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Out of habitat marine mammals – Identification, causes, and management recommendations

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ABSTRACT

An out of habitat (OOH) marine mammal is an individual found outside of their natural range, e.g., an Atlantic walrus (*Odobenus rosmarus rosmarus*) along the coastline of mainland Europe, or an individual within their natural range in habitat that is not optimal for their health or survival due to a lack of suitable conditions and/or because of potential conflict with humans. As the number of OOH marine mammals appears to be increasing, and following on from two international workshops, here we define what constitutes an OOH marine mammal and provide a detailed assessment of potential drivers. Climate change, habitat loss and/or degradation, disturbance, changes in prey distribution, and morbidity may all be reasons for a marine mammal being OOH. Appropriate management of OOH marine mammals is considered. This may simply involve monitoring to better understand the situation, to protect the welfare of the animal(s) and to ensure that members of the public are kept safe. However, on occasion, further intervention may be required, such as providing safe areas for the OOH marine mammal(s), encouraging the animal(s) to move, capture and translocation, or euthanasia. Regardless of the action taken, educating and communicating with the public are key elements of OOH marine mammal management. Lessons can be learned from human-wildlife conflict and rewilding scenarios. The potential for OOH marine mammals to be pioneers seeking new habitat, contributing to species resilience in the face of rapidly changing environments, and how to include them in conservation legislation and management planning are considered.

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1. Introduction

"Beluga charms British with impromptu visit"; "Marine mammal group confirms sighting of wayward minke whale in Montreal area"; "The arrival of a wandering walrus causes a splash" [1–3]. News headlines such as these, which describe the appearance of marine mammals in places they are not typically found, have become more commonplace in recent years. Since 2019, for example, four Atlantic walruses (*Odobenus rosmarus rosmarus*), a polar species, have been recorded in temperate areas of Europe, sometimes staying for prolonged periods [4,5], Fig. 1. Such animals are curiosities but may also require management to limit negative impacts to their welfare and risks to humans who interact with them, until they leave an area either of their own accord or as a result of appropriate intervention. There have been numerous situations around the globe involving so-called "out of habitat" (OOH) marine mammals in recent years. To investigate these more closely, the first OOH Marine Mammals International Workshop was held in 2021 [4], with a second workshop held the following year [5]. Experts with experience in documenting and/or managing such situations were invited, and case studies were reviewed that highlighted the variety of species and locations involved. This paper developed from discussions at the second workshop as it became clear that the scientific community is interested in further exploring and understanding the drivers behind OOH marine mammals. In this paper we consider what an OOH marine mammal is, explore potential reasons for why more of these cases are being recorded, provide guidance regarding how to keep both animals and humans safe, and highlight the importance of good communication, education and conservation/welfare planning including potential changes to legislation.

2. Definitions

The term "out of habitat" originally arose from informal discussions between colleagues who are interested in such animals and has been used in the literature [e.g. 6,7] and at the two workshops noted above [4,5]. The term "vagrant" is well known, and vagrant animals would be considered OOH. This and other relevant terms are included in Table 1 with definitions and examples from the literature. The definitions which we use in this paper are highlighted in bold.

We define an OOH marine mammal to be either:

- An individual outside of their natural range, or
- An individual within their natural range in habitat that is not optimal for their health or survival due to a lack of suitable conditions and/or because of potential conflict with humans.

Generally, the term OOH would apply to animals that find their own way into these situations, but it is possible that circumstances (e.g., changing sea conditions or loud noise) drive them there or even that humans release them into atypical habitat. Examples of recent cases of OOH marine mammals are given in Table 2.

3. Reasons for the occurrence of out of habitat marine mammals

Why an animal is OOH may not be immediately obvious, and unique circumstances may apply to individual cases including, perhaps, simple curiosity. For example, an apparently healthy beluga (*Delphinapterus leucas*), entered the River Thames, UK, in 2018 before leaving the area of its own accord a few months later [4] (Fig. 3).

There are several factors that may, alone, cumulatively, or synergistically, lead animals to leave their natural habitat or range including

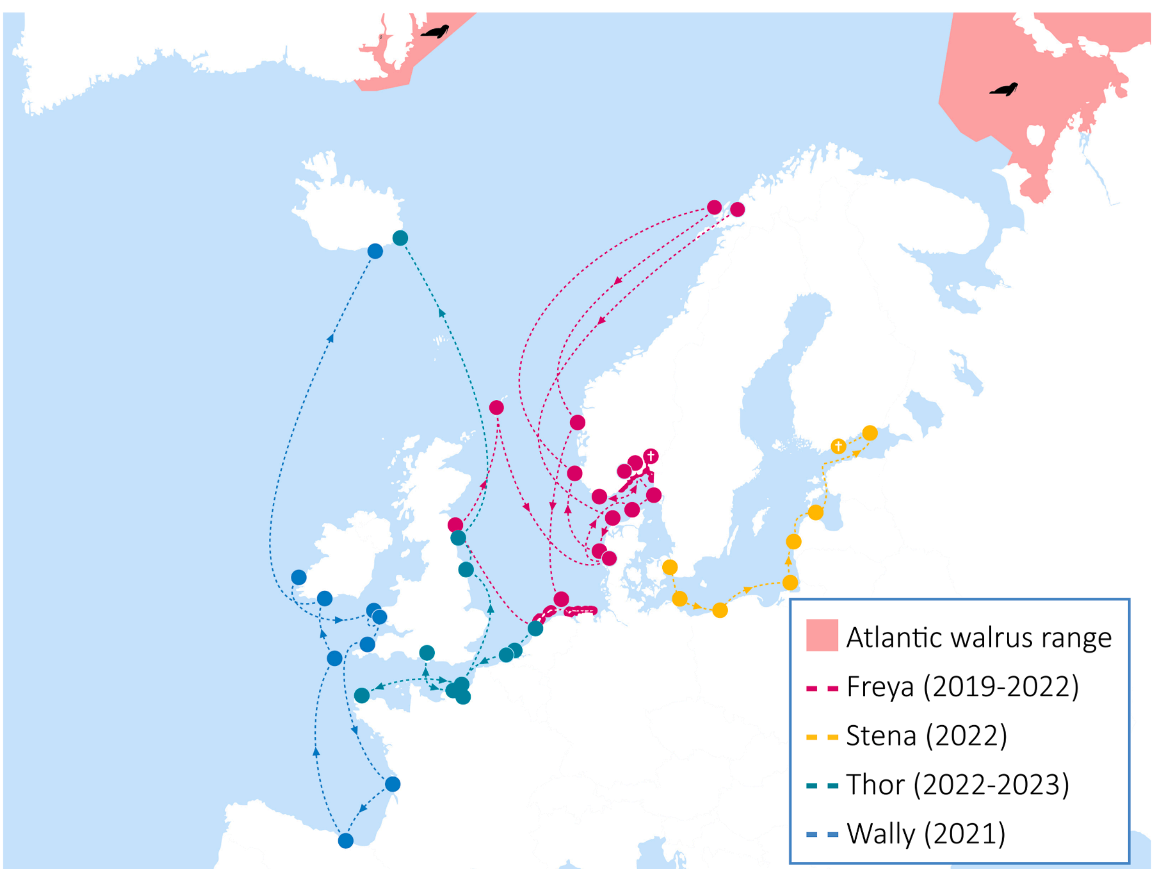

Fig. 1. Sighting locations and possible routes of four OOH Atlantic walruses (*Odobenus rosmarus rosmarus*) in Europe. Cross indicates location of death of individual.

Table 1
Key terms relevant to the discussion around out of habitat marine mammals (definitions highlighted in bold are those used throughout this paper).

