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Action plan for the conservation of great whales in the Eastern Pacific Ocean

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EXECUTIVE SUMMARY

The eastern Pacific Ocean extends over jurisdictional waters and island territories of 11 countries as well as an extensive area of high seas, where at least eight species of large whales converge with populations in one or both hemispheres. Their distribution is not limited to jurisdictional waters nor are their migratory movements exclusively latitudinal, obeying in many cases the reproductive status of the animals and/or specific environmental conditions. Given their wide distribution and complex migratory movements, the conservation of great whales constitutes an enormous challenge that requires a joint and dynamic approach between the different countries of the region. As in other parts of the world, whales in the eastern Pacific Ocean face a series of anthropogenic threats, including incidental mortality in fishing gear, collisions with ships, pollution in different forms and climate change, which require management and protection measures at the distribution scale of whales to be effective.

Whales provide humanity with a series of environmental, cultural and economic benefits that must be preserved. However, their conservation and management are constrained in the countries of the Eastern Pacific by a series of challenges that must be faced in the short and medium-term, such as lack of information, weak environmental institutions, lack of financing, limited technical capacities, weak transboundary governance, among others. It is recognized that there are differences between countries and between subregions, which also represents an opportunity for those furthest behind where information on great whales is still scarce.

The objective of the Plan is to promote the conservation of these species and their habitats to recover and maintain their optimal population levels in the long term. The Plan also attempts to strengthen transboundary governance processes for great whales, reduce the direct, indirect and cumulative impacts of human activities, promote scientific research and the integration of information, enhance the economic benefits of tourism associated with great whales and contribute to the development of an appropriate framework for the management and sustainability of the different economic activities in the sea.

The Plan includes 39 activities on seven different topics: **1)** research needs to fill information gaps; **2)** national actions to reduce anthropogenic threats; **3)** regional actions to reduce threats and promote regional governance; **4)** access, publication and exchange of information; **5)** enhance socioeconomic benefits through sustainable tourism; **6)** capacity building; **7)** awareness and dissemination. Activities were prioritized by country and region. The actions prioritized in this Plan are expected to be mainstreamed through national and regional science and policy agendas, regional projects, marine research programs and other conservation initiatives throughout the region.

I. INTRODUCTION

Whales are marine mammals that live in all seas and at all latitudes of the planet. During the past two centuries, large whales have been commercially hunted around the world in both tropical and polar zones, in coastal areas and on the high seas, bringing most species to the brink of extinction. Although some of them were protected since the mid-20th century and later extended to all species in 1986 when the global moratorium issued by the International Whaling Commission came into force, not all species have recovered and some will probably require decades to do so, considering the changes produced by human activities in the ocean. The species and populations that inhabit the eastern Pacific Ocean were not immune to the voracity of whaling companies and, although some of them, such as the gray whale (Eschrichtius robustus) in the northeastern Pacific and the two populations of humpback whales (Megaptera novaeangliae) in the northeastern and southeastern Pacific have recovered to pre-exploitation levels, this is not the case for others such as the highly endangered Southeast Pacific right whale (Eubalaena australis) or fin whales (Balaenoptera physalus). Currently, great whales face new anthropogenic threats such as incidental mortality in fishing gear, ship strikes, pollution in different forms and climate change, which require management and protection measures at the scale of whale distribution to be effective. The conservation of great whales in this new century requires novel approaches, technological tools, and improved cooperation among communities, science, civil society, industry, states, and international organizations (Johnson et al., 2022).

For the purposes of this management tool, "great whales" are considered to be those cetacean species greater than 10 m in length, whose populations were affected by commercial whaling either in the waters of eastern Pacific Ocean countries or in high latitudes where some of these species have their feeding grounds. This includes seven species of baleen whales (blue, fin, sei, Bryde's, humpback, right and gray whales) and one odontocete, the sperm whale, and their different populations or stocks in both hemispheres.

1.1 Importance of whales.

Whales provide mankind with a number of environmental, cultural and economic benefits that need to be preserved. Given their capacity for movement and high metabolic rates, whales and other marine mammals can affect the structure and function of ecosystems through different mechanisms over time. As predators, whales act as regulators of prey populations, contribute to evolutionary processes, recycle nutrients, and their carcasses provide food and substrate to benthic communities in deep waters when they sink or on beaches when they beach (Roman et al., 2014; Kirszka, et al., 2015; Quaggiotto et al., 2022). New evidence suggests that whales may play a key role in the planet's climate, fertilizing the oceans and sequestering large amounts of carbon, even more efficiently than trees (Chami et al., 2019). For all these reasons, they are considered to be good indicators of ecosystem productivity and health. In terms of conservation, whales are considered as umbrella species, that is, conservation measures implemented to protect them are also useful for other types of migratory marine megafauna affected by similar threats and even entire ecosystems in the case of protected areas declared to protect cetaceans.

Whales are currently an important source of income for numerous coastal communities in Latin America that have found in tourism a source of income and work for thousands of people. In 2008 it was estimated that whale watching generated more than 2.1 billion dollars worldwide (O'Connor et al., 2009). In the first decade of the 21st century the total benefits of the activity in Latin America were around 300 million dollars (Hoyt and Íñiguez, 2008), but given the rate of growth (11.3 % annually) that figure could well have doubled at the present time, which is why poorly managed tourism also represents a threat to its conservation. To continue providing such benefits to our society, whales need a healthy environment free of threats that endanger their recovery and long-term survival.

1.2. Need for regional management.

The eastern Pacific Ocean is a breeding area for large whales, where migratory species from both hemispheres converge. Migratory species show regular north-south movement patterns between tropical and temperate zones where they breed during the winter in the tropics and in the spring they return to high latitudes where they feed during the summer, something that has been known since whaling times (Kellogg, 1929; Townsend, 1935). In this process, some species such as the humpback whale can travel more than 16,000 km per year (Stone et al., 1990; Rasmussen et al., 2007). In the case of blue whales, migration does not appear to be as regular and is associated with the availability of food during migration and in breeding areas (Branch et al., 2007). Given that the seasons of the year in the two hemispheres are six months apart, in the tropical areas of the eastern Pacific Ocean there are two breeding seasons for migratory cetacean species, corresponding to the winter periods of each hemisphere.

Due to their wide distribution, the conservation of great whales constitutes an enormous management challenge not only because they occur throughout the jurisdictional zones of many countries, but also because in most cases their presence is seasonal, which implies considering dynamic management. As highly mobile animals, great whales require immense oceanic spaces to complete the different stages of their biological cycle. Their distribution is not limited to jurisdictional waters nor are their migratory movements exclusively latitudinal and, in many cases, are due to the reproductive state of the animals or to specific environmental conditions. The available information generally comes from specific sites where the research effort is concentrated, leaving large areas without coverage, although important progress has been made in recent years regarding migration routes thanks to satellite telemetry (e.g. Bailey et al., 2009; Félix and Guzmán, 2014; Hucke-Gaete et al., 2018; Sepúlveda et al., 2018).

An important part of migratory species management is to identify critical habitats, i.e., those destination sites where they concentrate for activities such as feeding, breeding, rearing and socialization (CPPS, 2014). Critical habitats have particular conditions that are essential for the survival of the species, this includes both ecological and biophysical aspects such as food availability, water temperature, depth, among others (Clark et al., 2010; Williams et al., 2011). Less progress has been made, however, in the identification of migratory routes, which are also sensitive areas and require specific management measures due to the possibility that human activities such as maritime transport may interfere with or pose a risk to the species. Understanding the relationship between environmental factors, species distribution and human activities is fundamental for the management of large whales (Johnson et al., 2022).

Most of the countries in the region are signatories to the main international conventions related to the conservation and sustainable use of marine resources, such as the Convention on Biological Diversity (CBD), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the International Convention for the Regulation of Whaling (ICRW), among others, developing a regional institutional framework through binding and non-binding instruments. Among these instruments are the 2030 Sustainable Development Goals, in particular Goal 14, Underwater Life (and its different sub-goals), action plans for large whale species (e.g. humpback and blue whales) and areas for the protection of marine megafauna. In the eastern Pacific Ocean there are hundreds of marine protected areas (MPAs) of high importance for large whales and other marine mammals, including some of the largest MPAs in the world such as Rapa Nui Sea (579,368 km2), Nazca-Desventuradas (297,000 km2), Juan Fernandez Sea (262,000 km2), Galapagos Marine Reserve (198,000 km2) and Revillagigedo (148,087 km2).

II. OBJECTIVE

The Conservation Plan for Great Whales in the Eastern Pacific Ocean relates to existing initiatives and institutional mechanisms established by the countries of this region to address the conservation of great whales. It promotes the identification of opportunities to articulate effective actions at the national and regional levels, identifies direct and indirect threats to great whales and describes the best alternatives to address them. Accordingly, the objective of the Plan is to "promote the conservation of great whales in the eastern Pacific Ocean with a view to recovering and maintaining their optimal population levels in the long term".

2.1. Specific objectives.

1) Strengthen transboundary governance processes of great whales in the region, promoting participatory management among governmental and intergovernmental stakeholders, relevant sectors and coastal communities.

2) To reduce the direct, indirect and cumulative impacts of human activities on great whales, in terms of mortality, animal welfare and habitat integrity.

3) Promote scientific research and the integration of information on a regional scale to fill existing gaps and guide decision making.

4) Enhance the economic benefits provided by responsible tourism associated with large whales, particularly for coastal communities.

