

# BLUE CORRIDORS OF THE EASTERN PACIFIC OCEAN

OPPORTUNITIES AND ACTIONS TO PROTECT MIGRATORY WHALES



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**THIS REPORT USES GRAPHICS DISPLAYING SCIENTIFIC DATA ON WHALE MOVEMENTS FROM THE GLOBAL "PROTECTING BLUE CORRIDORS" REPORT.<sup>1</sup> WE WOULD LIKE TO THANK ALL THE CONTRIBUTORS OF SCIENTIFIC DATA TO THE GLOBAL REPORT, INCLUDING:**

O. Adam (**Neurosciences Paris Saclay**) Alejandro Fernandez Ajó (**Northern Arizona University**), Artur Andriolo (**UFJF, Instituto Aqualie**), Virginia Andrews-Goff (**Australian Antarctic Division**), Salvatore Cerchio (**African Aquatic Conservation Fund**), Phillip Clapham (**Seastar Scientific**), Rochelle Constantine (**University of Auckland**), Mariano Coscarella (**CESIMAR-CENPAT**), Enrique Crespo (**CESIMAR-CENPAT**), Environment Society of Oman, Tim Collins (**Wildlife Conservation Society**), Luciano Dalla Rosa (**Universidade Federal do Rio Grande**), Mike Double (**Australian Antarctic Division**), Violaine Dulau (**Globice**), Matias Di Martino, Ken Findlay (**Cape Peninsula University of Technology**), Santiago Fernandez (**CESIMAR-CENPAT**), Raul González (**CIMAS / EsCiMar**), Claire Garrigue (**UMR ENTROPIE**), Guillermo Harris (**Wildlife Conservation Society**), Jason How (**Department of Primary Industries and**

**Regional Development**), F. Mayer (**Cetamada NGO**), Curt and Micheline-Nicole Jenner (**Centre for Whale Research**), Christian Lydersen (**Norwegian Polar Institute**), Carina Marón (**Wildlife Conservation Society**), Bruce Mate (**Oregon State University**), Martin Mendez (**WCS**), Simone Panigada (**Tethys Research Institute**), Howard Rosenbaum (**WCS**), Rui Prieto (**University of the Azores**), Mduduzi Seakamela (**Department of Environmental Affairs**), Maritza Sepulveda (**Universidad de Valparaiso**), Monica Silva (**University of the Azores**), Roxana Schteinbarg, Mariano Sironi, Diego Taboada, Raquel Soley, Nicolás Lewin and Marcos Ricciardi (**ICB Argentina**), Federico Sucunza (**Instituto Aqualie**), Laurène Trudelle (**Neurosciences Paris Saclay**), Matthew Witt (**University of Exeter**), Judy Uhart, Marcela Uhart (**UC Davis**), Florencia Vilches and Victoria Zavattieri (**Wildlife Conservation Society**).

## SPECIAL THANKS TO:

Roberto Troya, Lisa Ballance, Dermot O’Gorman, Pepe Clarke, Maggie Kinnaird, Gilly Llewellyn, Wendy Elliot, Jon Hutton, Nathalie Houtman, Heike Zidowitz, Maria Jose Villanueva, Cristina Torres, Tarsicio Granizo, Steve MacLean, Alison Cross, Leigh Henry, Rick Leck, Emily Grilly and Irina Onufrenya.

**Graphic design:** Catalyze ([catalyzecommunications.com](http://catalyzecommunications.com)).

## RECOMMENDED CITATION:

Palacios D., Felix F., Montecinos Y., Najera E., Kelez S., Samaniego J., Velásquez P., Zapata L., Lancaster M., Friedlaender A.S., Castro C.A., Quintana E., Bermúdez-Rivas C., Cazas J.J., Villamil Echeverri C., Rojas Bracho L., Sepúlveda M., Medrano-Gonzales L., Santillan L., Aguilar Arakaki R., Pineda, L., Reisinger R., and Johnson C.M. (2023). Blue Corridor of the Eastern Pacific: Opportunities and Actions for the protection of Migratory Whales. A Technical Report. World Wide Fund for Nature (WWF).

**WWF** is one of the world's largest and most experienced independent conservation organizations, with over 30 million supporters and a global network active in more than 100 countries.

**WWF Protecting Whales and Dolphins Initiative** is a global conservation programme bringing together experts, industry, policymakers and governments to co-design solutions to safeguard our ocean giants for future generations.

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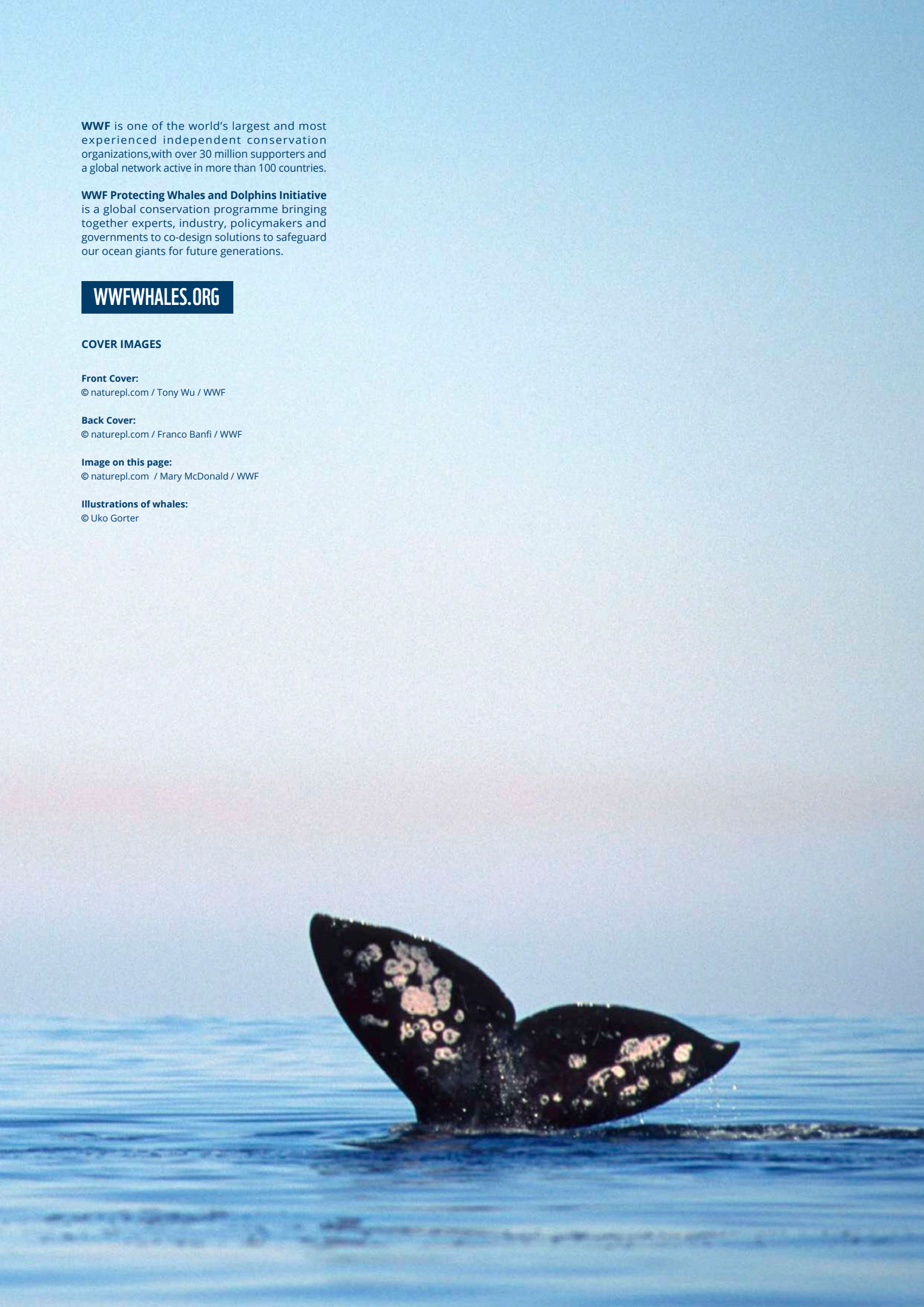
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## ABBREVIATIONS AND ACRONYMS

<b>ABNJ</b>	Areas Beyond National Jurisdiction (including both the High Seas and the seabed Area)
<b>AIS</b>	Automatic Identification System
<b>ALDFG</b>	Abandoned, lost or discarded fishing gear
<b>APMs</b>	associated protective measures
<b>ArcNet</b>	Arctic Ocean Network of Priority Areas for Conservation
<b>BBNJ</b>	Biodiversity Beyond National Jurisdiction
<b>CBD</b>	Convention on Biological Diversity
<b>CCAD</b>	Central American Commission for Environment and Development
<b>CCAMLR</b>	Commission for the Conservation of Antarctic Marine Living Resources
<b>CITES</b>	Convention on International Trade in Endangered Species of Wild Fauna and Flora
<b>CMAR</b>	Eastern Tropical Pacific Marine Corridor
<b>CMS</b>	Convention on the Conservation of Migratory Species of Wild Animals
<b>COP</b>	Conference of the Parties
<b>CPPS</b>	Permanent Commission of the South Pacific
<b>DOM</b>	Dynamic ocean management
<b>EBSA</b>	Ecologically or biologically significant area
<b>EEZ</b>	Exclusive economic zone
<b>FAO</b>	Food and Agricultural Organization
<b>GES</b>	Good environmental status
<b>GGGI</b>	Global Ghost Gear Initiative
<b>IATTC</b>	Inter-American Tropical Tuna Commission
<b>ICRW</b>	International Convention for the Regulation of Whaling
<b>IMMA</b>	Important Marine Mammal Area
<b>IMO</b>	International Maritime Organization
<b>INGO</b>	international non-government organization
<b>IOTC</b>	Indian Ocean Tuna Commission
<b>ISA</b>	International Seabed Authority
<b>IUCN</b>	International Union for Conservation of Nature
<b>IWC</b>	International Whaling Commission
<b>KBA</b>	Key Biodiversity Area
<b>MEPC</b>	Marine Environment Protection Committee
<b>MPA</b>	Marine Protected Area
<b>MSP</b>	Marine Spatial Planning
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>OECS</b>	Other Effective Area-based Conservation Measures
<b>PARCA</b>	Environmental Plan for the Central American Region
<b>PSSA</b>	Particularly Sensitive Sea Area
<b>RFMO</b>	Regional fisheries management organization
<b>SPRFMO</b>	South Pacific Regional Fisheries Management Organization
<b>UN</b>	United Nations
<b>UNCLOS</b>	United Nations Convention on the Law of the Sea
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change

# KEY MESSAGES

01

## BLUE CORRIDORS ARE CRITICAL OCEAN HABITATS FOR MIGRATORY MARINE SPECIES

Whales rely on critical ocean habitats – areas where they feed, mate, give birth, nurse young, socialise or migrate – for their survival. “Blue corridors” are movement routes for marine megafauna such as whales among different but ecologically interconnected areas essential to their survival.

02

## THE EASTERN PACIFIC OCEAN IS A HUB FOR WHALE SUPERHIGHWAYS

From the Bering Strait south to the temperate and tropical Pacific to the Antarctic Peninsula, productive oceanographic conditions, features and currents support a diversity of whale populations and their blue corridors, some spanning thousands of kilometers.



03

## WHALES CONTRIBUTE TO OCEAN HEALTH, BUT FACE THREATS WITH CUMULATIVE IMPACTS

Growing evidence shows whales play a critical role in maintaining ocean health and our global climate, all while contributing to a global economy through tourism revenue. Yet, entanglement in fishing gear (bycatch, ghost gear), ship strikes, chemical and underwater noise pollution, loss of habitat and climate change are impacting whales, their prey and their habitats.

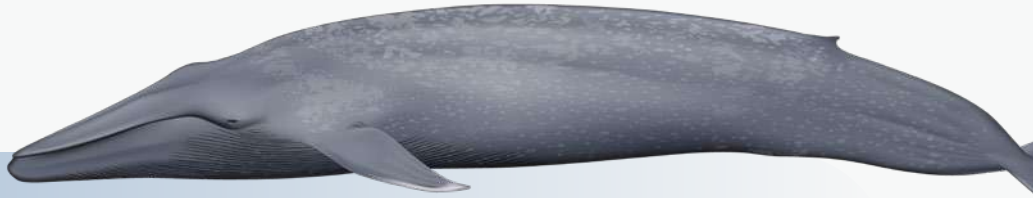
04

## URGENT COOPERATION IS NEEDED TO SAFEGUARD WHALE POPULATIONS TO RECOVER AND THRIVE

From local to regional to international levels, local communities, science, civil society, industry, states and intergovernmental bodies have a role in safeguarding whale migration, mitigating threats and co-designing solutions. The joint declaration on the “Americas Protection for the Ocean” during the ninth Summit of the Americas is a crucial first step to conserve and protect 30 per cent of regional seas by 2030.

# WHALES OF THE EASTERN PACIFIC OCEAN

Whale illustrations © Uko Gorter



## BLUE WHALES

*(Balaenoptera musculus)*

**IUCN Status:** *Endangered*  
**Population:** ~5,000-15,000

Two populations inhabit the region. The California population migrates between feeding grounds off the U.S. West Coast and breeding grounds in the Gulf of California and the Costa Rica Dome, in the Eastern Tropical Pacific.<sup>3-6</sup> The Chilean population feeds in the fjords of northern Chilean Patagonia and migrates to breeding areas off Peru, Ecuador and the Galápagos Islands.<sup>5,7-10</sup>



## FIN WHALES

*(Balaenoptera physalus)*

**IUCN Status:** *Vulnerable*  
**Population:** ~100,000

Several populations inhabit the region, including a non-migratory population found only inside the Gulf of California.<sup>11</sup> Other populations are found off the U.S. West Coast<sup>12</sup> and off the coast of South America from Chile to Ecuador.<sup>13-20</sup> Fin whales are frequent victims of ship strikes worldwide.



## HUMPBACK WHALES

*(Megaptera novaeangliae)*

**IUCN Status:** *Least concern*  
**Population:** ~84,000

The species is recovering well from commercial whaling, but is increasingly impacted by entanglement in fishing gear and ship strikes along its migrations. These threats may be especially affecting the population that breeds off Central America and feeds off the U.S. West Coast.<sup>21-23</sup>



## SPERM WHALES

*(Physeter macrocephalus)*

**IUCN Status:** *Vulnerable*  
**Population:** ~350,000

These oceanic nomads live in social matriarchal family groups in tropical and temperate waters. Groups studied at the Galápagos Islands have been re-sighted as far off as Chile and in the Gulf of California.<sup>24</sup>



## GRAY WHALES

*(Eschrichtius robustus)*

**IUCN Status:** *Least concern*  
**Population:** ~27,000

Between 2019 and 2022, 606 gray whales stranded along the west coast of North America from Alaska to Mexico. Climate change impacts on their prey is thought to be a major cause of this Unusual Mortality Event (UME). Wandering gray whales are occasionally seen in far-away areas not part of their normal distribution range, such as Hawai'i, the Mediterranean Sea, and even off Namibia.<sup>25-29</sup>



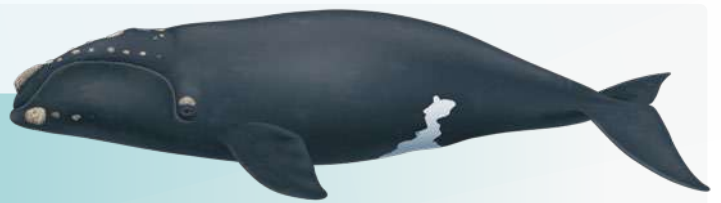


### NORTH PACIFIC RIGHT WHALES

*(Eubalaena japonica)*

**IUCN Status: Endangered**

**Population: ~350**



The eastern North Pacific population may only have 30 animals left, being listed as endangered. It is primarily found in the eastern Bering Sea and the Gulf of Alaska, with rare sightings reported off Washington State, southern California, Baja California, and Hawaii.<sup>30-33</sup>



### SOUTHERN RIGHT WHALES

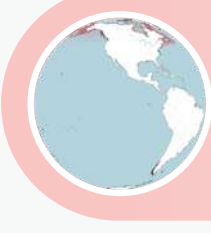
*(Eubalaena australis)*

**IUCN Status: Least concern**

**Population: ~13,600**



Although southern right whale populations are recovering from commercial whaling around the world, the Chile-Peru population is not and is critically endangered at only 50 animals.<sup>34</sup>



### BOWHEAD WHALES

*(Balaena mysticetus)*

**IUCN Status: Least concern**

**Population: ~10,000**



The only baleen whale endemic to Arctic and subarctic waters, bowhead whales are adapted to live in sea-ice covered waters. Strongly associated with sea ice, they are affected by climate change and associated increases in Arctic shipping.<sup>35-37</sup>



### SEI WHALES

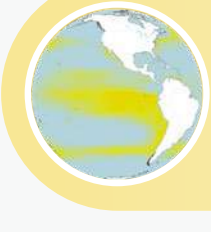
*(Balaenoptera borealis)*

**IUCN Status: Endangered**

**Population: ~80,000**



The sei whale has been referred to as 'the forgotten whale,' as it is poorly known throughout its range. They are mainly found offshore in subtropical and temperate waters. In 2015, a UME that killed at least 343 sei whales in southern Chile was attributed to a harmful algal bloom triggered by an El Niño event.<sup>38</sup>



### BRYDE'S WHALES

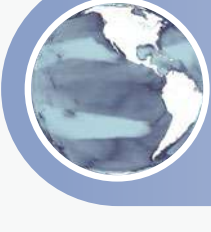
*(Balaenoptera brydei)*

**IUCN Status: Least concern**

**Population: ~90,000-100,000**



A poorly known species, the Bryde's whale occurs throughout tropical and subtropical waters, preferring areas of elevated productivity, both nearshore and offshore, where they feed on schooling fish such as sardines. Hotspots of aggregation have been discovered in coastal waters of the Gulf of California, Panama, Ecuador, Peru and the Galápagos Islands.<sup>39-41</sup>



### COMMON MINKE WHALES

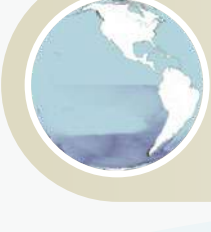
*(Balaenoptera acutorostrata)*

**IUCN Status: Least concern**

**Population: ~200,000**



In the Eastern North Pacific, the common minke whale is widespread but not particularly common. It ranges from the Gulf of Alaska to the Gulf of California, with only a few known areas of aggregation off San Francisco Bay and in the inland waters of Washington State and British Columbia.<sup>42-44</sup>



### ANTARCTIC MINKE WHALES

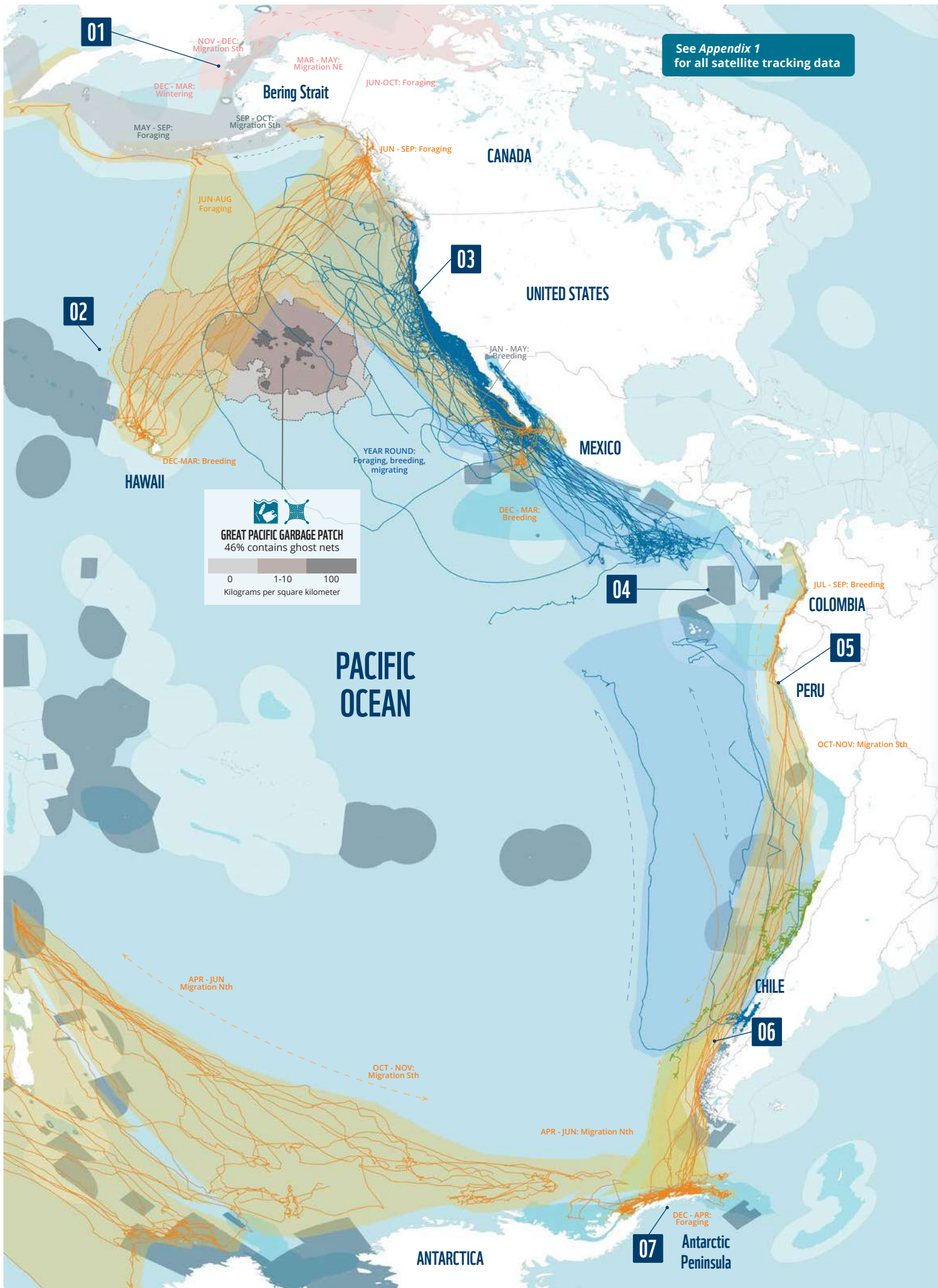
*(Balaenoptera bonaerensis)*

**IUCN Status: Data deficient**

**Population: ~500,000**



Primarily found in the Southern Ocean, the species is known to range into Chile, Peru and Ecuador. They are abundant in the Antarctic, especially near ice-covered regions where they feed on krill and find protection from killer whales.<sup>45-47</sup>



# WHALE SUPERHIGHWAYS OF THE EASTERN PACIFIC OCEAN

*Climate change, ship traffic, underwater noise and fishing activity are impacting whales along multiple points on their important migration routes, crucial for their survival.*

## 01 BERING STRAIT



A key migratory corridor between the Pacific and the Arctic for millions of animals, including whales, which are contending with risks of oil spills, ship strikes, underwater noise pollution and a marine ecosystem under pressure from a warming climate. National action and international cooperation are urgently needed to better manage shipping and fisheries expansion in the region.

## 02 HAWAII TO ALASKA



Patterns of ocean currents lead to the formation of convergence regions, most famously the Great Pacific Garbage Patch, where abandoned, lost or discarded fishing gear, also known as ghost gear, tends to accumulate, increasing the risk of entanglement. While the Hawaiian humpback whale population has been recovering strongly, recent climate-related perturbations to the North Pacific ecosystem known as "marine heatwaves" appear to have impacted birth rates.

