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Cetacean strandings along the Pacific and Caribbean coasts of Nicaragua from 2014 to 2021

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Abstract

Documenting marine mammal strandings provides important information needed to understand the occurrence and distribution patterns of species. Here, we report on strandings of cetaceans on the Pacific ($n = 11$) and Caribbean ($n = 2$) coasts of Nicaragua, documented opportunistically from 2014 to 2021. Strandings included three species of baleen whale (blue whale *Balaenoptera musculus*, Bryde's whale *Balaenoptera edeni*, humpback whale *Megaptera novaeangliae*) and five species of toothed whale (dwarf sperm whale *Kogia sima*, Guiana dolphin *Sotalia guianensis*, pantropical spotted dolphin *Stenella attenuata*, spinner dolphin *Stenella longirostris*, Cuvier's beaked whale *Ziphius cavirostris*). These are the first published accounts of blue whales, Bryde's whales, dwarf sperm whales, and Cuvier's beaked whales in Nicaraguan waters. Limited resources and the advanced decomposition of animals prevented necropsies in most cases, the identification of the causes of mortality in all cases, and the species identification of two dolphins. Information derived from these stranding events offers new insights into the occurrence of marine mammals on the Pacific and Caribbean coasts of Nicaragua and Central America.

Keywords: Central America, Cetaceans, Citizen science, Diversity, Eastern Tropical Pacific

Introduction

Assessments of the occurrence, distribution, and population status of whales and dolphins typically require logistically complex and costly methods such as systematic boat-based transects and aerial surveys. Implementing these methods in regions with limited resources is often infeasible. Data derived from stranding events, while typically restricted to mortality events along coasts, can help to document the presence of different cetacean species in under-studied areas (Peltier et al. 2012). Stranding events offer opportunities to gather information on live or dead animals and generate valuable insights on the presence, diversity, and possible sources of mortality of local species (Geraci and Lounsbury, 2005; Moura

et al. 2016). Cetaceans strand for a variety of reasons (both natural and anthropogenic) including poor health from infectious diseases (e.g., parasites, viruses, bacteria) and old age; injury caused by boat collisions or entanglement in fishing gear; and (potentially) behavioral and physiological impacts from pollution (e.g., chemical, sound) (Reynolds et al. 2009). If conditions and resources allow, data derived from necropsies can reveal causes of death and help to identify the population origin of stranded animals (Pyenson 2011).

The occurrence and distribution of cetaceans in some parts of the Pacific coast of Central America is poorly understood. The lack of basic information on species present in Nicaraguan waters limits the development of effective management practices for cetacean conservation. Recent findings on recurrent feeding of humpback whales (De Weerd and Ramos, 2019) and the presence of whales from distinct subpopulation (De Weerd et al. 2020) highlights the need for more in-depth studies on

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whales and dolphins in the regions. Information on these species in Nicaragua and Central America is lacking because of the limited amount of boat-based surveys, the absence of a coordinated stranding response, and of organizations trained and equipped to collect standard stranding data and conduct post-mortem analysis of stranded animals. Knowledge derived from strandings, notably cause of death, can help to highlight factors underlying mortality and serious injury. While the capture, killing, and harvesting of dolphins (and marine turtles) are prohibited in Nicaragua (Law 489 – Art. 77, Fisheries and Aquaculture), the lack of baseline information on species limits the effectiveness of any monitoring, and the lack of law enforcement and regulation limits marine megafauna protection. Additionally, Nicaragua has extensive coastlines on its Pacific and Caribbean coasts that are logistically challenging to monitor.

Here, we report strandings of cetaceans along the Pacific and Caribbean coasts of Nicaragua observed from 2014 to 2021. We briefly describe what is known about the occurrence of each species in Central America and provide information on each stranding event, including location, date, and state of decomposition.