5) Contribute to the development of an appropriate framework for the management and sustainability of different economic activities at sea.

III. SCOPE OF THE PLAN

3.1. The Eastern Pacific Ocean.

The eastern Pacific Ocean encompasses some 20 million km2 of territorial waters, exclusive economic zones and island territories of 11 countries, as well as an extensive marine area beyond national jurisdictions between Mexico and Chile (32°N - 55°S). In this extensive area there are a variety of tropical, subtropical, temperate and subpolar ecosystems, with complex systems of marine currents and other permanent and seasonal large-scale oceanographic processes. Along the coasts of Chile and Peru extends the Humboldt Current, a nutrient-rich cold water current with areas of intense upwelling near the coast, with an average productivity between 150 and 300 gC/m2-yr (Heileman, et al., 2008). Some of the most important fisheries occur in this region, with production reaching 10% of the world's total marine catch (FAO, 2021). The central zone of the eastern Pacific is considered a zone of high productivity (>300 gC/m2-yr), with upwelling zones along Central America and important nutrient inputs from runoff in the southern part (Bakun, et al., 1999; Kessler, 2006; Heilman, 2008). In contrast, the northwestern zone along the California Current is considered a low productivity zone (<150 gC/m2-yr) (Aquarone and Adams, 2008). Off the coast of Central America, the thermal dome of Costa Rica stands out, a zone of high productivity of about 300-500 km in diameter located at 9°N and 90°W that has been identified as an important area for blue whales and smaller cetaceans (Reilly and Thayer, 1990; Fielder, 2002). High oceanographic dynamics have made the eastern Pacific Ocean one of the richest regions for cetacean species, including populations in both hemispheres of the vast majority of known large whale species (e.g., blue, humpback, fin, sei, sperm, and sperm whales, among others).

3.2. Precautionary principle.

Although important advances have been made in the knowledge of great whales in the eastern Pacific Ocean in recent years, there are still many gaps in knowledge that will be very difficult to fill in the short term. Given this limitation, it is necessary that decision makers adopt the precautionary principle to the conservation and management of great whales, so that the lack of information should not be an obstacle to implement conservation measures.

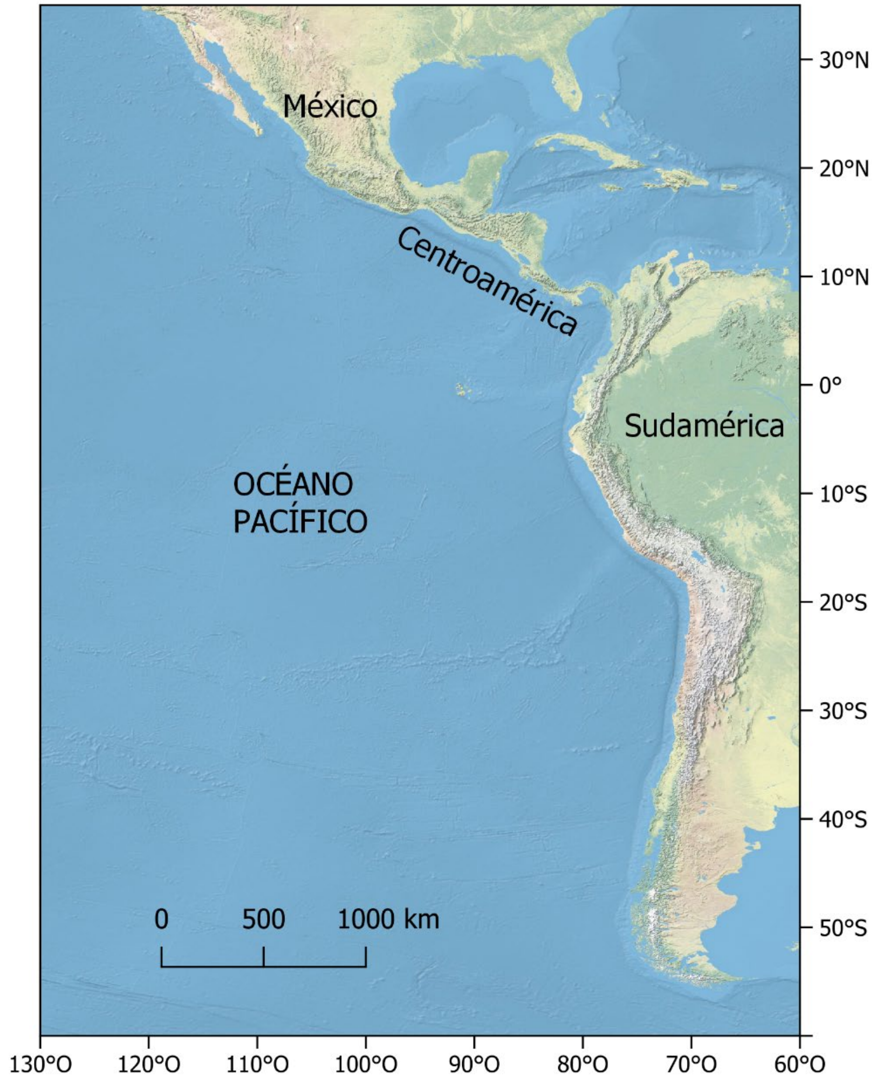

Figure 1. The eastern Pacific Ocean. For the purposes of this management tool, the region includes Mexico and all Central and South American countries with Pacific Ocean coastlines.

IV. LARGE WHALE SPECIES IN THE EASTERN PACIFIC OCEAN

Information on population abundance and trends is of particular interest to the International Whaling Commission (IWC), the secretariat of the International Convention for the Regulation of Whaling (ICRWC). The IWC has a technical body, the Scientific Committee, itself composed of different subcommittees, which periodically assesses the status of whale populations. Table 1 shows the abundance estimates for the different populations of large whales distributed in the eastern Pacific Ocean that are managed by the IWC. For some species the confidence intervals are very large, which implies that more effort is required to refine the estimates. In the case of the southeastern Pacific right whale, there is not even an abundance estimate. Table 1 also shows that, with the exception of humpback and gray whales, the other species and populations of the eastern Pacific are placed in some category of threat according to the IUCN criteria, four as Vulnerable (V), four as Endangered (E) and one as Critically Endangered (CE)

Table 1. Abundance estimates of the different populations of large whales inhabiting the eastern Pacific Ocean accepted by the International Whaling Commission (IWC).

Especie	Nombre común	Población/ subpoblación	Tamaño poblacional	Estatus IUCN	Referencia
Balaenoptera musculus	Ballena azul	Pacífico nordeste	2,500 (IC 95% 1,700-3,600)	E	CBI
	Ballena azul	Pacífico sudeste	570-760	E	Galleti et al. (2017)
	Ballena azul	Antárctica	2,300 (IC 95% 2,250-4,500)		CBI
Balaenoptera physalus	Ballena de aleta	Pacífico nordeste	9,029 (CV 0.12)	V	Nadeem *et al*. (2016)
		Golfo de California	613 (CI 426-970)	V	Díaz-Guzman (2006)
		Hemisferio sur	17,600 (CV 0.26)	V	Matsuoka & Hakamada 2014
Balaenoptera borealis	Ballena sei	Pacífico nordeste	29,600 (IC 95% 18,500-47,300)	E	CBI
		Hemisferio sur	10,000	E	IWC (1996)
Balaenoptera edeni	Ballena de Bryde/Rice	Pacífico oriental	41,000 (IC 95% 24,000-68,000)	LC	CBI
Megaptera novaeangliae	Ballena jorobada	Pacífico nordeste	14,407 (CV 0.56) (	LC	Inai *et al*. (2018)
	Ballena jorobada	Pacífico sudeste	11,780 (SE=266)	LC	Félix et al. (2021)
Eubalaena australis	Ballena franca del sur	Perú-Chile	No hay estimación	CE	
Eschrichtius robustus	Ballena gris	Pacífico nordeste	27,000 (IC 95% 24,400-29,900)	LC	CBI
Physeter macrocephalus	cachalote	Pacífico oriental	22,700 (14,800-34,600)	V	Wade & Gerrodette (1993)

The following is a description of some biological, ecological and natural history aspects of the large whales inhabiting the eastern Pacific Ocean. The description is not intended to be a complete evaluation of each species, but rather to give an overview of the current status of the species and populations inhabiting the region. For a complete description of each species it is suggested to consult specialized scientific literature and the recently updated IUCN assessments.

4.1. Blue whale (Balaenoptera musculus).

The blue whale is the largest animal that has ever lived. Its adult size ranges from 23 to 27 m in the northern hemisphere and up to 30 m in Antarctica (Jefferson et al., 2008). Cosmopolitan in distribution, the species primarily inhabits oceanic waters, but can also be observed close to shore in some places to rear calves and feed (Gendron, 2002; Hucke-Gaete et al., 2004). The blue whale was one of the species most affected by whaling in the 19th and 20th centuries, particularly in the Southern Ocean where its population was reduced to about 0.15% of its original population estimated at 239,000 animals (Branch, 2004). In general, migration patterns are unknown as migration routes are not as well defined as in humpback, right or grey whales; some populations appear to be resident. To a large extent the movements of blue whales are associated with the relatively predictable presence of krill concentrations - their main food - as they have to feed constantly to meet their energetic requirements (Branch et al., 2007).