## 03 WEST COAST OF NORTH AMERICA



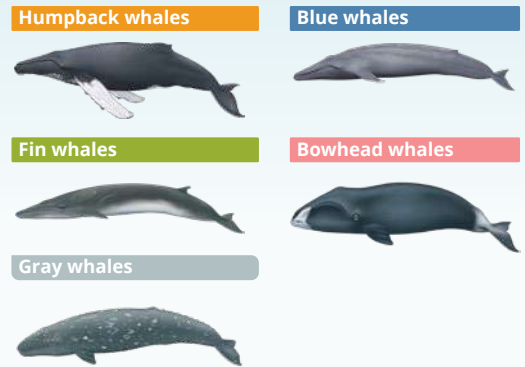
Migratory routes, foraging areas and breeding grounds of whales overlap with ship traffic, with fatal ship collisions the leading source of death for blue, fin, humpback and gray whales. Moreover, entanglements in a variety of fishing gear can cause mortality as well as significant injuries for these same whale species.

## 04 EASTERN TROPICAL PACIFIC



Whale populations from both the northern and southern hemisphere use this region as part of their migratory cycle during different parts of the year. The Eastern Tropical Pacific Marine Corridor (CMAR) initiative is a regional cooperation mechanism for the conservation

## LEGEND



## THREATS



and sustainable use of marine biodiversity and includes a proposed network of transboundary marine protected areas in one of the world's most important migratory routes for whales, sea turtles, sharks, rays and fish.

## 05 PERU



Northern Peruvian waters are part of the breeding area for southeastern Pacific humpback whales, where mothers, calves and escorts occupy shallow coastal waters for several months. To reach this breeding ground, whales have to migrate through coastal waters where gillnets and longlines represent serious threats along with ship traffic.

## 06 SOUTHERN CHILE



Blue whales within fjords of northern Chilean Patagonia are at high risk of ship strike and underwater noise impact, as are whales travelling through in the Magellan Strait of Chile.

## 07 ANTARCTIC PENINSULA



There is increasing overlap between industrial fishing for Antarctic krill and krill predators including baleen whales, penguins, seals, seabirds and fish that are foraging at the same time and place as the fishery. A new marine protected area proposal will help to conserve important Antarctic biodiversity and reduce this overlap.

# ACTIONS TO SAFEGUARD BLUE CORRIDORS OF THE EASTERN PACIFIC

*WWF and partners have identified actions for governments, industry and individuals to safeguard whale superhighways across the Eastern Pacific Ocean by 2030.*

01

## IMPLEMENT CONNECTED NETWORKS OF MARINE PROTECTED AREAS (MPAS) AND OTHER AREA-BASED CONSERVATION MEASURES (OECMS) TO CONTRIBUTE TO THE GLOBAL 30X30 TARGET

- 01** Support the “Americas Protection of the Oceans” joint declaration to implement networks of MPAs and OECMs in the Eastern Pacific, with the goal of protecting or conserving at least 30% of the ocean by 2030, as well as “contributing to ecological connectivity in the region protecting essential habitats and migratory routes on a regional scale for marine mammals.”
- 02** Support for the Global Oceans Treaty at the United Nations (BBNJ) to implement effective ocean management and cooperative arrangements both within and between international and national waters, informed by IUCN Important Marine Mammal Areas and other data sources.
- 03** Support the full, effective and equitable participation of Indigenous Peoples and local communities in design and implementation of MPA networks and OECMs.
- 04** Identify and implement innovative dynamic and seasonal ocean management measures across critical habitats.
- 05** Finalise the CMAR commitment in the Eastern Tropical Pacific, to include an effective network of MPAs across national boundaries of neighboring countries (Costa Rica, Panama, Colombia, Ecuador and Mexico).
- 06** Implement marine spatial planning and cetacean conservation as part of planned management efforts within the Central American Coastal Large Marine Ecosystem (PACA).
- 07** Support the proposed Antarctic Peninsula MPA (Domain 1) at the Commission for the Conservation of Antarctic Marine Living Resources, restricting industrial krill fishing in key foraging habitat.
- 08** Support ArcNet’s<sup>48</sup> ocean-scale ambitions and contribute to the establishment and effective management of a network of protected and conserved marine areas across the Arctic Ocean including for the Bering Strait region.

02

## THROUGH COOPERATIVE EFFORTS, REDUCE CUMULATIVE THREATS

- 01 Work to achieve zero whale entanglements by fisheries.
- 02 Reduce plastic and other pollution including supporting the new UN Plastics Treaty.
- 03 Eliminate and clean up ghost gear including supporting the Global Ghost Gear Initiative.
- 04 Reroute shipping lanes away from critical whale habitats including seasonal migration areas where possible. At the International Maritime Organization (IMO), implement a Traffic Separation Scheme (TSS) on the coasts of Peru and establish an Area to Be Avoided (ATBA) surrounding the Diomed Islands in the Bering Strait.
- 05 Set speed restrictions to 10 knots for vessels of 65 feet and greater, and in line with navigational safety needs, when whales are using corridors to reduce ship strike risk and underwater noise pollution.
- 06 Enhance requirements for reporting incidences of ship-whale collisions at the IMO and to the IWC.

03

## INVEST IN WHALES FOR A THRIVING OCEAN:

- 01 Invest in and integrate the ecological role of whales into global and national climate and biodiversity policies so populations can thrive.
- 02 Support large-scale regional collaborative research to inform policy recommendations as part of the UN Decade of Ocean Science.
- 03 Support regulated and safe whale watching practices through investment in capacity building of tourism operators, contribute to citizen science programs and provide legal support for community-based businesses to obtain necessary permits for operation according to national legislations.
- 04 Support community-based disentanglement networks to implement 'first responders' to assess and facilitate whale entanglement incidences safely.
- 05 Strengthen whale stranding networks, to respond to stranding events and improve our understanding of the causes of mortality.

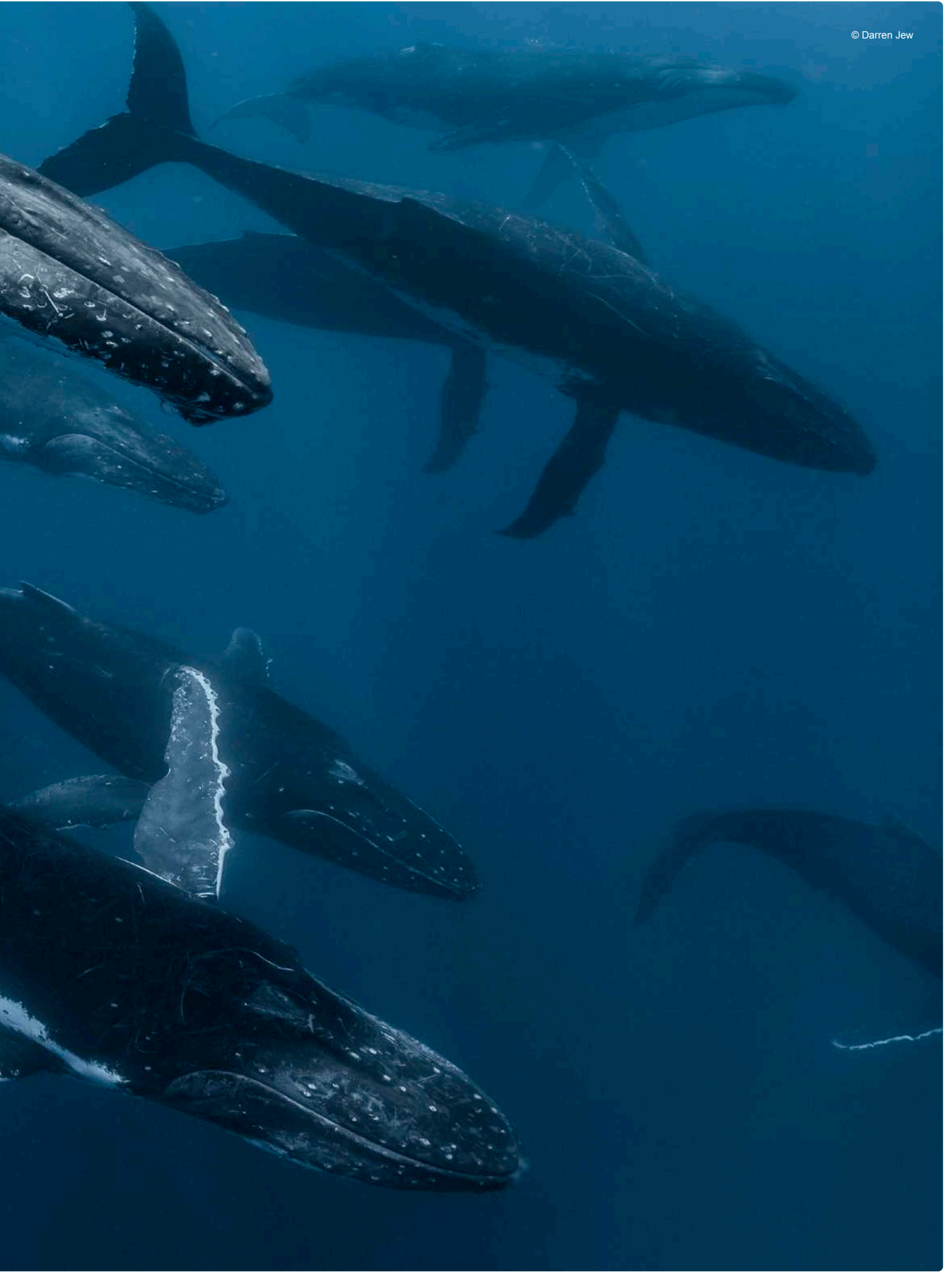




## INTRODUCTION

# THE EASTERN PACIFIC OCEAN - A HUB FOR MIGRATORY WHALES

*Our ocean is dynamic and interconnected, from the surface to the seafloor and from the coasts to the high seas. This connectivity plays a critical role to a healthy ocean. The focus of this report is the Eastern Pacific Ocean where we explore growing risks and conservation opportunities for whales undertaking oceanic migrations over thousands of kilometers, navigating the seas across the Bering Strait, the west coast of North America to Central America and the tropical Pacific to the Antarctic Peninsula in the Southern Ocean, to name a few. Its productive oceanographic conditions, features and currents support a wealth of great whale populations.<sup>49</sup>*





The Bering Strait connects the Arctic Ocean to the Pacific Ocean. Each year it hosts immense seasonal migrations of more than one million marine predators, including bowhead, beluga and gray whales, seals and walrus. As well as being a key migratory corridor, it is a persistent hotspot for many marine species and is one of the world's most productive marine ecosystems.<sup>50</sup>

The coastal waters of North America are important migratory routes and foraging areas for species including gray, blue, humpback and fin whales. Blue whales move between the Eastern Tropical Pacific and the California Current System or Gulf of Alaska, but probably feed year-round, targeting ephemeral, dynamic concentrations of krill.

The Eastern Tropical Pacific extends from the Gulf of California, Mexico to central Peru.<sup>51,52</sup> It is considered one of the most productive oceans in the world, with a biological richness that provides significant ecosystem services. For example, commercial fisheries (food production) are valued at approximately \$2 billion per year in this region, and other significant economic benefits include carbon storage and tourism.<sup>51,52</sup>

The coastal marine ecosystems of Chile are among the most productive. The Gulf of Corcovado is currently considered the largest feeding ground for blue whales in the southern hemisphere, where other baleen whale species such as humpback, sei and fin whales are frequently observed feeding

or migrating. The Antarctic Peninsula is an important foraging area for whale species including humpback, minke, fin, southern right and blue whales.<sup>53</sup> Here, they feed on Antarctic krill, their main prey in the Southern Ocean.

In June 2022, at the Ninth Summit of the Americas in Los Angeles,<sup>54</sup> the joint declaration of "Americas for the Protection of the Ocean" was signed by the governments of Chile, Canada, Colombia, Costa Rica, Ecuador, Mexico, Panama, Peru and the United States.<sup>55</sup> The main objective of the coalition is creating a space for collaboration, cooperation and coordination at a political level to design and implement Marine Protected Areas and Other Effective Area-Based Conservation Measures in the Pacific, with the goal of protecting or conserving at least 30% of the ocean by 2030, as well as "contributing to ecological connectivity in the region protecting essential habitats and migratory routes on a regional scale for marine mammals". It recognises that our "ocean covers three quarters of our planet, supplies nearly half the oxygen we breathe, absorbs over a quarter of the carbon dioxide we produce, plays a vital role in the water cycle and the climate system, and is an important source of our planet's biodiversity and of ecosystem services. It connects our populations and markets and forms an important part of our natural and cultural heritage. It contributes to sustainable development and to sustainable ocean-based economies, as well as to poverty eradication, food security and nutrition, maritime trade and transportation, decent work, and livelihoods."<sup>55</sup>



# WHALE SUPERHIGHWAYS

## BENEFIT NATURE AND PEOPLE

*In 2022, drawing on the latest scientific evidence from years of satellite tracking data and knowledge from the global research community, WWF and its partners – including University of California Santa Cruz and Oregon State University, University of Southampton and many others – compiled over thirty years of data to map routes of migratory whales as they move through international waters, national seas and coastal areas, between key breeding and foraging locations.*

The global report - *Protected Blue Corridors* – covered a range of ocean areas to identify where migratory routes and key areas overlap with a range of emerging and cumulative threats from human activities.

Cetaceans (whales, dolphins and porpoises) rely on different critical ocean habitats – areas where they feed, mate, give birth, nurse young, socialise or migrate – for their survival.<sup>56</sup> In their simplest and narrowest sense, “blue corridors” are migration superhighways for marine megafauna such as whales. More broadly, the term encompasses the idea that marine megafauna move among different but ecologically interconnected areas, and that movement between critical habitats is essential to their survival.

Scientific evidence gathered over the past decade bears this out, showing that whales play an essential role in the overall health of our oceans and, by extension, the whole planet.<sup>57,58</sup> Growing evidence shows that whales help to regulate the climate by capturing carbon throughout their lifetime – one whale captures the same amount of carbon as thousands of trees – but their excrement also fertilizes our oceans, which in turn fuels phytoplankton, microscopic plants that produce more than half of the world’s oxygen. This contribution to ocean productivity has benefits for nature, for people and their livelihoods, and for major global industries. Whales contribute to maintaining the food web of the commercial fishing industry, for example, which is valued at more than US\$150 billion.<sup>57</sup>

Economists have sought to quantify the numerous benefits whales offer nature and people. The International Monetary Fund estimates the value of a single great whale at more than US\$2 million, that totals more than US\$1 trillion for the current global population of great whales. The global whale-watching industry alone is valued at more than US\$2 billion annually.<sup>57</sup> But whales have intrinsic value, and our oceans need thriving populations. The benefits they provide – from capturing carbon to enhancing marine productivity – only strengthen the case for protecting them.<sup>58,59</sup>

**“BLUE CORRIDORS”  
ARE MIGRATION  
SUPERHIGHWAYS  
FOR MARINE  
MEGAFUNA SUCH  
AS WHALES.**

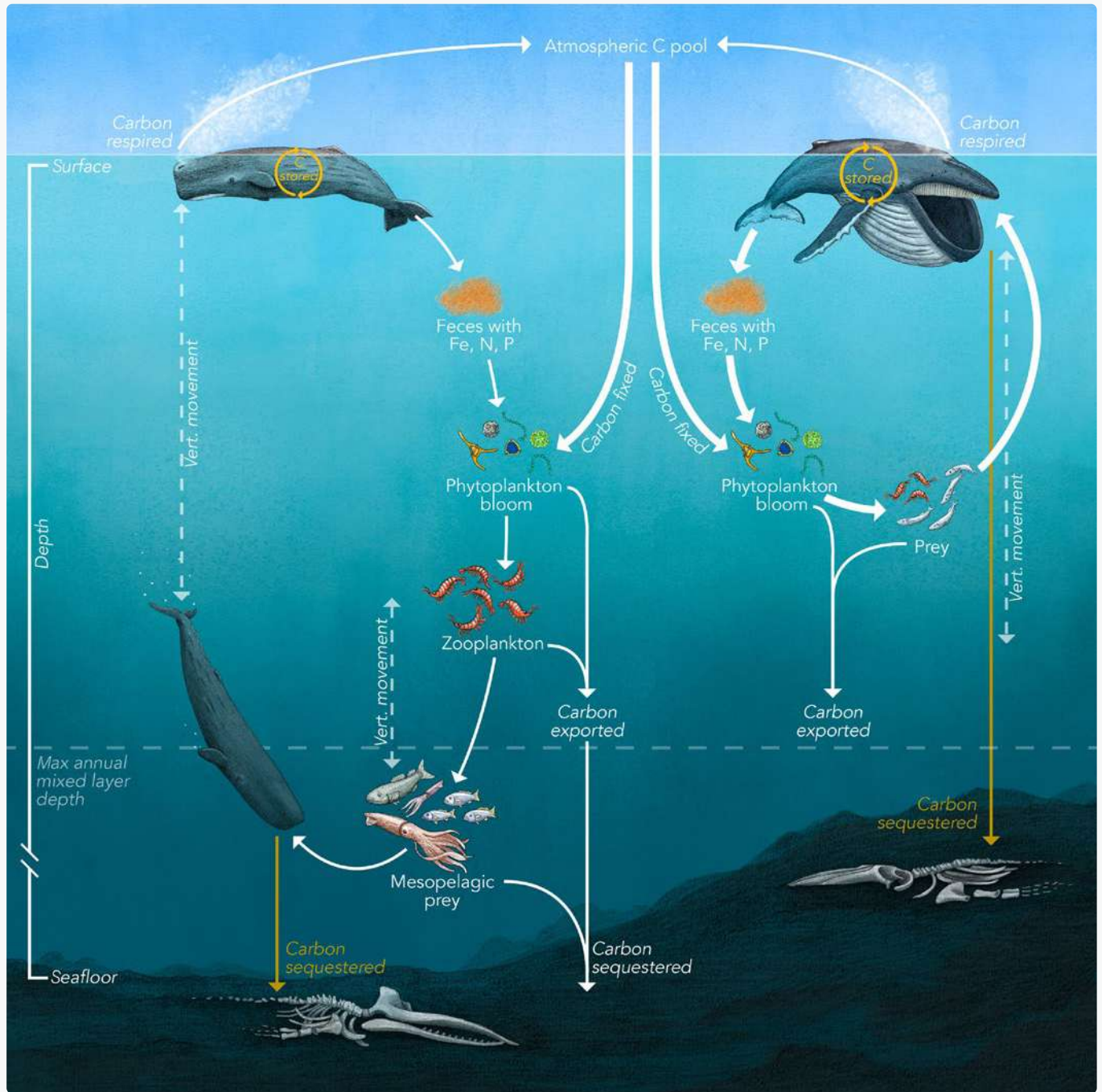
Humpback Whale illustration © Uko Gorier



**FIGURE 1**

**WHALE PUMP**

An illustration of great whales' direct and indirect nutrient and carbon cycling pathways.<sup>59</sup>



© Trends in Ecology & Evolution / Creative Commons CC-BY-NC-ND / Illustrations by Alex Boersma

**SCIENTIFIC EVIDENCE GATHERED OVER THE PAST DECADE BEARS THIS OUT, SHOWING THAT WHALES PLAY AN ESSENTIAL ROLE IN THE OVERALL HEALTH OF OUR OCEANS AND, BY EXTENSION, THE WHOLE PLANET.<sup>57,58</sup>**



Gray Whale illustration © Uko Gorter

## EXTINCTION RISK “REAL AND IMMINENT”

If healthy whale populations are an indicator of overall marine ecosystem health, there is growing concern. A third of the world's cetaceans are now classified by the International Union for Conservation of Nature (IUCN) as Threatened, meaning they have either a high, very high or extremely high risk of extinction in the wild. Six out of the 13 great whale species are classified as Endangered or Vulnerable, even after decades of protection after the commercial whaling moratorium.<sup>60</sup> The extinction risk to whales is “real and imminent” according to more than 350 scientists and conservationists – who signed an open letter in 2020 calling for global action to protect cetaceans from extinction.<sup>61</sup> More than half of all cetaceans are of conservation concern. They join small cetaceans such as the critically endangered vaquita porpoise, only found in the upper Gulf of California, Mexico; the species sits poised on the verge of extinction, with a minimum number remaining to be eight with two calves.<sup>62</sup>

## THREATS TO WHALES ARE INCREASING

During the 20th century, nearly 3 million whales were commercially harvested, driving many species to the brink of extinction.<sup>63</sup> While a significant reduction of commercial whaling has allowed some populations to bounce back, new threats have emerged<sup>64,65</sup> that make the migratory routes of whales and other marine species increasingly difficult and dangerous to navigate. As the threats to whales evolve, our conservation approach must evolve with them across their entire range.

In countless areas around the globe, cetaceans are under threat from human activities. An estimated 300,000 cetaceans are killed each year as a result of fisheries bycatch,<sup>66</sup> while populations are impacted from increasing ship traffic,<sup>67,68</sup> underwater noise,<sup>69</sup> pollution<sup>70,71</sup> and loss of important habitats including as a result of climate change.<sup>72</sup>

These threats often occur in concert and overlap with whales' critical habitats and migration routes, creating a hazardous and at times fatal obstacle course for whales travelling between breeding and foraging areas. For example, between 2019 and 2022, 606 gray whales have stranded along the west coast of North America from Alaska to Mexico and have been classified as an Unusual Mortality Events (UME).

**DURING THE 20<sup>TH</sup>  
CENTURY, NEARLY  
3 MILLION WHALES  
WERE COMMERCIALY  
HARVESTED, DRIVING  
MANY SPECIES  
TO THE BRINK OF  
EXTINCTION.<sup>63</sup>**



Although research is inconclusive, ongoing concerning factors include climate change impacts on Arctic sea ice and availability of key prey for gray whales. According to a U.S. National Oceanic and Atmospheric Administration assessment released in October 2022, the most recent count put the population at 16,650 gray whales – down 38% from its peak during the 2015-16 period.<sup>73,74</sup>

As this report emphasizes, it is not just one threat that is causing significant decline in whale populations (as well as the health of remaining individuals); it is many threats, working together, that are causing cumulative and often deadly impacts.