Term	Definition	Notes and/or examples
Out of habitat	**an individual outside of their natural range**	See Table 2 for examples.
	an individual within their natural range in habitat that is not optimal for their health or survival due to a lack of suitable conditions and/or because of potential conflict with humans	See Table 2 for examples.
	"an animal is considered "out of habitat" when it is found outside its normal habitat…Out of habitat animals may also be beyond their normal geographic range," [6]	For example, "pelagic dolphins that are found in estuaries or coastal bays and large whales that stray far into rivers away from the open ocean," [6].
	"an animal that is out of its normal distributional and/or habitat range and would most likely perish because of surrounding environmental factors and resource limitations," [7]	For example, "an ice seal in the Caribbean or a bottlenose dolphin in a freshwater canal," [7].
Habitat	**"the place or type of site where an organism or population naturally occurs,"** [8]	
	"any area in the range of a migratory species which contains suitable living conditions for that species," [9]	This definition could also be applied to non-migratory species.
Atypical habitat	**habitat that is outside of the species' natural range**	For example, "a Florida manatee (found in waters from Florida to N. Carolina) rescued in Massachusetts," [6].
	habitat that is within the species' natural range, but the individual is in a place or type of site where they do not naturally occur	Note: definition based on [8]. E.g., a marine species in a river. Another example: some leopard seals (*Hydrurga leptonyx*) in Aotearoa New Zealand (NZ) utilize atypical habitat including marinas, boat ramps, and pontoons, which brings them into close contact with humans and means they can be described as OOH marine mammals [5,10], Fig. 2. It is noted that leopard seals were previously classified as vagrants but based on *inter alia,* increasing numbers, distribution, duration of occurrence and births [11-13], they have recently been reclassified as "native resident," with NZ now considered part of their secondary range [11,14].
Range	Natural range: **"the geographical area over which a species has lived naturally in recent times (since about 5000 years before the present), excluding any changes to that range that result from human activities. Also known as ecological range or geographical range."** [15]	
	"all the areas of land or water that a migratory species inhabits, stays in temporarily, crosses or overflies at any time on its normal migration route," [9]	For non-migratory species, "range" could refer to areas of land or water that the species inhabits.
	Extent of occurrence: "the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy," [16] Area of occupancy: "the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy," [16]	
Vagrant	**"the species is/was recorded once or sporadically, but it is known not to be native to the area,"** [17]	Convention on the Conservation of Migratory Species of Wild Animals (CMS) Decision 13.140 highlighted that the definition for vagrant used by IUCN [17] does not indicate when a species stops being a vagrant, noting that "with the onset of climate change, a vagrant may become more established in a country if its range shifts," [18].
	"species that for a variety of reasons (physiological, physical changes in the environment) expand to an area, remain for a time then disappear; i.e. transitory but not migratory," [19]	ICES [19] also noted that "the definition of marine vagrants needs to be reviewed and defined by biologists".
	"rare and unexpected ones that do not occur annually," [20]	
	"a species represented by individuals found outside their native distributional range, appearing in a given region with high or extreme rarity," [21]	For example, the rough-toothed dolphin (*Steno bredanensis*) is considered regular in the eastern basin of the Mediterranean Sea and vagrant elsewhere in the Mediterranean [21].
Pioneer	**an individual exploring new territory beyond their natural range**	Some OOH marine mammals may be "pioneers" exploring new territory beyond their natural range. In rapidly changing environments, as habitats and prey come under increasing anthropogenic and environmental pressures, the biological incentive to pioneer new territory may be rising. This may partly explain the increasing occurrence of seemingly OOH individuals across a broad range of environments (see Table 2). According to Davis and Watson [22] "dispersal is the fodder of evolution, allowing dwindling populations to replenish and seeding the potential for lineages to diversify." It may only be possible to determine that an individual was a pioneer retrospectively.

Fig. 2. Leopard seal (*Hydrurga leptonyx*) on a marina fueling dock in New Zealand (Credit: Ingrid N. Visser, leopardseals.org).

climate change, loss of habitat, population growth, prey availability, underwater noise, disturbance, morbidity, inappropriate release or escape from captivity [4,5] (Fig. 4). It is also possible that an individual could be considered OOH because of our misunderstanding of its range or habitat, for example if a population has not been sufficiently studied.

Climate change affects marine life worldwide, with warming oceans generating unprecedented cascading effects. These include, but are not limited to, melting of polar ice [62], rising seas [63], marine heatwaves [64], and ocean acidification [65]. These processes have already caused a range of direct and indirect effects on marine mammals, including alterations to migratory behavior [66,67] and habitat shifts likely driven by the need to track changes in prey availability [68–71]. These shifts can cause OOH situations, both temporally (i.e., migratory species extending their seasonal abundance) and spatially (i.e., species extending their distribution outside their natural range) [70,72].

Climate change may alter or eliminate habitat; for example, pinniped haul-outs on seasonal ice shelves, used for breeding, hunting, or resting, have disappeared (i.e., ice does not form, is greatly reduced, or melts) [73]. Indeed, animals with the strongest dependency on sea ice currently provide the clearest examples of species dealing with habitat loss or significant degradation. The four walruses which travelled around temperate parts of Europe in recent years might be examples of this, Fig. 1 and Table 2. Another potential early sign of climate-driven distribution change are the two Pacific gray whales (*Eschrichtius robustus*) seen separately in the Mediterranean Sea in 2010 and 2021 [4,23], Fig. 5.

As climate conditions increasingly change, climatically-induced range-shifts are projected to continue and increase for several marine mammal species globally [69,74,75]. Extreme weather events, which are becoming more frequent with climate change [76,77], may also put marine mammals into OOH situations. For example, storm surges and coastal flooding during hurricanes can carry dolphins into atypical habitat which can impact their health and survival [78]. For example, Hurricane Rita hit the southwest Louisiana coast in the United States on 24 September 2005, and the accompanying storm surge trapped several bottlenose dolphins (*Tursiops truncatus*) well inland [7]. In the month following Rita, six dolphins were found in ditches, canals, and a flooded field, at distances ranging from 2.5 km to 11 km inland from the Gulf of Mexico. Five of the animals were captured and released at sea, but one was severely emaciated and died before he could be rescued.

Habitat degradation such as physical barriers or damage, chemical and noise pollution, and disturbance might also cause individuals or populations to shift their distribution [79]. The effects of noise and other disturbance on cetaceans can displace them from habitat temporarily or even cause them to abandon it permanently [80]. For example, gray whales were displaced for more than five years from one of their breeding lagoons in response to industrial noises [81] and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) showed avoidance behavior during pile driving [82]. Acute anthropogenic noise sources include seismic survey airguns and military sonars [83] and chronic noise sources include shipping, a noise source which may increasingly enter areas where it was previously less prevalent, in particular as polar ice retreats [84]. Offshore industries such as marine windfarms, which are developing at a fast pace in many areas, might also change habitat, leading animals to seek less disturbed habitat [e.g., 85,86] or to even be attracted to such structures [87]. Disturbance can also be caused by human recreational activities. The presence of boats and/or swimmers in a resting area [e.g., 88], for example, or people on land who disturb hauled-out pinnipeds may also cause displacement [e.g., 10,89].

Physical conditions such as temperature or salinity can be key to species distribution [90] and dilution of nearshore salinity by severe rainfall resulting from human-induced climate change may displace nearshore dolphins, in combination with other factors [24]. All of these types of habitat degradation can lead animals to lose access to parts of their normal habitat, which may compel them to search for suitable habitats elsewhere. However, this search could sometimes lead them into areas that are not appropriate.

Some species may expand into new areas as their populations grow, making a rise in OOH occurrences plausible. This expansion may simply be stochastic, with a larger population increasing the likelihood of animals entering unfamiliar areas or may be driven by limits to environmental carrying capacity, which can push animals to actively seek new habitats. Following the end of most commercial whaling, which had severely depleted a number of species and populations worldwide, some populations have shown recovery [e.g. 91], including humpback whales (*Megaptera novaeangliae*) in the North Atlantic [92,93]. The recent increase in sightings of these whales in the Mediterranean — a region outside their natural range — may be linked to the recovery of North Atlantic populations [25,94–97]. Although the reasons for their presence in the Mediterranean remain unclear, the overlap between these occurrences and high-productivity areas suggests that humpback whales may enter these waters in search of feeding opportunities [25,97]. The possibility of humpback whales in the Mediterranean being pioneers also needs consideration.

Marine mammals can move away from previously occupied areas due to depletion and/or shifts in distribution of their prey [98,99]. For example, in the Inner Ionian Sea Archipelago, there has been a progressive and dramatic decline in megafauna, including common dolphins (*Delphinus delphis*) [100,101]. This has been attributed to human overfishing of key prey species [102–105]. Recent survey effort in that area and surrounding waters has shown that the dolphins, while persisting in the archipelago at low densities, are now using waters beyond historical core habitat [106].

Cetaceans may find themselves OOH when they enter an inlet, river, or other body of water that connects to the ocean only at certain tidal cycles or under other specific conditions [107]. They can get trapped in harbors, canals, or rivers when the route back to normal habitat has a real or perceived barrier such as a bridge or culvert [e.g., 26]. In NZ, orcas regularly enter shallow harbors to forage on elasmobranchs, a strategy that carries a high risk of stranding [108–110]. In August 2021, a group of seven orcas passed under two bridges and entered the shallow harbor of Pāuatahanui Inlet, Porirua, North Island, where they remained for five days, foraging, resting, and engaging in social behaviors [4]. Attempts to drive the orcas out of the inlet with the noise from *oikomi* pipes (metal pipes placed in the water and hit with hammers) were unsuccessful and, eventually, the orcas left of their own accord overnight.

Morbidity caused by infectious disease, neoplasia (an abnormal growth of cells) [111,112], exposure to contaminants [113,114], biotoxins [115–117], and trauma from both anthropogenic and natural causes are likely contributing factors in some OOH situations. For example, debilitated individuals such as those weakened by starvation may be passively moved out of their normal habitat by winds or currents [118,119]. Conversely, underlying conditions may lead animals to actively move into atypical habitats. For example, animals with neurological impairments (e.g., from domoic acid poisoning [120]) or injuries

Table 2
Some examples of recent out of habitat marine mammals [4–6,10–12,14,23–61], personal communication JL Crespo Picazo 2023].