In the northeast Pacific there is evidence of movement of blue whales out of California in the United States where they feed, into the Gulf of California in Mexico, a breeding, feeding and probably breeding area, as well as into the so-called thermal dome of Costa Rica (Fiedler et al., 1998; Mate et al., 1999; Gendron, 2002; Bailey et al., 2009). Along the southeastern Pacific there is evidence of movements from the Gulf of Corcovado and Chiloé in southern Chile, where blue whales feed until late in the austral autumn, to the Galapagos Islands and further west, as well as the northern coast of Peru (Hucke-Gaete et al., 2018), showing a correspondence between the equatorial zone and southern Chile.

Blue whales in the northeast Pacific would belong to the subspecies B. m. brevicauda (Gilpatrick and Perryman, 2008), while in the southeast Pacific, along the Humboldt Current (Chile, Peru and Ecuador), a different population or subspecies would inhabit, according to genetic, acoustic and morphological studies (Branch et al., 2007). The best known population is the northeast Pacific population estimated to number around 2,500 animals (Calambokidis et al., 2010) of which 283 (CV = 48.4%) migrate annually to the Gulf of California (Gendron, 2002). Information on abundance of the species in the southeast Pacific is fractional and partial. The population in the so-called Chiloe ecoregion is estimated at 570-760 animals (Galleti et al., 2017). The blue whale is listed by the IUCN as "Endangered" in the northern hemisphere and "Critically Endangered" in Antarctica.

4.2. Fin whale (Balaenoptera physalus).

It is the second largest of the baleen whales. Its distribution is cosmopolitan, particularly in temperate and subpolar waters in both hemispheres, as well as in large inland seas such as the Mediterranean and Gulf of California, but it is considered rare in tropical areas (Jefferson et al. 2008; Edwards et al., 2015). Most of its populations were depleted by whaling activities in the late 19th and most of the 20th century, and it is therefore considered Vulnerable by the IUCN (Cooke, 2018a). Abundance monitoring in both hemispheres shows that the species is recovering, particularly in the northern hemisphere (Cooke, 2018a). Population structure, migration routes and seasonal distribution are poorly known for most populations because they would occur in the open ocean and their breeding grounds are still unknown (Jefferson et al. 2008; Edwards et al., 2015; Cooke, 2018a). The North Pacific subspecies is known as B. p. velifera and the Southern Hemisphere subspecies as B. p. quoyi, and perhaps a smaller, darker form B., p. patachonica occurs in the Southeast Pacific (Clarke 2004; Archer et al., 2013). The North Pacific fin whale population would have a complex population structure with up to six different subpopulations (Mizroch et al., 2009), including a genetically isolated population in the Gulf of California (Bérubé et al., 2002). Recent molecular studies in south-central Chile suggest an absence of structuring in the Southeast Pacific population (Pérez et al., 2021) although the number of sites sampled is still limited.

About 8,241 fin whales were hunted throughout the 20th century from whaling stations in Peru and Chile (Clarke et al., 1980). The most important hunting area was the south-central coast of Chile (37 and 44°S) (Risting, 1928). Recent satellite tracking studies on the central coast of Chile established that at least part of the fin whales distributed in this area during the austral summer and spring would migrate to Antarctica, while others would remain in mid-latitudes feeding in the highly productive Chilean waters (Toro et al., 2016; Sepúlveda et al., 2018; Acevedo et al., 2012). A recent record of a southern hemisphere specimen in Ecuador (Félix et al., in press) suggests that fin whales are widely distributed in the southeastern Pacific.

4.3. Sei whale (Balaenoptera borealis).

This is a cosmopolitan, mostly oceanic species that migrates between tropical and temperate zones to sub-polar waters during the summer. As with other oceanic whales, the areas and timing of breeding are unknown, which has made assessment very difficult. Externally it is similar to the Bryde's whale with almost uniform dark grey colouration and a prominent dorsal fin. In the eastern Pacific Ocean there are reportedly two recognised subspecies, B. b. borealis in the northern hemisphere and B. b. schlegelii in the southern hemisphere (Cooke, 2018b). In the North Pacific the species is distributed mainly north of 40° and occasionally further south in the Gulf of California (25° S) (Gendron and Chavez, 1996). During cetacean research cruises in the eastern Pacific conducted between 1986 and 2003 by the US NOAA, a single record of sei whales was made in the Gulf of California (Hamilton et al., 2009). However, the difficulty of differentiating sei whales from Bryde's whales at sea is possibly the cause of under-recording in the eastern tropical Pacific.

In the southeast Pacific the latitudinal distribution is wider than in the northeast Pacific, reaching north to the equator, although records are scarce compared to other large whale species even in colder areas to the south (see Acevedo et al., 2017a). Whaling records from northern Peru also show that the species' presence is not limited to the austral winter but also to the first months of the austral summer (Valdivia et al., 1984). According to Clarke (1980) during the 20th century a total of 5,666 sei whales were hunted from coastal whaling stations in Peru and Chile, although the figure should be taken with caution because they were treated together with Bryde's whales as a single species until 1972. Sei whales were also reported during the austral summer by Japanese whaling survey expeditions in the early 1960s between the coast of Ecuador and the Galapagos Islands (Loesch, 1966) and more recently by different scientific expeditions and naturalist guides in the Galapagos Islands (Denkinger et al., 2013). The sei whale is considered a threatened species by the IUCN.

4.4. Bryde's whale (Balaenoptera edeni).

Distributed in tropical and subtropical waters around the world, often near coasts or areas of high productivity. The species is widely distributed in the tropical and subtropical eastern Pacific throughout the year (CPPS, 2014). Extensive north/south migrations are not known, although significant movements have been reported, possibly in response to changing environmental conditions and food availability, such as during the El Niño phenomenon in the southeast Pacific (Ramirez and Urquizo, 1985) and in the southwest Gulf of California (Salvadeo et al. 2011). There is apparently a resident population in the Gulf of California (Jefferson et al., 2008). Around the Galapagos Islands they are relatively common, particularly to the west of the archipelago (Palacios and Salazar, 2002). Off Peru, two ecotypes have been reported, a coastal-neritic one up to 100 nm from the coast and an oceanic one beyond 100 nm (Ramírez, 1989; Reyes, 2009).

According to Rice (1974) this species was taken between 1913 and 1935 by Norwegian vessels off the Baja California peninsula and as far south as the southern offshore waters of Mexico. The species formed a major proportion of the whale catch taken in Peru since the early 20th century. Between 1976 and 1985, 2,299 Bryde's whales were hunted and 6,311 were sighted in the hunting area in northern Peru (3°30'S to 8°S to 200 nm and 8°S to 10°S to 60-80 nm), sites where hunting was conducted year-round, but most intensively in the months of October to March (Ramirez, 1989). Previously, between 1908 and 1975, sei whale catches between Chile and Peru reached 5,666 whales (Clarke, 1980), a figure that includes an unknown number of Bryde's whales, since, as mentioned above, the two species were then confused. It is estimated that there are between 20,000 and 30,000 whales in the North Pacific and another 10,000 in the tropical Pacific. There are no estimates for the southeast Pacific, but the population is probably also recovering. There is insufficient information on the species to assess its status.

4.5. Humpback whale (Megaptera novaeangliae).

It is also a cosmopolitan species with multiple populations in both hemispheres. Their habitat is mostly coastal in both continental areas and oceanic archipelagos. They regularly migrate between well-defined feeding areas at high latitudes and breeding grounds in the tropics. In the eastern Pacific there are two populations, one in the northeast Pacific and one in the southeast Pacific. The northeast Pacific population is quite structured and there is a correspondence between the feeding grounds located at lower latitudes in California and Oregon in the USA mainly with the breeding grounds located in northwestern Mexico and Central America as far south as Costa Rica and northern Panama (May-Collado et al. 2005; Calambokidis et al., 2008). However, the feeding grounds of humpback whales breeding in the Revillagigedo Archipelago are more closely related to the feeding grounds in central and high latitudes (Calambokidis et al., 2008). The southeastern Pacific population also shows both breeding and feeding ground structure (Guzmán and Félix 2017; Acevedo et al., 2017b). There are two identified feeding grounds, one in southern Chile and one around the Antarctic Peninsula. Breeding grounds extend from northern Peru to Nicaragua in Central America (Flórez-González et al., 2007; Rasmussen et al., 2007; DeWeerdt et al., 2020).

Although the migratory destinations of humpback whales are well defined, there are still gaps in our knowledge of the migratory routes they take. Most whales appear to take a more coastal route in both the northern and southern hemispheres, but other whales may migrate through oceanic waters. Information from satellite tracking of humpback whales migrating from Ecuador and Panama to Antarctica (Félix and Guzmán, 2014) and vice versa (Modest et al., 2021) suggests that the migration corridor of southeastern Pacific humpback whales extends at least 1,500 km along the coasts of Chile and Peru.

Humpback whales were widely exploited in all oceans. In the southeast Pacific, 2,281 animals were hunted to date in Chile and Peru (Clarke, 1980). The species is also affected by human activities probably because its habitat is more coastal. Recent estimates in the North Pacific show that there are around 18,000 animals with an average annual population increase of 4.9% (Calambokidis et al., 2008). It is estimated that during the breeding season 1,496 (CV=171) whales are distributed between central Mexico and Central America (Curtis, et al., 2022). In the Southeast Pacific, the current population is estimated to be 11,785 (SE = 266) animals with an annual increase of 5.07% (Félix et al., 2021a).