Methods

The Nicaraguan Pacific coast is composed of a series of sandy beaches and bays, and includes continental slopes extending over 100 km from the coast. Data on marine mammal strandings in the northern and southern Pacific region of Nicaragua and from the Caribbean coast were

collected between 2016 and 2021 by Association ELI-S. Data was sourced from both a citizen science observational network involving fishermen and local communities, and from publications encountered through online searches and/or on social media. Association ELI-S conducted basic necropsies when strandings occurred in the research areas located in both the Natural Reserve of Padre Ramos in the north and San Juan del Sur in the south of Nicaragua (Fig. 1). Stranding records were included only when the date, time and detailed location information were provided, and when photographic and/or video evidence was available to allow species identification. The state of stranded animals was evaluated based on pictures/videos, and codes were assigned according to Geraci and Lounsbury (2005): Code 1: Alive; Code 2: Fresh carcass; Code 3: Moderate decomposition; Code 4: Advanced decomposition and Code 5: Mummified or skeletal remains. On two occasions measurements and gross necropsies were performed when the stranding was managed by a member of Association ELI-S; these strandings involved *Stenella attenuata* and *S. longirostris*. Linear length measurements were made from the tip of the rostrum to the medial notch of the caudal fin (tail).

Results and discussion

A total of 13 strandings involving 16 animals were documented during the study period 2014–2021. This included 11 stranding events on the Pacific coast and two on the Caribbean coast. Details are given below.

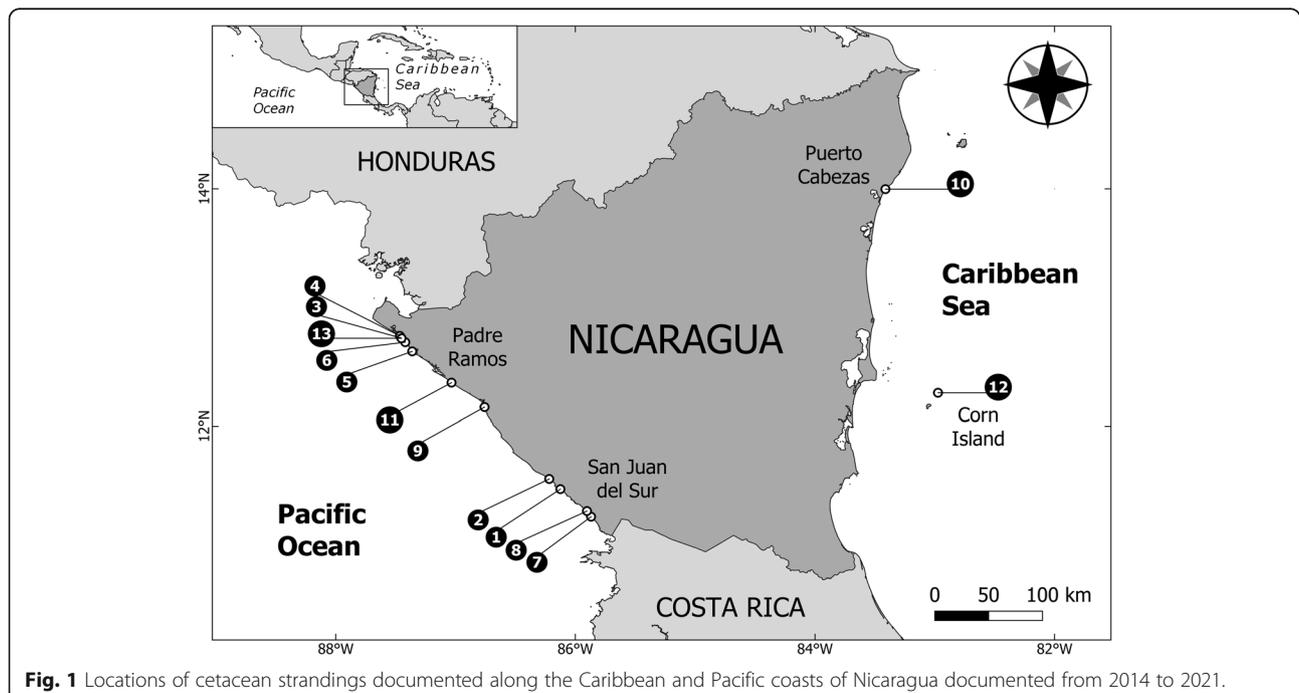


Fig. 1 Locations of cetacean strandings documented along the Caribbean and Pacific coasts of Nicaragua documented from 2014 to 2021.

Guiana dolphin (*Sotalia guianensis*)

Guiana dolphins are known to occur along the Caribbean coastal areas from Southern Brazil to Honduras (da Silva and Best 1996, Secchi et al. 2018). This species has been reported as abundant in the 1990s off the Nicaraguan coast (Carr and Bonde 2000) and present year-round in certain areas (Edwards and Schnell 2001). Concerns were raised in these studies regarding the local extinction of the species due to increasing bycatch in coastal gillnets. The conservation status of this species is listed as “Near Threatened” on the IUCN Red List (Secchi et al. 2018).