Species [name given to individual animal] (age/sex /group size)	Date	Natural habitat/ range	Location of OOH marine mammal(s)	Interventions/Outcome
Cetaceans				
Beluga *Delphinapterus leucas* [Nepi] (male)	June 2017	Arctic – this individual from the St. Lawrence Estuary population	Nepisiguit River, NB, Canada (~140 km from the open water of the Gulf of St. Lawrence) See Fig. 3	Captured and transported to Cacoua, Quebec, where he was released. He was resighted a year later (Sections 4.3 and 4.4)
Beluga [Benny]	September 2018 – May 2019	Arctic	River Thames, UK See Fig. 3	Monitored until it left the area of its own accord (Section 3)
Beluga [Hvaldimir] (male)	April 2019 – August 2024	Arctic	Various locations in Norway and Sweden See Fig. 3	Provisioned for the first few months after his arrival due to concerns about his body condition. Subsequently fed himself. Closely monitored until his death in August 2024 (Section 3)
Beluga [Lys] (male)	August 2022	Arctic	River Seine, France See Fig. 3	Euthanized during operation to translocate him
Bowhead whales *Balaena mysticetus*	2012 – 2017	Arctic and subarctic regions	Various reports of this species far from its natural range e.g., UK, Ireland, France, Belgium, Netherlands, Gulf of Maine, USA	Usually whales appeared to leave the area where they were sighted of their own accord
Common bottlenose dolphin *Tursiops truncatus* (adult and juvenile)	February – March 2016	Warm, temperate to tropical seas globally. These individuals from Gulf of Mexico	Freshwater lake in Seminole, Alabama, USA	During monitoring, the adult dolphin left the lake through a canal and headed into Perdido Bay. Attempts to herd the other dolphin out of the lake using bubblenets, pingers and a *hukilau* failed. The dolphin was captured, translocated, and released with a satellite tracking device. 85 days later the dolphin was found dead. Cause of death was entanglement in a fishing net
Common minke whale *Balaenoptera acutorostrata* [Minnie] (juvenile)	May 2021	North Atlantic	River Thames, UK	Euthanized
Common minke whale (two juveniles)	May 2022	North Atlantic	Old Port of Montreal, Canada (~450 km from known distribution area)	One whale died. Post-mortem revealed no obvious cause of death though prolonged exposure to freshwater might have played a part. The outcome for the second whale was unknown
Gray whale *Eschrichtius robustus*	May 2010	North Pacific	2 km off Herzliya Marina, Israel and 0.9 km from coast of Barcelona, Spain See Fig. 5	Last sighted moving southwards from Barcelona, Spain (Section 3)
Gray whale [Wally]	April –May 2021	North Pacific	Ponza, Italy, River Tiber Estuary, along French coast, Spanish waters See Fig. 5	Last sighted in Mallorca, Spain (Section 3)
Humpback whale *Megaptera novaeangliae* (female and calf)	May 2007	All oceans, these individuals likely from North Pacific	72 nmi inland in the Port of Sacramento, California, USA	Attempts were made to encourage the whales back downstream without success. Antibiotic treatment was administered to treat lacerations (presumed to be from boat strikes). The whales left the river system 20 days after entering it
Humpback whale (sub-adult or young adult)	February – April 2009	All oceans, this individual likely from North Atlantic	Waters off Piran, Slovenia (Gulf of Trieste, North Adriatic Sea)	Photographs and videos were taken for photo-identification purposes and to assess the whale's condition. The whale's location and diving behavior was recorded. The whale left the area of its own accord
Humpback whale (juvenile female)	October 2019	All oceans, this individual likely from North Atlantic	River Thames, UK	Cause of death determined to be vessel strike. No evidence of recent feeding and whale was nutritionally compromised with a heavy parasite burden in the intestine
Humpback whale (juvenile female)	May – June 2020	All oceans, this individual likely from feeding ground in Gulf of St Lawrence	Old Port of Montreal, Canada (500 km upstream from summer feeding ground)	After being monitored for several days, the whale disappeared and then a carcass was found. Postmortem was inconclusive. Boat strike was a possibility and her health had also been impacted negatively by prolonged exposure to freshwater
Indo-Pacific humpback dolphin	December 2004	Indian and Pacific Oceans around Southeast / South Asia	Small lagoon near Khao Lok, Thailand	Dolphin was stranded in a lagoon following the tsunami. After being captured, her

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Table 2 (*continued*)

Species [name given to individual animal] (age/sex /group size)	Date	Natural habitat/ range	Location of OOH marine mammal(s)	Interventions/Outcome
Sousa chinensis (adult female)				wounds were treated, and she was given antibiotics before being returned to the Andaman Sea
Northern bottlenose whale *Hyperoodon ampullatus* [Willy] (juvenile female)	2006	Northern Atlantic	River Thames, UK	Died during rescue attempt. Postmortem results found dehydration, muscle damage, kidney failure
Orca *Orcinus orca* (group)	August 2021	Wide distribution. Present in all oceans and most seas. These individuals from NZ coastal population	Harbor of Pāuatahanui Inlet, Porirua, North Island, NZ	*Oikomi* pipes failed to drive the orcas out of the harbor. They left of their own accord after 5 days (Section 3)
Orca [Sedna] (immature female)	May 2022	Wide distribution. Present in all oceans and most seas	110 km inland in the River Seine, France	Attempts to lure her downstream were unsuccessful and she died in the river. Cause of death was starvation. A bullet was found lodged in the base of her skull. It was not clear when the bullet had entered the body but at least several weeks or months before death. *Saprolegnia* sp. was detected on the skin (associated with the time spent in freshwater)
Pinnipeds				
Atlantic walrus *Odobenus rosmarus rosmarus* [Wally] (juvenile male)	March 2021 – September 2021	Atlantic Arctic	Ireland, Wales, southwest England including Isles of Scilly, France, Spain, Iceland See Fig. 1 and Fig. 6	He was monitored in each location and in some places was provided with a pontoon to haul out on. He left each location of his own accord (Section 4.1)
Atlantic walrus [Freya] (female)	December 2019 – August 2022	Atlantic Arctic	Various locations in Norway, UK, Denmark, Sweden, Germany, Netherlands See Fig. 1	Killed by Norwegian Government (Section 5.1)
Atlantic walrus [Stena] (female)	June – July 2022	Atlantic Arctic	Germany, Poland, Latvia, Estonia, Finland See Fig. 1	Died during transportation to Korkeasaari Zoo where she was being taken due to poor condition
Atlantic walrus [Thor] (male)	November 2022 – February 2023	Atlantic Arctic	Netherlands, France, UK, Iceland See Fig. 1	Left each location of his own accord (Section 5.1)
Bearded seal *Erignathus barbatus* [Tama-chan] (male)	August 2002 – April 2004	Circumpolar distribution throughout much of Arctic and sub-Arctic	Tama River, Tokyo and Katabira River, Yokohama, Japan	Failed attempt to capture the seal in March 2003 when he slipped through the net being used. Last seen in 2004
Galapagos fur seal *Arctocephalus galapagoensis* (sub-adult male)	June 2016	Galapagos Archipelago	Pacific coast of Guatemala	Initial attempts to release the fur seal back to sea failed so he was transported to a rehabilitation center in Hawaii where he was monitored for a few days before being released at a private beach in Guatemala
Gray seal *Halichoerus grypus* (adult male)	March 2022	North Atlantic	Coast of Sidi Hsain, near city of Al Hoceima, Morocco and then Murcia, Spain	The seal was captured in Spain and taken into rehabilitation. He died after one week. Post-mortem showed that he was blind with severe cataracts. He was emaciated and had pieces of fishing net in his stomach. There were also signs of trauma
Harp seal *Pagophilus groenlandicus* (male)	August 2020	Northwest Atlantic, Arctic	Azores	Monitored from a distance. No intervention took place
Hooded seals *Cystophora cristata*	1910 – 2023	Arctic	Various reports of this species far from natural range e.g., in the tropical and subtropical western North Atlantic, Caribbean Sea, Ireland and Netherlands	Various outcomes with several seals dying during rehabilitation
Leopard seals *Hydrurga leptonyx*	Documented in NZ since 12th century, increasing in numbers since 1990	Primary range = Antarctica and subantarctic islands. Secondary range = NZ, Australia, north-central Chile, South Africa	Leopard seals are now classified as a native resident species in NZ See Fig. 2	Leopard seals are regularly present in areas used by humans e.g., marinas, mangrove forests, beaches, and boat ramps. Various actions have been taken to prevent seals from damaging property / to keep them away from humans (Section 4.1)

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Table 2 (*continued*)