4.6. Southern right whale (Eubalaena australis).

The species is distributed in circumpolar waters of the southern hemisphere, generally between 20°S and 55°S. It is a migratory species that moves north during the winter to breed and south to feed, usually close to the coast. Several populations of the species are considered to exist in the southern hemisphere, one of them being the southeast Pacific, which has the most northerly distribution of the species with records as far north as 12°29'S (Van Waerebeek et al., 2009). However, there are only 170 historical records of the species in the region. Existing records show a continuous distribution along the coast of Chile to central Peru, mainly in winter and spring (June-November). During the summer and autumn months (January-May) the species is distributed in the southern part of Chile and west of the Antarctic Peninsula. Records of whales with calves are almost entirely located north of 40°S, mainly between September and October (Van Waerebeek et al., 2009; Aguayo et al., 2008). There is a probable record of the species in northern Peru at 4°S near the border with Ecuador. In Chile, most sightings are recorded between June and October between 20°S and 40°S (Aguayo et al., 2008; Hucke-Gaete, 2011).

It was one of the most exploited whale species in Antarctic waters. Historical records show that whales from this population were also intensively exploited in southern Chile from the 19th century, where around 9,000 animals were hunted (Aguayo et al., 2008). During the 20th century another 180 whales were hunted in Chile (Clarke, 1980). Although their neighbouring population in the western Atlantic shows signs of recovery, the Southeast Pacific right whale population is critically endangered and possibly only a few dozen survive (Cooke and Zerbini, 2018).

4.7. Grey whale (Escrichrius robustus).

This is a mostly coastal species of the North Pacific. During the breeding season it congregates in lagoons along the Baja California coast and in small numbers in the Gulf of California and the mainland coast of Mexico during the boreal winter (Cooke et al., 2018c). There is a record of a stranding of the species as far south as El Salvador (Barraza, 2011). Feeding grounds are in coastal waters northeast of the Bering Strait and south of the Chukchi and Beaufort Seas. A small population of the species known as the western stock is distributed in the Northwest Pacific. Its mottled colouration, the presence of abundant epibionts on the body and the lack of a dorsal fin make it easy to distinguish from other whale species (Jefferson et al., 2008). Because of its coastal habitat both in the aggregation areas and along the migration, the gray whale is one of the most studied whales. The feeding behaviour of the gray whale is different from other whales that are mostly planktivorous or piscivorous, feeding by sucking on the seabed to feed on small invertebrates such as amphipods, myscidaceans, polychaetes, crabs and possibly larvae of numerous marine species (Jefferson et al., 2008).

Driven to the brink of extinction in the 19th century by hunting both in breeding lagoons and along the California coast (Reeves and Smith, 2010), the eastern Pacific population of gray whales is one of the few that have fully recovered from commercial whaling. The most recent abundance estimate shows the population to be 26,960 animals (95% CI 24,420-29,830) (Durban et al., 2015), so it is currently considered Least Concern according to IUCN criteria.

4.8. Sperm whale (Physeter macrocephalus).

It is a cosmopolitan species, including all oceans from the tropics to the polar regions and enclosed seas, although only males reach the northern and southern extremes of distribution (Rice, 1989). It is the most sexually dimorphic cetacean species, with females reaching up to 12.8 m and males up to 18 m in length and weighing almost 60 tonnes. Sperm whales feed mainly on mesopelagic cephalopods such as the giant Humboldt squid (Dosidicus gigas) (Clarke et al., 1988; Jaquet and Gendron, 2002). Socio-ecological studies show that the species has a complex form of social organisation, with females and immatures living in social units (clans) that maintain a stable relationship for years or decades, have different dialects, but with a sympatric distribution (Whitehead et al., 1992; Rendell and Whitehead, 2003).

Sperm whales are widely distributed throughout the eastern Pacific Ocean occurring in highest density in areas of high productivity such as the California area, Gulf of California, Galapagos Islands and along the Humboldt Current in the southeast Pacific (CPPS, 2014). It has been suggested that the California population would be demographically independent of the central and eastern Pacific population (Mesnick et al., 2011). Migratory movements of this species are not as well defined as for most baleen whales. In the eastern tropical Pacific, groups of females and immatures adapt their movements over a range of spatial and temporal scales in response to changing food conditions. Movements of females and immatures have been recorded over 2,000 km between the Galapagos Islands, the coast of Ecuador and Panama, and up to 4,000 km between the Galapagos, Gulf of California (Jaquet et al., 2003) and northern Chile (Whitehead et al., 2008a).

Sperm whales were the main target of Yankee whalers from the mid-18th century, mainly because of the spermaceti, a thin oily fluid in a special organ that occupies most of the head. Probably because their populations were large, the species did not reach the critical levels of other commercially exploited species. Exploitation continued even more intensively during the 20th century, including in the southeast Pacific where 104,980 sperm whales were hunted between 1908 and 1975 (Clarke, 1980). The species has not fully recovered in the region. In fact, the population in the Galapagos Islands, another important historical whaling centre, has continued to decline over the last two decades at a rate of 20% per year possibly associated with the extirpation of adult males (Whitehead et al., 1997). There are an estimated 80,000 animals in the North Pacific, including some 26,000 in the eastern tropical Pacific (Wade and Gerrodette, 1993). The species has an IUCN Vulnerable status.

V. MAIN THREATS TO GREAT WHALES

This section describes the main threats to great whales in the eastern Pacific Ocean. The information available for the region is sparse and ad hoc, so the magnitude of the impact of each threat is unknown. It is most likely that there is an accumulation of impacts due to the synergistic and additive interaction of different types of threats such as pollution, interaction with fisheries, climate change, and even activities considered to be of low impact such as tourism.

5.1. Interaction with fisheries.

Interaction with fisheries is considered the main cause of unnatural mortality for great whales and, therefore, the main obstacle to the recovery of endangered species (Perrin et al., 1994; FAO, 2018.). It is estimated that around 300,000 dolphins and whales are killed annually in fishing nets (Read et al., 2006). Most interactions occur with bottom and surface gillnets, but can also occur with trap lines (FAO, 2018). Due to their large size and strength, interactions with nets do not always result in a quick death for the whales, as debris can become entangled and remain entangled for months until the whales weaken and die. Scars on the bodies of whales that have survived the interaction have been useful to better understand the magnitude of the problem (e.g. Robbins and Mattila, 2001).

Entanglement and mortality of large whales has been reported from five countries in the eastern Pacific involving six species, most of them with a coastal distribution or with concentration sites close to the coast (Figure 2). In the Southeast Pacific, mortality of southern right, Bryde's, blue, humpback and sperm whales has been reported (Hucke-Gaete et al. 2004; Gallardo and Pastene, 1983; Felix et al., 1997, 2011; Aguayo, 1999; Capella et al., 2001; García-Godos et al., 2013; Castro and Van Waerebeek, 2020; Torres and Sarmiento, 2021). An average annual entanglement rate of 0.57% (range 0.31-0.86 %) was estimated in humpback whales during the breeding season in Ecuador based on live animals found at sea with gear remains (Félix et al., 2011). Considering the current population size (around 12,000 animals), between 37 and 103 humpback whales could annually be victims of entanglement in fishing gear in this area. In the northeast Pacific, entanglements would occur mainly with humpback and gray whales, and to a lesser extent with fin and Bryde's whales in Mexico (Urban et al., 2003, 2018), but the problem extends further north along the US coast, where mortality of humpback, gray, blue, fin and sperm whales, most of them species and populations shared with Mexico and other eastern Pacific countries, has also been reported (e.g. Scordino et al., 2017; Saenz et al., 2021). Mortality of large whales by entanglement in Central American countries is poorly known, although recent records of cetacean strandings in El Salvador and Nicaragua indicate that humpback, Bryde's and blue whales frequent the area and may be victims of fishing activities (De Weerdt, et al., 2021; Ibarra et al., 2021).

It has long been considered that the impact on larger, oceanic whales such as blue and fin whales would not be as high as with humpbacks and greys. However, recent assessments with drone imagery in the Gulf of St. Lawrence in Canada reveal that the proportion of peduncle and tail scars in blue and fin whales are similar (60-80%) to those in humpbacks (Ramp, et al., 2021). In general, the impact of entanglements on large whale populations in the region is unknown and further efforts must be made to quantify it. The lack of official information and the disparity of information between countries are aspects that make assessment difficult. Most entanglements in Eastern Pacific countries occur with gillnets used by small-scale fisheries, which presents an additional challenge due to the sheer size of the fleets and the lack of control capacity in some countries. Given the high productivity of coastal waters throughout the eastern Pacific, fishing effort in most countries is large, so some areas are considered "hotspots" for the number of marine vertebrates killed during fishing interactions (Lewinson et al., 2014).

The International Whaling Commission launched a programme called the Global Whale Entanglement Response Network in 2011 with the aim of improving response capabilities for the safe and effective disentanglement of whales (IWC, 2018). Among other things, guidelines for whale disentanglement have been developed and training has been provided to hundreds of people around the world, including in countries in the eastern Pacific.

