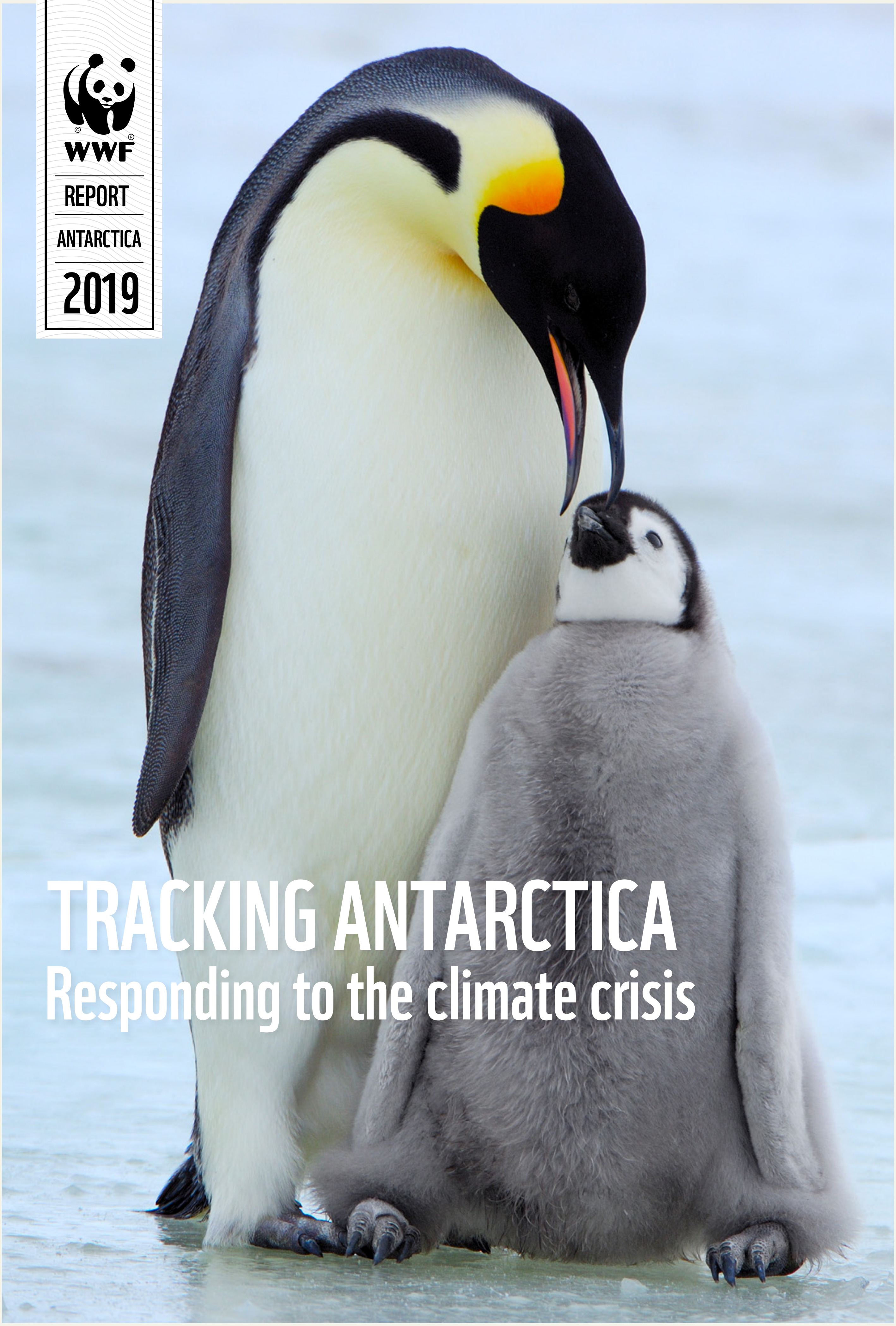
WWF

REPORT

ANTARCTICA

2019



TRACKING ANTARCTICA

Responding to the climate crisis

Credits

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WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global Network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

The WWF Antarctic Programme works to safeguard a thriving wild Antarctica with a diversity of life for future generations. Collaborating with individuals, NGOs, governments, industry and science bodies, we monitor and report on the state of species, ecosystems and human impacts to co-design and communicate urgent solutions that achieve impact.