## OPPORTUNITIES TO IMPLEMENT NEW APPROACHES TO WHALE CONSERVATION

*This analysis focuses on the Eastern Pacific Ocean, from the Bering Strait to the Antarctic Peninsula. It draws on a conservation practice already widely used on land known as “connectivity conservation”, but applies it to the world’s seas and through a singular focus on whales, which are considered “umbrella species” – that is, representatives of the biodiversity of the complex ecosystems they inhabit. Put simply, this means conserving whales across their entire range will also help many other species.<sup>56</sup>*

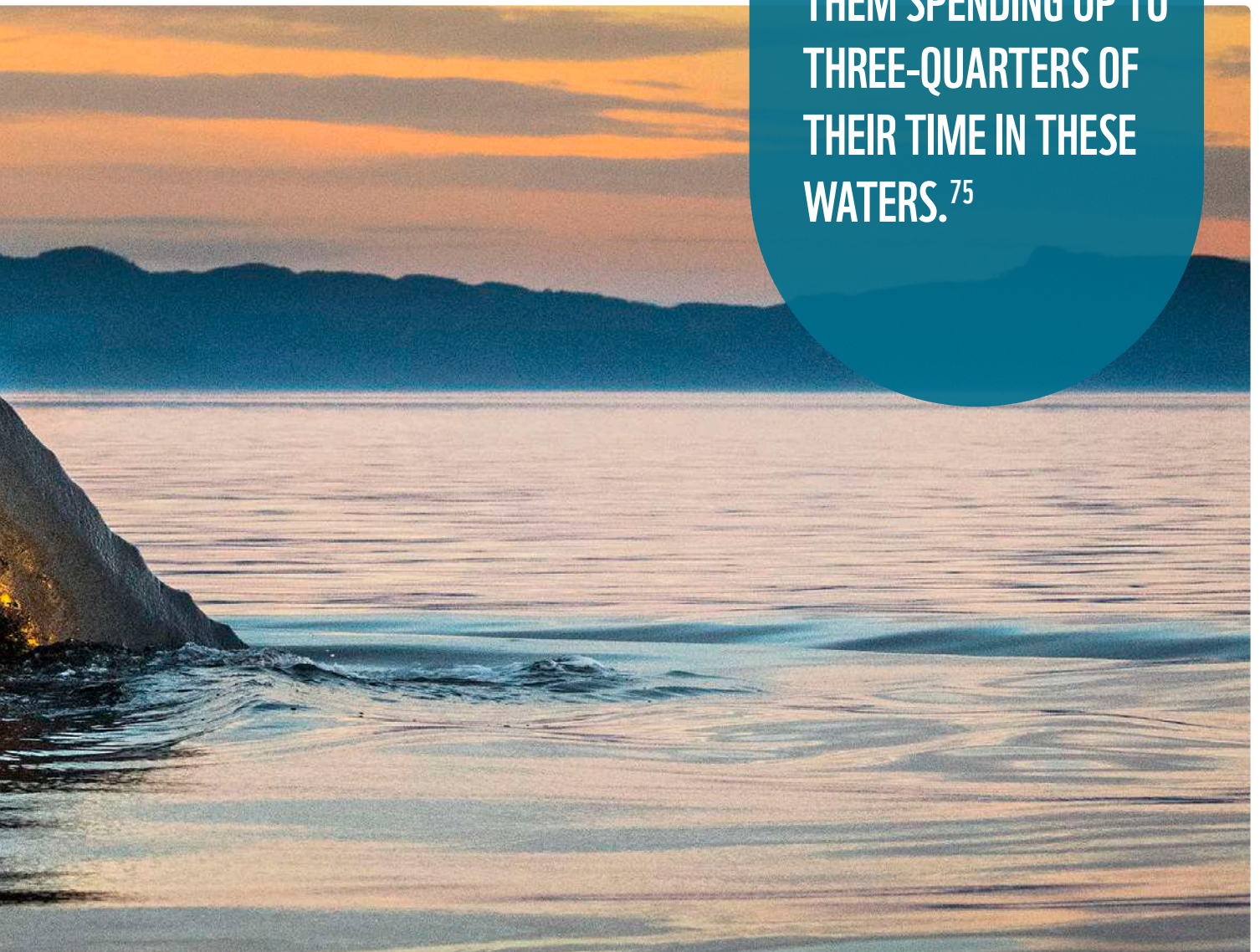


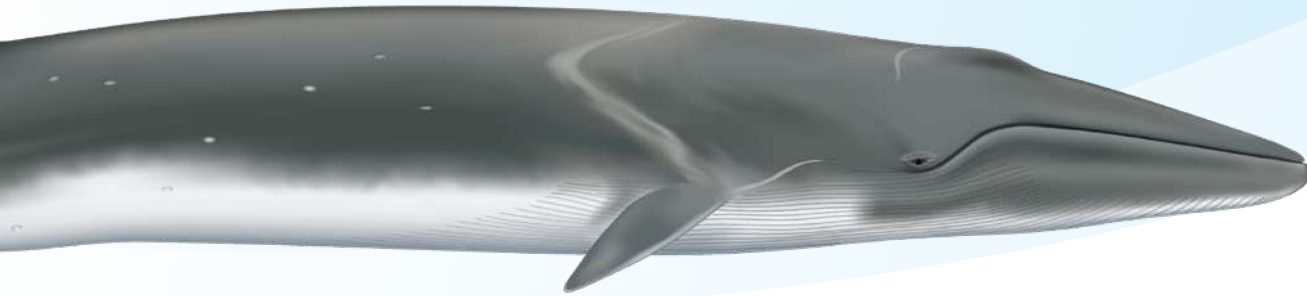
© Richard Barrett / WWF-UK

Connectivity conservation is a concept that recognizes that species survive and adapt better when their habitats are managed and protected as large, interconnected networks. The IUCN World Commission on Protected Areas Connectivity Conservation Specialist Group, and its Marine Connectivity Working Group, define connectivity conservation as the action of individuals, communities, institutions and businesses to maintain, enhance and restore ecological flows, species movement and dynamic processes across intact and fragmented environments. In essence, this is what our report seeks to achieve, and in applying these lessons learned on land to our seas, protect migratory whales into the future.

Protecting the *Eastern Pacific Blue Corridors* for whales requires a holistic strategy, one that engages multiple international and regional organizations responsible for formulating policies across a range of areas and industries, from fisheries to shipping, among them the International Whaling Commission (IWC), the International Maritime Organization (IMO), regional fisheries management organizations, and international conservation agreements such as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the Commission for Environmental Cooperation.

**THE HIGH SEAS MAKE UP TWO THIRDS OF THE EARTH'S OCEAN, YET NO OVERARCHING TREATY EXISTS TO CONSERVE AND RECOVER VULNERABLE SPECIES AND THEIR ECOSYSTEMS, DESPITE THEM SPENDING UP TO THREE-QUARTERS OF THEIR TIME IN THESE WATERS.<sup>75</sup>**





Fin Whale illustration © Uko Gorter

## TYPES OF ECOLOGICAL CONNECTIVITY

*The unimpeded movement of species and the flow of natural processes that sustain life on Earth.*<sup>84,85</sup>

### **ECOLOGICAL CONNECTIVITY FOR SPECIES:**

The movement of populations, individuals, genes, gametes and propagules between populations, communities and ecosystems, as well as that of non-living material from one location to another.

### **FUNCTIONAL CONNECTIVITY FOR SPECIES:**

A description of how well genes, gametes, propagules or individuals move through land, freshwater and the ocean.

### **STRUCTURAL CONNECTIVITY FOR SPECIES:**

A measure of habitat permeability based on the physical features and arrangements of habitat patches, disturbances and other land, freshwater or seascape elements presumed to be important for organisms to move through their environment. Structural connectivity is used in efforts to restore or estimate functional connectivity where measures of it are lacking.

### **ECOLOGICAL CORRIDORS:**

A clearly defined geographical space that is governed and managed over the long term to maintain or restore effective ecological connectivity. The following terms are often used similarly: "linkages", "safe passages", "ecological connectivity areas", "ecological connectivity zones" and "permeability areas".

### **ECOLOGICAL NETWORK (FOR CONSERVATION):**

A system of core habitats (terrestrial or marine protected areas, OECMs and other intact natural or semi-natural areas), connected by ecological corridors, which is established, restored as needed and maintained to conserve biological diversity in systems that have been fragmented.<sup>86</sup>

### **OECM**

#### **(OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURE):**

A geographically defined area, other than a protected area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity with associated ecosystem functions and services and, where applicable, cultural, spiritual, socio-economic and other locally relevant values are also conserved (IUCN WCPA, 2019).<sup>87</sup>

### **PROTECTED AREA:**

A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.<sup>85</sup> Ecological corridors in marine environments may connect marine protected areas (MPAs) or other key marine, coastal and estuarine habitats.<sup>88</sup>

The high seas, or Areas Beyond National Jurisdiction (ABNJ), make up two thirds of the Earth's oceans, yet no overarching treaty exists to conserve and recover vulnerable species and their ecosystems, despite them spending up to three-quarters of their time in these waters.<sup>75</sup> The Global Oceans Treaty is under negotiations at the United Nations (UN) and is particularly critical to managing and reducing growing human impacts in ABNJ.<sup>76</sup>

Marine protected areas (MPAs) are conservation tools intended to protect biodiversity, promote healthy and resilient marine ecosystems, and provide societal benefits.<sup>77</sup> Today, only 8.16 per cent of the world's ocean has actively managed MPAs. However, in ABNJs it is only 1.44 per cent.<sup>78</sup> The call to protect and conserve 30 per cent of our ocean by 2030 through implementing networks of MPAs or Other Effective area based Conservation Measures (OECMs),<sup>79,80</sup> commonly known as "the 30 by 30 pledge" (30x30), was recently adopted by 196 governments as a target within the Convention on Biological Diversity's Global Biodiversity Framework.<sup>81,82</sup>

There is still much more to discover about migration of many whale populations. To help inform this work, the report identifies key conservation opportunities globally and some innovative solutions available to governments, policymakers and industry to safeguard whales, their migrations and their critical habitats for future generations.

In terms of their execution, we require a suite of responses to tackle the multiple threats, from reducing bycatch and shipping impacts in key hotspots to establishing well-connected networks of MPAs and OECMs. As some whales' migrations span across ocean basins, networks of protected areas will need to be large and potentially mobile where boundaries shift across space and time, as climate change impacts dynamic habitats and causes shifts in species range.<sup>83</sup> Whales' movements across jurisdictional boundaries also present opportunities for innovative transnational collaboration strategies among neighboring countries toward common conservation goals.



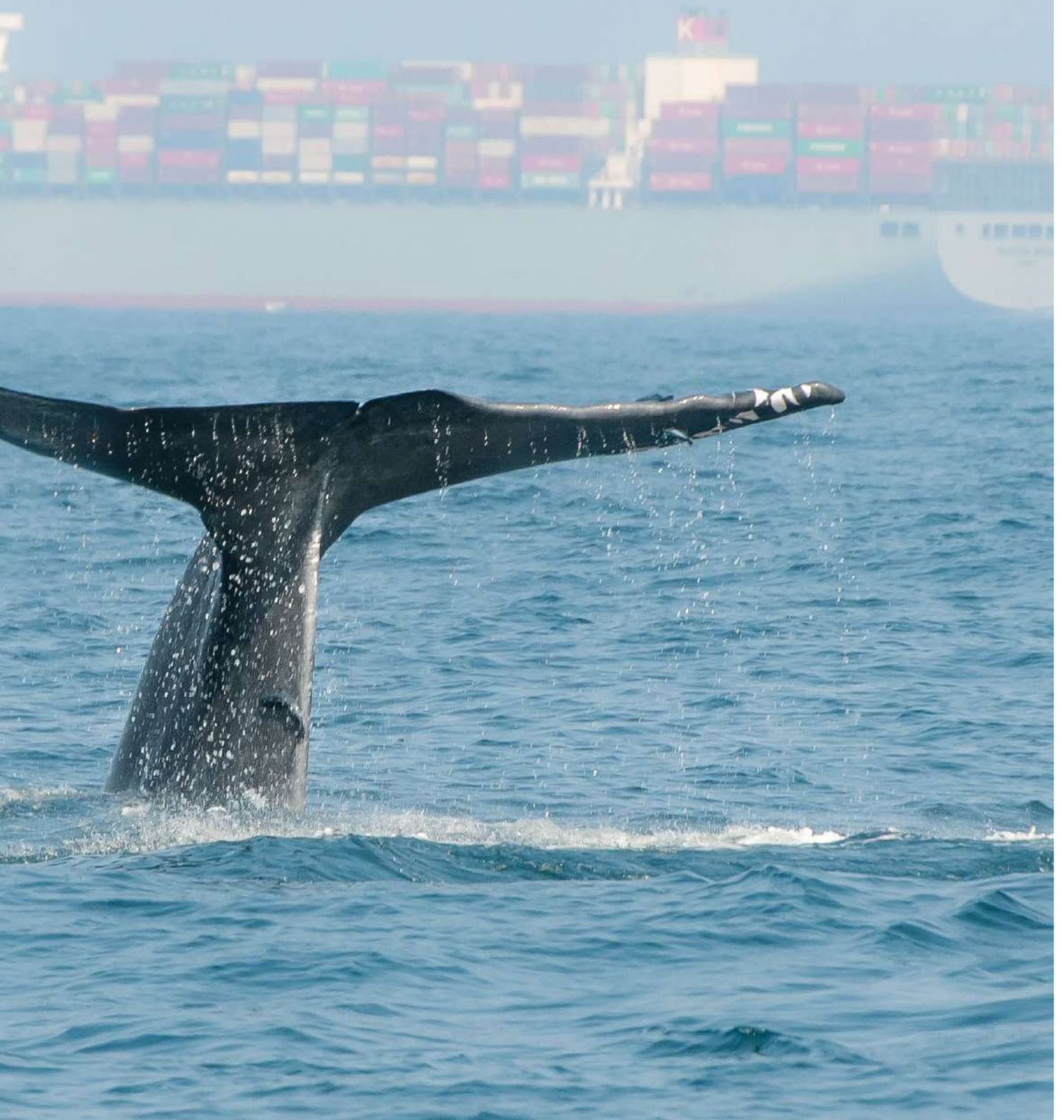
**WHALES HAVE  
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TO ENHANCING MARINE  
PRODUCTIVITY – ONLY  
STRENGTHEN THE  
CASE FOR PROTECTING  
THEM.<sup>58,59</sup>**

# GROWING THREATS

*Whales face increasing threats due to human activities in their critical habitats and migratory corridors across their entire range.<sup>64,65</sup> Populations are affected by increasing fishing activity, entanglement in ghost gear, ship traffic and noise pollution. Climate change and chemical and plastic pollution are impacting their habitats and prey.*



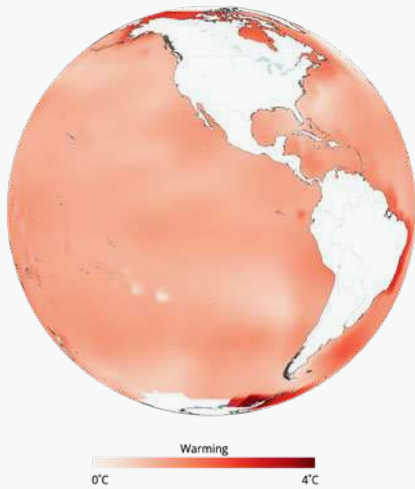




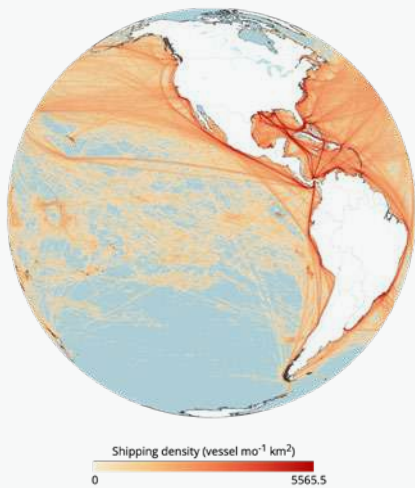
**FIGURE 2**

Maps of some of the growing threats for whales, including climate, vessel traffic and fishing. See Appendix 2 for more information.

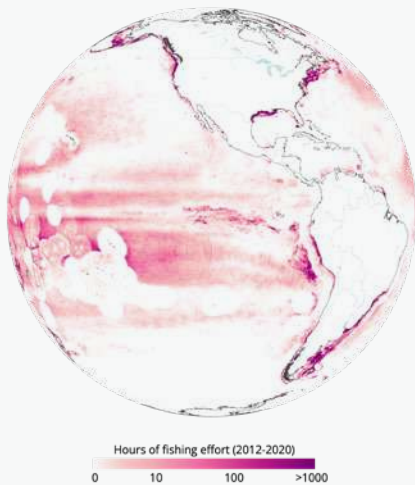
**CLIMATE CHANGE**



**SHIP TRAFFIC DENSITY**



**FISHING EFFORT**




## CLIMATE CHANGE IMPACTS ON WHALES AND THEIR PREY

*Marine ecosystems are being severely impacted by climate change.<sup>89,90</sup> Marine mammals have unique ecologies with complex life cycles that make predicting their responses to climate change more difficult and, for some species, make them especially vulnerable to climate change impacts.<sup>91,92</sup>*

Broadly, climate change affects the phenology (the timing of recurring biological events, such as migration), demography (aspects such as survival rates and calving rates) and distribution of marine vertebrates,<sup>93</sup> which can influence marine ecosystem structure and functioning. Shifting geographic ranges of marine species have been observed across all ocean regions.<sup>90</sup>

Changes in the distribution and abundance of prey is a central way in which climate change impacts whales. However, how climate change impacts the individual physiology of whales is still poorly understood.<sup>91</sup> Whales also may be affected by physical changes to their habitats and increased susceptibility to disease and contaminants.<sup>94</sup>

Arctic and Antarctic cetaceans are thought to be especially sensitive to climate change because many of them rely on sea ice and sea ice ecosystems.<sup>95,96</sup> The rapid decline of sea ice in the Arctic is altering habitat availability, shelter from predators and timing of important life events for endemic whales. This includes their seasonal migrations, which for bowhead and beluga (*Delphinapterus leucas*) whales in the Bering Strait, follows sea ice retreat in spring/summer and advance in autumn/winter.<sup>97-99</sup> Increasing frequency of marine heatwaves in the Pacific Arctic as a result of climate change may also be responsible for bowhead whales in this region foregoing their seasonal migration south and remaining in their summer feeding grounds over winter for the first time in 2018-19.<sup>35,36</sup> This possibly represents a major shift in migration behaviour for these whales as a result of climate change.

A humpback whale is captured mid-breach, its dark, ribbed back and flippers visible above the water's surface. The whale is surrounded by splashing water. In the background, a vast, icy landscape unfolds with snow-covered mountains and large icebergs floating in the water. The sky is a pale, overcast blue. A large, light blue circular graphic element is overlaid on the right side of the image, containing text.

ARCTIC AND  
ANTARCTIC  
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THOUGHT TO  
BE ESPECIALLY  
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CLIMATE CHANGE  
BECAUSE MANY OF  
THEM RELY ON SEA  
ICE AND SEA ICE  
ECOSYSTEMS.<sup>95,96</sup>

© National Geographic Creative / Robert Harding Picture Library / Michael Nolan

In the Southern Ocean, there are regional, southward shifts in Antarctic krill distribution due to ocean warming.<sup>100</sup> For whales feeding almost exclusively on krill – such as Antarctic blue (*Balaenoptera musculus intermedia*), humpback and Antarctic minke whales – it is likely to impose high energetic costs on migration, with effects on body condition, reproductive fitness and population abundance.<sup>101,102</sup> In particular, the distribution and ecology of Antarctic minke whales are directly tied to sea

ice<sup>45</sup> where any changes that affect the quantity and quality of their habitat and food availability could be significant.<sup>103</sup>

Climate change will impact cetaceans in other regions too.<sup>72</sup> Particularly concerning is the possibility that multiple stressors will act in concert and magnify the impact of climate change long term.<sup>104</sup>



**640,000 TONNES  
OF FISHING GEAR  
ARE LEFT IN OUR  
OCEANS ANNUALLY.**



## **INCREASED RISK OF BYCATCH IN FISHING GEAR AND GHOST NETS**

*Bycatch is the accidental catch of non-target species in fishing gear leading to unintentional mortality. It is recognized as the most significant threat to the survival of marine megafauna, including marine mammal, turtle, shark and ray species and populations world-wide.<sup>65,66</sup>*

Many international non-governmental organizations, intergovernmental organizations and national regulatory bodies realise that addressing the threat of bycatch is one of the most pressing cetacean conservation challenges of the 21<sup>st</sup> century. Bycatch of cetaceans occurs in all kinds of fishing operations, from large industrial to localised artisanal fisheries. It also occurs in most types of fishing gear. Driftnets, gillnets and entangling nets are known to cause the highest amount of cetacean bycatch. Large whales are particularly susceptible to becoming entangled in nets and ropes associated with pots and traps and fish aggregating devices, which are used to attract fish.<sup>105</sup>

The International Whaling Commission (IWC) launched the Bycatch Mitigation Initiative to develop, assess and promote effective bycatch prevention and mitigation measures worldwide.<sup>105</sup> Similarly, the Food and Agricultural Organization

**IT CAN PERSIST IN THE MARINE ENVIRONMENT FOR UP TO 600 YEARS, CONTINUING TO CATCH AND KILL MARINE LIFE BEFORE EVENTUALLY BREAKING DOWN INTO MICROPLASTICS AND ENDING UP IN THE FOOD CHAIN.<sup>109</sup>**

(FAO) has several subsidiary bodies, such as the Committee on Fisheries, that are recognizing the importance of addressing fisheries bycatch.

There is also growing awareness of the lack of effective monitoring of fishing activities at sea, which means that we know little about the true impact that fisheries have on non-target species such as cetaceans. Meanwhile, technology is moving swiftly to the point of being able to deliver cost-effective, real-time coverage of fishing activities at sea, and there is a real opportunity for Remote Electronic Monitoring of our fisheries activities. That way we better understand more about what target fish species are being caught and what species are accidentally caught in fishing gear. This move will help improve the sustainability of fishing and help bring an end to wildlife bycatch on large and small vessels.<sup>106</sup>

Each year, 640,000 tonnes of fishing gear are left in our oceans. Abandoned, lost or discarded fishing gear (ALDFG) – commonly called “ghost gear”<sup>107</sup> – accounts for a minimum of 10 per cent of all marine litter entering the oceans.<sup>108</sup> That’s more than one tonne of fishing gear lost in the sea for every minute of the year. This type of litter can persist in the marine environment for up to 600 years, continuing to catch and kill marine life before eventually breaking down into microplastics and ending up in the food chain.<sup>109</sup>

A recent study estimates that 5.7 per cent of all fishing nets, 8.6 per cent of all traps and 29 per cent of all lines are lost around the world each year.<sup>110</sup> The Great Pacific Garbage Patch is a major ocean plastic accumulation zone in the subtropical waters between California and Hawaii. At least 46 per cent of it consists of fishing gear.<sup>111</sup> The impact that ghost gear entanglement has on marine megafauna is significant: a total of 76 publications highlight that more than 5,400 individuals from 40 different species were recorded as entangled in, or associated with, ghost gear.<sup>112</sup>

## SHIP STRIKES



*Between 1992 and 2012, global ship traffic increased fourfold<sup>113</sup> and it is projected to increase 240–1,209 per cent by 2050.<sup>69,114</sup> The ever-expanding shipping traffic from super-tankers and cargo vessels in whales’ breeding grounds and along their migration routes results in an increased risk of ship strikes. Some of the busiest ports and channels in the world’s oceans overlap with important habitats for whales.<sup>115</sup>*

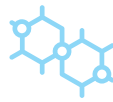
Globally, shipping poses multiple threats to whales, including deaths directly caused by vessel strikes.<sup>68,116</sup> Ship strikes are one of the leading causes of human-induced mortality for several whale populations around the globe, including many that are already threatened or endangered after decades of whaling.<sup>68,117,118</sup> Moreover, although collisions with small vessels have a lower probability of lethal injury for whales, these collisions may result on vessel damage or even risks to vessel crew who may incur injuries, or even die.<sup>68</sup> This situation should be given special attention in whale aggregation areas with heavy recreational vessel traffic.

**SHIP STRIKES  
ARE ONE OF THE  
LEADING CAUSES OF  
HUMAN-INDUCED  
MORTALITY FOR  
SEVERAL WHALE  
POPULATIONS  
AROUND THE GLOBE.**



© Chris Johnson

# CHEMICAL, PLASTIC AND UNDERWATER NOISE POLLUTION



*Many different substances to which marine mammals are exposed may adversely affect their health. These include natural elements that become more concentrated due to human activities, synthetic chemical compounds, oil-pollution-derived substances, marine debris, sewage-related pathogens, excessive nutrients causing environmental changes and radionuclides.<sup>119</sup> Although there is broad awareness of the threat of pollution to marine mammals, the long-term impact of pollution on marine mammal health is difficult to study and not well-known.<sup>119</sup>*

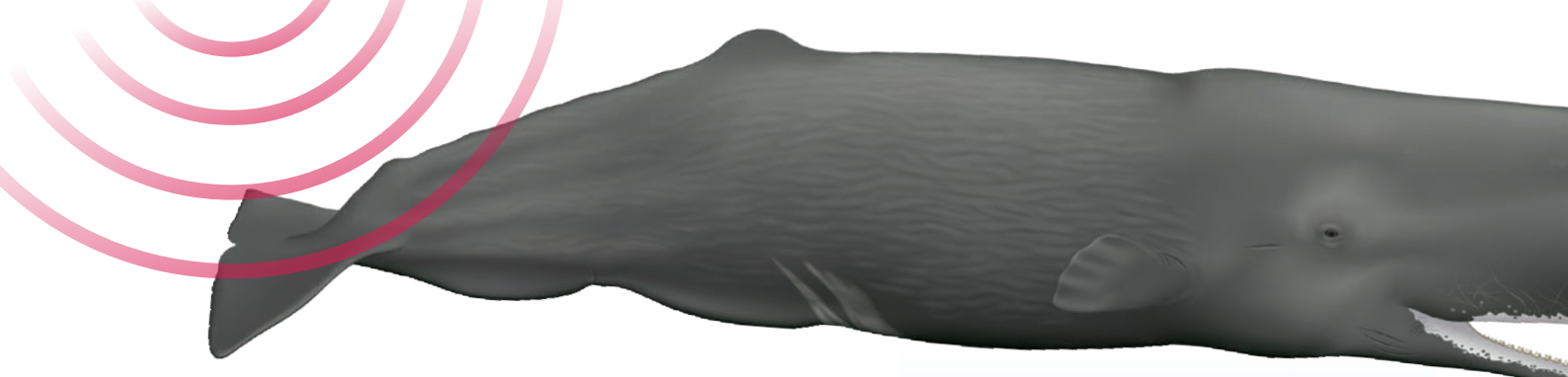
Chemical pollutants include persistent organic pollutants, heavy metals, and pharmaceuticals and personal-care products.<sup>120</sup> Marine mammals are especially vulnerable to such pollutants because they often occur in polluted coastal waters, are long-lived and therefore accumulate pollutants over time, occupy high trophic levels and thus biomagnify pollutants, and cannot metabolically eliminate persistent chemicals.<sup>121,122</sup>

Marine anthropogenic debris, in particular synthetic materials, affects marine mammals. Individuals can die or be negatively impacted by entanglement in or the ingestion of plastic litter. Published records indicate that currently 66 per cent of marine mammal species have been affected – 41 per cent by entanglement and 50 per cent by ingestion<sup>123</sup> – but likely every species will eventually be affected.

