the shoreline but the fur seal did not move. Because of the animal's behavior and thin body condition, it was decided that the fur seal needed to be taken to a rehabilitation center and with authorization from the Guatemalan Commission of Protected Areas (Consejo Nacional de Areas Protegidas), the seal was

transported to the Wildlife Rescue and Conservation Association (Asociación de Rescate de Vida Silvestre, ARCAS) located in Hawaii, Santa Rosa (Fig. 1).

Reports of pinnipeds ranging far in search of more favorable conditions have been documented during ENSO events (Trillmich and Limberger 1985; Capella et al. 2001; Aurióles-Gamboa et al. 2004; Alava and Salazar 2006; Elorriaga-Verplancken et al. 2016a,b; Villegas-Zurita et al. 2016; Alava and Aurióles-Gamboa 2017). Thus, to investigate the potential correlation of the stranding of the fur seal with the 2014–2016 ENSO event, the average anomalous sea surface temperature (SST) was examined for the day of the stranding and on the three consecutive months prior to the event in the eastern tropical Pacific including the Galapagos Islands following Villegas-Zurita et al. (2016).

Results

The fur seal was identified as *Arctocephalus galapagoensis* and the identification was independently confirmed by all five pinniped specialists originally contacted. The following morphologically key diagnostic features enabled the identification of this individual as *A. galapagoensis* (diagnostic features of *A. galapagoensis* and other *Arctocephalus* were discussed in Methods as described by Reeves et al. (1992) and Jefferson et al. (1993, 2007)):

1. Muzzle size, shape and color: The fur seal had a short pointed muzzle. The muzzle was pale tan and the color extended onto the face and forehead over the eyes, forming the distinctive pale mask characteristic of the species (Fig. 2a, b).
2. Head shape: The fur seal had a slightly rounded crown, short sloping forehead and did not have a conspicuous sagittal crest characteristic of other male otariids (Fig. 2b–d).
3. Fur coloration (body and head): The front and sides of the muzzle and underparts of the body of the dry fur of the seal were a pale tan, and the sides and back of the body (Fig. 2b) were grizzled gray-brown.

The fur seal was considered to be a subadult male based on his body size, relatively thick neck (females have a thinner neck) and the presence of testicles. Total body length was estimated to be 140 cm and the weight was estimated to be 90 lb. For comparison, adult males of *A. galapagoensis* measured to date are slightly larger with an average length and weight equal to 150–160 cm and 132–150 lb., respectively.

At ARCAS, the fur seal received 4-days of supportive care following the advice of local (Protortugas) and international (Universidad Autónoma de Baja California Sur, Mexico; Organización Científica para la Conservación de Animales Acuáticos, Peru) veterinarians that have experience working with stranded pinnipeds. Analyses of blood samples and ultrasound imagery of the fur seal did not reveal major health problems. Blood values were compared to published data (Horning and Trillimich 1997) and discussed with veterinarians at The Marine Mammal Center, U.S.A. (TMMC). The fur seal appeared to be moderately anemic, a common finding in stranded fur seals, and therefore it did not appear to be clinically significant (C. Simeone pers. comm.).



Fig. 2 Photographs of *Arctocephalus galapagoensis* at Barra El Jiote community on Jutiapa 9 June 2016 (**a, b**) and 10 June 2016 (**c**), and at Asociación de Rescate de Vida Silvestre on 14 June 2016 (**d**), Guatemala. The morphological characteristics captured in the photographs distinguish this species from other *Arctocephalus*. The characteristics include a short pointed muzzle (**a, b, d**) with a pale tan extending onto the face and forehead over the eyes forming a small pale mask (**b, c, d**); a slightly rounded crown, a short sloping forehead; and no conspicuous sagittal crest (**a, b, c**). Additionally, the individual had a grizzled gray-brown fur on the back of the body and sides (**b**). Photo credits: A. Flores (**a, c**) and E. Quintana-Rizzo (**b, d**)

On the first few days, the fur seal did not eat the dead squid put in the enclosure. Subsequently, live silver mullets (*Mugil curema*) were given but the fur seal only ate one. Still, the fur seal appeared to have good resilience (C. Simone pers. comm.) as suggested by the fact that it bathed and groomed on a daily basis. On 17 June, the fur seal was more active, particularly around sunset and night hours (1700–2200 h). This peak of activity seemed normal since *A. galapagoensis* is a nocturnal species (Salazar 2002; Alava and Salazar 2006). In consultation with pinniped experts at TMMC, it was recommended that if the fur seal did not eat on a regular basis in the next few days, the best option was to release it.