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A recent United Nations report urges action to protect Antarctic marine habitat and safeguard humanity from catastrophic climate impacts.[1]

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are melting ice sheets and accelerating global sea level rise.

SEA ICE LOSS
threatens survival of krill, penguins and whales.

FRAGILE ECOSYSTEMS
need space to recover and build resilience.

MARINE PROTECTED AREAS
must be delivered urgently as a nature-based climate response.

POLICYMAKERS MUST ACT NOW
to preserve biodiversity and ensure sustainable fisheries.

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1. INTRODUCTION WE ARE FACING A GLOBAL CLIMATE AND BIODIVERSITY CRISIS[1,2]

According to the recent Special Report on the Ocean and Cryosphere in a Changing Climate from the United Nations Intergovernmental Panel on Climate Change (IPCC SROCC), climate change is transforming the Antarctic in lasting and fundamental ways.[1]

CHANGES IN THE ANTARCTIC ARE AFFECTING PEOPLE AT HOME

Earth is losing its cryosphere—the planet's snow and ice-covered places—and the polar regions are ground zero for the climate crisis. Accelerating changes in the oceans and cryosphere are some of the most dramatic consequences of human-induced climate change. While the world discusses how to limit global mean temperature increase to 1.5 degrees Celsius (°C), parts of Antarctica have already experienced a 2°C rise in temperature.

Antarctic ice shelves have shrunk in size by almost one quarter since the 1950s[3] and the continent has lost an astounding 3 trillion tonnes of ice since 1992,[4] similar to the weight of water needed to fill 1.2 billion Olympic swimming pools. The Antarctic Peninsula in particular is a hotspot of environmental change, with almost 90% of the western peninsula's 674 glaciers receding since the 1940s.[5] Ocean temperatures here have risen by more than 2.7°C since the 1970s—about five times the global rate of warming.[6]

Ice loss in Antarctica is having a profound impact on communities and coastlines around the globe. Projected losses from the Antarctic ice sheet are expected to contribute to raising global sea level beyond one meter by 2100.[1]

By 2050, more than a billion people living in low-lying coastal areas will be at risk of coastal flooding and extreme sea level events associated with tropical cyclones. The loss of ecosystems that support food security, jobs and cultures will be further exacerbated as climate change unfolds.

Remote and unpopulated, Antarctica plays a pivotal role in climate regulation[1] and supports globally significant commercial fisheries.[8]

IMPACTS ARE SIGNIFICANT FOR NATURE AND FISHERIES IN THE ANTARCTIC

Antarctic marine ecosystems are also undergoing rapid, unprecedented transformation. Projected warming, ocean acidification, reduced seasonal sea ice extent and continued loss of sea ice directly and indirectly affect wildlife habitats, populations, ecosystem resilience and commercial fisheries.

In the Southern Ocean, the sea ice habitat of Antarctic krill—a key prey species for penguins, seals and whales—is shrinking, with krill distribution moving southward as the ocean warms.[9] The shift in krill distribution will lead to greater competition between fisheries and wildlife reliant on krill, altering food web dynamics and potentially putting entire ecosystems at risk of collapse. Maximum potential catches in Antarctic krill fisheries could be expected to decline due to climate effects, as has been observed elsewhere in temperate and tropical fisheries.[1] Rising temperatures may also jeopardise populations of Antarctic toothfish, a commercially-valuable species that is specially adapted to cold waters.[8]

PROTECTING NATURE IS PART OF THE SOLUTION

Governments around the world are making commitments to fight climate change and WWF is working globally to increase the ambition and speed of implementation of these pledges. The IPCC SROCC emphasizes that there is a pressing need to adopt strong conservation measures in the polar regions to allow nature to adapt to the effects of the climate crisis.[8]

Well-managed networks of marine protected areas (MPAs) are powerful tools that allow wildlife and habitats to recover and build resilience to future disturbances.[10,11]