© naturepl.com / Franco Banfi / WWF



**UNAVOIDABLY, ALL MARINE MAMMALS WILL INGEST MICROPLASTICS, PARTLY BECAUSE MARINE MAMMALS' PREY SPECIES INGEST THEM AT SIGNIFICANT RATES.<sup>129</sup>**



Entanglement is often lethal, but in most cases it is impossible to distinguish between entanglement in active gears (mostly fishing) or in true debris. Similarly, examples exist for lethal ingestion of debris, such as 7.6 kg of plastic debris causing stomach rupture in a sperm whale (*Physeter macrocephalus*).<sup>124</sup>

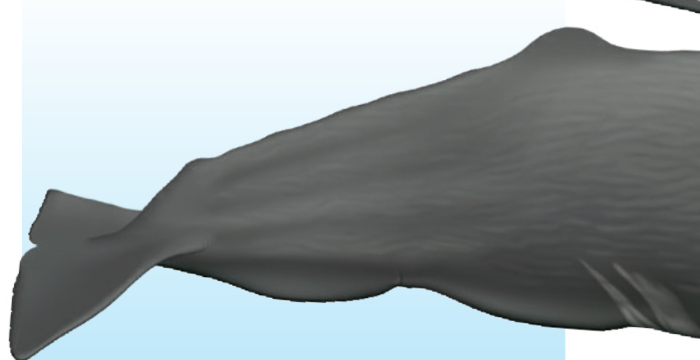
However, in many situations, debris found in stomachs does not provide firm evidence that it caused death and sublethal impacts are hard to quantify.<sup>119</sup> This example is concerning as sperm whales feed at depths up to 1,000 metres.<sup>125</sup>

It is often unclear why marine mammals ingest debris. Contrary to what might be expected, ingestion of debris in the filter-feeding baleen whales (54 per cent) appears less common than in the more target-hunting toothed whales (62 per cent). Within species, the frequency of nonlethal ingestion of plastic debris is often poorly known, as sample sizes are usually small and research methods do not focus on detecting debris in stomach contents.<sup>126</sup> Nevertheless, ingestion rates of up to 35 per cent for individuals have been recorded for estuarine dolphins<sup>127</sup> and up to 12 per cent in harbour seals.<sup>128</sup> Unavoidably, all marine mammals will ingest microplastics, partly because marine mammals' prey species ingest them at significant rates.<sup>129</sup>

Microplastics have been found in the gut of humpback whales,<sup>130</sup> while their baleen can accumulate small plastic particles.<sup>131</sup> Negative physical and chemical impacts from microplastic ingestion have been shown experimentally to occur at lower trophic levels. Impacts in natural situations and at higher food web levels are not known, but may occur as some plastic additives have endocrine disrupting properties.<sup>132</sup> Effects of nanosized synthetic particles are even more unclear, but of concern as such particles may permeate cell membranes affecting cellular functions through physical or chemical interactions.<sup>133</sup>

Underwater noise pollution is of growing global concern because of its impacts on a wide range of marine species.<sup>116,134</sup> Whales in particular have evolved to use sound as their primary sense, and depending on the source, underwater noise can have a range of impacts on individuals and populations.<sup>69</sup>

Shipping is the leading contributor to ocean noise pollution worldwide<sup>116</sup> and in some parts of the ocean, underwater noise levels have doubled each decade since the 1960s.<sup>115,116,135</sup> Ship noise is characterized as continuous and generally low in frequency, although it can extend to high frequencies.<sup>136</sup> Most noise is incidentally caused by propeller cavitation (the formation and implosion of small bubbles against propellers as they rotate). Hull vibration and engine noise also contribute to a ship's acoustic footprint. Other sources of underwater



**UNDERWATER NOISE POLLUTION IS OF GROWING GLOBAL CONCERN BECAUSE OF ITS IMPACTS ON A WIDE RANGE OF MARINE SPECIES.<sup>116,134</sup>**

Sperm Whale illustration © Uko Gorler

noise range in frequency from low to high and can be high in their intensity. They include explosions, sonar, underwater construction and seismic survey.

Vessel noise has been shown to disrupt communication and feeding behaviour and cause displacement of whales from important habitats,<sup>116</sup> which can impact health and reproduction and lead to population declines. High-intensity sources of underwater noise can result in direct impacts through acute injury (temporary or permanent hearing damage) or death.<sup>136-139</sup>

© Henrik Lehnerer

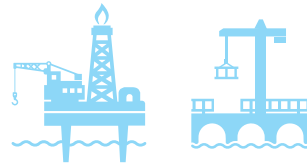
Oil Rig in the Channel Island near Ventura California.

**OIL AND GAS EXPLORATION AND EXTRACTION CAN DISTURB WHALES AND THEIR PREY THROUGH UNDERWATER NOISE POLLUTION, CONSTRUCTION OF SUPPORTING INFRASTRUCTURE, OIL LEAKS, ASSOCIATED SHIPPING AND THE POTENTIAL FOR LARGE, CATASTROPHIC OIL SPILLS.**





# OFFSHORE EXPLORATION AND COASTAL DEVELOPMENT



*Industrial activities include land reclamation, the construction of infrastructure such as ports as well as facilities related to aquaculture, energy production and military activity. Potential impacts on whales include habitat loss, degradation or fragmentation, as well as, displacement or injury on account of construction and operational noise.<sup>65</sup>*

Offshore oil and gas infrastructure such as pipelines and platforms have proliferated along continental margins and in the deeper oceans worldwide.<sup>140</sup> Oil and gas exploration and extraction can disturb whales and their prey through underwater noise pollution, construction of supporting infrastructure, oil leaks, associated shipping and the potential for large, catastrophic oil spills.

The ocean below 200 m depths is referred to as the deep-sea and is the largest biome on our planet, with much of its

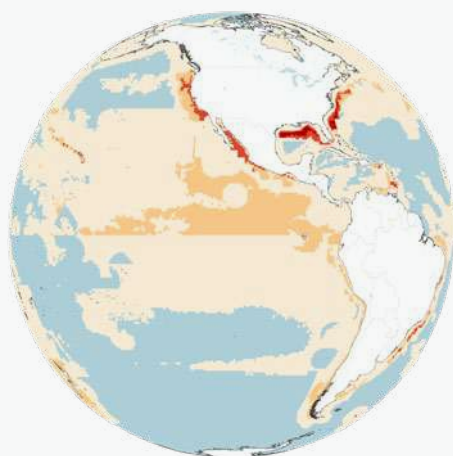
diverse life unmapped. Parts of the deep seabed also contain mineral deposits. Interest in deep seabed mining to extract minerals several kilometres below the surface is increasing. Until there is enough knowledge about the life and functions of the deep sea, diverse voices are calling for a moratorium on this emerging practice.<sup>141</sup> Seabed mining could affect whales and their prey through disturbance of the seafloor, sediment plumes, noise and pollution.<sup>142</sup>

## FIGURE 3

### CUMULATIVE RISKS MAP FROM AVILIA ET AL (2018)<sup>20</sup>

*This cumulative risk map shows the number of species affected by any threat based on the intersection of published documented threat categories (all threat types) and predicted species core habitat (AquaMaps presence probability threshold  $\geq 0.6$ ) - with a focus on the Eastern Pacific. Blue areas represent the core habitats for each group without any documented threat. Red areas represent high-risk areas or hotspots.*

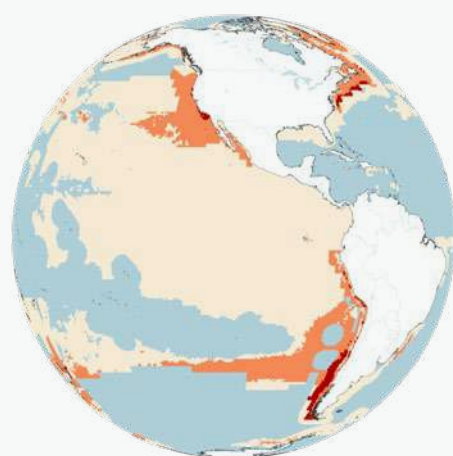
**A.**  
CUMULATIVE RISK MAP  
FOR TOOTHED WHALES  
(Toothed whales, N species = 65).



Number of species in risk per cell

1-4	5-10	11-15	16-20
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**B.**  
CUMULATIVE RISK MAP  
FOR BALEEN WHALES  
(Baleen whales, N species = 13).



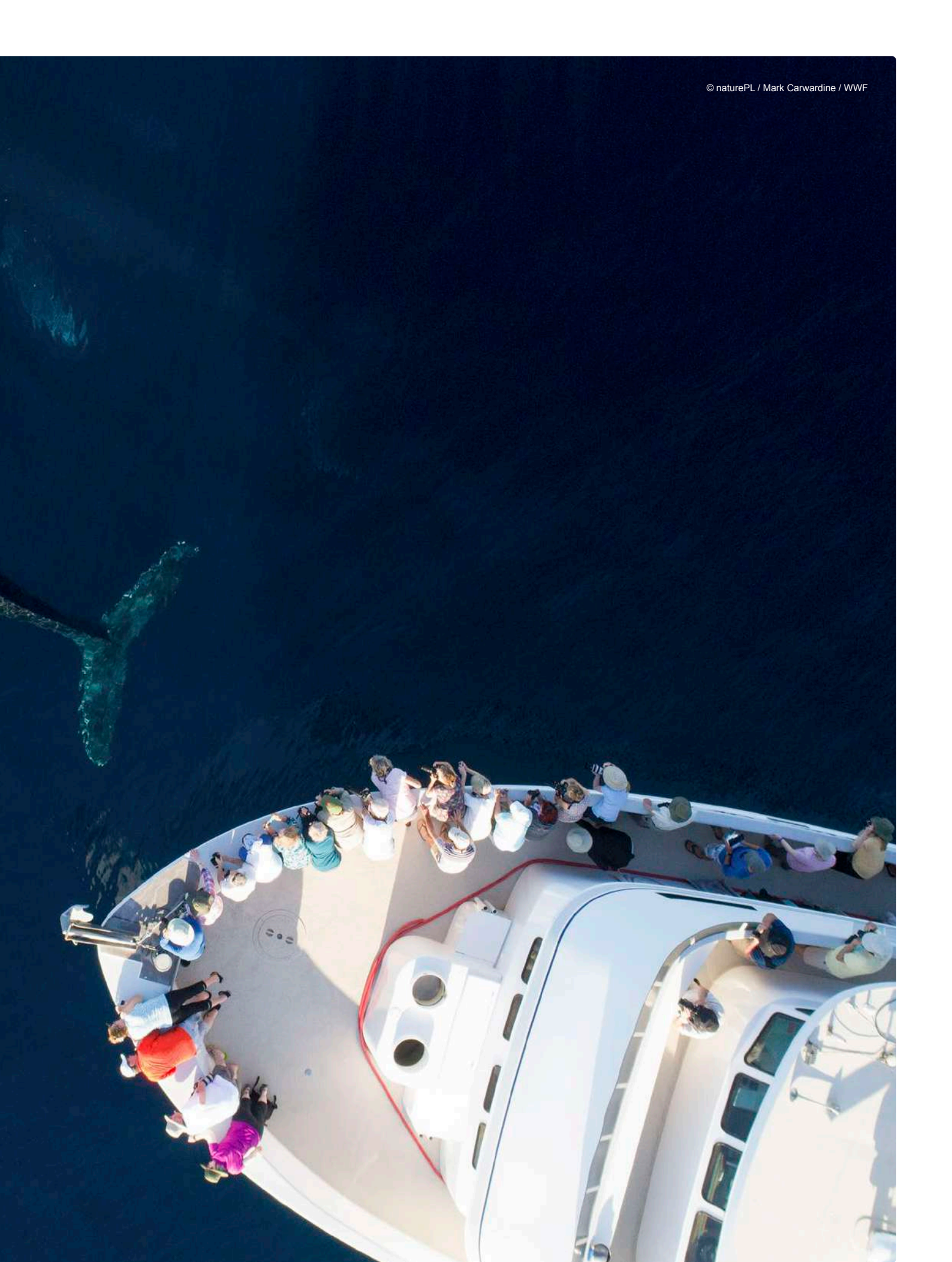
Number of species in risk per cell

1-2	3-4	5-7
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# CONSERVATION OPPORTUNITIES

*Based on satellite tracking, photo identification and other data sources, we illustrate case studies of emerging blue corridors for whales, some hotspots where there is growing human interference and highlight conservation opportunities and ideas to implement solutions.*



## BERING STRAIT

*The Bering Strait connects the Arctic Ocean to the Pacific Ocean. Each year it hosts immense seasonal migrations of more than one million marine predators, including bowhead, beluga and gray whales, seals and walrus. As well as being a key migratory corridor, it is a persistent hotspot for many marine species and is one of the world's most productive marine ecosystems.<sup>50</sup>*

Seasonal migrations of Arctic and subarctic marine mammals closely follow the timing of sea ice retreat north in spring and its advance south in autumn. The highly productive, plankton-filled cold Arctic waters north of the Bering Strait also increasingly attract temperate cetacean species such as fin whales and killer whales from the Pacific Ocean up through the Strait and into the Arctic Ocean to exploit these rich feeding grounds in summer months. Gray whales travel more than 16,000 km each

way annually to and from Mexico.<sup>143,144</sup> Humpback whales frequent the Bering Sea in summer and can be found as far north as the Chukchi and Beaufort Seas.<sup>145</sup> As well as their importance to the marine ecosystem, populations of whales that migrate through the Bering Strait are of immeasurable importance to coastal Indigenous Peoples in the United States and Russia, who have relied on them for millennia for their culture, nutrition and livelihoods.<sup>143,146</sup>



© naturepl.com / Martha Holmes / WWF

THE ARCTIC IS WARMING MORE THAN TWICE AS FAST AS THE REST OF THE PLANET DUE TO ANTHROPOGENIC CLIMATE CHANGE AND IS NOW WARMER THAN IT HAS BEEN AT ANY TIME DURING THE LAST 2,000 YEARS.

## CONSERVATION CHALLENGES

### A CHANGING ARCTIC

The Arctic is warming more than twice as fast as the rest of the planet due to anthropogenic climate change and is now warmer than it has been at any time during the last 2,000 years.<sup>89,147</sup> A major consequence of this is loss of sea ice. Summer ice extent has declined by 40 per cent since satellite observation began in 1979 and what remains is younger and thinner, melts earlier in spring and re-freezes later in autumn.<sup>89</sup>

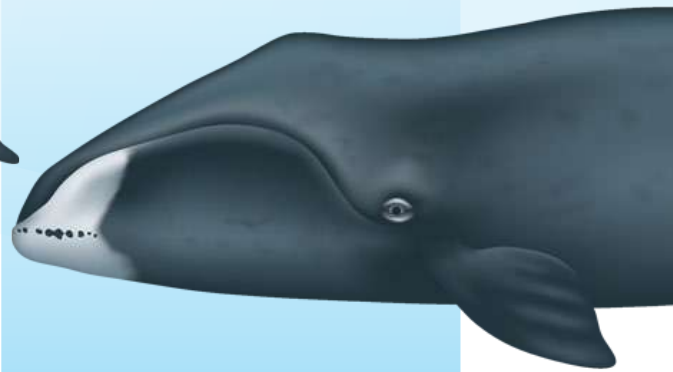
Sea ice has, until recently, been a physical barrier to heavy industrialization of the Arctic Ocean and associated impacts. However, as the ice-free season lengthens, this is rapidly changing. Financial experts estimate that future development in the Arctic will attract approximately a trillion dollars of new spending in the next 20 years.<sup>148</sup> Realisation of new development and infrastructure plans, stimulated by global demand for resources, is now possible due to the climate crisis. Extremely warm conditions in recent years have put the Pacific Arctic marine ecosystem under high pressure.<sup>143</sup> Whales in the Bering Strait region are contending with changes in prey availability, a higher risk of predation by killer whales and changes in sea ice and other climate drivers that cue migration and other life events.<sup>143,149,150</sup> Early signs of transformative change in the region include shifts in the productivity and distribution of fish species, changes in migrations of bowhead and beluga whales, and unusual mortality events for ringed, spotted and bearded seals and gray whales.<sup>36,143,150-152</sup>

### GROWING RISKS FOR CETACEANS

On top of these dramatic ecosystem changes, multiple anthropogenic stressors are growing in the Bering Strait region. Projected increases in ship traffic and expanding commercial fisheries carry direct risks for cetaceans.

Known as the “fish basket” of the United States, the southeastern Bering Sea contains major fish stocks that make up a US\$2 billion fishery<sup>153</sup> and account for about half the seafood landings in the country. As these fish stocks move northwards due to climate change, so too will commercial fishing pressure. In 2020, the Russian Federation announced plans to open the first commercial pollock fishery in the Chukchi Sea to take advantage of this species’ apparent range expansion.<sup>154</sup> The Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, known as the Central Arctic Ocean Fishery Agreement (CAOFA), that entered into force in 2021 indicates the interest that some fishing countries have in accessing potential fishery resources in the Central Arctic Ocean.

Shipping activity in the Bering Strait overlaps in space and time with whale migrations and brings several risks, including oil spills, ship strikes and underwater noise pollution.



Bowhead Whale illustration © Uko Gorter

The number of ships transiting the Bering Strait has almost doubled in the last decade. Where only 262 transits were recorded in 2009, in 2019, 494 ship transits were observed through the Strait, with large increases projected in the future.<sup>155,156</sup> Underwater noise pollution from current shipping – the amount of additional noise on top of the ambient underwater soundscape – is well above levels known to have a negative impact on whale communication.<sup>157</sup>

In addition to increases in shipping through the Bering Strait for local or national commerce, with the loss of sea ice, new global shipping routes through the Arctic are materializing to connect the world's oceans. Of four such routes, three would pass through the Bering Strait: the Northwest Passage, the Northeast Passage (which includes the Northern Sea Route) and the Transpolar Sea Route. All offer significant benefits of shorter distances compared to those through the Suez and Panama Canals.<sup>89</sup>

## CONSERVATION OPPORTUNITIES

### INTERNATIONAL ACTION TO REGULATE SHIPPING NEEDED NOW

The Bering Strait is clearly an important migratory corridor and destination for marine wildlife and is vital for the many coastal Indigenous Peoples who use marine resources as a way of life. Climate change is also creating opportunities for commercial and industrial growth that will result in new and elevated risks for the Bering Strait marine ecosystem and its components, including endemic species like bowhead and beluga whales and seasonal visitors such as gray and humpback whales.

Commercial activities including shipping and fishing must be managed through national action and international cooperation, especially between the Russian Federation and the USA, as the Bering Strait is within the territorial waters of both countries.

Development of a holistic system to manage shipping, thereby improving maritime safety and environmental protection, could include the use of emerging e-navigation technologies to enable real-time monitoring and information exchange; development of seasonal or dynamic MPAs; adoption of voluntary or mandatory speed restrictions and standards of care and operation led and implemented by the maritime industry.<sup>117,156</sup>

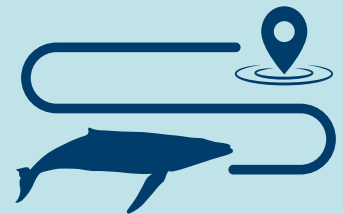
**WITH TRANSFORMATION OF THIS MARINE ECOSYSTEM UNDERWAY, PROTECTION OF THESE MIGRATORY CORRIDORS TO MAINTAIN ECOLOGICAL CONNECTIVITY AND THE IMMENSE NATURAL VALUES OF THE REGION IS A MATTER OF URGENCY.<sup>156</sup>**

WWF is working with governments, local communities, and other conservation organizations in Russia and the United States to identify area-based protections in the Bering Strait to protect whales and other marine mammals, and the communities that rely on these areas. Areas to Be Avoided (ATBAs) are special areas identified by the IMO to keep large vessels away from sensitive habitats. WWF has identified the Diomed Islands as important areas that require further protection and recommends implementing ATBAs around both islands.

The CAOFA, recently entered into force, creates the opportunity to establish best practices for a science plan, standards for exploratory fisheries, and development of a regional fishery management organization (RFMO) for the Central Arctic Ocean. If implemented consistent with the Precautionary Approach and utilizing Ecosystem Based Management principles, the CAOFA can ensure the sustainability of Arctic fisheries and minimize the potential impact of commercial fishing on the Bering Strait. With transformation of this marine ecosystem underway, protection of these migratory corridors to maintain ecological connectivity and the immense natural values of the region is a matter of urgency.<sup>156</sup>



# HOW DO WE KNOW WHERE WHALES MIGRATE?



## SATELLITE TRACKING

For several decades, scientists have used satellite tracking – also known as satellite telemetry – to better understand the movement patterns and large-scale behaviour of marine mammals. Satellite tags have been developed to track marine mammals for several months at a time, collecting spatial information using orbiting satellite networks. Similar to a GPS, satellite tags send and receive signals to and from satellites several times per day and these are used to calculate the position of the tagged animal. Data are sent via satellite to users and offers a remote means for monitoring animals that otherwise would be nearly impossible to track. Over time, positions from satellite tags can be used to determine the behaviour of the tagged animal (for example, migrating or transiting versus foraging) by using mathematical models. Because satellite tags can collect data over long periods, they are a useful tool for understanding fundamental aspects of the life history of marine mammals, including when and where they migrate, how much time they spend in migratory corridors and where these corridors may overlap with human activities.

To study whale migration, satellite tags are generally deployed on animals on their breeding or feeding grounds while animals are close to shore and are remaining in more or less the same area. As animals transition to migratory behaviour, satellite tags provide critical information on when migration occurs, the routes that animals take during migration, and when they reach their destination. Continuously tracking migrating animals is nearly impossible to do from a logistical point of view without the aid of satellite transmitters. By using satellite tag technology, scientists can learn, for example, about the routes that marine mammals take, the speed at which they move and whether different portions of the population migrate at

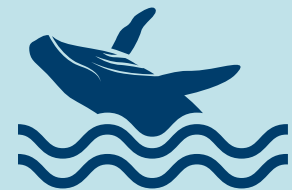
different times. The latest satellite tags can also record dive behavior, including feeding events, adding an additional dimension to the data they can collect.<sup>158</sup> Additionally, satellite tag data can be used to show when migrating marine mammals overlap in space and time with human activities such as fishing and shipping, and to determine the amount of time that animals spend in the territorial waters and exclusive economic zones (EEZs) of different countries.