Due to the loss of hunger in the following days, on 23 June, the fur seal was transported and released at a quiet private beach on the Guatemalan Navy Base on the Pacific coast (Comando Naval del Pacífico, CONAPAC; Fig. 1). The base is located about 25 km from the San Jose Canyon (Cañon de San José), a deep canyon dropping from 200 to 2000 m, that could potentially provide better food sources than shallower portions of the

continental shelf. The fur seal was released at about 1800 h to coincide with the animal's peak of activity. Upon release, the fur seal moved quickly in the direction of the ocean and swam away. Members of CONAPAC monitored the beach for 15 days after release but no observations of the fur seal at this beach or other parts of the coast were reported (as of 29 January 2017).

Examination of the average SST for the day of the stranding of the fur seal and on the three consecutive months prior to the event showed that in March and February 2016, a current of warm surface water existed along the Equator, including the Galapagos Islands (Fig. 3). In May, the month prior to the stranding, an area of warm surface water was on the north side of the islands. At the beginning of June 2016, a cooling trend started in the equatorial current but the SST had been above normal for several months.

Discussion and conclusions

The tropical waters off the Pacific coast of Guatemala are not part of the known range of *A. galapagoensis*. The

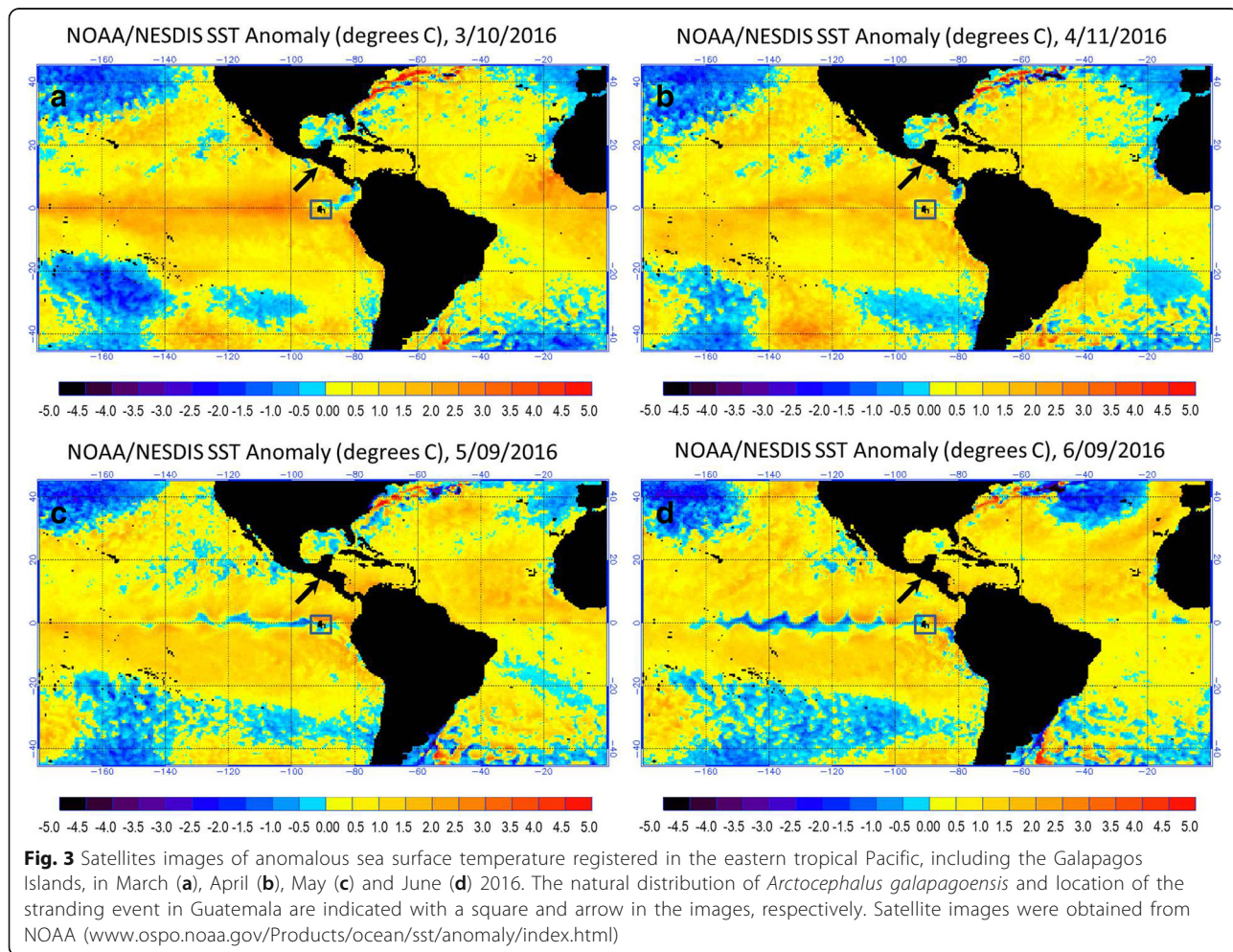


Fig. 3 Satellites images of anomalous sea surface temperature registered in the eastern tropical Pacific, including the Galapagos Islands, in March (a), April (b), May (c) and June (d) 2016. The natural distribution of *Arctocephalus galapagoensis* and location of the stranding event in Guatemala are indicated with a square and arrow in the images, respectively. Satellite images were obtained from NOAA (www.ospo.noaa.gov/Products/ocean/sst/anomaly/index.html)

species is endemic of the Galapagos Islands, and is distributed primarily on the coasts near intense upwelling areas (Reeves et al. 1992; Salazar 2002; Alava and Salazar 2006; Salazar and Denkinger 2010; Alava et al. 2017). Its presence outside the archipelago is known only from a few records of vagrant individuals sighted on the coasts of South America and Mexico (Capella et al. 2001; Aurióles-Gamboa et al. 2004; Félix et al. 2007). Thus, this report represents the first known observation of the species in Guatemala and in the Central American region.