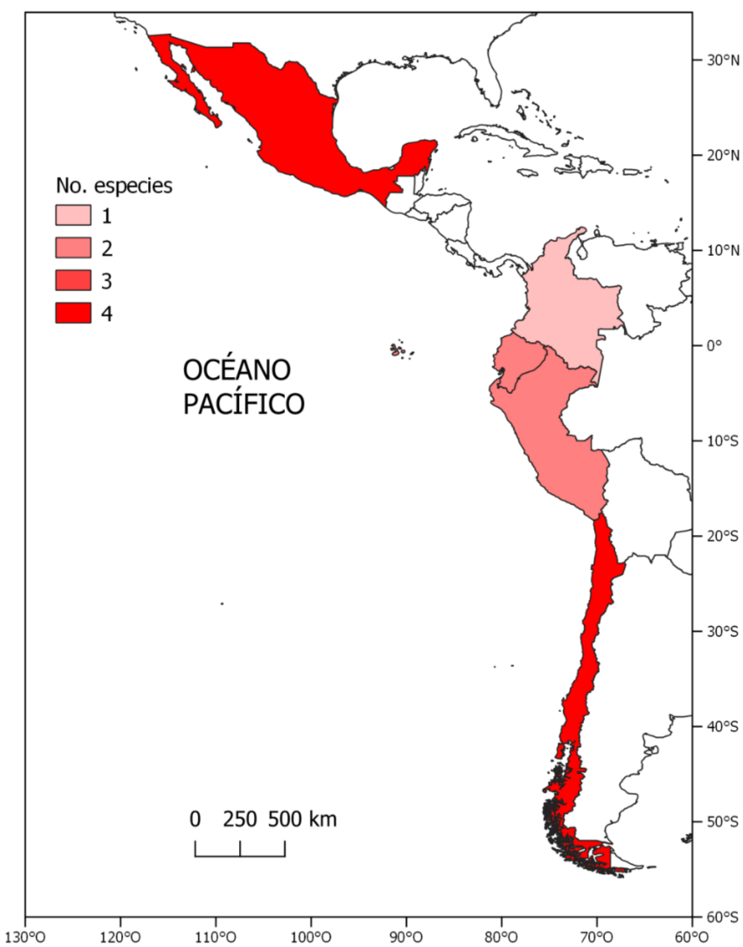

Figure 2. Number of whale species reported as victims of fisheries interactions in Eastern Pacific Ocean countries.

5.2. Collisions with ships.

This is considered to be the second most important cause of unnatural mortality for large whales. The increase in international trade and coastal shipping activities, as well as the fact that ships are becoming larger and faster, means that the problem is expected to increase over time. Collisions occur with all types of vessels, including smaller fishing and tourist boats where crews and tourists may be affected, so it is an issue that also involves maritime safety aspects. Although there are databases and reports that have compiled information from around the world, the vast majority of cases go unnoticed because there is no obligation to report them (Laist et al., 2001, Van Waerebeek et al., 2007; Ransome et al., 2021).

A recent assessment of ship strikes with whales in the eastern Pacific accounts for 40 records that demonstrate not only that cases are under-reported, but that they have been occurring for a long time (Ransome et al., 2021). Ship strikes have been recorded in nine of the eleven Southeast Pacific countries involving seven different species of large whales (Table 3). Most of the cases reported in the eastern Pacific countries involve humpback whales (Van Waerebeek et al., 2007; Ransome et al., 2021), probably because it is an easily identified coastal species. Sometimes it is not possible to identify the species because the crews are not familiar with the different whale species. Collisions are not always fatal, but can cause deep wounds and mutilation of appendages on the animals that can affect the rhythm of their activities and expose them to predators.

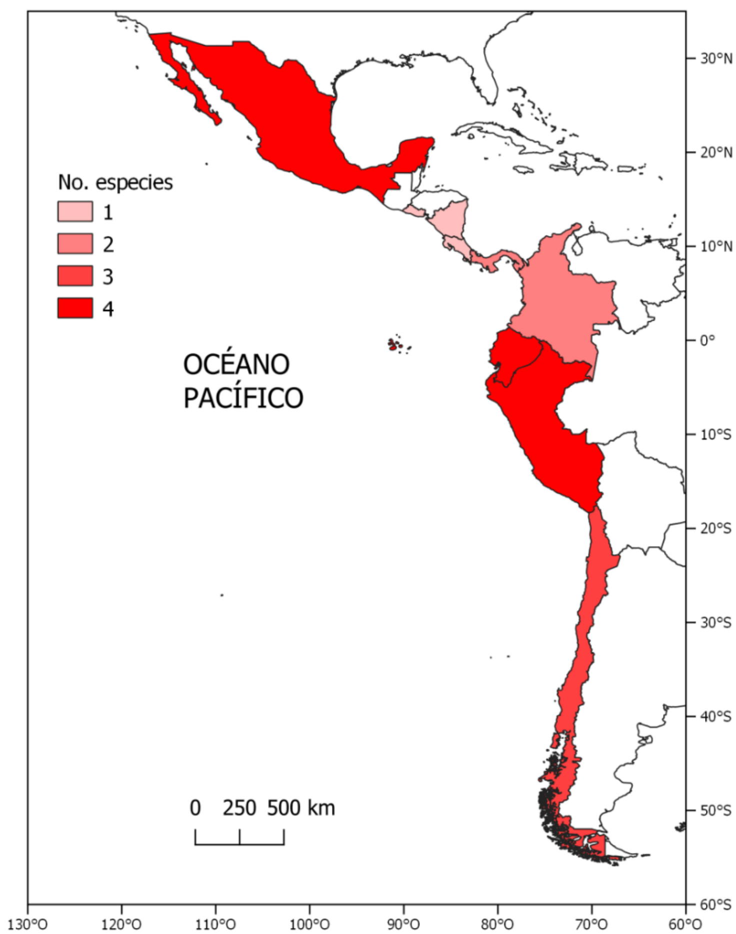

Figure 3. Number of species of whale victims of ship strikes recorded in the Eastern Pacific Ocean countries.

High-risk whale collision sites have been identified in the region, for example, in northern and southern Chile for fin and blue whales, respectively (García-Cegarra and Pacheco, 2018; Bedriñana-Romano et al, 2021); in the Gulf of Guayaquil in Ecuador for humpback and Bryde's whales (Félix and Van Waerebeek, 2005; WWF-Ecuador, 2021); in Buenaventura for humpback whales (Ávila and Giraldo, 2022); at the exit of the Panama Canal for humpback whales (Guzmán et al., 2013); in northwestern Mexico for humpback and gray whales (Nájera et al., 2022); among others. The right whale is the cetacean species that suffers the highest mortality from collisions in the southern hemisphere, with cases having been recorded in Peru and Chile (Van Waerebeek et al., 2007). Both the International Whaling Commission (IWC) and the International Maritime Organization (IOM) have established working groups to address the issue and have developed guidelines and strategies to reduce the likelihood of collisions with whales (IMO, 2009; Cates et al., 2017). In the southern hemisphere, the right whale is the species with the highest collision mortality with 56 documented cases up to 2007 (Van Waerebeek et al., 2007). One of the six records of the species in Peru included a mother and calf in an attempted collision with a fishing vessel (Van Waerebeek et al., 2009).

5.3. Pollution.

Pollution in the sea has different origins and forms, it can directly affect marine species by altering physiological functions or trigger other mechanisms causing unforeseen impacts, such as the presence of toxic red tides due to eutrophication processes. In general, two types of pollution sources are recognised, those coming from land, such as organic and chemical pollution and plastic waste, and those coming from maritime activities, which also include other aspects such as noise and abandoned or discarded fishing gear, hydrocarbon spills, among others. Areas where marine activities are concentrated, such as the continental shelf and slope, have accumulated the greatest amount of impacts from human activities of both terrestrial and marine origin (Halpern et al., 2008), and are where most large whales concentrate their vital activities. While polar areas are the least degraded on the planet, some large whales that feed in these areas and breed in the tropics such as humpback whales show significant mercury concentrations (Angel-Romero et al., 2018). The accumulation of pollutants such as organochlorines and heavy metals in whales and other marine mammals occurs by a process through the trophic web known as biomagnification.

Little is known about the impact of persistent organic pollutants and heavy metals on large whales in the eastern Pacific. Studies to quantify mercury, a highly toxic element associated with immune and endocrine disorders and cancer, have been conducted in species such as humpbacks (Angel-Romero et al., 2018, Remili et al., 2020), grey whales (Ruelas-Inzunza et al., 2003). Although the use of organochlorines has been banned or regulated, traces are still found in marine organisms, probably due to their persistence and dispersal mechanisms through water and atmosphere. Organochlorines have been found in humpback whales in the northeast Pacific at higher concentrations than in those in the northwest Atlantic, although not at population-threatening levels (Elfes et al., 2010).

Marine litter is a growing threat to marine wildlife, including large whales due to entanglement, ingestion and toxicity (Panti et al., 2019, IWC 2020). Ingestion of rubbish and plastics can cause intestinal occlusion and perforation, among other injuries, affecting nutritional status and inducing stress and panic (IWC, 2020). As filter feeders, large whales can also be affected by microplastics floating in the sea due to the presence of toxins associated with plastics (Germanov, et al., 2018; IWC, 2020). In the Southeast Pacific, plastic interactions have been reported in 97 marine species, including 19 marine mammals (Thiel, et al., 2018). Lost, abandoned and discarded fishing gear, known by its acronym ALDFG, represents a major risk to whales, although it is not always possible to differentiate whether it is active or discarded gear. Among the main types of lost gear are nets and recently fish aggregating devices (FADs), which are widely used in tuna fisheries in the eastern tropical Pacific. Marine litter is of concern and interest to many international organisations that have developed guidelines to address the problem in order to seek comprehensive solutions and mitigate its impact (e.g. FAO, 2019).