Photo-identification is likely the most ubiquitous marine mammal data collected around the world and enables researchers to define migratory destinations for populations and the patterns of occurrence of individuals in these areas over time. As well, photo-identification can help determine the frequency of reproduction in individuals and can provide information on entanglements and other scars/injuries incurred from incidents with human activities.



## PHOTO-IDENTIFICATION

One of the most commonly used methods for tracking the movements of marine mammals is photo-identification. Most animals have markings that are unique to individuals and in the case of humpback whales, the patterns of scarring and pigmentation on the underside of the tail flukes can be used to identify individuals with great precision. Photographing animals is a relatively simple and passive way to collect valuable information on the presence of an animal in a certain place at a certain time. By collecting fluke (or other body part) images regularly in the same place, researchers can learn about occurrence patterns of individuals over long periods of time or within a season. However, some of the most critical information on animal movements comes from when researchers compare photographic images across regions to make matches. In this case, many of the main migratory end points (feeding and breeding grounds) for marine mammal populations have been identified and fidelity to these has been established for many individuals. Researchers are leveraging artificial intelligence technology to greatly facilitate and expedite the arduous matching process, for example via platforms like [Flukebook.org](https://www.flukebook.org).<sup>159</sup>



## INDIGENOUS KNOWLEDGE

Vast knowledge about whales, their movements, behaviour and ecology is held by coastal Indigenous peoples around the world, particularly those who have relied and still rely on whales for their culture, food and livelihoods. Indigenous Knowledge, or Traditional Ecological Knowledge, is accumulated by people who have successfully lived in close connection with nature for generations, often in remote places, and often as the only year-round residents, enabling deep, detailed and experiential observations and knowledge to be gained.

Indigenous Peoples' knowledge is increasingly recognized by scientists as unique and intrinsic to understanding the nature of biodiversity and ecosystems. Indigenous Knowledge has been used alone and alongside scientific research to understand whale migrations, including pathways, timing, changes and factors influencing its onset (e.g. for beluga and bowhead whales).<sup>160,161</sup>



## HAWAII TO SOUTHEAST ALASKA

*The importance of the Hawaiian Islands as a breeding area for North Pacific humpback whales is underscored by the fact that it is used during winter months by almost half (about 10,000 animals) of the population inhabiting the North Pacific.<sup>162</sup>*

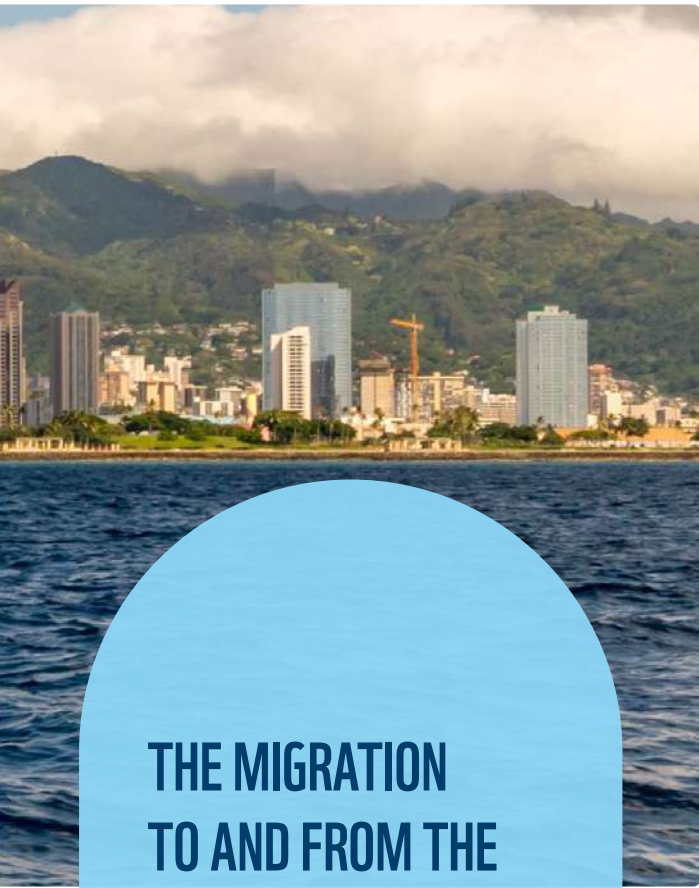
These whales come from various high-latitude feeding areas across the North Pacific, but the vast majority originate in southeast Alaska and adjacent feeding areas in northern British Columbia and the northern Gulf of Alaska.<sup>162</sup> Humpbacks are abundant in Hawaii from mid-December through early April, reaching peak numbers in February and March, when most females are believed to go into estrus.<sup>163</sup> The pattern of male activity around females suggests that the peak in ovulation for non-pregnant females is from December to early February, while a secondary peak from mid-February to March appears to be the result of pregnant females from the previous winter going into estrus after giving birth. Mating occurs during the brief period (a few days) when females are receptive, so most individuals (certainly most females) may be present in Hawaii for only a few weeks.<sup>163</sup>

Thus, we might expect that a typical adult female that has spent spring, summer and part of the autumn in the feeding areas may migrate to Hawaii (a distance of ~4,000–5,000km) in late autumn (say, late November), arrive there 30 to 40

days later (late December), remain in Hawaii for 20 to 30 days (40 days if rearing a calf) while looking for a mate, and then undertake the return migration to finally arrive in the feeding area at the beginning of spring (mid-March) of the following year. The pattern of male residence in Hawaii is possibly similar, although the most dominant ones may spend significantly longer (up to 91 days).<sup>163</sup>

A recent comprehensive analysis of the movements of 86 satellite tagged animals in Hawaii from 1995 to 2019 showed that while in the Hawaii breeding area, whales moved at a mean speed of 1.62 km/h and that their residency ranged from 1.1 to 42.8 days, with a mean of 13.1 days.<sup>164</sup> Once they started their migration to the feeding areas, tagged whales moved at a mean speed of 4.65 km/h and their migration lasted between 28 and 44.8 days, with a mean of 34.2 days.<sup>164</sup> However, migration speed was not sustained but showed variation over time, with periods of increased and decreased speed lasting several days.<sup>164</sup>





**THE MIGRATION TO AND FROM THE FEEDING AREAS TAKES THE WHALES ACROSS A VAST EXPANSE OF THE OPEN OCEAN THAT IS REGULARLY CROSSED BY MAJOR SHIPPING “HIGHWAYS” WHERE THE RISK OF SHIP STRIKE IS ELEVATED.**

## CONSERVATION CHALLENGES

By virtue of Hawaii’s location in the middle of the North Pacific, the migration to and from the feeding areas takes the whales across a vast expanse of the open ocean that is regularly crossed by major shipping “highways” where the risk of ship strike is elevated.<sup>165</sup> Patterns of ocean currents in this region lead to the formation of convergence zones, most famously the Great Pacific Garbage Patch, where abandoned, lost or discarded fishing gear tends to accumulate,<sup>108,111,166,167</sup> increasing the risk of entanglement. At least 46 per cent of the Great Pacific Garbage Patch is made of discarded fishing gear.<sup>111</sup>

While the Hawaiian humpback whale population has been recovering strongly,<sup>168</sup> recent climate-related perturbations to the North Pacific ecosystem known as “marine heatwaves” appear to have affected survival and recruitment in this population.<sup>169-172</sup>

## CONSERVATION OPPORTUNITIES

Preventing fishing gear loss is the top priority, with education, voluntary measures and regulations all having a role to play. Prevention measures include restricting the use of high-risk gear in certain areas or times of year, marking fishing gear so it’s clearly visible and the owner can be identified, and improving end-of-life disposal and recycling.

Even so, some fishing gear will inevitably get lost, so it’s important to adopt mitigation measures. Including biodegradable components so the gear breaks down quickly is one effective way to prevent ghost fishing. Finally, since plastic gear can have long-lasting impacts, it’s important to remove and retrieve as much lost and abandoned gear as possible, though this can be expensive, particularly in deep-sea habitats. Programmes for reporting and retrieving lost gear already operate in some places, and “fish for litter” schemes – which reward fishers for bringing back marine debris, including ghost gear – are growing in popularity.<sup>107</sup> WWF is urging governments to sign on to the Global Ghost Gear Initiative (GGGI) and implement its fishing gear best management practices to prevent gear loss. The GGGI is the world’s only global cross-sectoral alliance of 100 organizations, including WWF. By joining the GGGI, countries will access critical technical support to address ghost gear in their national fisheries, contribute to the collective impact of GGGI and its members, and help to develop the global capacity to solve this problem throughout our ocean.<sup>107</sup>

Globally, a legally binding UN agreement is needed as a priority to stop the leakage of plastics into our oceans by 2030 and accelerate the transition to a circular economy for plastic so it never becomes waste or pollution.<sup>173</sup>

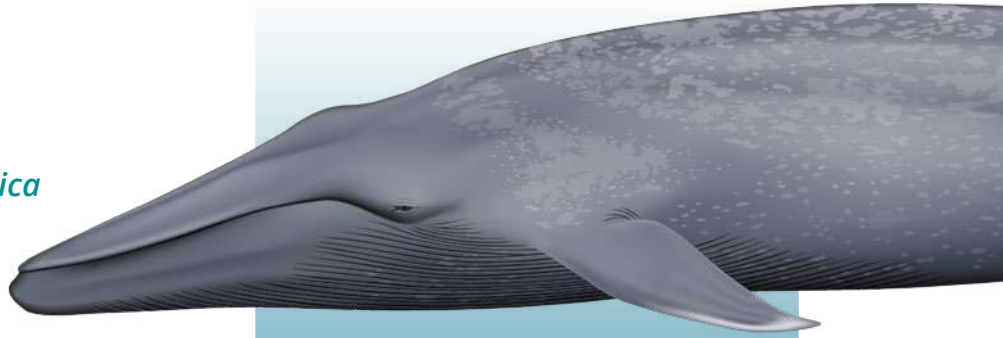
# WESTERN COAST OF NORTH AMERICA

*The coastal waters of North America are important migratory routes and foraging areas for species including gray, blue, humpback and fin whales. Blue whales move between the Eastern Tropical Pacific and the California Current System or Gulf of Alaska, but probably feed year-round, targeting ephemeral, dynamic concentrations of krill.*

Blue whales in the Eastern North Pacific are listed as Endangered under the *United States Endangered Species Act*, NOM-059 of Mexico, the Species at Risk in Canada and Protected under the *United States Marine Mammal Protection Act*. Their population size in this region is about 1,500 animals.<sup>174</sup> They migrate between the California Current region or the Gulf of Alaska and the Eastern Tropical Pacific, likely tracking abundant krill that they feed on year-round.<sup>3,175-177</sup>

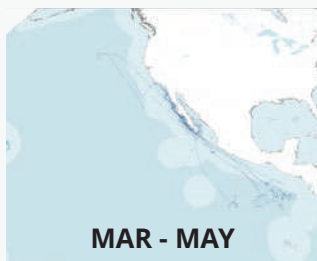
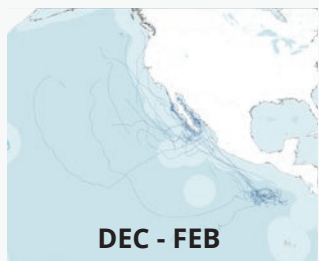
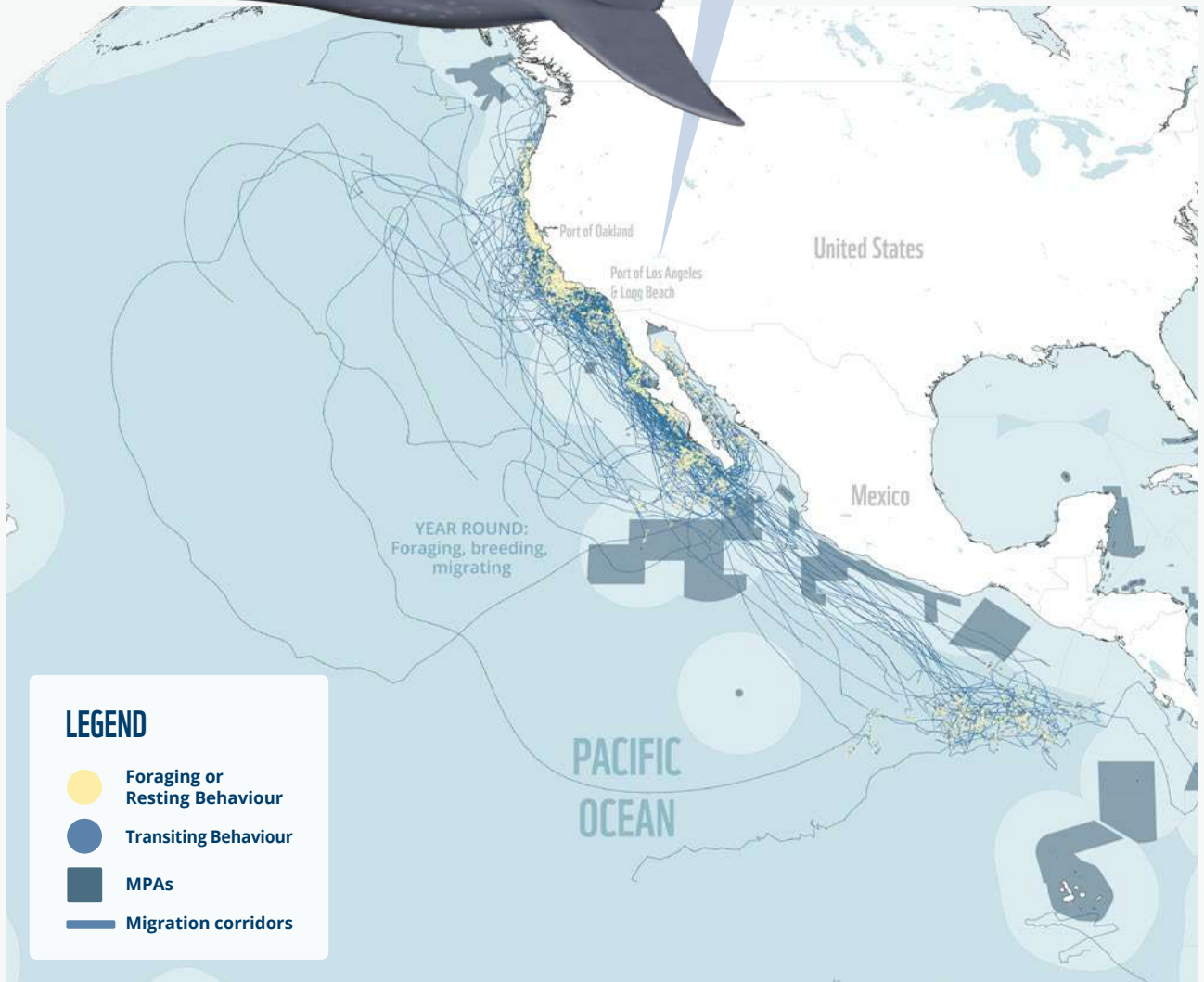
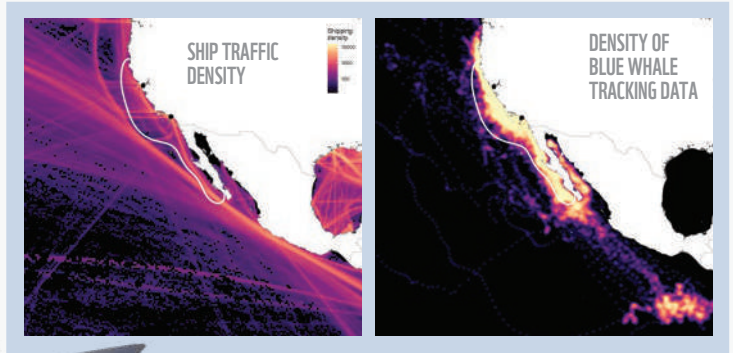
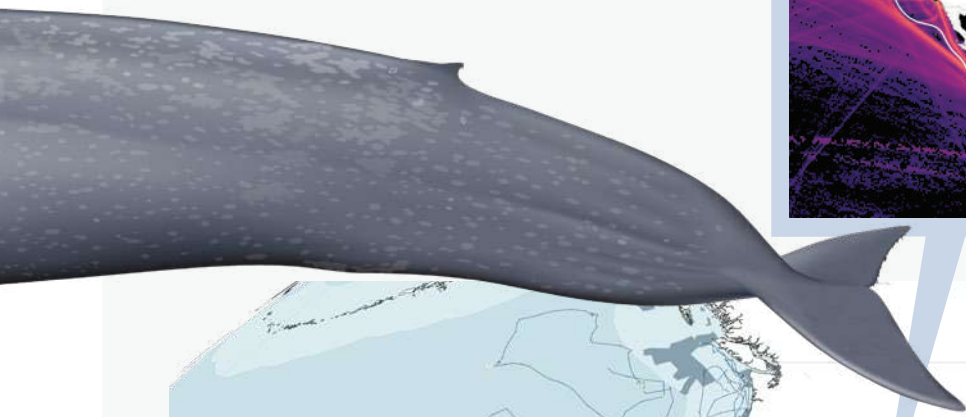
## CONSERVATION CHALLENGES

Off the United States West Coast, migratory routes and foraging areas of many species overlap with various kinds of ship traffic,<sup>178-183</sup> including commercial traffic to and from the ports of Los Angeles and Long Beach, two of the world's 50 busiest container ports. The risk of collisions between ships and whales is thus high in this area: it is estimated that most mortality risk for blue, humpback and fin whales is concentrated in about 10 per cent of the United States West Coast EEZ.<sup>183</sup> Fatal collisions with ships are a leading source of mortality for blue, fin, humpback and gray whales,<sup>184</sup> and may be one of the factors inhibiting recovery of blue whale populations post-whaling.<sup>183,185,186</sup> Studies of the impacts of acoustic disturbance on blue whales has shown that these whales generally are affected disproportionately when feeding and as a result of disturbance, stop feeding.<sup>187</sup> Animals that are chronically exposed to disturbances, therefore, are at risk of losing critical foraging opportunities that can lead to changes in body condition that ultimately may lead to changes in reproductive rates and decreased population growth.<sup>188,189</sup>



Blue Whale illustration © Uko Gorter

**FATAL COLLISIONS  
WITH SHIPS ARE A  
LEADING SOURCE  
OF MORTALITY  
FOR BLUE, FIN,  
HUMPBACK AND  
GRAY WHALES,<sup>184</sup>  
AND MAY BE ONE  
OF THE FACTORS  
INHIBITING RECOVERY  
OF BLUE WHALE  
POPULATIONS POST-  
WHALING.**



## FIGURE 4

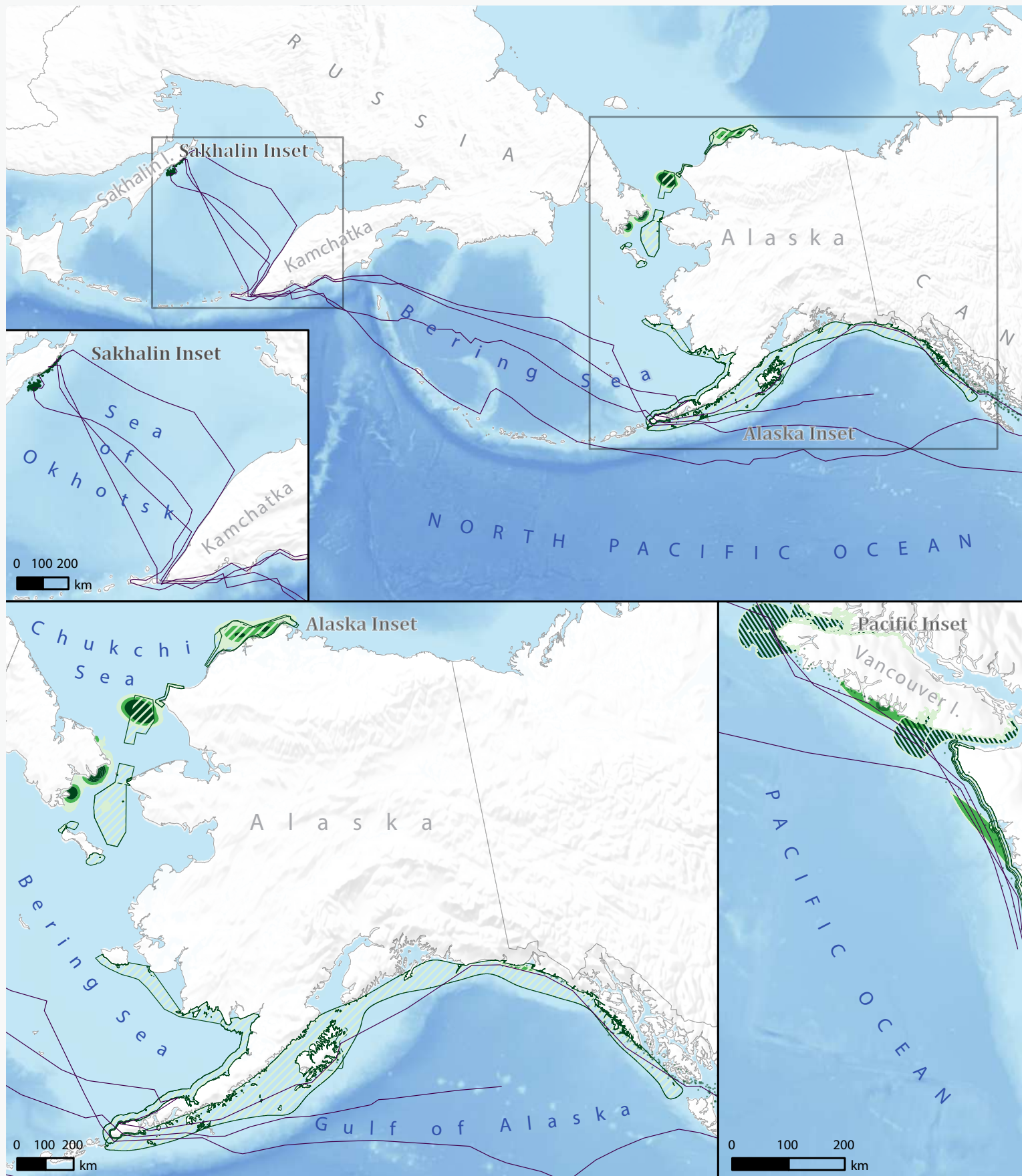
### EASTERN NORTH PACIFIC BLUE WHALES

Over 17 years between 1994 and 2017, 189 whales were satellite-tracked for 2-504 days. Locations were recorded in the EEZs of nine countries with 15 per cent of locations recorded in the high seas. Most locations were in United States (52 per cent) and Mexican (32 per cent) waters. The satellite tracks cover an area of 23 million km<sup>2</sup>. In this area, the mean shipping density (number of vessels counted in 2015) is 0.36 vessels/km<sup>2</sup>, but in the whales' core-use area, it is 0.99 vessels/km<sup>2</sup>.

## FIGURE 5

### GRAY WHALE SUMMER FEEDING AND WINTERING AREA

Satellite tagging shows the yearly round-trip migration of gray whales between the Arctic and Mexico along the west coasts of Canada and the United States.