The reasons influencing the movement of the Galapagos fur seal to Guatemala are unclear. It is possible that the fur seal exhibited health problems that were undetected by blood analysis and ultrasound tests. The loss of hunger was probably due to the fact that *Arctocephalus* is particularly sensitive to noise and people (C. Simeone pers. comm.) which were present near the enclosure and/or the unavailability of regular prey items such as pelagic fish and squid (Clarke and Trillmich 1980; Dellinger and Trillmich 1999; Salazar 2002). The species has often been reported to show little interest in eating while in rehabilitation (C. Simeone pers. comm.).

The presence of a Galapagos fur seal in Guatemala could also have been influenced by the severe 2014–2016 ENSO event. Communication with pinniped experts suggested that this was the likely cause. In 2015 and 2016, a high number of pinniped strandings was reported in Mexico and California (C. Simeone pers. comm.; Elorriaga-Verplancken et al. 2016b). In Guatemala, two other pinnipeds were sighted near the release site of *A. galapagoensis* including one adult female of *Zalophus californianus* and another *Zalophus* whose identification to the species level, gender, and estimated age could not be confirmed by researchers with expertise on this species (Dr. D. Páez-Rosas, Universidad San Francisco de Quito, Ecuador; Dr. F. Elorriaga-Verplancken, Centro Interdisciplinario de Ciencias Marinas, Mexico; Dr. S. Villegas, University of California in Santa Cruz, U.S.) using the available photographs. Those pinnipeds did not strand but were sighted repeatedly over a period of a few days (*Z. californianus*: July 2016) to a few weeks (*Zalophus* sp.: Fall 2014). Two South American species of pinnipeds of the genus *Arctocephalus* have been reported in the Pacific coast of neighboring country of Mexico (*A. galapagoensis*, Aurióles-Gamboa et al. 2004; *A. australis*, Villegas-Zurita et al. 2016). Over the past decade, the Mexican South Pacific has experienced multiple unusual stranding events of fur seals and sea lions where no natural populations of pinnipeds exist (Villegas-Zurita et al. 2016). The global distribution of pinnipeds is largely influenced by ocean temperature, which affects their food availability, and by changes in SST and thermocline depth due to ENSO events (Elorriaga-