Three adult individuals stranded dead but in good condition (Code 2) on 8 September 2020 along the northern Caribbean coast of Nicaragua within the sandy beach of Bilwi, Puerto Cabezas (Table 1; Fig. 2). There was insufficient information to determine cause of death.

Pantropical spotted dolphin (*Stenella attenuata*)

Pantropical spotted dolphins from the Eastern Tropical Pacific (ETP) belong to two subspecies based on morphological and genetic analysis: *Stenella attenuata attenuata* (offshore form; two stocks) and *S. a. graffmannii* (coastal form) (Leslie & Morin 2016; Perrin 1994). This species is listed as “Least Concern” on the IUCN Red List (Kiszka & Braulik 2018). Spinner dolphins and pantropical spotted dolphins were reported in the ETP and in Central American waters through sighting and stranding data (Cabrera et al. 2014, De Weerd et al.

2017; Oliveira et al. 2011; Perrin & Gilpatrick 1994; Rodriguez & Cubero 2001).

Two pantropical spotted dolphins (unknown subspecies) were found stranded. One individual live stranded on Playa Veracruz de Acayo, along the Pacific coast on the 23 February 2016 (Table 1; Fig. 2). The animal was released from a 200-lb long line while in the water and washed up onto coral reefs after being cut free. It was kept in a tidal pool by locals but died that same morning. A necropsy was not performed on this animal, and besides the evidence for entanglement-related injuries, there was insufficient data to determine cause of death.

Another individual stranded on Playa Marsella in southern Nicaragua on 26 September 2019, in good external condition with an inflated tongue (Code 3), and a body length of approximately 2 m (Table 1; Fig. 2).

Spinner dolphin (*Stenella longirostris*)

Spinner dolphins are listed as “Least Concern” on the IUCN Red List (Braulik & Reeves 2018). They are widely distributed in tropical waters (Perrin 2009) and occur in the ETP, both in coastal areas and offshore (Perrin & Gilpatrick 1994). The ETP pelagic subspecies favours tropical surface waters, which are characterised by relatively small annual variations in surface temperature and by a shallow mixed layer (Perrin 2009).

A single adult spinner dolphin was found stranded on 05 April 2017 and deceased in Padre Ramos along the northern Pacific coast of Nicaragua (Table 1; Fig. 2). The lack of decomposition of the carcass (Code 2) suggests it had died recently. The body was measured in the field

Table 1 Summary of reported stranding events in Nicaragua. † = Dead; Unk. = Unknown; F = Female. Population status according to the International Union for the Conservation of Nature (IUCN) status: LC = Least Concern; EN = Endangered; DD = Data Deficient; VU = Vulnerable. Codes according to Geraci and Lounsbury (2005)

Species	Case Number	Code	Decomposition Code	Stranding date	Location	IUCN status	Sex	Necropsy
Odontoceti								
<i>Kogia sima</i>	1	Alive	1	27 Apr 2017	Pacific	DD	UK	No
<i>Kogia sima</i>	2	†	2	05 Dec 2020	Caribbean	DD	F	Yes
<i>Sotalia guianensis</i>	3	†	2	08 Sep 2020	Caribbean	NT	UK	No
<i>Stenella attenuata</i>	4	Alive	1	23 Feb 2016	Pacific	LC	UK	No
<i>Stenella attenuata</i>	5	†	3	28 Sep 2019	Pacific	LC	F	No
<i>Stenella longirostris</i>	6	†	2	05 Apr 2017	Pacific	LC	F	Yes
Unidentified dolphin	7	†	4	20 Feb 2017	Pacific	LC	UK	No
Unidentified dolphin	8	†	4	14 Feb 2021	Pacific	LC	UK	No
<i>Ziphius cavirostris</i>	9	Alive	1	23 July 2020	Pacific	LC	UK	No
Mysticeti								
<i>Balaenoptera musculus</i>	10	Alive	1	17 Nov 2014	Pacific	EN	UK	No
<i>Balaenoptera edeni</i>	11	†	2	23 Nov 2020	Pacific	VU	UK	No
<i>Megaptera novaeangliae</i>	12	†	3	08 Sep 2017	Pacific	LC	UK	No
<i>Megaptera novaeangliae</i>	13	†	3	17 July 2019	Pacific	LC	F	No