Species [name given to individual animal] (age/sex /group size)	Date	Natural habitat/ range	Location of OOH marine mammal(s)	Interventions/Outcome
Mediterranean monk seal *Monachus monachus* [Argyro] (female)	March 2014 – May 2017	North-eastern Mediterranean and north-eastern Atlantic	Samos, Greece	Monitored by veterinarians. She was found dead in the sea with a stab wound and multiple bullet wounds (Section 5.3)
New Zealand fur seal *Arctocephalus forsteri* [Sammy] (juvenile male)	October – November 2021	Rocky shores of mainland NZ, Chatham Islands, subantarctic islands	90 km inland in a freshwater lake at the Lord of the Rings Hobbiton movie set in Matamata, NZ	Spent 18 days in the lake and left of his own accord via a waterway from a neighboring farm which led to a river
New Zealand fur seal	July 2023	Rocky shores of mainland NZ, Chatham Islands, subantarctic islands	Inside a hardware store, Whangārei, NZ	Translocated by DOC rangers to a marine reserve at Reotahi, Whangārei, where there is a fur seal haul-out site
Southern elephant seals *Mirounga leonina*	2017 – 2019	Circumpolar distribution around the south pole. Breeds on subantarctic islands	Various reports of this species far from its natural range for example in Gulf of Guayaquil, Ecuador, Arraial do Cabo, Brazil, Southern coast of Sri Lanka	Reported elephant seals have generally been in good body condition, so they have been monitored without intervention
Steller sea lion *Eumetopias jubatus* (adult male)	August 2018	North Pacific from Japan to southern California, USA	200 m inland, Sitka, Alaska, USA	After four days trying unsuccessfully to encourage the Steller sea lion back to the water, he was sedated and translocated
Sirenians				
Florida manatee *Trichechus manatus* ssp. *latirostris*	2016	Florida to North Carolina, USA	Massachusetts, USA	Rescued

(e.g., boat strike [26]) could become disoriented and travel outside their natural range.

OOH situations for marine mammals have also arisen from inappropriate releases and/or escapes from captivity. In 2018, as many as 100 belugas (along with 11 or 12 orcas) were captured in the Sea of Okhotsk and kept in captivity over 1500 km away in Srednyaya Bay, to the south-east of Vladivostok, Russia [121]. A year later, after extensive lobbying by advocates and scientists, all the cetaceans were released from the holding facility which had become known as the "whale jail" due to the overcrowding and poor conditions. At least 20 belugas were released nearby and far from their natural range [122] meaning they can be considered OOH. Several of these individuals have continued to be sighted in the general area, venturing into ports and populated areas with some of them continuing to interact with people [123,124], Fig. 3.

An example of an animal that was displaced directly by human action was the beluga known as Hvaldimir first recorded in northern Norway in 2019 and believed to have escaped from captivity [27,28]. He spent some time in Sweden, where he was clearly outside the natural distribution range for his species [125,126] and his continued interactions with human-made habitats and people, and the potential for conflict to arise, were further reasons for him to be considered an OOH marine mammal, Fig. 3. He was found dead in August 2024, seemingly as a result of a mouth injury.

4. Managing out of habitat marine mammals

Due to increasing public awareness of human impacts on free-ranging wildlife and the concerns for species' survival and welfare [127–133], many animals considered OOH will likely be the target of some form of wildlife management/intervention. To ensure that optimal outcomes — for the animal — are achieved, it is important that both conservation and welfare considerations inform decision-making [130,131,134–140]. However, depending on how decision-makers perceive welfare, approaches may differ, influencing how welfare is assessed and how assessment outcomes lead to management decisions [110,133,137,138,141,142].

There is no single accepted definition of animal welfare. There are three different orientations regarding what is important for understanding animal welfare and how to scientifically assess it: biological functioning, natural state, and affective (mental) state [143,144]. Biological functioning focuses on minimizing physiological stress; natural state reflects the idea that animals should be able to perform natural behaviors; and affective state focuses on how the animal is experiencing its life. Contemporary animal welfare science generally considers all three elements to be interrelated; therefore, most current definitions encompass an individual's physical (health and functioning) and behavioral states and the cumulative effect these have on mental (affective) state at a given time [143,144].

Recently, a group of international and interdisciplinary experts characterized the concept of welfare for stranded cetaceans [138], identifying various animal- and resource-based indicators that may be valuable for assessing cetacean welfare [139]. Specifically, these experts highlighted that welfare should be assessed holistically, in a multidisciplinary manner, considering intrinsic animal factors (nutrition, health, and behavior), as well as extrinsic factors such as human interventions and the context of the animal's situation. Due to the parallels of stranded animals being outside of their natural environment, it is suggested that similar concepts should be considered when undertaking welfare assessments on OOH marine mammals. Importantly, how the animals' situation, including human intervention, impacts on animal biological function (health and physiology), behavior and the cumulative impacts on mental state must be reflected in the assessment, as their relative importance will likely be context-dependent. For example, an animal in poor body condition in its normal habitat may be able to recover, whereas in an atypical/OOH situation, sufficient high-quality prey may not be available and/or other extrinsic stressors may compound impacts on an already compromised individual.

It is often tempting for humans to initiate rescue attempts of marine mammals in atypical habitat. Public pressure may exacerbate this issue [133]. However, such attempts usually assume we have a good understanding of why the animal(s) are there in the first place, which is often not the case. Rescue attempts may do more harm than good if not carefully considered, especially considering limited information and uncertainty. Members of the public often feel inclined to "help" stranded or OOH marine mammals. This can have negative consequences (for the animals and people); for example, when an ill or injured animal is

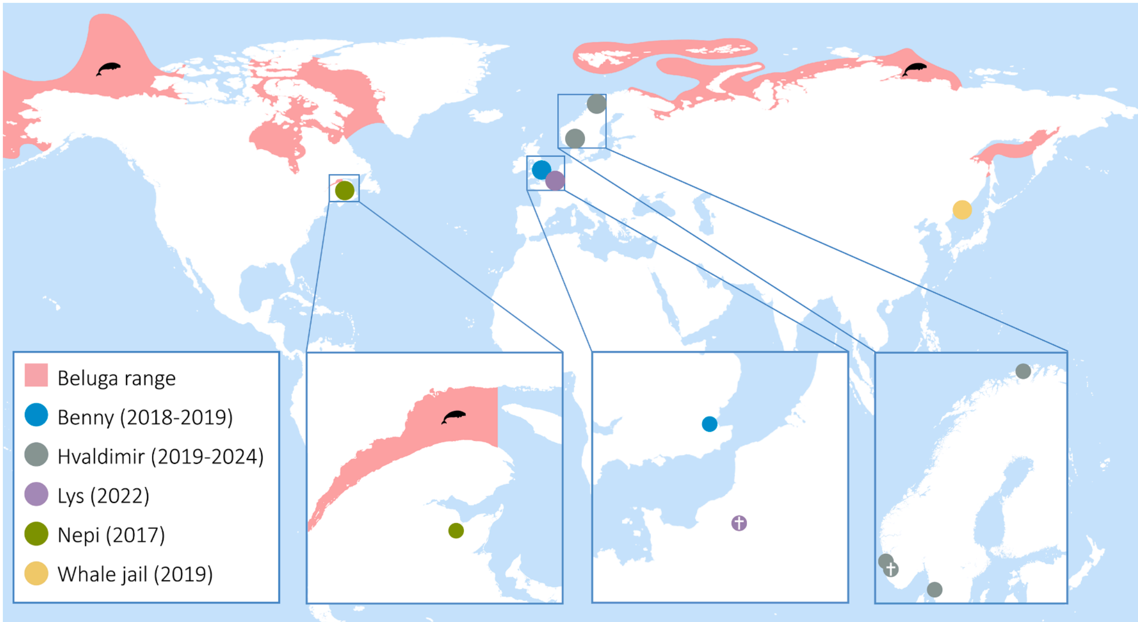

Fig. 3. Sighting locations of four OOH belugas (*Delphinapterus leucas*) and the location of the "whale jail". Cross indicates death of individual.

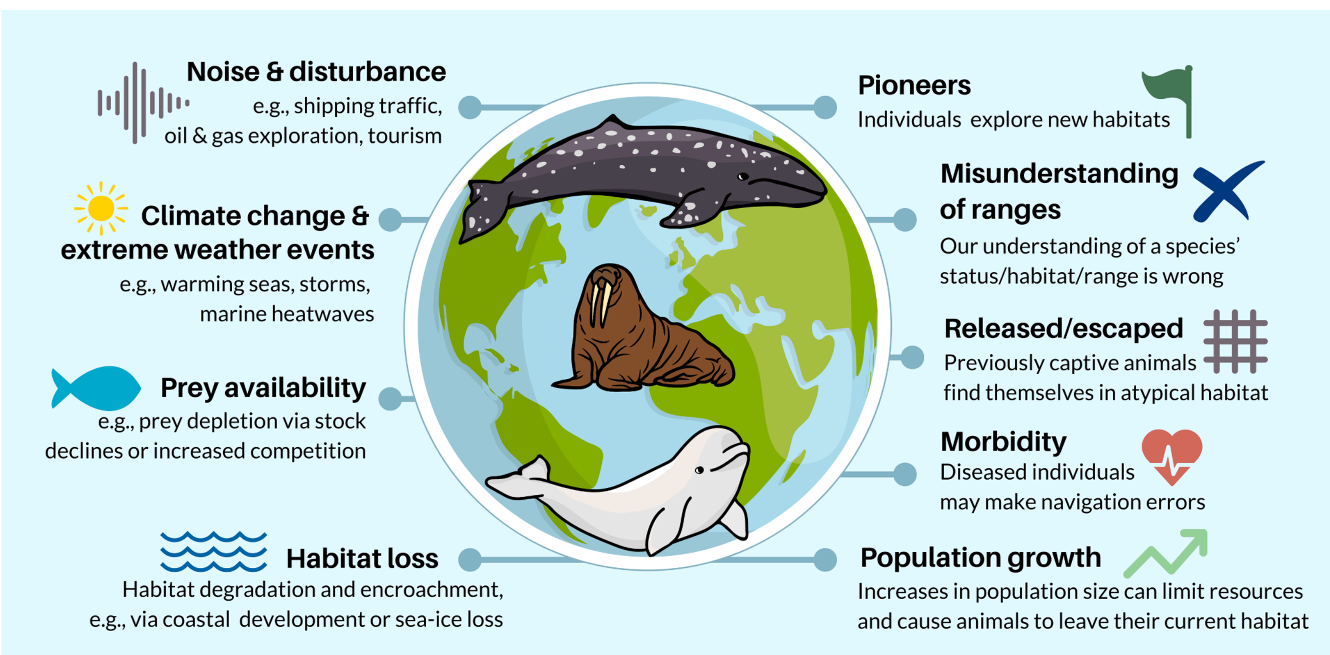

Fig. 4. Potential reasons for the occurrence of out of habitat marine mammals.