## LEGEND

Wintering Lagoons<sup>1</sup>

Whale Location<sup>2,3,4,5</sup>

Satellite-tagged Whale Route<sup>6,7</sup>

## GRAY WHALE SUMMER HABITAT<sup>5,8,9,10</sup>

Regular Use

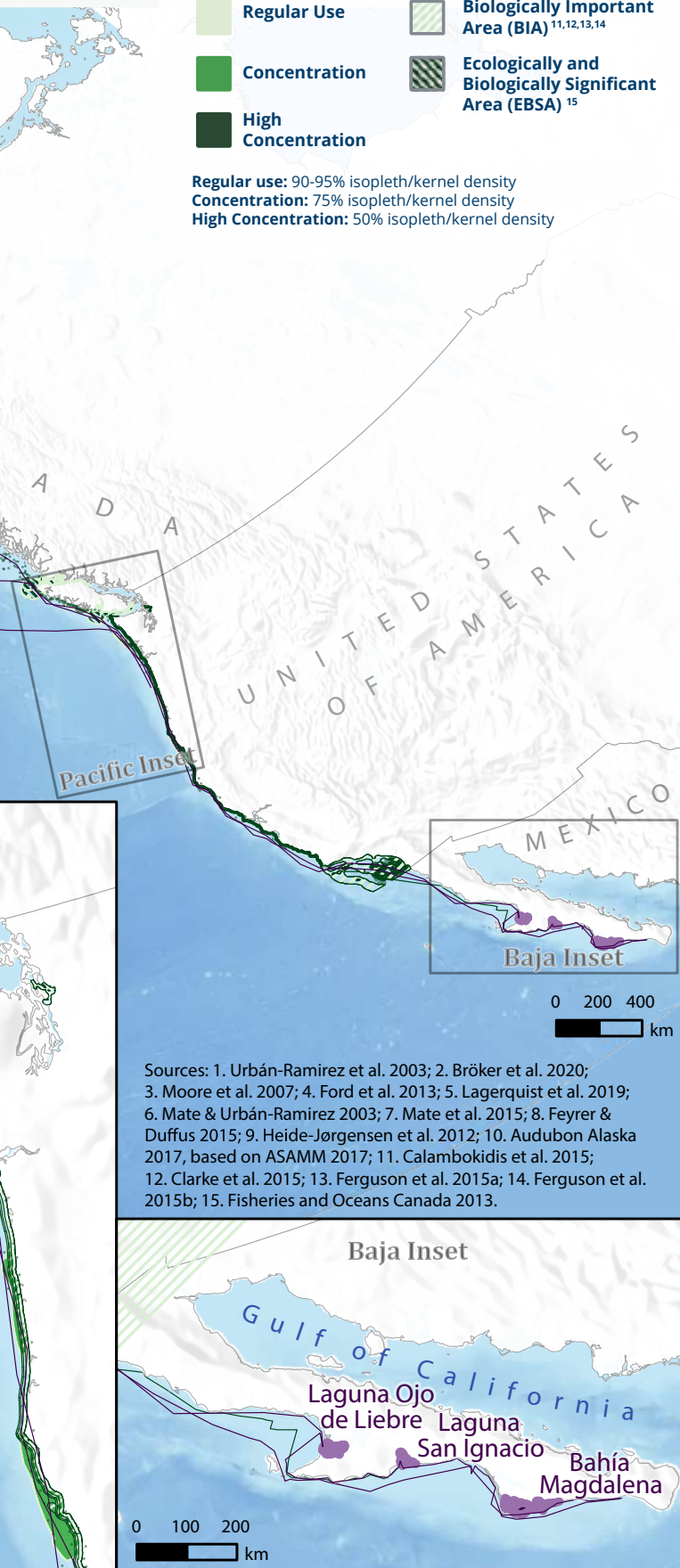
Biologically Important Area (BIA)<sup>11,12,13,14</sup>

Concentration

Ecologically and Biologically Significant Area (EBSA)<sup>15</sup>

High Concentration

Regular use: 90-95% isopleth/kernel density  
 Concentration: 75% isopleth/kernel density  
 High Concentration: 50% isopleth/kernel density



Sources: 1. Urbán-Ramirez et al. 2003; 2. Bröker et al. 2020; 3. Moore et al. 2007; 4. Ford et al. 2013; 5. Lagerquist et al. 2019; 6. Mate & Urbán-Ramirez 2003; 7. Mate et al. 2015; 8. Feyrer & Duffus 2015; 9. Heide-Jørgensen et al. 2012; 10. Audubon Alaska 2017, based on ASAMM 2017; 11. Calambokidis et al. 2015; 12. Clarke et al. 2015; 13. Ferguson et al. 2015a; 14. Ferguson et al. 2015b; 15. Fisheries and Oceans Canada 2013.



© Barbie Halaska / The Marine Mammal Center  
 A gray whale found dead off Point Reyes National Seashore in Northern California

# CONSERVATION CONCERN: CUMULATIVE IMPACTS ON GRAY WHALES ALONG THEIR SUPERHIGHWAY FROM THE ARCTIC TO MEXICO

*Since 1 January 2019, elevated gray whale strandings have occurred along the West Coast of North America from Mexico to Alaska. An unusual mortality event was declared by the National Oceanic and Atmospheric Administration (NOAA) in May 2019, and through May 2021 at least 454 strandings were reported, including 218 in Mexico, 218 in the United States and 18 in Canada.<sup>190</sup>*

The peak of the unusual mortality event was in 2019, and the number of strandings has been decreasing in 2020 and 2021. Most of these strandings have occurred from April through June, coinciding with the northbound migration from the breeding to the feeding areas, when the nutritional status of the whales is normally at its lowest. However, as the primary source of mortality appears to be severe malnutrition, it is likely that the deaths are related to a lack of food during the feeding season in the Arctic.<sup>191</sup> As a result of climate change, dramatic environmental changes took place in the North Pacific and the Arctic through the 2010s that likely affected the annual primary production cycles and the marine food chain, leading to the whales not finding sufficient food.<sup>143</sup>

The net result has been a loss of about 24 per cent of the eastern gray whale population from the 2016 estimate of around 27,000 whales.<sup>190,192</sup> During this time, the whales also appear to be arriving later by about a month to the breeding lagoons of Mexico in winter, although the departure dates have remained constant, suggesting that they are spending less time in the lagoons.<sup>193</sup> Health assessments have indicated an increasing number of whales in poor body condition, to more than 30 per cent of the animals in the breeding lagoons in recent years.<sup>193</sup> Gray whales feed on a diet of invertebrates but are otherwise opportunistic feeders and can use multiple strategies, including suction feeding, lunge feeding and skim feeding that allows them to exploit alternate prey. This flexible foraging strategy confers the species resilience against these short-term environmental fluctuations, which likely allowed the gray whale population to rebound to greater numbers than before after a similar unusual mortality event in 1999–2000, during which the population was reduced by 23 per cent.<sup>192</sup>

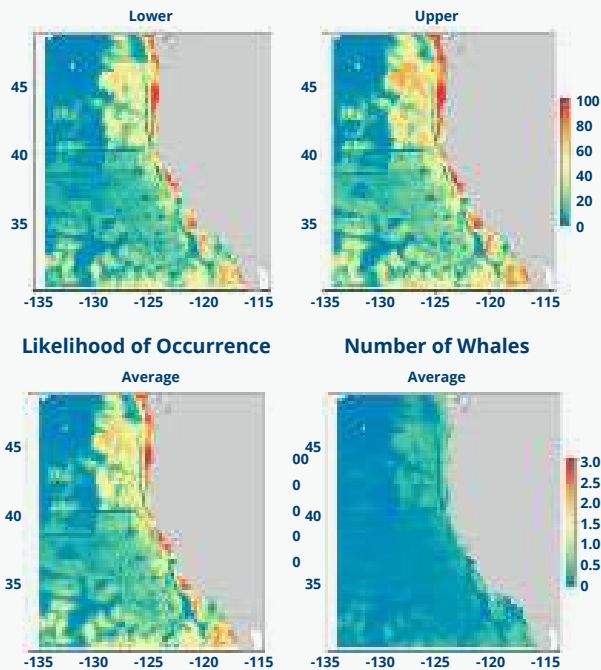
## CONSERVATION OPPORTUNITIES

**FIGURE 6**

### MODEL ESTIMATES FOR BLUE WHALES OFF THE US WEST COAST FOR JULY 2021

For more information about WhaleWatch visit [fisheries.noaa.gov/west-coast/marine-mammal-protection/whalewatch](https://fisheries.noaa.gov/west-coast/marine-mammal-protection/whalewatch)

1-Nov-2022 - 1-Dec-2022



### NEW TECHNOLOGY TO PROTECT WHALES FROM SHIPPING AND FISHING IMPACTS

To help reduce human impacts on whales, a collaborative initiative between NOAA, academic scientists and shipping companies developed WhaleWatch, a computer-based tool that provides predictions of where blue whales are likely to be off the United States West Coast.

The tool uses models that link whale tracking data to environmental conditions to predict the likelihood of whale presence.<sup>180</sup> This near real-time information helps reduce human effects on whales by providing information on where the whales occur and hence where whales may be most at risk from threats such as vessel strikes, entanglements and underwater noise.

For more information, see:

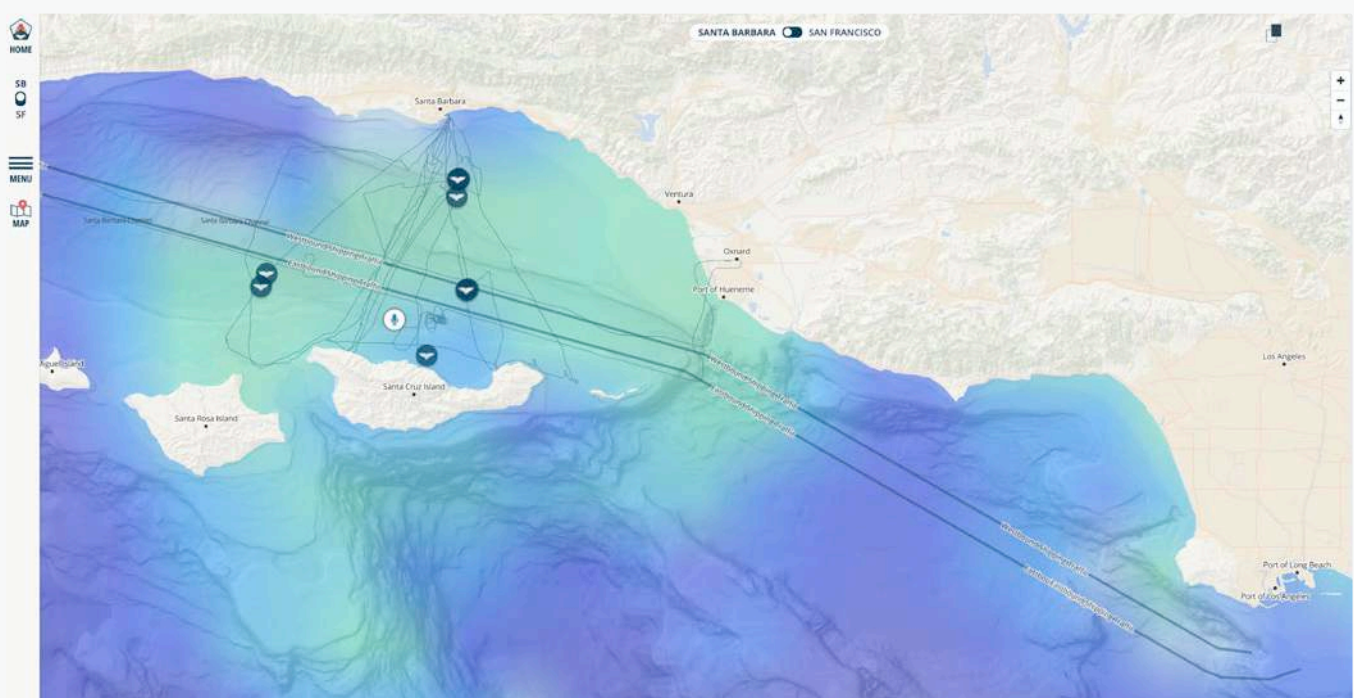
[COASTWATCH.PFEG.NOAA.GOV/PROJECTS/WHALEWATCH2/](https://coastwatch.pfeg.noaa.gov/projects/whalewatch2/)

Another recent, related effort is Whale Safe, a technology-based mapping and analysis tool developed by the Benioff Ocean Initiative and partners. The tool collects and displays near real-time whale and ship data for the Santa Barbara Channel, with the goal of helping to prevent fatal ship collisions with whales.<sup>178,179,194</sup>

**FIGURE 7**

### WHALE SAFE PLATFORM

For more information, see [whalesafe.com](https://whalesafe.com)



In 2022, the tool was expanded to provide coverage for the busy shipping channels outside of San Francisco Bay. 2018 and 2019 were the worst years on record for whale-ship collisions off the West Coast of the United States. Despite this trend, there are solutions to combat the problem. Research demonstrates ships that slow to 10 knots in areas with high whale presence significantly reduce the danger to whales in the area.

*For more information, see:*

**WHALESAFE.COM**

## **REDUCING VERTICAL LINES IN THE WATER TO ELIMINATE ENTANGLEMENT**

Large whale entanglements on the West Coast of the U.S. have increased dramatically in recent years.<sup>195,196</sup> In California, from 2014 through 2017, at least 142 whales—mainly humpbacks—became entangled in crab pot ropes. Several more were reported for 2018.<sup>197</sup>

Currently, fishermen use rope to connect surface buoys to fixed gear on the seafloor, which allows them to mark the location of and retrieve deployed gear. On-demand, or ropeless, fishing removes these static vertical buoy lines from

the water column while allowing fishermen to continue to fish their current gear, reduce entanglements and minimize gear loss.<sup>195,198</sup>

The technologies – marking and retrieving traps without buoys or end lines – are currently being explored and tested in both Canada and the US.<sup>199,200</sup> The development and operational use of ropeless fishing has the promise to eliminate most fixed gear entanglements as well as allow access to closed fishing grounds.<sup>201</sup> Ropeless technologies represent a more fundamental change for fishers. There is further development and testing needed to ensure that these technologies provide a safe, legal, practical and affordable alternative to scale up its use and impact in a changing climate.<sup>200</sup>

Existing whale-safe technologies include weak ropes or weak breaking points (e.g. sleeves and cutters), which is based on evidence that ropes with breaking strengths of 1,700lbs could reduce the number of life-threatening entanglements by allowing whales to swim free more easily.<sup>202</sup> The National Marine Fisheries Service requires all trap/pot gear to use weak links at the buoy line since the early 2000s. In Canada, weak rope will be mandatory by the end of 2022 followed by maximum rope diameters, sinking rope and reductions in vertical and floating rope<sup>200</sup> whereas the US has mandated sinking groundlines since 2007.<sup>203</sup>



**RESEARCH  
DEMONSTRATES SHIPS  
THAT SLOW TO 10  
KNOTS IN AREAS WITH  
HIGH WHALE PRESENCE  
SIGNIFICANTLY REDUCE  
THE DANGER TO WHALES  
IN THE AREA.**

**FIGURE 8**

AN ILLUSTRATION OF ON-DEMAND, OR ROPELESS, FISHING TYPES.<sup>204</sup>







© Karel Beets ECOBAC

A humpback whale entangled in fishing nets. A team from Mexico's National Whale Disentanglement Network, known as RABEN, attempts to free the whale from the net.

## NETWORK OF MPAS AND CONNECTIVITY

In 1972, Mexico was the first country in the world to create a whale sanctuary in the Laguna Ojo de Liebre, a coastal lagoon in the Pacific coast of the Baja California Peninsula. This area is home of the most important gray whale breeding grounds.<sup>56</sup> Since then, a network of MPAs has been established, which now covers 22.05% of Mexico's marine territory.

In particular, the protected areas in the Mexican Pacific hold globally significant reproduction areas for migratory gray whales (the El Vizcaino Biosphere on deReserve),<sup>205</sup> humpback whales (National Parks of Revillagigedo, Cabo Pulmo, Islas Marietas and Huatulco)<sup>206,207</sup> and blue whales (Loreto National Park)<sup>208</sup> as well as other key habitats along their migratory routes (the Islas del Pacifico de la Península de Baja California, Islas Marias Biosphere Reserves and the Islas del Golfo de California Protection Area for Flora and Fauna).<sup>209-211</sup>

All cetaceans that occur in Mexico are protected by national legislation. Mexico's protected areas play a significant role managing critical habitats of migratory whales in North America, but need to be strengthened.<sup>212</sup> The development of environmental policies specifically designed to strengthen the conservation of whales, have contributed to strengthen

the protection of migratory whales outside protected areas, increasing connectivity and community participation.<sup>213</sup> An official standard has been put in place to regulate all whale-watching activities, and response protocols for whale strandings and entanglements have been developed.<sup>214-216</sup>

At least 10 stranding networks work under the auspices of the Federal Attorney for Environmental Protection along the Mexican coasts. Such networks integrate staff from government agencies, research facilities and non-government organizations, and have assisted hundreds of strandings since 2014, but heavily rely on volunteers and lack government funding.<sup>217</sup> The National Whale Disentanglement Network, known as RABEN, integrates 15 trained teams of disentanglement experts with 180 volunteers along the Mexican Pacific Coast, all equipped with specialized gear to assist in the rescue of entangled whales. The network has been able to confirm 239 entanglements of six whale species, with humpbacks being the most affected (86 per cent). During the 2021–2022 season, the network received 37 entanglement reports (31 confirmed and 6 unconfirmed) and was able to successfully rescue 7 whales (six humpbacks and one gray). This network relies on philanthropic funding.



## EASTERN TROPICAL AND TEMPERATE PACIFIC


*The Eastern Tropical and temperate Pacific encompasses territorial waters, EEZs and island territories of 14 countries, as well as an extensive marine area beyond national jurisdictions between Mexico and Chile. The combination of ecosystem diversity and high productivity has fostered a high diversity of cetacean species in this vast region. More than 40 species of cetaceans inhabit the eastern Pacific, including nine baleen whales (Mysticeti) and more than 30 species of toothed cetaceans (Odontoceti).<sup>218</sup>*

Understanding the large-scale distribution patterns of these species is critical to promoting their conservation. Because the breeding grounds of most migratory whales are in the tropics and subtropics, populations of the same species in both hemispheres may share the same breeding grounds in the eastern tropical/subtropical Pacific, but at different times of the year. This is the case of the humpback whale on the coasts of Central and South America and probably also with blue whales in the Galápagos Islands and the Costa Rica Dome.<sup>8,219-221</sup> The Costa Rica Dome is a regional centre of high productivity and likely supports high prey availability for cetaceans within the Dome and in surrounding waters. The productive equatorial waters of the Galápagos Islands also contain important regional habitats<sup>222</sup> and have been subject to recent high intensity industrial fishing along its EEZ.<sup>223</sup>

Sperm whales (*Physeter macrocephalus*) are a cosmopolitan species. Females and young males are found in tropical and subtropical waters. They are deep-diving predators with a

broad diet of squid.<sup>224</sup> Other large whale species such as Bryde's whales also have wide ranges of distribution in the region, without an evident periodic migration.<sup>225</sup> Even so, both can show large-scale movements depending on the availability of food or specific oceanographic conditions.<sup>226-228</sup>

In this region, humpback whales breed in warm coastal waters from northern Peru north to Nicaragua mainly from July to October.<sup>229</sup> Satellite tracking studies of these whales have followed their long migrations along the Central and South America coast to the Antarctic Peninsula,<sup>227,228,230</sup> where they feed on krill in the Antarctic summer. Among whales tagged off Ecuador, mothers and their calves seemed to prefer the longer, coastal route to Antarctica, while lone adults seemed to prefer a more direct offshore route, sometimes hundreds of kilometres from the coast.<sup>227</sup> More recent tracking has revealed two areas where migrating whales converge near the southernmost point of Chile as well as Peru's Illescas Peninsula, where they could be exposed to increased human activities.<sup>230</sup>



## ENTANGLEMENT AND MORTALITY IN FISHING GEAR, SHIP STRIKES AND CLIMATE CHANGE ARE THE MAIN THREATS TO WHALES IN THE EASTERN PACIFIC.

ADDRESSING THESE PROBLEMS REQUIRES INFORMATION ON ECOLOGY, DEMOGRAPHY AND THE IDENTIFICATION OF CRITICAL HABITAT AND MIGRATION ROUTES.

While migrating, eastern South Pacific humpback whales spent 64 to 79 per cent of their time inside the jurisdictional waters of these countries, and 21 to 36 per cent of their time in international waters.<sup>230</sup>

The coastal marine ecosystems of Chile are among the most productive in the world. This is particularly the case for the Chiloense Marine Ecoregion, a well-known coastal region of northern Patagonia with high biological productivity, great ecological value and the presence of emblematic species in serious states of conservation. Hundreds of blue whales and humpback whales migrate to the Chiloense Marine Ecoregion to feed and nurse their young every year, where the Corcovado Gulf, the Chiloé Archipelago's inner sea and Moraleda Channel are some of the most important feeding grounds in all of Patagonia.<sup>231,232</sup>

The Corcovado Gulf is currently considered the largest feeding ground for blue whales in the southern hemisphere, where other baleen whales such as the humpback whale,

sei whale and fin whale are frequently observed feeding or migrating. It is also possible to observe different species of toothed whales such as sperm whales, Peale's dolphins (*Lagenorhynchus australis*) and killer whales (*Orcinus orca*), among others.

### CONSERVATION CHALLENGES

Entanglement and mortality in fishing gear, ship strikes and climate change are the main threats to whales in the eastern Pacific. Addressing these problems requires information on ecology, demography and the identification of critical habitat and migration routes. However, data availability is a weakness for this region that cannot be overcome in the short term. Therefore, proactive conservation strategies are required in the face of this knowledge gap. Whales' broad distributions, the inherent difficulties in studying highly mobile animals at sea, and the different threats they face are major challenges for their conservation.