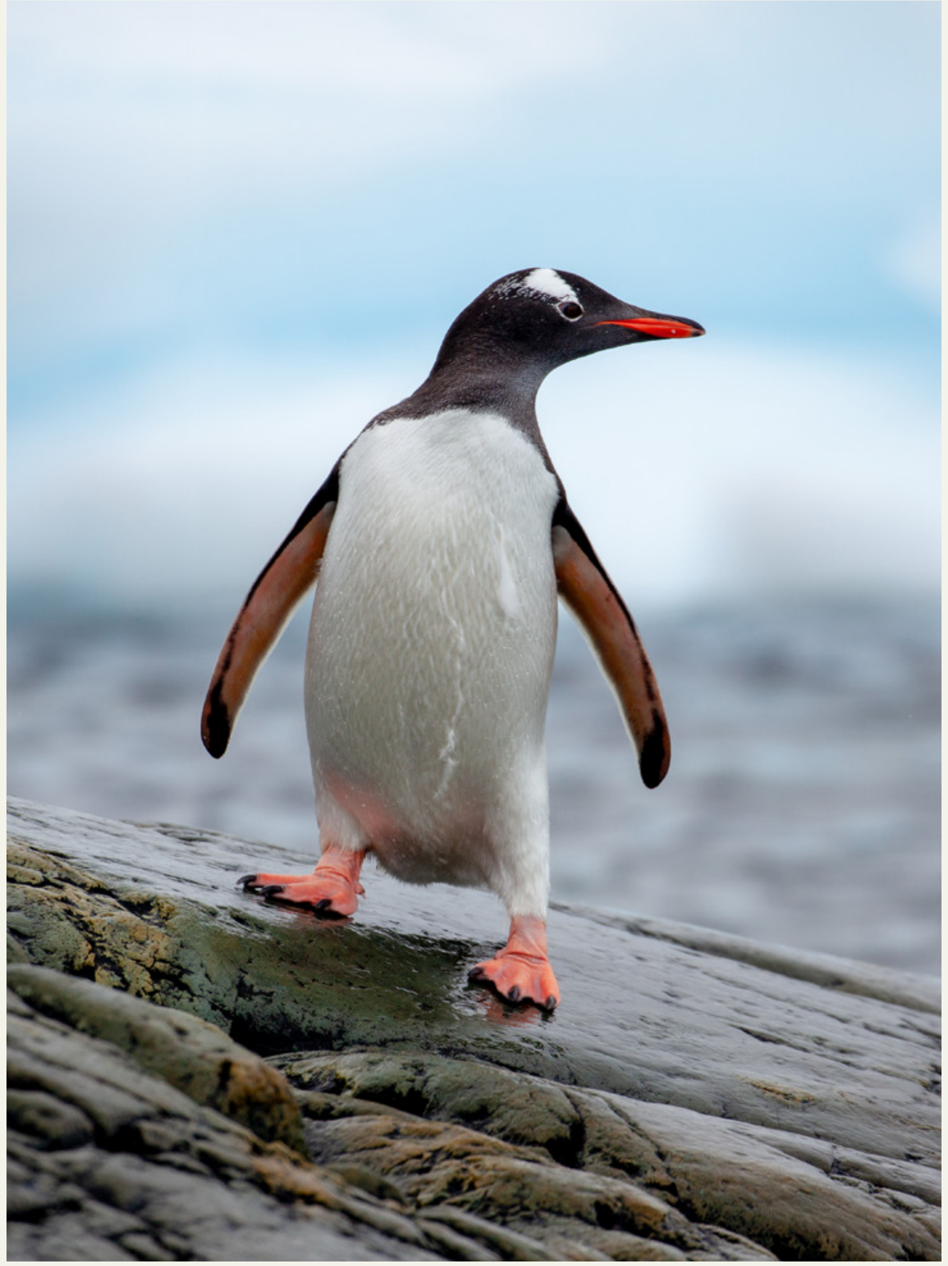
In a rapidly-melting Antarctica, creating an MPA network is vital to protect biodiversity and increase the resilience of Southern Ocean ecosystems to current and future environmental change.

South of the Antarctic convergence zone, the responsibility to sustainably manage the marine ecosystem falls to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Recognising the need for an innovative, ecosystem-based management approach, CCAMLR committed to adopt a network of MPAs in the Southern Ocean in 2002.[12] To protect the Antarctic and respond to the climate crisis, WWF urgently calls for CCAMLR to establish a comprehensive, effective network of MPAs surrounding the continent—including no-take marine sanctuaries.

The IPCC SROCC makes it clear that we are at a critical crossroads. Now is the time for bold and immediate action to address the climate crisis on all fronts—and CCAMLR must seize the opportunity to set an example to other governing bodies and act on the IPCC's recommendations.

GLOBALLY, WWF RECOMMENDS PROTECTING 30% OF THE WORLD'S OCEANS BY 2030.