Fig. 2 Images of four species of cetaceans found stranded along the Pacific and Caribbean coast of Nicaragua from 2014 to 2021. Case 3: *Sotalia guianensis* (photo credit : Bilwi community); Case 4–5: *Stenella attenuata* (photo credit: Arry Buddha / Celeste Quintana Facebook); Case 6: *Stenella longirostris* (photo credit : Etienne Pouplard); Case 7–8: unidentified delphinid (photo credit : Etienne Pouplard / George Bevan)

and was 150 cm long from snout to fluke; examinations of its surface revealed no lesions, wounds, or signs of a possible cause of death. The stomach contained some leftovers parts from fish, but the animal had apparently not eaten recently, as evidenced by the absence of undigested fish.

Unidentified delphinid

Two dolphins were reported along the northern Pacific coast on 20 February 2017 in Padre Ramos, and 14 February 2021 in Jiquillo, and were both in an advanced stage of decomposition (Code 4) preventing species identification (Table 1; Fig. 2). Both individuals were long-snouted delphinid with small teeth, indicating it could have been either *Stenella longirostris* or *Delphinus capensis*.

Dwarf sperm whale (*Kogia sima*)

The two extant species of *Kogia* spp., pygmy sperm whale *K. breviceps* and dwarf sperm whale *K. sima* inhabit tropical and temperate waters globally. Both species are listed as “Data Deficient” on the IUCN Red List (Taylor et al. 2012). The lack of data on both species

reflects their deep-water ecology. They dive for long periods of time, travel alone or in small groups, and avoid vessels (Willis & Baird 1998). Dwarf sperm whales have a slight preference for the continental shelf and slope, as deduced from the stomach contents of stranded individuals (Caldwell and Caldwell, 1989).

On 26 April 2017, an adult dwarf sperm whale live-stranded (Code 1) in the Natural Reserve of Padre Ramos on the northern Pacific coast (Table 1; Fig. 3) and died after a rescue attempt by local fishermen. Videos and pictures of the animal allowed for confirmation of species identification based on the presence of the triangular dorsal fin placed midway along the back, together with the shape of head (Willis & Baird 1998). No body measurements were taken of the animal. No physical damage was detected on the individual prior to the rescue attempt. Sightings of *Kogia* spp. along the Pacific Coast of Central America are rare. In the ETP, there is one published report of a mother-calf pair interacting with tuna purse-seine fisheries (Scott & Cordaro 1987). *K. sima* strandings have been previously reported in Guatemala (Cabrera et al. 2014) and Costa Rica (Oliveira et al. 2011) but not along the Pacific coast of Nicaragua.



Fig. 3 Images of two species of cetaceans found stranded along the Pacific and Caribbean coast of Nicaragua from 2014 to 2021, Case 1–2: Adult *Kogia sima* and foetus (photo credit: Eddy Aluvin / George Bevan). Case 9: Adult *Ziphius cavirostris* (photo credit: Christian Shane)

On 5 December 2020, an adult female dwarf sperm whale stranded dead (Code 2) in the Caribbean, on Corn island (Table 1; Fig. 3). The presence of a young fetus confirmed pregnancy. Adult size was visually estimated by locals to be about 3 m. Local communities consumed the animal.

Cuvier's beaked whale (*Ziphius cavirostris*)

Cuvier's beaked whales are listed as "Least Concern" on the IUCN Red List and are widely distributed in deep (> 200 m) offshore waters (Baird et al. 2020). This species is sensitive to acoustic disturbance (e.g., seismic disturbance and naval sonar) which can cause behavioral changes such as habitat displacement (Southall et al. 2016), and sometimes strandings (Simonis et al. 2020). Cuvier's beaked whales have been sighted in Guatemala during boat-based surveys (Cabrera et al. 2014). One stranding was reported in Costa Rica (Rodriguez & Cubero 2001), and three strandings occurred in El Salvador (Bachara et al. 2020).

On the 23 July 2020 a single Cuvier's beaked whale live stranded (Code 1) at 10:40 on Miramar beach, Leon, along the Pacific coast (Table 1; Fig. 3). Large scrape marks were observed, presumably made by contact with coral reefs, and the animal appeared to be stunned. Local community members forcefully hit the animal in attempts to make it regain consciousness. The animal safely swim away from the beach. Videos and photos allowed species identification.