The IWC has identified the Gulf of Panama as a High Risk Area where humpback whales are at high risk of ship strike.<sup>233,234</sup> In December 2014, the IMO adopted a Traffic Separation Scheme with corresponding inshore traffic zones and seasonal speed limits of less than 10 knots to reduce the whale-vessel strike risk in this area. Humpback whales are present in the area from July to September.<sup>221,235,236</sup>

Recent analysis shows that compliance varied depending on vessel type using the Traffic Separation Scheme and overall speed compliance was low.<sup>237</sup> In Ecuador, both ship strikes and entanglements in fishing nets have been reported.<sup>238,239</sup>

Along the coast of Peru, whale-watching has increased exponentially in the last 5 to 10 years and there is no formal regulation that protects whales. A recent study recommended that whale-watching regulations be implemented to regulate the number of boats, the distance to the whales, boat speed, duration of observation, and that encounters with calves should be limited. Poor whale-watching practice can elicit short-term behavioural responses besides negative impacts from noise emitted by vessels.<sup>240</sup>

Studies of movements and dive behaviour have shown that blue whales within fjords in the northern Chilean Patagonia are at high risk of ship strike in specific areas and at specific times.<sup>241,242</sup> Areas of high risk of ship strike have also been identified in the southernmost part of Chile.<sup>243</sup> In the central-south coast of Chile, two fin whales were found stranded in 2018 and 2019 with signs of ship strike.<sup>244</sup>

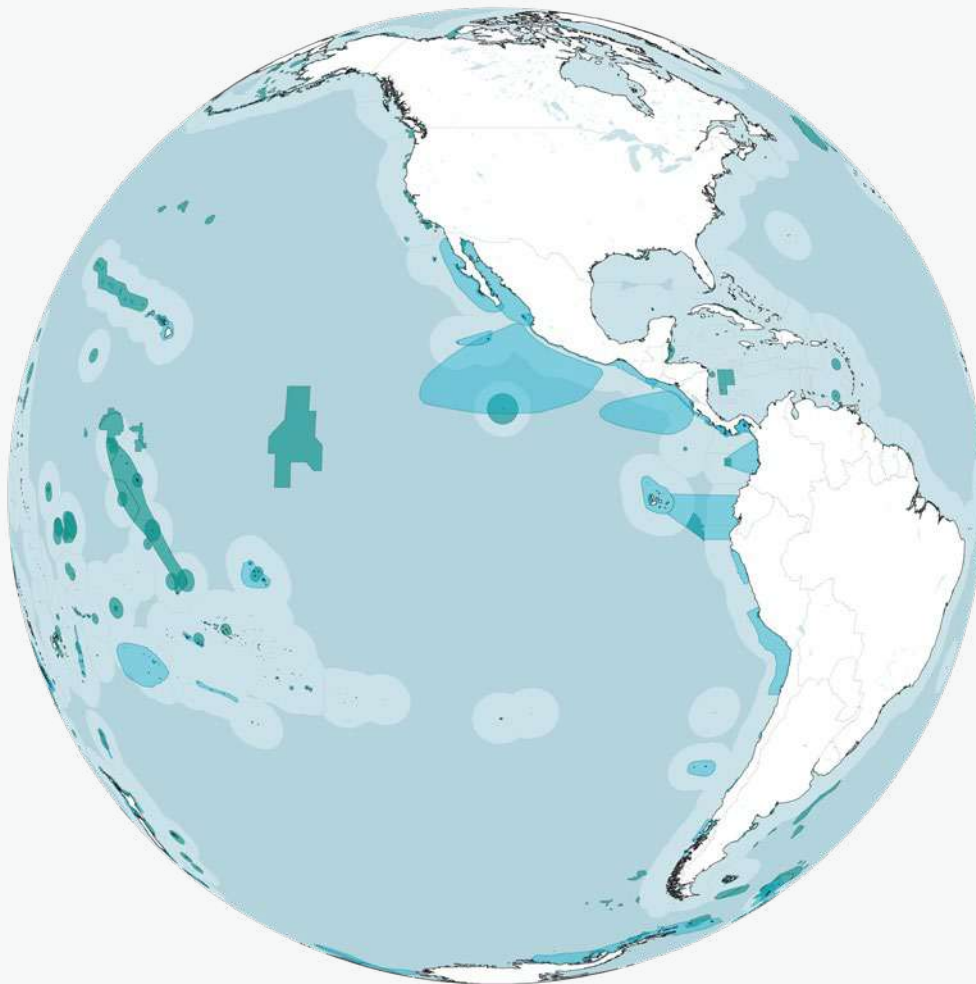
High density of marine ship traffic occurs between Chiloé Island's inner waters and the Pacific Ocean as well as the channel and fjords from southern Chile through the Magellan Strait, a narrow passage connecting the Pacific and Atlantic oceans in South America. Between <sup>249</sup> and 1,322 vessels navigate this area, with sizes varying between 10 to 200 m long. Vessel speed ranges between 8.3 and 22.5 knots, and recent studies have identified around 729 active vessels operating per day in association with the aquaculture industry in this region.<sup>241</sup>

# MAPS OF IUCN IMPORTANT MARINE MAMMAL AREAS AND MARINE PROTECTED AREAS

*Important Marine Mammal Areas (IMMAs) are a tool developed by the Marine Mammal Protected Areas Task Force of the IUCN Species Survival Commission and World Commission on Protected Areas.<sup>392,393</sup>*

**FIGURE 9**

*Map of current IMMAs, MPAs and MPA proposals in the Eastern Pacific and Southern Ocean. See **Appendix 2** for more information on data sources.*



## LEGEND

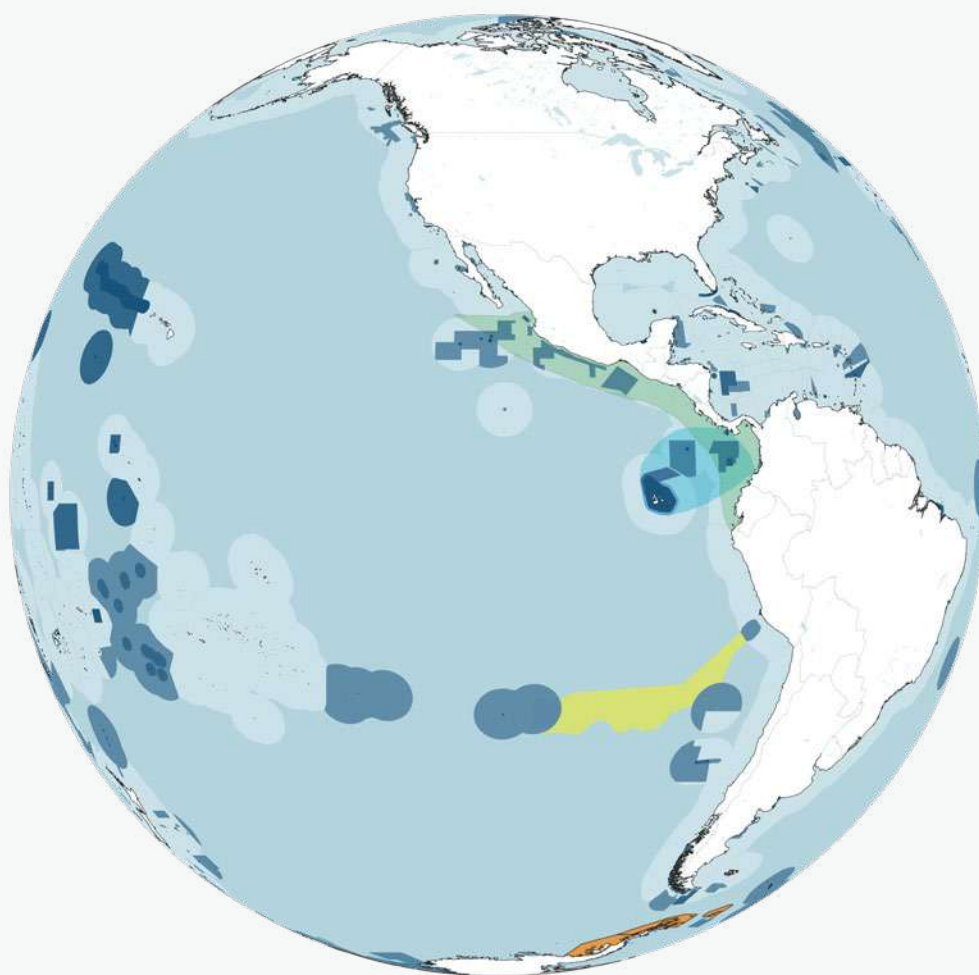
 IUCN Important Marine Mammal Areas (IMMAs)

 Key Biodiversity Areas (KBAs)

 EEZ

IMMAs highlight areas that are important for one or more marine mammal species and have the potential to be managed for conservation. In this context, “important” means “any perceivable value, which extends to the marine mammals within the IMMA, to improve the conservation status of those species or populations”. IMMAs thus provide an objective and consistent framework to identify the most critical marine mammal habitats worldwide, to prioritize their conservation and inform the designation and management of networks of MPAs.<sup>263</sup>

In June 2022, a week-long workshop with the region’s leading scientists compiled data on candidate areas for peer review. As a result of this process, in November 2022 the Task Force updated its e-Atlas with 36 new IMMAs, 5 candidate IMMAs, and 11 Areas of Interest for the South East Tropical and Temperate Pacific Ocean—a region spanning from northern Mexico to the southern tip of Chile.



## LEGEND

- |   |   |   |
|---|---|---|
|  MPAs              |  CMAR Region                                 |  Antarctic Peninsula MPA proposal (CCAMLR) |
|  PACA Region (LME) |  Salas y Gómez and Nazca Ridges MPA Proposal |  EEZ                                       |



© Yacquie Montecinos / WWF

## CO-DESIGNING SOLUTIONS TO SAFEGUARD WHALE BLUE CORRIDORS

*In May 2022, WWF hosted a workshop in Bogota, Colombia with 31 experts from the scientific community, civil society and governments representing 10 different countries.*

The aim was to create a set of national and regional actions to promote the conservation of large whales in the Eastern Tropical and temperate Pacific from Mexico to Chile - based on concepts presented in the global *Protecting Blue Corridors* report. Discussions included ideas to strengthen transboundary governance processes to reduce the direct, indirect and cumulative impacts of human activities, promote scientific research and integrate information for improved management. The workshop explored ways to enhance the management and sustainability of ecotourism associated with whales, and contribute to its long-term economic growth responsibly.

Seven areas were highlighted as crucial to strengthening the conservation needs of whale superhighways in the Eastern Pacific, including: addressing existing research needs to fill information gaps for management; identifying national actions needed to reduce anthropogenic threats; identifying regional actions to reduce threats and improve governance; improving

the access, publication and exchange of information; enhancing socio-economic benefits through sustainable tourism; building capacity of regional experts; and improving awareness and dissemination of solutions.

These concerted actions are highlighted throughout this report in order to help support connectivity conservation for whales through national and regional science and policy agendas, regional projects, marine research programs and other conservation initiatives throughout the region.

**To download the workshop report visit:**

[WWFWHALES.ORG/2022-COLOMBIA-WORKSHOP-REPORT-EN](https://www.wwfwhales.org/2022-colombia-workshop-report-en)

## CONSERVATION OPPORTUNITIES

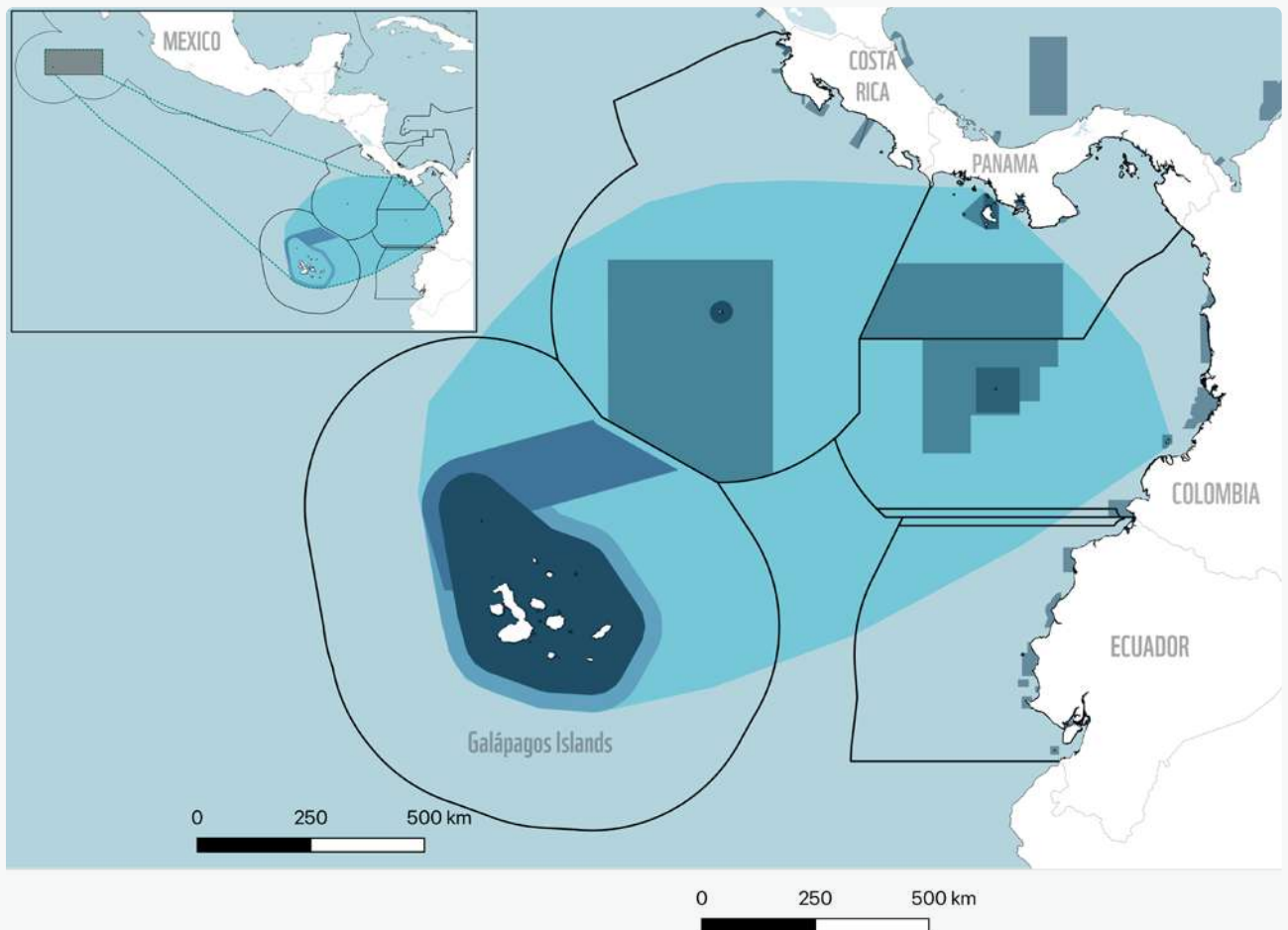
### PROTECTING CRITICAL HABITATS OF MARINE SPECIES WITH BENEFITS TO WHALES - EASTERN TROPICAL PACIFIC MARINE CORRIDOR (CMAR)

The Eastern Tropical Pacific Marine Corridor (CMAR) initiative is a regional cooperation mechanism between Panama, Ecuador, Colombia, and Costa Rica for the conservation and sustainable use of marine biodiversity and includes a proposed network of marine protected areas covering an extent of approximately 500,000 km<sup>2</sup>. Contained within CMAR are some of the world's most important migratory routes for whales, sea turtles, sharks and rays. Its implementation will help protect threatened endemic, native and migratory species in the region, including blue, Bryde's and sperm whales, along with a range of dolphin species.<sup>245</sup> Recently, the Revillagigedo National Park in Mexico joined CMAR, adding another 148,000 km<sup>2</sup> of no-take protected area to the CMAR network.<sup>246,247</sup>

This network of marine reserves follows the Cocos Ridge, an underwater mountain range that connects Costa Rica's Cocos Island National Park and Ecuador's Galápagos Marine Reserve,

both UNESCO World Heritage Sites and a 700-km underwater chain of seamounts with Revillagigedo National Park in Mexico.<sup>246,248</sup> Many species of marine birds, invertebrates, fish, sharks, sea turtles and whales could benefit from this conservation initiative, as it further protects their critical habitats in eastern Pacific.<sup>249,250</sup>

CMAR also includes a new protected area, the "Hermandad Marine Reserve," that consists of two parts: a no-take zone of 30,000 km<sup>2</sup> to the northeast of the Galápagos Islands connecting Ecuador's waters with those of Costa Rica along the underwater seamounts of the Cocos Ridge, a key migration route for ocean-going species. Another 30,000 km<sup>2</sup> area is a no-longline fishing zone wrapping northwest around the existing Galápagos Marine Reserve. Networks of marine protected areas are an effective tool for restoring ocean biodiversity and ecosystem services and can play a role in mitigating climate change.<sup>245,251-253</sup>



**FIGURE 10**

*The proposed multinational protected marine corridor CMAR (bright blue), when fully implemented, will cover more than 500,000 km<sup>2</sup> and will help conserve many marine species including cetaceans in the Eastern Tropical Pacific.*

## SHIFTING SHIPPING LANES OFF THE COAST OF PERU

Peruvian waters are an important area for several species of whales, as they are transiting, feeding and breeding habitats.<sup>254</sup> These include blue whales, fin whales, sperm whales and southern right whales (*Eubalaena australis*). The latter is of particular concern, as the Chile–Peru subpopulation of southern right whales is Critically Endangered according to the IUCN, with less than 60 remaining adults, whose main threat is mortality due to ship collisions.<sup>255</sup>

Shipping routes in the southeast Pacific often overlap with whale habitat, either during the breeding season<sup>233</sup> or during migration.<sup>256</sup> This overlap, in addition to the speed of the shipping vessels, puts whales at risk of harmful collisions and it has received little attention in conservation management.<sup>257</sup>

Due to projections of the region's trade growth with East Asia, researchers predict an increase in maritime traffic density in the near future, with the consequent increase in the probability of ship strikes.

However, the potential risk of ship strikes is still a non-quantified threat for cetaceans within Peruvian waters.<sup>257</sup> Evidence from neighbouring countries supports the need to address this issue through preventive measures, such as the rerouting of marine traffic, especially in areas of aggregation in northern Peruvian waters.<sup>233</sup>

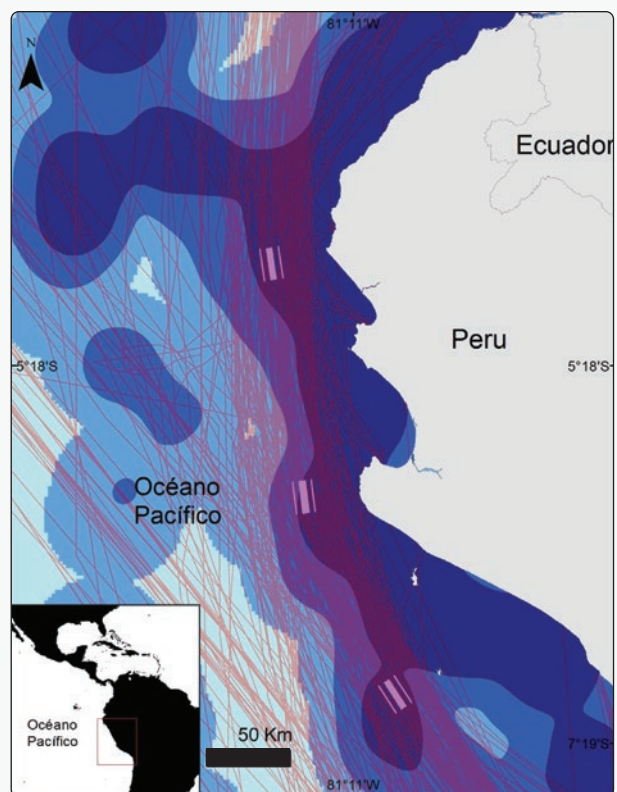
Three Traffic Separation Schemes within the jurisdictional waters of Peru are being proposed to help reduce ship strikes. This system would be recommended for use by all vessels, after being adopted by the IMO, with the exception of national vessels engaged in fishing, hydrocarbon and tourism activities that have the corresponding permit granted by the government of Peru, and areas established for the activity.

## TAKING A MULTI-POLICY APPROACH TO PROTECT MIGRATION

Most of the countries in the region are signatories to the main international conventions related to the conservation and sustainable use of marine resources. They also have developed a regional institutional framework through binding instruments, particularly in the southeast Pacific. Despite this, institutional weaknesses both nationally and regionally persist. Several action plans for species such as humpback and blue whales have been developed, as well as networks of MPAs that promote marine management through capacity building, scientific research and promoting the exchange of experiences. However, in many cases these plans are out of date and require review and strengthening.

Notwithstanding these deficiencies in the conservation of great whales, regional institutionalism constitutes an opportunity. In the southeast Pacific there is a specialized maritime agency, the Permanent Commission of the South Pacific (CPPS), which is, among other things, the technical secretariat of the United Nations Environment Programme's Action Plan for the Conservation of Marine Mammals in the Southeast Pacific, a management instrument created specifically to promote the conservation of these species and their habitats. There is no such specialized regional institution in Central America nor an action plan for marine mammals, but other national or regional institutions could assume that role.

Several initiatives in the region are aimed at strengthening the management of MPAs and migratory species, such as the CMAR and the UNESCO World Heritage Sites and Biosphere Reserves. In 2012, the CBD Secretariat led a scientific process to describe 21 EBSAs in the eastern tropical Pacific.<sup>259</sup>



**FIGURE 11**

*The Traffic Separation Scheme proposed for the Pacific Coast of Peru is defined in the light red areas with the lines showing vessel traffic.<sup>258</sup>*



# CASE STUDY: PROTECTING CRITICAL OCEAN HABITATS IN SOUTHERN CHILE WITH INDIGENOUS COMMUNITIES

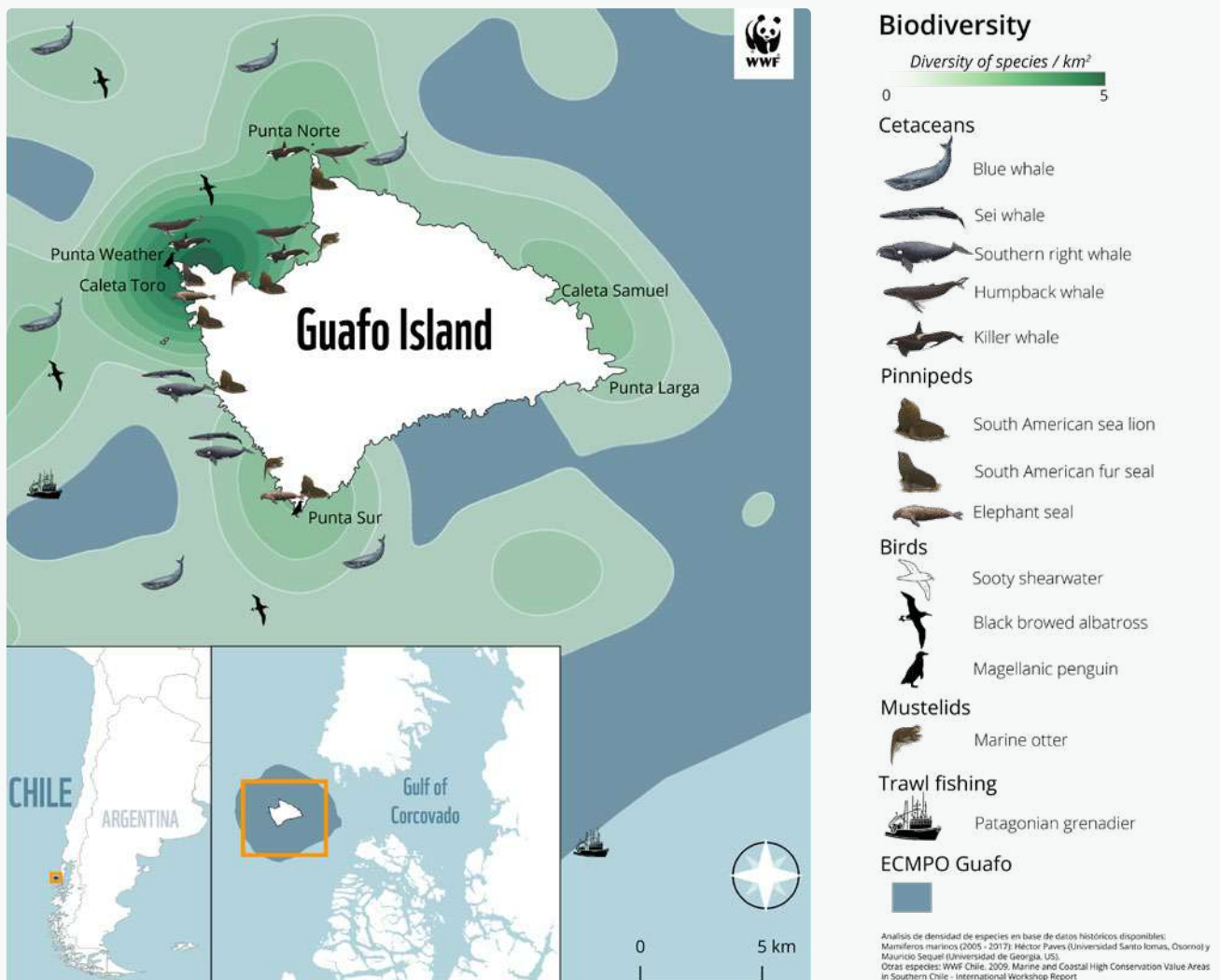
*In recent years, Chile has protected a significant area of the country's EEZ (42.4 per cent). However, only 5 per cent is in coastal areas. In the Chiloé Marine Ecoregion in southern Chile, only 0.11 per cent of this critical habitat is managed or protected.*

In 2008, the Chilean government created a category of protected areas called Native Peoples' Marine Coastal Spaces (ECMPOs). These are coastal and marine areas designated by the government's Undersecretary of Fisheries and Aquaculture (SUBPESCA) and entrusted to Indigenous groups to use and administer.

Over the last decade, WWF-Chile has worked to identify and advocate for effective management of MPAs including working with Indigenous communities in Chiloé and Guafo Islands.<sup>260</sup>

Currently, 11 Mapuche-Huilliche communities on Chiloé Island have created and administered the Wafo Wapi Coastal Marine Area of Guafo Island, located 40 km southeast of Chiloé Island. This area is recognized for its high biological productivity, great ecological value and presence of highly migratory, emblematic and endangered marine species, such as the blue whale.

The blue whale holds great cultural value for Mapuche-Huilliche communities, which regard this species as a ferry that transports their ancestor spirits around the island waters. The ECMPO area consists of the entire coastal marine area, from the coastline to 12 miles around the island, and covers 299,000 km<sup>2</sup>.