Another area of concern associated with the deterioration of habitat quality due to human activities is noise pollution, as cetaceans rely on hearing as their main sense. The main sources of noise at sea are ship engines, seismic surveys, oil drilling, sonar and explosions during military manoeuvres. Impacts associated with noise pollution include hearing damage, sudden decompression sickness, habitat abandonment, masking of natural sounds, reduced feeding efficiency and changes in social behaviour (Weilgart, 2007). Studies on baleen whales in the North Atlantic show that sounds produced by marine vessels can mask the communication space (the area over which individual sounds can be detected by whales) by more than 80% depending on the source and species, forcing the animals to make adjustments to the amplitude and frequency of sounds with as yet unknown long-term consequences on their ability to perceive other environmental sounds (Cholewiak, et al., 2018). In Colombian waters it has been determined that the communication space of humpback whales could be reduced by 63% in the presence of whale-watching boats (Rey-Baquero et al., 2021).

5.4. Competition for resources with fisheries.

Both industrial and artisanal fishing fleets compete with whales for the same resources, in particular small pelagic fish, squid and krill. Large purse seine fleets catch small pelagic fish such as anchoveta, sardine, mackerel, jack mackerel, among others, throughout the Southeast Pacific, which are also part of the diet of large whales such as Bryde's, fin and blue whales. There is insufficient information to measure their impact on whales, but given the volumes fished, around six million tonnes per year of small pelagic fish (FAO, 2021), they could be affecting the recovery of some species of large whales and other marine predators in this region. Another important fishery that has been increasing in intensity over time is the giant Humboldt squid (Dosidicus gigas) fishery along the Southeast Pacific coast, which could pose a threat to sperm whales, as this species of squid accounts for 99% of their diet (Clarke et al., 1988; 2002). The problem has recently been exacerbated by the presence of the Chinese fishing fleet in the Southeast Pacific, particularly during the austral winter. The catch of Humboldt squid reached 900,000 tonnes in 2019 (FAO, 2021).

Fisheries beyond the region could also have an impact on whales in the eastern Pacific. This is the case for the fishery for sardines and other small pelagics along the west coast of the United States, Canada and Alaska on which many species of fish, birds and marine mammals depend. The krill fishery in Antarctica could also affect the availability of food for whale species that have their feeding grounds in the Southern Ocean. The krill fishery is regulated by the Commission for the Conservation of Antarctic Marine Living Resources (CCMLAR) which has established a quota of 620,000 tonnes per year, representing 1.6% of the Antarctic krill biomass (Atkinson et al., 2009).

5.5. Climate change.

Climate change is currently one of the main topics of study with great whales because of its accelerating pace and ecological implications. The dietary specialisation of great whales makes them susceptible to changes in ecological conditions that will occur with increasing sea temperatures which, among other things, will also lead to a decrease in primary productivity affecting the diversity of oceanic cetaceans in tropical waters (Whitehead, et al., 2008b). Changes in prey distribution and feeding grounds for humpback whales in the North Atlantic have been associated with climate change (Askin et al., 2017), but in general, ranges are shifting for many marine species in all oceans (Poloczanska et al., 2016). Although there is as yet no direct evidence of climate change impacts in the eastern Pacific on large whales, indirect information on changes in distribution and food availability have been recorded during the El Niño phenomenon when sea temperatures are unusually higher, which could give an idea of the potential permanent changes that could occur if sea temperatures continue to rise and large-scale ocean-atmospheric phenomena in the region such as El Niño increase in frequency as projected in climate change scenarios (IPCC, 2021).

In the eastern Pacific Ocean, changes in the distribution and abundance of blue, fin, Bryde's and sperm whales have been recorded during the 1982/83 El Niño phenomenon, decreasing their abundance off the northern coast of Peru by up to 65% and increasing their presence south of 8° S in colder waters (Ramirez and Urquizo, 1985). The impact of El Niño extends to Antarctica where the main feeding grounds for migratory whales in the Southern Hemisphere are located, causing changes in ice cover and affecting the availability of food for the whales. A relationship between krill availability around the Antarctic Peninsula and calf production of humpback whales in Ecuador and right whales in southern Brazil has been found (Seiboth et al., 2016, 2021). A relationship between the length of the ice age and calf production has also been found in grey whales (Salvadeo et al., 2015). Changes in the timing of humpback whale arrivals at Gorgona Island in Colombia in the last 31 years have been reported and could be associated with the change in ice masses in Antarctica (Avila et al., 2020). This highlights the need to consider the connectivity of migratory species in the eastern Pacific with other areas beyond the region.

An international workshop held in Costa Rica in 2009 on cetaceans and other marine biodiversity in the eastern tropical Pacific and climate change concluded that no actions have been taken in the region to reduce vulnerability for these species due to the level of uncertainty that still exists (Hoffman et al., 2009). The most effective way to address the potential impacts of climate change on great whale populations at this time is to reduce non-climatic threats as much as possible and to adapt ocean management to changing scenarios according to new information, incorporating ecological, social and economic dimensions.

VI. NON-LETHAL USES OF WHALES

Nine of the eleven countries in the eastern Pacific Ocean are members of the International Whaling Convention, with the exception of El Salvador and Honduras, and have joined the global moratorium. Most countries have issued specific regulations prohibiting commercial whaling in accordance with the moratorium, so the current uses of whales are not associated with direct consumption. There are basically two uses of whales in the region, scientific research and whale watching tourism. In the first case, research efforts are aimed at better understanding the ecology and movement and migration patterns of the great whales for conservation purposes. The second involves economic exploitation associated with the welfare and health of the targeted whale populations, so that conservation, education and research aspects are directly or indirectly included. Both activities coexist in many places and in most cases research has given way to tourism.

6.1. Scientific research.

There are about 50 research groups in the region belonging to non-governmental organisations, universities and governmental institutions that maintain research programmes or address aspects associated with the conservation of cetaceans and other marine mammals (Annex 1). The best studied whale species are the humpback whale and the grey whale, both of which are regular migrants that have aggregation sites in coastal areas, making them more accessible to research from the coast. In most cases, research on these species has been supported by whale-watching tourism programmes to reduce costs (e.g. Felix et al., 2021a). Important efforts have been made to study sperm whales in the Galapagos Islands, Southeast Pacific and Gulf of California (Whitehead et al., 2008a; Jaquet and Gendron, 2009), as well as blue and fin whales in south-central Chile and the Gulf of California (Bérubé et al., 2002; Hucke-Gaete et al., 2018; Sepúlveda et al., 2018; Costa-Urrutia, 2013). Thanks to NOAA's marine mammal survey programme between 1986 and 2005 in the eastern tropical Pacific (Hamilton et al., 2009), we have important information on distribution and abundance of some large whales, but most of the information on oceanic distribution in the region has been collected opportunistically on oceanographic cruises and tourist vessels. However, information has also been collected throughout the region through marine mammal stranding programmes, some of them based on citizen science (e.g. Félix et al., 2011; Gómez-Hernández et al., 2019; De Weerdt, et al., 2021; García Cegarra, et al., 2021; Ibarra et al., 2021). The main research topics on large whales in the region include distribution, ecology, reproductive behaviour, anthropogenic impacts, risk of ship strikes, habitat modelling, population genetics, strandings, migration routes, among others.

6.2. Whale watching tourism.

Although whale watching is currently an important source of income for coastal communities throughout the eastern Pacific (Hoyt and Íñiguez, 2008), as well as an important tool to raise awareness and promote conservation, the activity is not always carried out in compliance with international standards and regulations issued by the countries themselves (e.g. Guidino, et al., 2020; Ávila et al., 2021;). The lack of control and monitoring mechanisms has meant that in many places the activity is carried out informally and the safety of tourists is put at risk, and the sustainability of the activity is also at risk. Studies in the region show temporary impacts on humpback and grey whale behaviour such as changes in breathing patterns, speed and direction in the presence of tourist vessels that can extend even after the observation period ends (e.g. Heckel, G., et al., 2001; Scheidat et al., 2004; Ávila et al., 2015). Periods of socialisation, maternal care, resting and breeding may be disrupted by tourist boats, but it is not yet clear what the long-term impact on whales is. Where these problems have been better studied, it has been documented that animals may abandon habitat, avoid or reduce their use of certain areas where boats are concentrated, and their energy budget is affected by the effort to avoid boats (Machernis et al., 2018). The presence of boats increases the noise level and, given the short distance at which they are sometimes located, the risk of collisions is increased. Developing guidelines where none exist and monitoring compliance with them is key to reducing the impact of tourist boats on whales (Heckel et al., 2003).

VII. CHALLENGES FOR THE CONSERVATION AND MANAGEMENT OF GREAT WHALES IN THE EASTERN PACIFIC OCEAN

Countries in the region face a number of challenges when it comes to managing highly mobile or migratory marine species. These include institutional issues associated with a lack of defined competencies or lack of coordination, economic issues to be able to cover costly research, technical issues to catch up with changing technology or to fill information gaps that are key to understanding the population and ecological dynamics of these species, among others. It is recognised, however, that there are differences between countries and between sub-regions, which also represents an opportunity for those lagging behind where information on large whales is still scarce. In this sense, promoting the exchange of experiences and the transfer of knowledge among the countries of the region is a key aspect of the Plan.