By removing or limiting direct human stressors from these areas, we can provide space for nature to adapt to current and projected changes in environmental conditions, safeguarding Earth's biodiversity for future generations.



A gentoo penguin (*Pygoscelis papua*)

2. THE CLIMATE CRISIS AND ANTARCTICA'S MARINE ENVIRONMENT

RISING TEMPERATURES ARE PLACING ANTARCTIC HABITATS AND ECOSYSTEMS AT RISK OF COLLAPSE

The Southern Ocean region spans nearly 10% of the Earth's ocean and plays a critical role in maintaining a stable global climate by absorbing heat and carbon from the atmosphere.

Over the last 15 years, Antarctic waters have soaked up more than 60% of human-added heat from greenhouse gas emissions.[1] Now, the latest IPCC report warns that the rapid melting underway in Antarctica will have far-reaching impacts on biodiversity, commercial fisheries and global climate regulation.

Sea ice is a vital component of Antarctic marine ecosystems, but it is rapidly disappearing as the planet warms.

New research shows that human-caused warming is destroying sea ice habitat in the Antarctic, threatening the survival of many iconic polar species.[13,14] The duration of sea ice cover has decreased by 85 days (+/- 19) in the Western Antarctic Peninsula,[15] resulting in resulting in population declines for sea ice-dependent Adélie (*Pygoscelis adeliae*)[6] and chinstrap penguins (*Pygoscelis antarcticus*).[42] Similarly, emperor penguins (*Aptenodytes forsteri*) in the Weddell Sea have experienced multi-year breeding failures due to melting sea ice.[16] Climate models of diminishing sea ice predict that emperor penguins are facing staggering population decreases—between 40% and 99%—by the end of the century.[17]

A recent study notes that the emperor penguins' high degree of climate vulnerability could prompt a change in their conservation status[18] from Near Threatened to Vulnerable, or even Endangered.[17]

High densities of Antarctic minke whales (*Balaenoptera bonaerensis*) occur near the edges of seasonal sea ice (Figure 1), where they are more protected from open-water predators, such as Type A killer whales (*Orcinus orca*).[19] Recent studies found that Antarctic minke populations may also be declining as a result of reduced seasonal sea ice.[20]