refloated by well-meaning people who do not have the necessary expertise to know that returning the animal to the sea may subsequently lead to its death after additional suffering, and that the human "rescuers" may also be injured.

Management options for an OOH marine mammal will be very situation-, location-, species- and context-dependent. Monitoring the situation without intervening may be the best course of action for managers, at least initially, including recording sightings and behaviors, preferably with accompanying photographs and videos [6]. Lessons learned from each OOH marine mammal may help in future cases.

Welfare assessment frameworks, such as the Five Domains Model [144–146], can help guide decision-making by considering the impacts of an animal's situation on its nutrition, physical environment, health, and behavioral interactions, and the potential cumulative or synergistic effects that these have on the individual's affective (mental) state [145,147]. Such impacts are evaluated via behavioral, physiological, and pathological indicators [148–150] and through situation-based indicators that represent potential risk to welfare, e.g., food availability [151]. The Five Domains Model has been applied to guide assessments of marine mammal welfare in a variety of circumstances [146,152–155]. It should be stressed that monitoring alone, without intervening, can be a management decision option. Other management decisions need to ensure that animal safety is taken into account and may involve encouraging the animal to move, capture, translocation and post-release

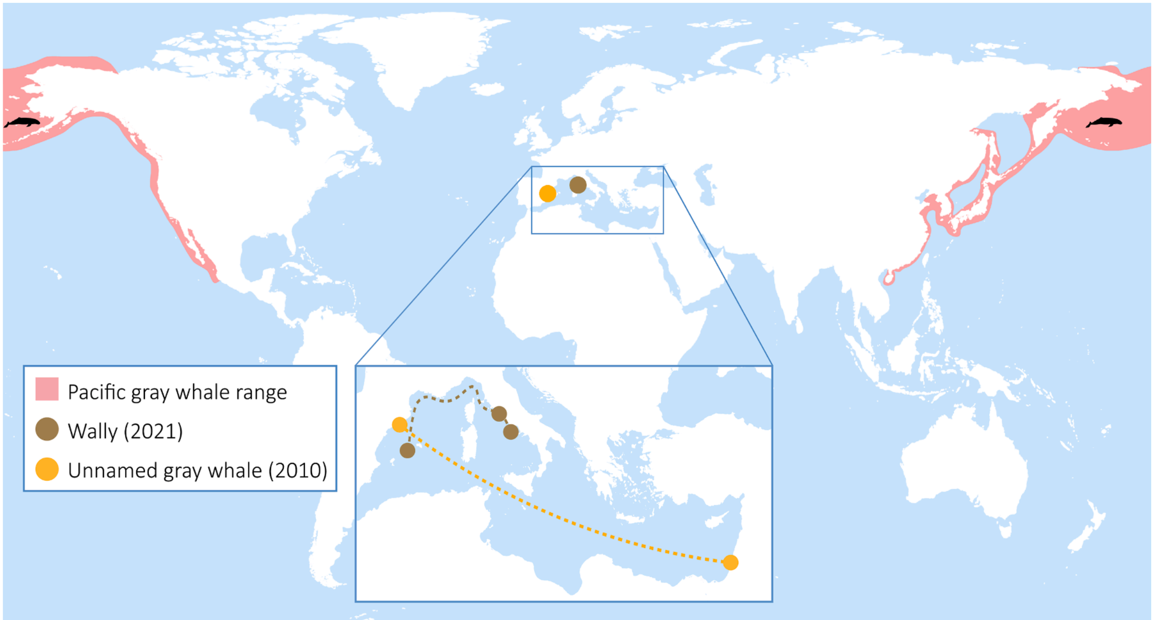

Fig. 5. Sighting locations and possible routes of two OOH gray whales (*Eschrichtius robustus*) in the Mediterranean Sea.

monitoring, or euthanasia. The contexts in which each of these interventions is appropriate are discussed below.

4.1. *Ensuring animal safety*

A range of options exist to keep OOH marine mammals safe. These typically start with monitoring (from land or on the water) but can extend to more hands-on methods if intervention is necessary because the animal's health is deteriorating or the environment is degraded or dangerous. In the UK, a specially designed haul-out pontoon (Fig. 6) was provided for Wally the walrus so he could safely rest [4]. This tool also successfully dissuaded him from hauling out on vessels and kept him at a distance from the public. "No go" zones where boats and swimmers are not allowed to enter, or are limited in number, reduce the risk of injury to all involved. Such areas are also used to protect resident marine mammals from human disturbance; for example, the San Diego City Council supports an amendment to the municipal code to enact year-round beach closures to protect sea lions [156]. Such protection, even if only temporary, will likely safeguard OOH marine mammals.

In NZ, various methods have been used to try to prevent leopard seals from entering marinas and docks, to mitigate conflict [10]. For example, a non-governmental organization (NGO) successfully used large containers, including "fish bins" and 20 liter buckets filled with water, as physical barriers to prevent seals hauling out on docks, or to deter them from moving into specific areas on docks [10]. The NZ Department of Conservation (DOC) deployed bunting flags as visually "active" barriers (the flags flapping in the wind were hoped to be a deterrent). However, these were ineffective and installed in a manner some felt was an entanglement risk for the seals [10]. Conversely, other methods have kept both humans and seals safe. When seals were hauled out on a beach, "exclusion tape" (e.g., "Danger" / "Keep Out" tape) and informative signs effectively reduced human-animal interactions and provided the seals with safe areas to rest [10], with the signs also engaging members of the public by providing relevant information.

Fig. 6. Wally the walrus (*Odobenus rosmarus rosmarus*) resting on a specially-built pontoon (Credit: Dan Jarvis, British Divers Marine Life Rescue).

Exclusion zones in the marine environment may be difficult to implement as animals may not be visible when submerged. Such zones would likely need to be continually adjusted, depending on the movements of the OOH individual(s). Likewise, unless carefully monitored, the public might ignore an exclusion zone or "push the boundaries;" for example, recreational vessels have been documented closely approaching various OOH cetaceans [e.g., 157,158]. Several cetaceans have been injured or killed by vessel strikes when they were OOH in rivers with high traffic volume [e.g., 26,29,159]. A general requirement for vessels to reduce their speed to 5 knots or slower (no-wake) when an OOH cetacean is present would be a good rule of thumb, to lower the risk of vessel strike in narrow rivers or shallow areas, where avoidance is difficult [e.g., 159].

It should also be noted that the presence of an OOH marine mammal could have an impact on other wildlife [160] which could be an issue if a species of conservation concern is displaced or otherwise impacted.

4.2. *Encouraging out of habitat marine mammals to move*

When animals may be compromised if they remain in an area (due to e.g., low food availability, high boat traffic) or the risk to human safety increases (or is merely perceived to increase), managers may seek to encourage the animal(s) to move. Agencies around the world have used diverse methods, with mixed results, including airhorns, water hoses [10], sirens (attempting to drive the animal in a certain direction) [161], conspecific sounds (to lure the animal away) [159,162], bubble nets

[24], a *hukilau* (typically a long line with floats and suspended, shorter lines, which acts as a visual barrier) [24], a human barrier (including slapping the water surface) [107], a line of boats (to create an underwater noise barrier) [161], *oikomi* pipes [4,159,162], and underwater explosives [162]. Several of these methods did not achieve the desired results and in some cases, particularly those involving the use of a deterrent noise or explosion, presented a risk to the animals involved or to other wildlife. The *oikomi* pipes used with orcas in NZ mentioned in Section 3, for example, caused the animals to demonstrate behavioral signs of stress (e.g., spy hopping and vocalizing, IN Visser unpublished data). Some individuals also moved into extremely shallow water, putting themselves at risk of stranding. A similar use of *oikomi* pipes was unsuccessful in attempts to herd humpback whales out of a river delta in California [26]. The animals eventually left of their own volition.