7.1. Availability and access to information.

There is a relatively large amount of information on large whales in the region, both current and historical, the latter associated with whaling activities that began in this part of the world in the late 18th century. Most of the information related to basic biological aspects such as size and reproductive aspects comes from the study of carcasses on the butchering platforms (e.g. Ramirez, 1983; Clarke et al., 2013). There is even historical information on distribution and seasonality for most commercial species based on whaling ship logs (e.g. Townsend, 1935). In recent decades, a significant amount of information has been generated in the region on coastal whale species such as greys and humpbacks, but much less on other oceanic species such as blues, sperm whales, fin, Bryde's and sei, which are more difficult to study. There are also geographical biases in the availability of information, for example, blue and fin whales are better known in the northern hemisphere than the southern hemisphere, and there is more information on sperm whales around the Galapagos Islands and off the coast of Peru than elsewhere in the eastern Pacific. Geographic bias also occurs within countries, with more remote areas generally having a lower level of coverage.

In recent years, the development of whale-watching tourism programmes has greatly helped to generate information on species concentrated in coastal areas throughout the region, but little progress has been made on oceanic species such as Bryde's, fin and sei whales. For four species (humpback, grey, blue and fin) satellite tags have been deployed, allowing a better understanding of their migratory movements. For those species that are better studied, there is information on abundance, population trend and distribution. In some cases there is information on population structure, trophic ecology, habitat use and behaviour. Less information is available on contaminants, biotoxins, pathology (bacterial, fungal and parasitic diseases) and ecological aspects associated with climate change. Significant progress has also been made in identifying the main anthropogenic threats, although no assessments have been made of their impact at the population level and no work has been done on mitigation measures.

Access to information is limited in some cases by the associated costs of obtaining or disseminating it, which cannot always be covered by independent researchers or those belonging to NGOs with small budgets or even university faculties, contributing to the fact that information often remains in the grey literature. The lack of national policies to make information generated by national or international institutions publicly available through web portals or to place it in international databases limits the use of information. Academic restrictions, time lag until the information is published and, on occasions, the lack of agreements between research groups to share or integrate information also limit the usefulness of the information collected.

7.2. Management constraints.

All countries in the region have in one way or another generated regulations and tried to implement management actions to protect large cetaceans. The most important of these is the prohibition of whaling, a commitment made largely following the guidelines of international bodies that regulate the use or trade of these species (e.g. International Whaling Commission, CITES). Generally speaking, this is the most effective measure that has been taken throughout the region, as there has been no commercial whaling since the mid-1980s when the last whaling station in northern Peru was closed. However, the same cannot be said of other initiatives that, based on an express will for conservation and management, have not been as effective. An example of this is the regulation of commercial whale watching in some countries in the region. The general perception is that the regulation is only half enforced. In countries where the activity has not been regulated, there have been attempts to implement codes of ethics, but these have not been effective either. The lack of supervision and control of tourism activities is the reason for the low level of compliance and could have an impact on the sustainability of the activity.

Other measures that have not been fully effective are whale species action plans (national or regional) that are difficult to incorporate into the planning of the competent institutions. These plans are often undertaken with significant academic efforts to prioritise research, management and awareness-raising actions, but they are usually born without funding and without a governance structure, so that responsibilities end up being diluted. Something similar also occurs with other conservation initiatives such as declarations of marine mammal sanctuaries or corridors, for which the scope and competence of national institutions to implement conservation or management measures, let alone monitoring, is often unknown.

Marine protected areas and networks of marine protected areas are still insufficient to generate effective protection for large whales in the region, either because they are too small, because whales are not their main conservation target, or because there is insufficient coordination with other institutions that have competence over activities such as fishing and shipping. Although the region has taken important steps towards the goals of the Convention on Biological Diversity regarding the coverage of 10% of the marine area under some kind of protection scheme (currently being discussed to extend it to 30%), the lack of inter-institutional coordination and the sectoral vision of maritime activities limit planning, control and enforcement. With a few exceptions related to regulations to concentrate maritime traffic through the use of traffic separation devices in areas of whale concentration (e.g. Panama, Guzman et al. 2013), there are no specific measures to regulate the impact of sectoral activities, in particular fisheries. However, it is recognised that measures to restrict fishing access in sensitive areas such as the Galapagos Marine Reserve implemented by Ecuador, or the declaration of particularly sensitive marine areas to divert maritime traffic around the Galapagos archipelago, Malpelo Island in Colombia, the Paracas National Reserve in Peru, agreed through the International Maritime Organisation (IMO), contribute to the conservation of great whales.

One of the most relevant aspects limiting the management of great whales is the lack of investment by countries in conservation and research. There is generally little interest in funding the conservation of non-commercial species, so it is necessary to increase its priority in national and regional environmental agendas. While this is a systemic problem in most countries in the region, the scarcity of national resources means that competition between research groups for the few funds, when available, is very high, creating an unfavourable environment for cooperation. Marine research is very costly, so national and regional policies are needed to generate funds from those sectors that make use of marine resources and marine areas and also pose a risk to whales. Lack of money also affects the quality of the information generated by limiting the use of new technology and the equipment of laboratories and research vessels to carry out the required studies.

7.3. Capacity building needs.

Although there are research groups that include marine mammals in their work (see Annex 1), there is not yet a critical mass of researchers in all countries that can carry out the whale research that is needed. In addition to economic constraints, there are also limitations in technical capabilities because, as in other areas of science, the technology and methodologies of analysis are continually evolving. Training needs identified include the following aspects:

a) Methods for abundance estimation and training for data collection on board research vessels. This is an area of work that, like the development of methods to mitigate incidental mortality of marine mammals during fishing operations, is recently gaining attention due to the entry into force of the US Marine Mammal Protection Act that will restrict the entry of fishery products from foreign fisheries with higher levels of incidental mortality of marine mammals than their domestic fisheries from 2023 onwards (Felix et al., 2021b).

b) Related to this issue is also the need to train groups to release entangled whales and equip them with the appropriate tools. The role played by the International Whaling Commission (IWC) in addressing this problem with its member countries is noteworthy and, although rescue groups already exist in the region, it is necessary to continue with the transfer of knowledge to the rest of the countries that do not yet have trained personnel.

c) Molecular techniques applied to biodiversity management are widely available in the countries of the region, however, there are not many people engaged in whale genetic studies, mainly because of the cost of collecting samples. Greater efforts are needed to fund sample collection and improve collaboration between research groups and academia to reduce costs. Associated with the use of molecular techniques is bioinformatics, the use of specialised software for statistical analysis and management of information obtained from molecular analyses.

d) Significant progress has been made in satellite telemetry through collaboration between researchers in different countries, but the technology is not available to many research groups because of its high cost. The use of software to model and interpret the movement of instrumented whales is highly specialised and requires training.

e) Another technological tool that is gaining popularity and has high potential for whale research is autonomous vehicles (drones), which can be useful for recording behaviour, physical condition or even taking samples (e.g. Pirotta et al., 2017; Ramp et al., 2021). They are relatively inexpensive and require basic training to use.

f) One area of interest, but where little progress has been made in the region, is passive acoustic monitoring of whales. Through this methodology, which involves deploying hydrophones in areas known or presumed to be important for whales, it is possible to detect the occurrence of whale species and track their movements by recording sounds that are unique to each species. This technology also allows the recording of noise levels in the sea from both natural and human activities and can be a key tool in assessing changes in noise levels in the marine environment.

g) Species distribution models (e.g. Maxent, Marxant, etc.), are fundamental tools to support the management of large whales, as they allow habitat modelling based on environmental variables and define priority conservation areas according to habitat use and threats. Their use for whale conservation is spreading in the region (e.g. Bedriñana-Romano et al., 2021; Avila and Giraldo, 2022) and they are currently considered as standard tools for planning human activities in the marine environment.

h) In some countries in the region there are networks for marine mammal stranding care that are contributing a lot of information to better understand the species and threats, and developing protocols to care for stranded or entangled animals, as for example in Mexico, Ecuador and Chile through formal stranding networks and citizen groups (e.g. Ministry of Environment, 2018; Gómez-Hernández et al., 2020; García Cegarra, et al., 2021). These experiences could be shared with other countries in order to create new whale and other marine mammal care groups.

i) The use of environmental communication tools to inform different levels of society about species, threats, ongoing initiatives, among other conservation aspects, is a complementary aspect to research and management work that must be well directed to generate a positive impact.

New technologies are complementary to each other and answer different research questions, so their use must be carefully evaluated in order to obtain the information needed at the lowest cost. When invasive technologies are involved, ethical and animal welfare aspects must be taken into consideration, following protocols and guidelines that have been developed by scientific societies and academic institutions, an aspect that still needs to be worked on in Latin America (Felix and Van Waerebeek, 2021).

Training processes should be framed by an assessment of the needs in the different countries, taking into account the progress made, the possibility of having trainers within and outside the region, and the initiatives underway in both the academic and governmental sectors. Although the greatest responsibility lies with governmental institutions that require information for management, it is necessary to include specialised training in the planning of universities, marine research institutes, international bodies, non-governmental marine conservation organisations and even in the plans of private sectors that make use of marine resources or spaces. Regional conservation and resource management projects should have an important component associated with local capacity building.

7.4. International and transboundary aspects.

Although with different levels of maritime environmental institutions, the countries of the Eastern Pacific Ocean have recognised the need to implement a regional approach to marine biodiversity management through the adoption of binding instruments and the implementation of global initiatives for the conservation and sustainable use of marine resources. Eastern Pacific countries are signatories to the most important international agreements such as CBD, CITES, ICRB, and those developed under the IMO. However, there are five countries that have not ratified CMS and three have not ratified UNCLOS.