Verplancken et al. 2016a; Villegas-Zurita et al. 2016; Alava 2017; Alava and Aurióles-Gamboa 2017).

In 2014, a high SST started in the eastern Tropical Pacific (Dahlman 2016). The average SST anomalies fluctuated between about 1 °C and 2.3 °C for the 2014–2016 period; a high value in the Oceanic Niño Index (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml) and is as severe as the previous strong ENSO events. For comparison, the five strongest ENSO events, which initiated in 1972, 1982, 1997, 2002, and 2009 in the equatorial Pacific and that include the 1982–83 ENSO event that dramatically reduced the population size of *A. galapagoensis*, had the following characteristics: a mean SST anomalies exceeding 0.9 °C, a highest anomalous SST equal to 2.26 °C, and the events persisted for 9–14 months (Fisher et al. 2015). During and after those severe ENSO events, primary productivity shifted dramatically. Thus, the anomalous high SST resulting from the 2014–2016 ENSO event could have caused an unusual dispersion of the Galapagos fur seal in search of food resources. Further, a change in surface current patterns could have affected his ranging patterns. We investigated similar unusual reports and mortality events of seals in the Galapagos but did not find peer-review references related to the last ENSO event. However, in Ecuador, a local newspaper (El Universo) reported sightings of Galapagos sea lions (*Z. wolfebaeki*) and fur seals along its coast (approximately 1000 km from the Galapagos Islands) in 2014 and 2015 (J.J. Alava pers. comm.). In Mexico, a decline by >50% in the total abundance of two other pinniped populations was reported for Guadalupe fur seals (*A. P. townsendi*) and California sea lions due to the same ENSO event (Elorriaga-Verplancken et al. 2016b).

The stranding of the fur seal in Guatemala occurred at approximately 1500 km from the Galapagos Islands. Analysis of atypical dispersion events of *A. galapagoensis* may provide insight into the effects of anomalous high SST on the species. This is becoming increasingly important since climate change is predicted to escalate the frequency and the strength of ENSO events (Simmonds and Isaac 2007), which in turn, according to models, will decrease the population size of *A. galapagoensis* and could further result in a high risk of extinction (Salazar and Denkinger 2010). Thus, understanding the underlying causes of atypical dispersions can help identify conservation measures that protect the species and its ecosystem.

Abbreviations

ARCAS: Asociación de Rescate de Vida Silvestre; Cm: Centimeters; CONAPAC: Comando Naval del Pacífico; ENSO: El Niño Southern Oscillation events; km: Kilometer; lb.: Pound; m: Meter; SST: Anomalous sea surface temperature; TMMC: The Marine Mammal Center

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Availability of data and materials

Not applicable.

Authors' contributions

EQR, LG, R JL and ST responded to the reported stranded fur seal and were involved in its transportation to ARCAS. ST and EQR established and maintained contact with pinniped specialists in the United States, Mexico and Ecuador. EQR and LG supervised and took care of the rehabilitation effort of the fur seal, and participated in every veterinary exam. R JL provided veterinarian care and professional advice. ST helped with the initial identification of the fur seal, provided professional advice and together with ALR organized much logistical support for the care and the release of the fur seal at CONAPAC. EQR drafted the manuscript with contributions from ALR and ST. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

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Competing interests

The authors declare that they have no competing interests.

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