Blue whale (*Balaenoptera musculus*)

Blue whales are listed as "Endangered" on the IUCN Red List (Cooke 2018). Individuals from the Southern

Hemisphere have complex movement patterns, and their distribution remains unclear (Branch et al. 2007). In the ETP, blue whale occurrence is related to the major oceanographic complex known as the Costa Rica Dome (CRD; Reilly & Thayer 1990; Wade & Friedrichsen 1979). Prior to this stranding, the closest observation of a blue whale (a mother-calf pair) to Nicaragua was made 230 km offshore in September 2003 (Pitman et al. 2007).

An adult blue whale (Code 1) live-stranded on a beach in Nicaragua in November 2014 (Table 1; Fig. 4). The individual died after a rescue attempt by local communities. No body measurements were taken from the animal and there was insufficient data to identify the cause of death.

The annual movement pattern of the CRD brings nutrient-rich waters closer to Central American coastal waters in November (Fiedler 2002). Satellite tracking data showed that one tagged blue whale migrated towards the CRD for feeding, leaving California in September and moving along the Mexican coastline (Mate et al. 1999). The geographical proximity of the CRD to Nicaragua potentially explains the presence of the stranded blue whale there. Strandings of blue whales from the ETP are rare (Branch et al. 2007), probably due to the species' typically offshore distribution in this region.

Bryde's whale (*Balaenoptera edeni*)

Bryde's whales are listed as "Least Concern" by the IUCN and are generally found offshore even if some in-shore populations or forms exist within the species (the overall taxonomy of this group remains partly unresolved, Cooke & Brownell 2018). Little information is



Fig. 4 Images of three species of cetaceans found stranded along the Pacific coast of Nicaragua from 2014 to 2021, Case 10: adult *Balaenoptera musculus* (photo credit : website); Case 11: juvenile *Balaenoptera edeni* (photo credit : website); Case 12 adult *Megaptera novaeangliae* (photo credit : Eddy Aluvin); Case 13 juvenile *M. novaeangliae* (photo credit : Damaris Obando)

available on this species' ecology in Central America. A stranded Bryde's whale, but usually exhibit offshore distribution patterns (Quintana-Rizzo 2017). In Oaxaca, Southern Mexico, four observations were made within coastal areas (Villegas-Zurita 2016). One stranding event of a 14 m-long female was documented in Playa Bandera, Costa Rica (Rodríguez & Cubero 2001) and another was in Guatemala (Cabrera et al. 2014).

On 23 November 2020, a juvenile Bryde's whale of about 4 m in length was found dead (Code 2) in Las Peñitas, León (Table 1; Fig. 4). Species identification was confirmed with the presence of the dark left jaw, and the three ridges on the rostrum. At about 4 m, the animal would have been no older than a yearling. According to local fishermen it was hit by a boat, but this could not be inferred from the pictures collected in the field. The individual was eaten by local communities.

Humpback whale (*Megaptera novaeangliae*)

Two humpback whale populations migrate into the coastal Pacific waters of Nicaragua during their breeding season: the Central American population from the Northern Hemisphere (Calambokidis 2008), and the population classified by the International Whaling Commission as "G-Stock" from the Southern Hemisphere (De Weerd et al. 2020). Although humpback whales are

listed as "Least Concern" by the IUCN (Cooke 2018), the status of the Central American population has been classified as "Threatened" by the National Oceanic and Atmospheric Administration (NOAA); NOAA recognizes Central American humpback whales as a "Distinct Population Segment" that requires special attention for future management actions (Bettridge et al. 2015).

Two humpback whale strandings were reported at two different sites: one adult in the Natural Reserve of Padre Ramos (northern Nicaragua) in September 2017 (Code 3), and one juvenile/subadult along the coast of San Juan del Sur, southern Nicaragua in July 2019 (Code 3) (Table 1; Fig. 4). Images of the young individual revealed the presence of linear scars on its flank. No body measurements were taken of either animal, but measurements of the skeleton of the young individual showed the length to be 10 m. Based on the stranding dates of these animals and their overlap with the humpback whale's migratory season (September and July, Table 1), both whales were likely part of the G-Stock Southern Hemisphere population. Animals from this population migrate north from Antarctic waters along the coast of South America in the austral winter, and sometimes reach Nicaragua (De Weerd et al. 2020).