Attempts to move animals can cause them to strand or can separate mother-calf pairs, thereby worsening their welfare and odds of survival. To improve the methods used to move animals it is important for rescue communities around the world to share the methods that they have used and their outcomes in a timely fashion. As noted, the methods used may adversely affect the animal's welfare and hence a careful assessment needs to be made before attempts to move animals are made. This assessment process will need to be guided by veterinary and other experts.

4.3. Capture and translocation

Managers choosing methods for capturing and translocating an OOH marine mammal should consider the welfare of the individual, especially noting that capture myopathy [163] may lead to death [164]. It is essential to work with species-specific experts, stranding experts, and/or marine mammal veterinarians to ensure that technology appropriate for the species and situation is used. It is important to ensure that the individual marine mammal is translocated to an area which is recognized to be part of the animal's natural habitat/range. Capture and translocation should be undertaken after a sufficient period of observation, only after attempts to encourage the animal to move on its own have failed, and when it is considered that the animal staying in the area is at greater risk than the risk of moving it. Comprehensive welfare assessments, including health, should be carried out to weigh the risks and potential benefit for the animal when deciding to capture and translocate [165].

Appropriate specialized equipment for capture and transport should be used, to ensure the safety of humans and animals. Nets are frequently used to capture both cetaceans and pinnipeds, and may range from individual hoop nets to in-water purse seine nets [166,167]. Pinnipeds are often transported for short distances via stretcher nets, or in crates or cages for longer distances [168–170]. Small cetaceans may also be transported in stretchers that can either be suspended in water or rested on padding, and may be moved by excavator, truck, boat, or plane [171,172]. Larger cetaceans may be refloated and translocated with pontoon stretchers or slings [134,173].

Physical and mechanical methods of capture are used more frequently than chemical restraint, although drugs for either immobilization for capture or sedation for transport may have a role in specific cases. Remote sedation to capture free-ranging pinnipeds can be useful for otherwise healthy animals that are difficult to capture with physical means [174]. Chemical sedation may also be valuable during the transport of certain individuals. The use of chemical methods requires adherence to local laws which, in many cases, require administration under the supervision of a veterinarian. If the species is one that personnel have not encountered before, consulting with veterinarians familiar with the species is essential as species and individuals respond differently to various drug combinations and dosages, particularly when debilitated, and risks such as drowning must be evaluated and mitigated.

During translocation, the animal should be protected from environmental extremes, e.g., temperature, wind, direct sun [175]. Continuous monitoring of vital signs and behavior throughout transport and in the post-release period is critical for ensuring that any necessary medical interventions can be provided in a timely manner and that the translocation has the highest chance of success with minimal negative impacts on welfare. A beluga named Nepi was captured using a net and several vessels in the freshwater Nepisiguit River in northern New Brunswick (NB), Canada, in 2017 [4], Fig. 3. After capture and examination by veterinarians, he was taken to an airfield in Bathurst, NB, and flown to Riviere-du-Loop, Quebec. He was then driven to Cacouna for release, using whale rescue pontoons deployed from a vessel. He was successfully returned to his natal population in the St. Lawrence Estuary.

There are also examples of OOH marine mammals captured and taken into permanent captivity [176], however given the welfare implications of captivity [e.g., see 177], this is not endorsed here as an appropriate option.

4.4. Post-release monitoring

When managers intervene with an OOH marine mammal, a monitoring protocol should be implemented, to determine whether the actions taken have been successful. For cetaceans, Wells et al. [178] defined a successful release as one in which "the cetacean exhibits ranging patterns, habitat use, locomotion, behavior, and social interactions typical for the species, stock or individual, and/or at least does not exhibit abnormal behavior, for a minimum of six weeks," emphasizing that the first six weeks post-release are critical for determining longer term survival for cetaceans. A failed release, on the other hand, is one with "direct evidence of atypical mortality, restranding, reliance on human provisioning, use of habitats atypical for the species, stock, or individual, atypical surfacing/respiration/dive patterns, or severely abnormal clinical signs" [178]. McHugh et al. [179] considered survival beyond one year as a benchmark for long-term success when dolphins are rescued from fishing gear entanglements. Such a time frame might also be relevant in OOH cases.

Monitoring can be accomplished through direct observation or using simple techniques such as photo-identification of individuals or more advanced technology such as telemetry. Most marine mammals can be identified by naturally-occurring marks and scars [e.g., 180]. Photo-identification has been used successfully for post-release monitoring of stranded cetaceans. For example, the orca Ben was documented for more than 23.5 years after his rescue, during which time he travelled more than 37,700 km [110]. The beluga Nepi (Section 4.3) was resighted one year after his translocation and identified by his unique scar patterns [181]. Animals are frequently marked before release so they can be identified afterward. For example, rehabilitated pinnipeds may have numbered plastic tags attached to flippers [182,183]. If an animal is unlikely to be directly observed after release, satellite tagging may be an option [e.g., 184]. This should only be undertaken with the necessary ethical approval, using best practice standards and with caution and a clear understanding of the risks involved for an animal whose welfare has already been compromised. Satellite tagging can lead to behavioral changes as well as physical damage and/or infection, which in some cases may contribute to death [see e.g., 185–188]. Horning et al. [189] and Andrews et al. [190] provide best practice recommendations for tagging pinnipeds and cetaceans, respectively.

4.5. Euthanasia

Some cases of OOH marine mammals will require end-of-life decision-making. This can involve palliative care (keeping the animal comfortable until it dies) or euthanasia (providing a humane death when an animal is suffering) [191]. Euthanasia is generally only an option when the animal's welfare is compromised to the point that death is a preferable outcome [192]. Usually, euthanasia should only be considered when an animal is debilitated beyond the hope of recovery and/or moribund; however, in exceptional cases, there may be other reasons that lead to choosing this option. These include disease control and/or public health protection [191]. Euthanasia should not be considered the first option based solely on the need to manage human behavior, as was specified by Norwegian government authorities in the case of Freya the walrus [5,193] who was observed along the coast of Norway and in various other places in Europe (see Fig. 1), see Section 5.1 for more details. Appropriate methods to manage the animal, as well as humans (especially when people are approaching the animal, Section 5) should be implemented and exhausted first, before considering euthanasia as an option.

Multiple criteria should be used to evaluate the situation before deciding to euthanize. These criteria include: being solitary and unweaned (if the mother cannot be located); disabling injuries; loss of reflexes; significant hemorrhaging; poor body condition; excessive skin blistering over a significant portion of the body; persistent muscle tremors; behaviors consistent with neurological deterioration (e.g., free-ranging animal swimming in continuous circular pattern or consistently listing, noting that those in rehabilitation pools will have restrained swimming abilities); and/or a core body temperature suggestive of hypo- ($\leq$35°C) or hyperthermia ($\geq$40°C) [175,182,192,194–197].

Euthanasia means humane techniques are used to induce as rapid, painless, and distress-free a death as possible [191]. Therefore, euthanasia includes techniques (e.g., sedatives) used before administering the selected lethal method [191]. Euthanasia should result in rapid loss of consciousness, followed by cardiac arrest and loss of brain function. Euthanasia options can be technically challenging and restricted by species, location, local legislation, and logistical constraints. Data on the methods of euthanasia for marine mammals are limited and remain highly variable [198]. However, there are generally three methods employed: chemical, ballistic, and explosive (see [198] and [199] for details and further reading on each euthanasia method).

No matter the method or outcome, it is critical that certain information is reported before, during, and after euthanasia. These include: the reason for considering end-of-life options; rationale for euthanasia over palliative care; method, procedure, and equipment employed for euthanasia; rationale for choosing the method employed; criteria assessed to verify insensibility and/or death; time from application of the euthanasia method until insensibility is verified; and animal behavioral reactions during and post-application of the euthanasia method [155,197]. Importantly, in cases where the application of the primary method does not render the animal insensible, details must be provided on any additional methods and/or procedures applied, including time from the application until insensibility is achieved.

5. Managing the public

OOH marine mammals may restrict their movements to coastal areas, making them relatively easy for the public to access. Human-marine mammal interactions may lead to various management, animal welfare and human safety problems, including injury or death of the animal or a human. It is important that management authorities, organizations, and individuals work collaboratively to protect animals and people in these often unique circumstances.

5.1. Ensuring public safety

The safety of people involved with, or observing, the OOH marine mammals should be addressed concurrently with the animal's safety. In some instances, it may be people, rather than the marine mammal(s), that need managing. Concerned members of the public may decide they want to interact directly with an OOH marine mammal and, as with all situations involving free-ranging wild animals, this could put the human and/or animal at risk of injury or death. Lessons can be learned from situations which did not involve an OOH animal, but which illustrate the dangers of human interaction with wild animals, particularly if the animal is stressed by its current situation. For example, Tião, a solitary-sociable bottlenose dolphin in Brazil, was frequently harassed by members of the public, and he injured at least 29 swimmers and caused the death of one man who, with others, had tried to drag the dolphin out of the water to photograph him [200,201]. A management program to monitor interactions between people and Tião and to discourage people from entering the water with him, as well as an extensive education program, prevented further incidents.