Significant progress has been made in relation to regional regulation, policy and marine governance, particularly in the Southeast Pacific countries through the Permanent Commission for the South Pacific (CPPS). Within the framework of CPPS and the Lima Convention, the five member countries have ratified more than 20 binding agreements and protocols related to resource management, scientific research and marine conservation. This has resulted in the implementation of regional programmes and action plans for species such as sharks, turtles, marine mammals and a regional network of marine and coastal protected areas. In Central America, there are also international cooperation bodies such as SICA and CCAD that address a wide range of social, economic and environmental aspects, including a developed Central American System of protected areas. The case of Mexico, in terms of natural resource management, is more closely linked to the United States and Canada, countries with which it has a free trade agreement (North American Free Trade Agreement NAFTA) that entered into force in 1994 and which also includes environmental aspects. The agreement was renewed in 2020 and is known as the Mexico-United States-Canada Agreement (T-MEC). Because most of Mexico's Pacific coast has extensive ecological connectivity with Central America, conservation programmes for migratory cetaceans, such as the blue whale, require the active participation of Central American countries, as direct connectivity of this species has been demonstrated between California, Baja California and the Costa Rican dome (Bailey et al., 2009).

A regional initiative promoting the management of ecosystems and migratory species in the central region is the Eastern Tropical Pacific Marine Corridor. Its activities have been geared towards strengthening the management of AMCPs and iconic species such as sharks and sea turtles. CMAR has had limited resources from governments for its operation, however, international projects such as Conservation International's marine programme have provided significant financial resources for capacity building activities, networking of experts, exchange of experience and promoting scientific research. CMAR is an initiative that originated from a presidential declaration rather than a binding intergovernmental agreement, and therefore lacks a mandate to implement management measures. Strengthening CMAR to further support the management of core marine protected areas can bring benefits for the management of migratory and widely distributed cetaceans in the Eastern Pacific such as Bryde's whales and blue whales.

Other international initiatives to identify areas of importance for marine biodiversity developed by CBD, FAO and recently IUCN to identify Important Marine Mammal Areas (IMMAs) (Tetley et al., 2022) are fundamental management tools for cetaceans in the eastern Pacific. Because of their international ecological value, some marine protected areas in the region have been recognised by

UNESCO as Biosphere Reserves or World Heritage Sites. These designations are an important asset for these areas and make them attractive for international conservation initiatives.

In the case of maritime traffic management, an activity regulated by the International Maritime Organisation (IMO), the Regional Operational Cooperation Network of Maritime Authorities of the Americas (ROCRAM) exists in the region. ROCRAM is a regional body made up of Argentina, Brazil, Bolivia, Chile, Colombia, Cuba, Ecuador, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela and the Dominican Republic (as observer), which promotes the exchange of information and documentation to implement the international conventions on maritime safety and the environment developed within the framework of the IMO.

Regional projects are valuable initiatives that promote the sustainability of marine resources within and beyond national jurisdictions. They allow for capacity building, promote the exchange of experiences and seek to have a political impact. The participation of national and regional institutions from the outset, assigning them a leading role, is fundamental in order not to undermine regional institutionality and to generate empowerment. Strengthening regional institutions should be a fundamental objective of regional projects that seek to have a long-term impact on natural resource management.

Regional action plans for cetacean species such as for humpback and right whales in the Southeast Pacific (Flórez et al., 2007; Galletti et al., 2017) and for humpback and blue whales in the Northeast Pacific (SEMARNAT 2018, 2018a,b) are important management tools that need to be internalised in the planning of competent institutions so that they do not remain just academic exercises. Action plans provide a roadmap for linking research with decision-making. Humpback and grey whales are an important source of income and employment for coastal communities in the Eastern Pacific countries where these species breed, so there is additional motivation to promote effective management measures.

VIII. ACTION PLAN

The Activity Plan includes 39 prioritised actions per country and region under seven topics: 1) research needs to fill information gaps; 2) national actions to reduce anthropogenic hazards; 3) regional actions to reduce hazards and promote regional governance; 4) access, publication and exchange of information; 5) enhancing socio-economic benefits through sustainable tourism; 6) capacity building; 7) awareness raising and outreach. Table 2 shows the list of activities according to topic and Annex 2 describes the scope of each activity in the regional context.

TOPIC	CODE	ACTIONS
Research needs to fill information gaps	**A1**	Collect systematised information on the presence and distribution of large whales.
	A2	Identify and classify sites of ecological importance/critical habitat for large whales in the region.
	A3	Identify areas of overlap and spatial and temporal interaction of whales with fisheries that cause injury and mortality of large whales in the region.
	A4	Identify the trend of entanglement and mortality in fishing gear by species of large whales in the region.

	A5	Evaluate mitigation measures that reduce the risk of entanglement and mortality to whales, such as modified traditional fishing gear, new gear, acoustic devices, alternative operational methods or fisheries management measures that reduce the risk of entanglement to whales.
	A6	To estimate abundance, population trends and life history of large whale species with a regional approach.
	A7	Identify areas of spatio-temporal overlap of maritime traffic and concentration of large whales and their level of risk (collisions and noise).
	A8	Conduct studies on identity and population genetic structure with samples from different distribution sites.
	A9	Conduct studies on trophic ecology.
	A10	Assess levels of persistent pollutants in large whales.
	A11	Assess the impact of plastic and microplastic pollution on large whales.
	A12	Analyse the impact of climate change on large whales.
	A13	Assess the negative and positive impacts of whale-watching tourism.
	A14	Conduct studies on the roles and ecosystem services provided by large whales.
National actions to reduce anthropogenic threats	**B1**	Incorporate aspects associated with their impact on large whales (e.g. serious injury and incidental mortality) into fisheries management.
	B2	Implement measures to mitigate the impact of fishing activities on large whales and evaluate their effectiveness.
	B3	Define national maritime traffic management strategies to reduce the risk of collisions with large whales.
	B4	Implement mitigation measures for large whales in activities with high impact on the marine environment (e.g. port infrastructure construction, seismic exploration, seabed mining, offshore and coastal wind energy, and hydrocarbon exploitation and associated activity).
	B5	Include great whales as environmental conservation values in MPA management plans or management plan updates.
	B6	Creation or extension of MPAs based on critical habitats of large whales.
Regional actions to reduce threats and promote regional governance	**C1**	Incorporate great whale conservation and research into regional environmental and/or sustainable development agendas through relevant intergovernmental institutions (e.g. CCAD, RFMOs, SICA, CPPS, etc.).
	C2	Positioning in international agreements with FAO, IWC-Buenos Aires Group, IMO, CBD, the conservation of great whales.

	C3	Declare areas of transboundary and/or regional importance to promote the conservation of great whales and the management of sectoral activities.
	C4	Include sites of regional or transboundary importance for the conservation of great whales in regional MPA networks.
	C5	Incorporate issues associated with large whale research and technical capacity building into regional projects on biodiversity and marine resource management (with emphasis on fisheries resources).
	C6	Manage, develop, update and implement regional action plans for large whale species.
	C7	Include in national reports to intergovernmental bodies (related Conventions), conservation measures on large whales implemented by countries.
Access, publication and exchange of information	**D1**	Encourage the publication and dissemination of scientific and conservation-relevant information on great whales.
	D2	Develop collaboration agreements between research groups, at national and regional level.
	D3	Promote the publication of scientific papers, with particular attention to journals in the region.
Enhancing socio-economic benefits through sustainable tourism	**E1**	Promote the formalisation and updating of regulations for responsible whale watching in the countries of the region.
	E2	Implement regulations for responsible whale watching, including control and enforcement measures on whale watching activities.
	E3	Implement continuous training programmes on responsible tourism for control, surveillance and inspection personnel, crew members, guides, tour operators and tourism service providers.
	E4	Implement outreach programmes or campaigns for tourists on responsible large whale watching.
	E5	Promote international, national or local certification or recognition of whale watching tourism programmes.
Capacity building	**F1**	Provide training and capacity building for researchers and promote the exchange of experiences between research groups in the region.
	F2	Provide training to government personnel, relevant institutional technicians and others in large whale conservation and management.
Awareness raising and outreach	**G1**	Carry out permanent awareness-raising activities and/or campaigns on the importance of conserving the great whales and their benefits, informing the public about the threats they face, the need to take concrete actions and the role of the public.

	G2	Include aspects of great whale conservation in formal, non-formal (e.g. NGOs) and informal curricula.

IX. MONITORING THE PLAN

Although indicators have been defined for each of the activities, the Plan does not contemplate a monitoring mechanism or a governance scheme, nor does it identify specific sources of funding. The responsibility for financing the activities and monitoring the Plan lies with the people and institutions that have participated in the process of constructing this management instrument, who have undertaken to socialise it in academic, scientific and political bodies according to their sphere of competence. The Plan also does not establish a timeframe for the activities, some of which can be carried out in the short term with little funding or are being implemented to a certain degree. Other activities, however, require long data sets and continuous funding, which only states are in a position to do.

It is hoped that the actions prioritised in this Plan will be taken up through national and regional scientific agendas and policies, regional projects and other marine research and conservation initiatives throughout the region. Countries are encouraged to identify novel sources of funding for the Plan's activities, including charging for environmental services to industry sectors that make use of marine resources such as industrial fishing, shipping and whale-watching tourism.