Stranded humpback whales have been reported in neighbouring Guatemala (Cabrera et al. 2014) and Costa

Rica (Rodríguez & Cubero 2001; Oliveira et al. 2011) but limited information prevent determination of population of origin. Two dead humpback whale calves were reported floating along the Pacific Coast of El Salvador (23 km off Costa de Sol and 28 km off Playa La Zunguana) in August 2019 (Baires J., *personal communication*). Because of the absence of postmortem examination, it was not possible to determine whether linear scars found on the stranded juvenile reported here were acquired pre- or post-mortem. The coastal distribution of humpback whales coincides with areas of high anthropogenic activity, making them vulnerable to fishing gear entanglements (Reeves et al. 2003).

Conclusions

Here we report the stranding of sixteen individual animals of seven different species along the Pacific and Caribbean coasts of Nicaragua. To the best of our knowledge, these include the first documented cases of a blue whale, Bryde's whale, Cuvier's beaked whale, and dwarf sperm whale in Nicaraguan waters. Out of the seven stranded species we identified in Nicaragua, all species with the exception of the blue whale have stranded in Guatemala (Cabrera et al. 2014) and in Costa Rica (Rodríguez & Cubero 2001) and five stranding events occurred within protected areas (cf. Natural Reserve of Padre Ramos on the northern Pacific coast). Decomposition state varied between strandings, and the cause of strandings could not be clearly identified for any specimen due to the lack of necropsies. Necropsies should be used in future monitoring to provide additional data and, where possible, to determine the cause of death. This information is crucial especially for species and small populations with high conservation priority.

Natural diseases can be the cause of strandings for cetacean species, as observed in Costa Rica, where cases of brucellosis were reported in different dolphin species (Oliveira et al. 2011). Visual detection of diseases is often difficult, making it hard to determine whether disease contributed to a stranding event in absence of a necropsy. In addition to natural causes, anthropogenic activities can be the ultimate cause of stranding events; these can include boat collisions, fisheries bycatch, and also (potentially) chemical and sound pollution (Reynolds et al. 2009). While boat collisions and bycatch are sometimes obvious even in an external examination, other anthropogenic activities are difficult to identify externally without necropsy, such as chemical and sound pollution and the acoustic effect of underwater detonation (Reynolds et al. 2009).

The presence of the longline observed with one pantropical spotted dolphin suggests that fisheries can have an impact on animals in these waters. Humpback whale entanglement in fishing lines were observed in 2018 in

Padre Ramos and in 2021 in San Juan del Sur (Pers. Obs.), and illegal trawling activities in southern Nicaraguan coastal areas were observed in 2018 in proximity to a mother-calf pair humpback whale near the stranding location (Pers. Obs.). The illegal use of home-made bombs as a fishing technique along most Nicaraguan shorelines (except for the Department of Rivas) could potentially pose an additional threat to marine mammals. No formal studies exist on the impact of these specific explosive devices on acoustic or other behaviour, but studies on seal bombs used in purse-seine fisheries suggest a potential impact on, and potentially physical damage to cetaceans (Baumann-Pickering et al. 2015).

Recommendations for future work in this region include coastal surveys for strandings, obtaining detailed information on stranded animals from improved necropsies, the collection and analysis of tissue samples to assess health and diseases, and assessment for possible influences of human interactions on stranded animals.

Cetacean strandings potentially involve risk for humans. People attempting to render assistance to stranded animals are at risk of injury and possibly even death if the animals thrash, and disease can be transmitted from contact with tissue or bodily fluids. In addition, the consumption of animals by local communities is concerning for a variety of reasons. These animals carry diseases that are potentially transmissible to humans through contact or ingestion. Trace elements, heavy metals and pesticides are specific contaminants found in marine mammals that can potentially impact human health. Regulations governing strandings should be established to mitigate these threats to human health.

Abbreviations

CRD: Costa Rica Dome; DPS: Distinct Population Segment; ETP: Eastern Tropical Pacific; IUCN: International Union for Conservation of Nature; NOAA: National Oceanic and Atmospheric Administration

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Authors' contributions

JDW and EPO collected the data from the field and from various sources. JDW, EAR, PC and MK produced the manuscript. All authors approved the final manuscript.

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