Interaction with free-ranging marine mammals also puts humans at risk of exposure to zoonotic pathogens including tuberculosis, leptospirosis, brucellosis and "seal finger" (*Mycoplasma* spp. or *Erysipelothrix rhusiopathiae*) [202]. Highly pathogenic avian influenza A (H5N1), which is also known to infect humans [203], has been detected in marine mammals [204–206]. Therefore, in addition to keeping the public away from OOH animals, it is imperative that those in close contact with OOH marine mammals, such as veterinarians, biologists, and rescue teams, wear appropriate personal protective equipment (PPE) [196]. PPE also serves to protect the marine mammals from any potential zoonotic pathogens that may be carried by rescue workers.

OOH marine mammals may be approached by members of the public in inappropriate ways. In the case of Freya the walrus she was, at times, approached by hundreds of members of the public who got within meters of her [5,207]. The Norwegian authorities deemed her a threat (despite no evidence of aggression on her part, nor any records of wild walruses harming humans) and killed her, without any consultation with citizen groups focused on her welfare, species-specific experts, or those familiar with OOH marine mammals [207,208]. (The term "killed" is used here rather than "euthanized" because we believe that the latter would usually only apply if the euthanized animal had been seen to be suffering and this does not seem to the case.) The Norwegian authorities, after the fact, justified their actions by saying the public did not respond to directives to give Freya space [5,207,209], highlighting that this was a problem of people management, not Freya's behavior. However, the authorities had not attempted to use other methods to keep the public away from the walrus such as using barriers or issuing monetary fines to members of the public who approached too closely [208].

In other locations, it has been possible to keep the public and OOH marine mammals apart by putting up barriers or cordons and via well-coordinated actions between local police, harbor masters, NGOs, and other parties; for example, when the walrus known as Thor hauled out in Scarborough, UK [210], and when leopard seals are in urban areas in NZ [10].

5.2. Managing public expectations

Managing public expectations regarding compromised charismatic megafauna is increasingly difficult, whether terrestrial or marine [211–214]. As with strandings, traditional and social media often focus on OOH events, which can lead to heightened expectations guided more by best intentions and human sentiment than scientifically informed decision-making. When public pressure mounts, managers may occasionally implement inconsistent and/or inappropriate intervention which may, at times, lead to unrealistic public expectations, particularly when considering end-of-life options [133,197,215]. Such decision-making can also be contrary to best practice animal welfare considerations. Clearly defined protocols for OOH marine mammals, which provide detailed guidance on assessing both animal welfare and survival prognoses, are imperative to reduce the risk of inappropriate intervention. These should be developed with input from veterinarians, animal welfare scientists, marine animal rescue experts and species-specific experts. Such approaches would also enhance transparency in decision-making and ensure that the critical link between welfare and survival is not overlooked [131,133,137–140].

5.3. Communication, education, and legislation

Communication and education regarding OOH marine mammals are critically important to manage public expectations; to help coordinate regulatory agencies, citizen groups, and researchers; and to guide intervention and management actions to protect animal welfare and human safety. Accurate, consistent communication regarding the animal's condition, its location, and any intervention/management actions is vital. However, with multiple communication channels available (traditional and social media, including print, television, radio, and a plethora of other platforms; [see 216]), as well as outreach through direct public interaction, consistency can be challenging. OOH marine mammals often develop a high public profile through media attention, and they can be seen as both a flagship for conservation and a lightning rod for controversy [217].

Varying audiences will require varying levels and styles of information; researchers and managers need scientific and legal data and the public needs more general messaging. Providing consistent and accessible information may determine the outcome for marine mammals that are in proximity to human activities. Deciding if and when to intervene, and what kind of intervention is appropriate, the subsequent mobilization and coordination of resources, expertise, and emergency response(s) are all dependent on accurate and sufficient exchange of information from frontline monitors to regulatory agencies and other involved parties.

Further complicating the delivery of consistent and accurate communication when dealing with OOH marine mammals is the often-complex matrix of authorities, organizations, and individuals who seek to intervene, through mandate or interest. Public outreach and communication about associated risks of getting close to OOH marine mammals, both for humans and animals, are critical. Both are at risk of injury and, as such, the public should be informed that these OOH individuals are vulnerable to interaction, targeted abuse, vessel strikes, and disturbance of their resting and foraging behaviors. Swimming with, feeding, and touching a free-ranging marine mammal can lead to health issues for the animal, or to it being injured, disturbed, or lethally removed if deemed a nuisance or threat to human safety. Several marine mammals have been injured or killed because authorities have failed to adequately communicate with the public regarding risky human behavior around them. For example, several solitary-sociable dolphins have been injured or killed following their close associations with humans [218] and, similarly, a Mediterranean monk seal (*Monachus monachus*), who regularly interacted with people in Greece, was eventually found dead, having been shot and stabbed [27]. Vessel strikes are a particular issue for marine mammals and several solitary-sociable dolphins have been killed in this way [e.g., 27,219].

Unfortunately, regulatory agencies often do not have clear lines of authority in dealing with OOH marine mammals, and national responses may be delayed or confused as agencies consider management options, policies, and legal jurisdictions. To avoid this, agency staff should be educated and trained to respond appropriately to OOH animals [e.g., 220].

At present, most countries do not have explicit guidelines or legislation for OOH marine mammals. The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) includes wording in its Agreement text stating that it "applies to all cetaceans that have a range which lies entirely or partly within the Agreement area or that accidentally or occasionally frequent the Agreement area," indicating that Parties to ACCOBAMS are required to protect OOH cetaceans [221]. However, this does not necessarily mean that Parties have developed management guidelines for them. In most locations, OOH animals are managed under general wildlife legislation such as the European Union's Habitats Directive which, for example, prohibits the "deliberate disturbance" of species listed in Annex IV, which includes all cetacea but only the Mediterranean monk seal for pinnipeds [222]. Therefore, any OOH pinnipeds would not necessarily be protected. Even in the few places where specific marine mammal legislation has been put in place (e.g., the Marine Mammal Protection Act in the United States [223]), there are no specific provisions included regarding how to manage OOH individuals. In instances where an OOH marine mammal moves between jurisdictions (e.g., between states or between countries), responses may be further diluted or muddied.

In addressing these complex scenarios, the following is recommended:

- **Develop and enact specific legislation for OOH marine mammals.** This may require new legislation being developed or existing wildlife legislation being adapted to include OOH marine mammals.
- **Develop an (informal or formal) network, alliance, stewardship council, or working group to consolidate and coordinate information exchange and communication among interested parties.** This can include members of the public, researchers, species-specific experts, veterinarians, indigenous communities, NGOs, academic institutions, and regulatory agencies.
- **Establish a central location for information dissemination.** This can be a website, newsletter, social media platform, messaging app, or email listserv, where current and accurate information can be shared with the public and authorities.
- **Collaborate with existing channels of communication to disseminate information.** Organizations, institutions, and agencies dedicated to marine mammals and ocean health can serve as collaborative platforms. Researchers with large social media followings may help disseminate accurate information.
- **Consider additional tools to communicate with the public.** Signage, flyers, placards, emergency or tip hotlines, and designated spokespersons or local frontline experts or monitors encourage two-way communication with the public and authorities. On-site, accurate education is critical, to ensure that the public is aware of the animal(s)' presence, but also to avoid misinterpretation of behavior or threat. A leopard seal's yawn, for example, may be incorrectly interpreted as a threat, rather than a normal haul-out behavior [220].
- **Develop codes of conduct and protocols.** In the absence of laws safeguarding marine mammals and the public, safety protocols should be established and communicated as early as possible to set boundaries and expectations for the public. These protocols may become policies if effective and/or integrated into marine mammal response plans. If legal policies already exist, it is vital that they are comprehensive and simple to follow, and that they are communicated to the public early on. This will assist managers, who are often under pressure in these challenging situations, to not only protect the OOH marine mammal, but to make decisions quickly and clearly communicate the rationale behind those decisions with transparency.
- **Draft messaging about OOH marine mammals before they appear.** Regulatory agencies can develop a communications strategy regarding marine mammals' shifting ranges and climate change, utilizing specific case studies, to help educate the public and media in advance, to mitigate potential public hysteria when marine mammals appear in atypical habitat, especially when this occurs in proximity to people.

6. Lessons from human-wildlife conflict and rewilding

"Human-wildlife conflict" (HWC) can broadly be defined as conflict arising between people and wildlife. While this definition suggests that actions by humans or wildlife may have adverse effects on one another, the term is often used to denote threats posed by wildlife to human life, economic security, or recreation, as well as the perception that wildlife endangers human safety, health, food supplies, and property [224,225].