**FIGURE 12**

Marine biodiversity found around Guafo Island including important habitat for blue whales.



## AREAS BEYOND NATIONAL JURISDICTION

*The global ocean can be divided into areas within the national jurisdiction of states (the Exclusive Economic Zone), usually extending 200 nautical miles (370 km) offshore, and those in international waters, called “the high seas,” or more formally, Areas Beyond National Jurisdiction (ABNJ). Approximately 61 per cent of the sea surface is defined as ABNJ.*

Whale conservation in ABNJ is highly challenging, since:

- **Marine mammals are highly mobile and often occur in the high seas;**<sup>75</sup>
- **There is still limited knowledge of the distribution of many species; and**
- **Only limited mechanisms exist for conservation and management in these areas.**<sup>261,262</sup>

### CONSERVATION OPPORTUNITY

#### GLOBAL OCEANS TREATY - A NEW UN AGREEMENT ON BIODIVERSITY BEYOND NATIONAL JURISDICTION (BBNJ)

Although it is still a legal instrument in development, the new agreement on Biodiversity Beyond National Jurisdiction (BBNJ) will lay the foundations for the future management of marine biodiversity in ABNJ. The objective of this agreement is “to ensure the long-term conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction

through effective implementation of the relevant provisions of the Convention and further international cooperation and coordination”.<sup>263</sup> The agreement is based on several principles such as common heritage, equity, precaution, ecosystem and integration approaches.



## FOR WHALE CONSERVATION AND RECOVERY, HAVING AN INTERNATIONAL BODY WITH THE COMPETENCY TO DESIGNATE MPAS IN ABNJ IS A KEY AMBITION.

There are four main components to this agreement:

1. Marine genetic resources, including questions on the sharing of benefits;
2. Area-based management tools, including MPAs;
3. Environmental impact assessments; and
4. Capacity-building and transfer of marine technology.

A strong BBNJ agreement is essential because whale migration can occur between ABNJ and national waters and is subject to a variety of threats; thus, protection measures are needed to address cumulative impacts. For whale conservation and recovery, having an international body with the competency to designate MPAs in ABNJ is a key ambition.

The agreement can provide the framework for the “enhanced cooperation” needed between states and international bodies to ensure the conservation and recovery of whales. As whales migrate across jurisdictions, a large number of individual coastal, flag and port states are involved and these need to share the ambition if effective action is to be taken with the myriad of sub-regional, regional and global bodies across multiple sectors of maritime activity.

This new agreement will complement existing international agreements dealing with high seas fisheries, deep-sea mining (should it be allowed to occur), pollution and conservation, and will therefore set the basis for a holistic, integrated and ecosystem-based governance of the ocean.

A Conference of the Parties (COP), likely to be established by the BBNJ agreement, would have the responsibility to foster enhanced cooperation not only between states but between the bodies established by various other agreements. This would address a key concern of states that “silo” decision-making by sectoral bodies is unhelpful to achieve necessary conservation and cooperation outcomes.

WWF is proposing that the BBNJ COP be given the responsibility of delegation to establish regional arrangements that would be given the mandate to implement the provisions of the BBNJ agreement (including designating high seas MPAs and facilitating enhanced cooperation). Such a regional delegation of global responsibilities would be done in response to a request from states with an interest in the conservation and sustainable use of ABNJ biodiversity in that region, where “region” is at the scale of ocean basins – seven globally – being the scale at which ecological, commercial and diplomatic interests best align.<sup>1</sup>

# ANTARCTIC PENINSULA AND SOUTHERN OCEAN

*The Antarctic Peninsula is an important foraging area for whale species including humpback, minke, fin, southern right and blue whales.<sup>53</sup> Here, they feed on Antarctic krill, their main prey in the Southern Ocean.*

Krill are small, semi-transparent crustaceans and a vital component of the Antarctic ecosystem. They are a main source of food for many mammals such as seals and whales, as well as birds and fish.<sup>264</sup> There are around 380 million tonnes of these shrimp-like crustaceans in the Southern Ocean, similar to the total weight of human life on the planet.<sup>265</sup> They live for about seven years and are no larger than a little finger. Past studies indicate that krill survival and lifecycle are directly linked to fluctuations in sea ice and have already revealed a decline in krill abundance.<sup>266</sup>

During summer months, whales generally feed in the upper 100 metres, and in autumn between the surface and as deep as 400 metres.<sup>267-271</sup> Recovering humpback whale populations require lots of krill, but this is potentially in conflict with human demands for krill.

The Gerlache and Bransfield Straits along with the adjacent bays (e.g. Wilhelmina, Andvord and Flandres) are the most important feeding areas for baleen whales around the Antarctic Peninsula.<sup>268,272,273</sup> These areas are used throughout the summer and become the exclusive feeding habitat in autumn as sea ice develops and krill move inshore in autumn.<sup>274,275</sup> For example, in one day, more than 500 humpback whales and 2.3 million tonnes of krill were measured in Wilhelmina in May 2009.<sup>273,276</sup> Feeding behaviour is spatially and temporally clustered as krill are not uniformly distributed. Tagging studies and surveys have shown high concentrations of whales in May and June and animals remaining around the peninsula into July.<sup>271,275</sup>

## CONSERVATION CHALLENGES

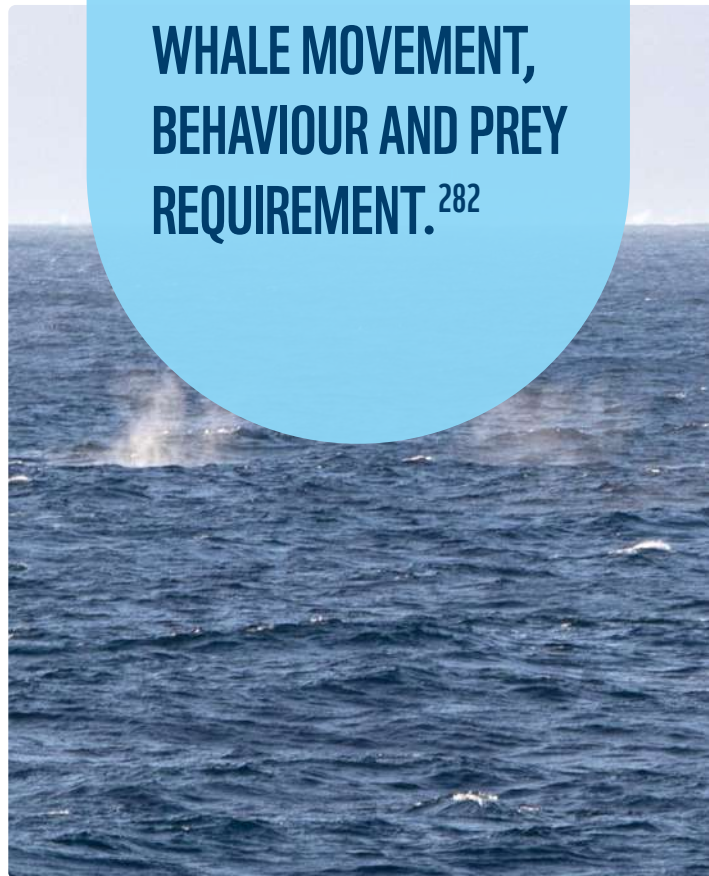
### 20<sup>TH</sup> CENTURY COMMERCIAL WHALING

During the 20<sup>th</sup> century, unchecked commercial whaling dramatically reduced whale populations throughout the Southern Ocean, driving many species to the brink of extinction. The international community has long since recognized the importance of protecting whales in the Southern Ocean, with the IWC specifically prohibiting commercial whaling through a moratorium on commercial whaling in 1982 and the establishment of the Southern Ocean Whale Sanctuary in 1994.



Antarctic Minke Whale © Uko Gorter

**THE ANTARCTIC KRILL FISHERY, WITH A TOTAL 2020 CATCH OF 450,000 TONNES, CURRENTLY OPERATES WITHOUT FINE-SCALE INFORMATION ON WHALE MOVEMENT, BEHAVIOUR AND PREY REQUIREMENT.<sup>282</sup>**





More than 2 million whales were commercially harvested to near extinction in the southern hemisphere,<sup>63,277</sup> including blue, fin, right, humpback, sei, minke and sperm whales taken from oceanic and coastal waters. Throughout the Southern Ocean, more than 725,000 fin, 400,000 sperm, 360,000 blue, 200,000 sei and 200,000 humpback whales were killed during this time.<sup>63</sup>

## A CHANGING CLIMATE

The Western Antarctic Peninsula is a hotspot of global environmental change. Climate change is having an increasing impact, warming the ocean and causing it to become more acidic.<sup>278</sup> Projected warming, ocean acidification, reduced seasonal sea-ice extent and continued loss of sea ice directly and indirectly affect wildlife habitats and populations. Sea ice is critical habitat for Antarctic krill.<sup>100</sup> Modelling predicts that suitable krill habitat, as well as krill populations, will shift southward by the end of the 21<sup>st</sup> century.<sup>100,279</sup>

For baleen whales feeding almost exclusively on krill – such as humpbacks, fin, Antarctic blue and Antarctic minke whales – these southward shifts in krill distribution may

impose high energetic costs on migrating whales, with effects on body condition, reproductive fitness and population abundance.<sup>101</sup>

## GROWING INDUSTRIAL KRILL FISHING

Historically, industrial krill fishing occurred around the entire continent of Antarctica. This led to the establishment of CCAMLR in the 1980s.

Currently, CCAMLR does not include information on climate change or fine scale krill distribution in its assessment of risks to manage krill fisheries. Whales are delegated to management under the IWC and are not considered in ecosystem-based management decisions related to commercial fishing and long-term monitoring under the CCAMLR Ecosystem Monitoring Program (CEMP). While CEMP focuses on land predators, WWF and others have called for the program to be modernised so that it includes whales and seals as part of its future monitoring and management efforts.<sup>53</sup>

In recent years, krill fishing has primarily taken place in the Antarctic Peninsula and Scotia Arc where catches are increasing in critical habitats for eastern Pacific humpback whales. Commercial krill fishing is the largest in the southern hemisphere. Unlike most of the world's large fisheries it has scope to expand<sup>266</sup> and could become the largest fishery of any type.<sup>280</sup> Industrial krill fisheries that operate along the Antarctic Peninsula overlap with important humpback whale foraging areas, increasing risks of bycatch and competition for krill.<sup>275,281</sup>



© Conor Ryan



**FIGURE 13**

*At the 2022 CCAMLR meeting, Norway reported that humpback whales were killed as bycatch in Industrial krill fishing operations undertaken by Aker BioMarine for a second straight year. Scientists and WWF are calling for a review of their fishing nets as there are increasing concerns of whale, seabird and seal bycatch that may be underreported. Photo: IWC SC/68D/HIM/04 283*

## CONSERVATION OPPORTUNITIES

### A SOUTHERN OCEAN NETWORK OF MPAS – HELPING THE RECOVERY AND CONSERVATION OF WHALES

The Southern Ocean covers 10 per cent of the world's ocean and includes some of the most productive marine areas in the world.

In protected areas of the ocean, activities are managed, limited or entirely prohibited. Antarctic ocean life is conserved through coordinated international management by CCAMLR, which can make binding consensus decisions about controlling the use of marine living resources.

CCAMLR has committed to the creation of a representative system of MPAs throughout the Southern Ocean.<sup>284</sup> Implementing effective MPAs will help conserve important Antarctic biodiversity including whales. They can also be used as a reference area to help monitor and understand the effects of fishing outside these regions, as well as the impacts of climate change on the Antarctic ecosystem.

### IMPROVING SPATIAL DISTRIBUTION AND MANAGEMENT OF THE KRILL FISHERY

The fishery for Antarctic krill is managed by CCAMLR under an ecosystem-based framework according to which fishing should not interfere with the population growth of Antarctic krill predators.<sup>285</sup> Nonetheless, potential competition between fisheries and krill predators, including baleen whales, is concerning.<sup>281,286–289</sup> Krill catches have become more concentrated,<sup>281,290</sup> raising concerns about how local depletion of krill impacts predators.<sup>281,289</sup> CCAMLR recognized that this necessitates a smaller-scale management approach and designated “Small Scale Management Units” (16,000 km<sup>2</sup> to 440,000 km<sup>2</sup>). However, catches are still managed in the much larger “subareas” (658,730km<sup>2</sup> to 1,033,248 km<sup>2</sup> for Subareas 48.1–48.4).

Consequently, there is a mismatch between the spatial and temporal scale at which krill fisheries are currently managed, and that at which fisheries operate and predators forage. There is a clear and urgent need to better understand potential interactions between baleen whales and the krill fishery. This involves understanding the dynamics and typical spatial scales, both of foraging whales and fishing vessels, implementing the Antarctic Peninsula MPA to reduce interactions.



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# TECHNOLOGIES TO UNCOVER THE LIVES OF ANTARCTIC WHALES

*New technologies are allowing us to study whales and the ocean in new ways. Over recent years, WWF has supported field work such as using digital tags and drones to better understand how and where whales feed to uncover their favorite hotspots along the Antarctic Peninsula.<sup>53</sup> It gives us a window into their world, to understand the health of populations, how they are affected by climate change, and how we might protect their critical ocean habitats worldwide.*

Marine conservation that makes a difference takes collaboration. Long-time science partners from University of California Santa Cruz (UCSC) with others from Stanford University published research in the journal *Nature*.<sup>58</sup> Using this new toolbox of technologies, including over 300 digital tags the size of an iPhone with suction cups, they analyzed an array of information on baleen whales such as blue, fin, humpback and minke whales. Baleen whales feed by gulping a large amount of water and filtering it through their mouths' fringed baleen plates until only their prey remains. It turns out, an individual blue whale eats an average of 16 tons of food every day — about three times more than scientists had thought.<sup>58</sup>

One area of focus was on the Southern Ocean. Here, baleen whales devour up to 30 percent of their body weight in krill each day. Previous

estimates suggested baleen whales consume less than 5 percent of their body weight daily.<sup>58</sup>

Importantly, after all of this eating, comes pooping. Recently, scientists have realized that this helps fertilize our oceans and boosts the growth of phytoplankton, tiny life forms at the bottom of the marine food web that are eaten by krill. It's another example of the important relationships and dependencies between predator and prey.

Researchers feel that if we restore whale populations to pre-whaling levels, we'll restore a huge amount of lost function to ocean ecosystems. It's helping nature help itself, and all of us who depend on it.<sup>291</sup>

# APPENDIX 1

## SATELLITE TELEMETRY DATA – EASTERN PACIFIC OCEAN

SPECIES	AREA	NUMBER OF TRACKS	CONTRIBUTORS	SOURCE
Blue whales	Eastern North Pacific	189	Daniel Palacios (Oregon State University)	<p>Mate, B. R., Lagerquist, B. A. &amp; Calambokidis, J. MOVEMENTS OF NORTH PACIFIC BLUE WHALES DURING THE FEEDING SEASON OFF SOUTHERN CALIFORNIA AND THEIR SOUTHERN FALL MIGRATION1. <i>Mar. Mamm. Sci.</i> 15, 1246–1257 (1999)</p> <p>Bailey, H., Mate, B. R., Palacios, D. M., Irvine, L., Bograd, S. J. &amp; Costa, D. P. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. <i>Endanger. Species Res.</i> 10, 93–106 (2010).</p> <p>Irvine, L. M., Mate, B. R., Winsor, M. H., Palacios, D. M., Bograd, S. J., Costa, D. P. &amp; Bailey, H. Spatial and temporal occurrence of blue whales off the U.S. West Coast, with implications for management. <i>PLoS One</i> 9, (2014).</p>
Blue whales	Chile	10	Publication supplement.	Hucke-Gaete, R., Bedriñana-Romano, L., Vididi, F. A., Ruiz, J. E., Torres-Florez, J. P. & Zerbini, A. N. From Chilean Patagonia to Galapagos, Ecuador: Novel insights on blue whale migratory pathways along the Eastern South Pacific. <i>PeerJ</i> 2018, 1–22 (2018).
Blue whales	Chile	15	Publication supplement.	Bedriñana-Romano, L., Hucke-Gaete, R., Vididi, F. A., Johnson, D., Zerbini, A. N., Morales, J., Mate, B. & Palacios, D. M. Defining priority areas for blue whale conservation and investigating overlap with vessel traffic in Chilean Patagonia, using a fast-fitting movement model. <i>Sci. Rep.</i> 11, 1–16 (2021).
Fin whales	Chile	6	Natalya Hernández	Sepúlveda, M., Pérez-Álvarez, M. J., Santos-Carvalho, M., Pavez, G., Olavarría, C., Moraga, R. & Zerbini, A. N. From whaling to whale watching: Identifying fin whale critical foraging habitats off the Chilean coast. <i>Aquat. Conserv.</i> 28, 821–829 (2018).
Humpback whales	Eastern North Pacific - Hawaii	49	Daniel Palacios (Oregon State University)	<p>Mate, B. R., Gisiner, R. &amp; Mobley, J. Local and migratory movements of Hawaiian humpback whales tracked by satellite telemetry. <i>Can. J. Zool.</i> (1998).</p> <p>Mate, B., Mesecar, R. &amp; Lagerquist, B. The evolution of satellite-monitored radio tags for large whales: One laboratory's experience. <i>Deep Sea Res. Part 2 Top. Stud. Oceanogr.</i> 54, 224–247 (2007).</p> <p>Tagged in Hawaii. Years: 1994–2000</p>
Humpback whales	Eastern North Pacific - Southeast Alaska	46	Daniel Palacios (Oregon State University)	<p>Mate, B., Mesecar, R. &amp; Lagerquist, B. The evolution of satellite-monitored radio tags for large whales: One laboratory's experience. <i>Deep Sea Res. Part 2 Top. Stud. Oceanogr.</i> 54, 224–247 (2007).</p> <p>Palacios, D.M., B.R. Mate, C.S. Baker, C.E. Hayslip, T.M. Follett, D. Steel, B.A. Lagerquist, L.M. Irvine, and M.H. Winsor. Tracking North Pacific Humpback Whales To Unravel Their Basin-Wide Movements. Final Technical Report. Prepared for Pacific Life Foundation. Marine Mammal Institute, Oregon State University. Newport, Oregon, USA. 30 June 2019. 58 pp. doi:10.5399/osu/1117. (2019). <a href="https://ir.library.oregonstate.edu/concern/technical_reports/z890s0924">https://ir.library.oregonstate.edu/concern/technical_reports/z890s0924</a></p> <p>Oregon State University, unpublished. Tagged in SE Alaska. Years: 1997, 2014, 2015</p>
Humpback whales	Eastern North Pacific - Mexico	17	Daniel Palacios (Oregon State University)	<p>Lagerquist, B. A., Mate, B. R., Ortega-Ortiz, J. G., Winsor, M. &amp; Urbán-Ramirez, J. Migratory movements and surfacing rates of humpback whales (<i>Megaptera novaeangliae</i>) satellite tagged at Socorro Island, Mexico. <i>Mar. Mamm. Sci.</i> 24, 815–830 (2008).</p> <p>Tagging done in Baja California, Mexico (1998; unpublished) and in the Revillagigedo Islands, Mexico (2003; Lagerquist et al. 2008).</p> <p>Oregon State University, unpublished.</p>
Humpback whales	Southern Ocean	378	Ryan Reisinger (University of Southampton) and collaborators	Reisinger RR, Friedlaender AS, Zerbini AN, Palacios DM, Andrews-Goff V, Dalla Rosa L, Double M, Findlay K, Garrigue C, How J, Jenner C, Jenner M-N, Mate B, Rosenbaum HC, Seakamela SM, and Constantine R. Combining regional habitat selection models for large-scale prediction: circumpolar habitat selection of Southern Ocean humpback whales. <i>Remote Sensing</i> (2021).
Southern right whales	South Africa	21.00	Daniel Palacios (Oregon State University), Els Vermuelen (University of Pretoria)	Mate, B. R., Best, P. B., Lagerquist, B. A. & Winsor, M. H. Coastal, offshore, and migratory movements of South African right whales revealed by satellite telemetry. <i>Mar. Mamm. Sci.</i> 27, 455–476 (2011).



# APPENDIX 2

## MARINE AND ENVIRONMENTAL DATA

DATA LAYERS DISPLAYED IN MAPS AND INFOGRAPHICS	SOURCE
<b>Marine Protected Areas</b>	<p>UNEP-WCMC and IUCN. Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM) [Online], December 2022, Cambridge, UK: UNEP-WCMC and IUCN (2022). Available at <a href="http://www.protectedplanet.net">www.protectedplanet.net</a>.</p> <p>For CCAMLR MPA data layers, special thanks to Cassandra Brooks, University of Colorado, Boulder (USA)</p>
<b>IUCN Important Marine Mammal Areas (IMMAs)</b>	<p>IUCN Marine Mammal Protected Areas Task Force. Global Dataset of Important Marine Mammal Areas (IUCN-IMMA). December 2022. Made available under agreement on terms of use by the IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force (2022).</p> <p>Available at <a href="http://www.marinemammalhabitat.org/imma-atlas">www.marinemammalhabitat.org/imma-atlas</a></p>
<b>Key Biodiversity Areas (KBAs)</b>	<p>BirdLife International. World Database of Key Biodiversity Areas. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. September 2021 version (2021).</p> <p>Available at <a href="http://keybiodiversityareas.org/kba-data/request">http://keybiodiversityareas.org/kba-data/request</a></p>
<b>Other Effective Area-based Conservation Measures (OECMs)</b>	<p>UNEP-WCMC and IUCN. Protected Planet: The World Database on Other Effective Area-based Conservation Measures (WD-OECM) [Online], November 2021, Cambridge, UK: UNEP-WCMC and IUCN (2021).</p> <p>Available at <a href="http://www.protectedplanet.net">www.protectedplanet.net</a></p>
<b>Country Borders, Land and Sea Areas</b>	<p>Available at <a href="https://www.naturalearthdata.com/">https://www.naturalearthdata.com/</a></p>
<b>Country EEZs</b>	<p>Flanders Marine Institute. Maritime Boundaries Geodatabase: Maritime Boundaries and Exclusive Economic Zones (200NM), version 11 (2019).</p> <p>Downloaded from <a href="https://www.marineregions.org/">https://www.marineregions.org/</a>. Last accessed 10 February 2021. <a href="https://doi.org/10.14284/386">https://doi.org/10.14284/386</a>.</p>
<b>Climate Change Data</b>	<p>GISTEMP Team: GISS Surface Temperature Analysis (GISTEMP), version 4. NASA Goddard Institute for Space Studies (2021). Dataset accessed 2021-03-22 at <a href="http://data.giss.nasa.gov/gistemp/">data.giss.nasa.gov/gistemp/</a>.</p> <p>Lenssen, N., G. Schmidt, J. Hansen, M. Menne, A. Persin, R. Ruedy, and D. Zyss. Improvements in the GISTEMP uncertainty model. <i>J. Geophys. Res. Atmos.</i>, 124, no. 12, 6307-6326, doi:10.1029/2018JD029522 (2019).</p>
<b>Global Fishing Effort</b>	<p>Global Fishing Watch. Fishing effort, Version 2. Global Fishing Watch. (2021). Downloaded (19 March 2021) from <a href="https://globalfishingwatch.org/data-download/datasets/public-fishing-effort">https://globalfishingwatch.org/data-download/datasets/public-fishing-effort</a>.</p>
<b>Global Ship Traffic Data</b>	<p>ExactEarth Vessel Traffic Density Layers, (2015). <a href="https://www.exactearth.com/product-exactais-density-maps">https://www.exactearth.com/product-exactais-density-maps</a></p>
<b>Species Probability of Occurrence</b>	<p>Kaschner, K., K. Kesner-Reyes, C. Garilao, J. Segschneider, J. Rius-Barile, T. Rees, and R. Froese. AquaMaps: Predicted range maps for aquatic species. World Wide Web electronic publication, <a href="http://www.aquamaps.org">www.aquamaps.org</a>, version 10/2019 (final) (2019). Last accessed 22 December 2022.</p>

All data was visualised using R and QGIS 3.

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