Conflicts related to OOH marine mammals such as interactions with fisheries, restricted access to recreational areas, damage to boats and other property, or injury risks, may arise in locations where previous attempts at marine mammal conservation or management, due to HWC, were unsuccessful. The engagement of community and other interested parties is key when resolving and transforming HWC [225–228], but often these engagement attempts merely involve posting of notices or public meetings, rather than investigating local social and community issues and structures that may make or break a project [229]. A meeting where only the usual NGO and agency participants, or the loudest voices on an issue, are invited will likely not represent a true cross-section and/or views of a community. Care should be taken to spend time engaging with a community to understand local leaders, stakeholders, and possible champions for marine mammals before setting up any meetings, and to ensure that meetings are held at a time, place, and in a format convenient for all key interested parties, not just scientists or agency staff.

Much of the conflict that arises in so-called HWC situations could more accurately be described as human-human conflict [224], as disagreements often arise among groups of people about the scale of threats to human interests and the best way to mitigate them [10]. This is certainly sometimes the case with OOH marine mammals.

Marine conservation and wildlife management are increasingly considering the human element in their planning, including social science and HWC and its resolution [225,228,230]. However, agency staff, scientists, and many involved in OOH marine mammal interventions may lack training or exposure to HWC resolution and transformation [10,228,229]. Their actions could make constructive interventions more difficult [10] —especially when interacting with people who may not understand or be actively opposed to marine mammal conservation and welfare. It would be beneficial to have someone with HWC and/or social science training on an intervention team, who could take a central role in coordinating and liaising with local groups and acting as an intermediary between marine mammal scientists and agency staff. It would be even better if that person was from the local community. The inter-human dimensions of any OOH marine mammal intervention should not be underestimated, as an understanding of these interactions can make the difference between success and failure.

In 2010, discussion about the reintroduction of Hawaiian monk seals (*Neomonachus schauinslandi*) to the main Hawaiian Islands, a location from which they had been historically extirpated, led to concerns ranging from worries that monk seals would impact fisheries, to fear that recreational beaches would be closed to protect seals hauling out [231]. However, in addition to these conflicts, there were several "underlying conflicts" [see 232] related to distrust of the federal process by which the public had been engaged and contacted about the proposed translocations [231]. Monk seals feature prominently in native Hawaiian culture, and these communities should have been extensively consulted. Lack of engagement can build on (hundreds of years of) resentment for lack of inclusion in marine resource decision-making. Conflict was exacerbated when monk seal project managers primarily selected white retirees rather than local Hawaiian community members as volunteers [231]. Interventions for OOH marine mammals should include volunteers and representatives from the local community, including indigenous or local tribal communities and grassroots groups [10,233].

Lessons can also be learned from rewilding projects. The term "rewilding" has been used to refer to different concepts including restoring areas of connected wilderness, abandoning human-managed land, and a variety of species reintroductions [234]. It has recently been defined as "the process of rebuilding, following major human disturbance, a natural ecosystem by restoring natural processes and the complete or near complete food web at all trophic levels as a self-sustaining and resilient ecosystem with biota that would have been present had the disturbance not occurred" [235]. Rewilding projects may involve the reintroduction of species that have been absent from a location for many years. They are distinct from situations involving OOH marine mammals which have usually arrived in an area without the help of humans. However, both rewilding situations and the arrival of pioneer marine mammals can lead to conflictive situations.

The main parallels between rewilding and OOH marine mammal situations relate to the management of human perceptions and responses to the introduction/appearance of such species. It has become best practice for rewilding projects to educate local communities, respond to their concerns and actual consequences of rewilding, and maintain monitoring. In the rewilding scenario, consultation must precede any action, but, in the case of OOH situations, this is rarely possible.

"Rewilding should encourage public understanding and appreciation of wild nature and should address existing concerns about co-existing with wildlife and natural processes of disturbance. Stakeholder engagement and support can reinforce the use of rewilding as an opportunity to promote education and knowledge exchange about the functioning of ecosystems" [236]. These principles should apply equally to managing human responses to OOH individuals, although the actual message will differ according to the circumstances.

To be effective, community engagement must do more than merely provide information. There needs to be active and reactive engagement with relevant interested parties to achieve collaborative solutions. This will likely require the establishment of an official governance structure that can accommodate all interested parties [237].

7. Conclusions and recommendations

In many instances, determining a specific cause for a marine mammal being OOH may not be possible and some cases are likely multifactorial. Unfortunately, limited documentation exists on underlying health conditions in most OOH situations [26]. Furthermore, primary causes for entering atypical habitat may be masked by secondary factors related specifically to the OOH event (e.g., dehydration, emaciation) [238].

OOH marine mammals are generally not included in legislation and management plans [22]. By not recognizing them or having appropriate response mechanisms in place, we may be limiting the potential for their species to adapt to changing conditions. It is, therefore, important for governments to actively take note of OOH individuals and to consider that range expansions, due to climate change and other factors discussed above, may mean that these individuals are the originators of what, in the future, could become naturally established populations that will allow a species to persist. There may be a threshold between the potential positive outcomes from being a pioneer, and potential sub-optimal outcomes where there may be threats to health or survival, or potential for conflict with human activities.

In the absence of established metrics for determining if an individual is OOH, or is prospecting new habitat, managers should apply the precautionary principle and assume that all OOH individuals in good health have the potential to be pioneers – removing them should not be the de facto response. These individuals may be gathering essential ecological knowledge on the suitability of new habitat, which could be transmitted to conspecifics as an important element in a population's response to increasing anthropogenic pressures. Arguably, we need to protect those innovators that may be at, or beyond, the edge of their natural range. Rigorous monitoring of OOH individuals will be essential, as we seek to understand how species and wider biological systems are responding to changing conditions. Successful colonization of a new area or habitat may not take place, of course, if there are not sufficient resources and/or if too few conspecifics follow - one pioneer cannot establish a new population [22], but recognizing the process is important for understanding these situations.

Reframing these individuals as pioneers or marine mammal explorers should be part of every authority's messaging toolkit. The "Seeds of a Good Anthropocene" initiative suggests that new ways of thinking and acting may provide important "seeds" to help "address different Anthropocene challenges" [239]. Marine wildlife is facing many significant challenges in the Anthropocene and OOH marine mammals exploring new territory may be essential "seeds" for their species, ensuring that knowledge on the suitability, or lack thereof, of other habitats is transmitted across social groups and populations.

OOH marine mammals should be continuously monitored to ensure that interventions, if any, are in the best interest of animal welfare. If the need to move an animal arises, such interventions should begin with the least invasive methods possible, such as deterrents and physical barriers, before consideration of invasive capture and relocation [6,10]. In cases where animal welfare is significantly compromised, end-of-life decisions should be considered, even if that could elicit an unfavorable public reaction.

Based on the discussion in the previous section and taking into account ideas from the literature [e.g. 236,237,240], we propose the following statements to guide the operation of an OOH governance body:

- Coordination by a relevant official with the legal authority to implement decisions;
- A biological assessment to determine species, together with any information available regarding the individual(s) in question;
- Monitoring of the behavior of the OOH animal and other species (including humans) that interact with it;
- Identification of the full spectrum of interested parties, both apparently negatively and positively impacted by the presence of the animal;
- Design and implementation of an Adaptive Co-Management body; and
- Development of a strategy for protecting the welfare of the OOH marine mammal(s) while, at the same time, minimizing negative impacts on interested parties.

Drawing further on the information reviewed above, the following recommendations are provided for the various interested parties to better prepare for and manage future OOH situations:

Government

- Develop protocols for monitoring and managing situations involving OOH marine mammals, including how best to communicate and collaborate with the various interested parties including indigenous communities;
- Initiate special protection for OOH marine mammals under existing migratory species acts or other relevant legislation, to prevent them from being persecuted or disturbed;
- Include OOH marine mammals in conservation management plans, bearing in mind that these animals are potentially pioneers and, in the future, more individuals may appear in a particular area, or a population may establish itself;
- Protect and enhance key habitats that are repeatedly used by OOH marine mammals; and
- Train staff in various aspects to deal with OOH marine mammals, including HWC and resolution.

NGOs and volunteer groups

- Work with government and law enforcement to monitor and manage situations involving OOH marine mammals;
- Survey areas where marine mammals may become trapped after extreme weather events [see, e.g., 7];
- Provide consistent, clear communication.

Scientists/researchers

- Monitor welfare, via health and behavioral assessments, of OOH marine mammals;
- Collect data from wildlife rescue centers, stranding networks, and marine mammal surveys to detect trends regarding cases involving OOH marine mammals;
- Engage with local and traditional knowledge holders to gain insights on species' historical ranges;
- Where feasible, publish findings and case studies to enhance knowledge of these events;
- Advise governments when action is required for individual animals or newly arriving pioneers; and
- When commenting on the situation, provide consistent, clear, and scientifically accurate communication.

Whilst these recommendations are addressed to three different sectors, we appreciate that there may be some overlap in responsibilities and that these may vary between different countries.

We also emphasize the need for improved education and information for the public about OOH marine mammals. The arrival of an unusual animal in an area can generate considerable interest ranging from hostility to intense curiosity and a desire to interact. Information needs to be swiftly provided to ensure that risks are appropriately identified, and so that the animal is not demonized.

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Declarations of interest

none

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No data was used for the research described in the article.

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