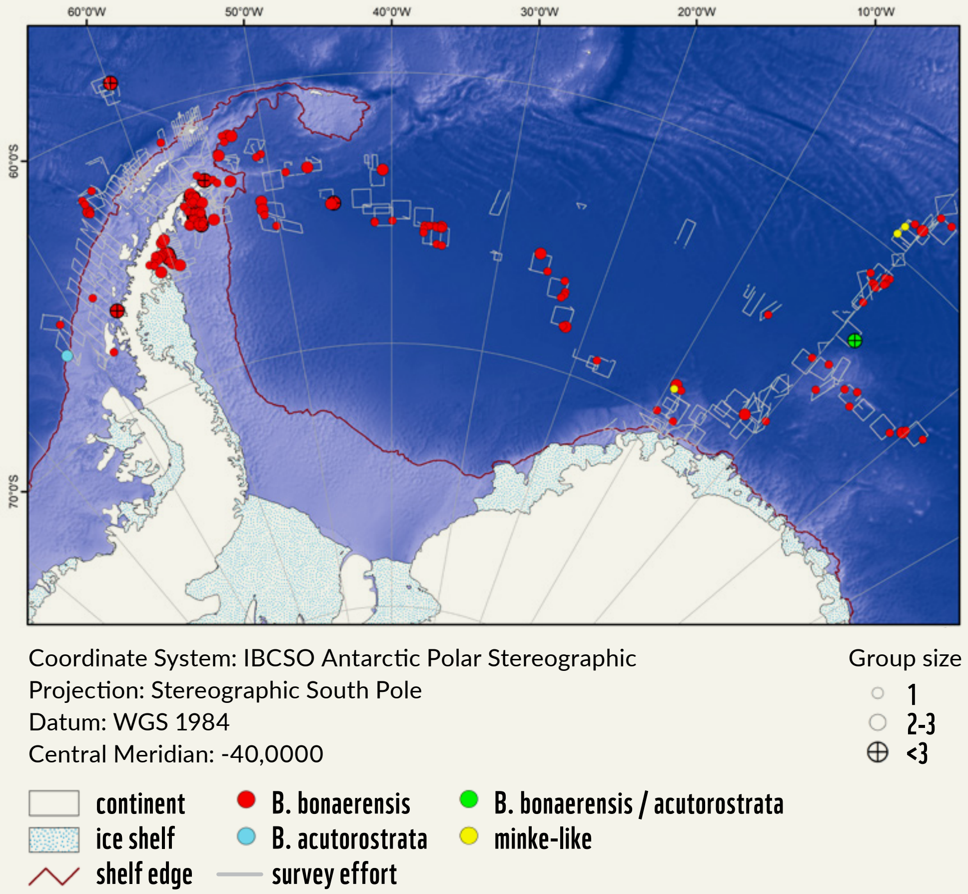


Figure 1: Aerial surveys for Antarctic minke whales (*Balaenoptera bonaerensis*) in the the Weddell Sea and Antarctic Peninsula reveal sea ice-dependent distribution patterns.[20]

In the past 4 years, the Antarctic lost more sea ice than the Arctic did in 34 years.[14]

Melting sea ice also poses a grave threat to Antarctic krill (*Euphausia superba*). These tiny crustaceans are a key species of the Antarctic food chain[21] and support marine nutrient cycling and carbon sequestration.[22] The krill lifecycle is closely linked to seasonal sea ice habitat, where they feed on phytoplankton growing beneath the ice.

Compilation of long-term data supported by WWF has revealed that krill populations are contracting southward by as much as 440 km (4 degrees latitude) as their suitable habitat recedes due to climate change (Figure 2).[9]

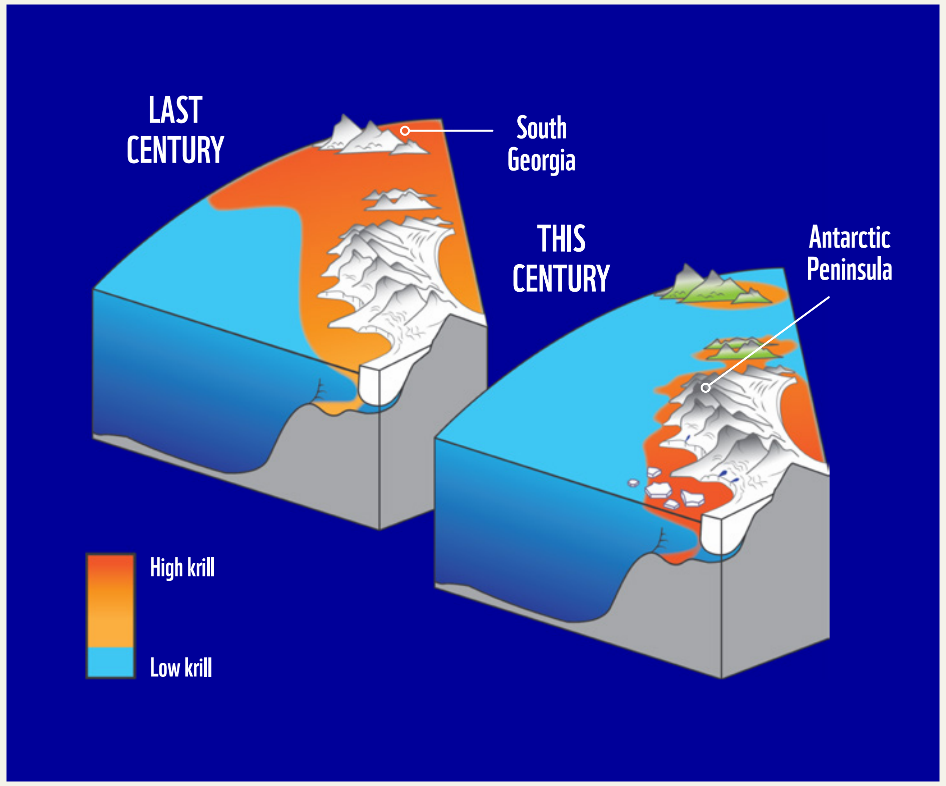


Figure 2: Potential effects of observed and future krill population contraction towards shallower and more southern waters.[9]

Long-distance migrants, such as humpback whales (*Megaptera novaeangliae*), occur disproportionately in higher latitudes where the speed and magnitude of climate change are the greatest, and are thought to be particularly vulnerable to the detrimental impacts through changes in habitat and prey availability and mismatches in timing.[43]

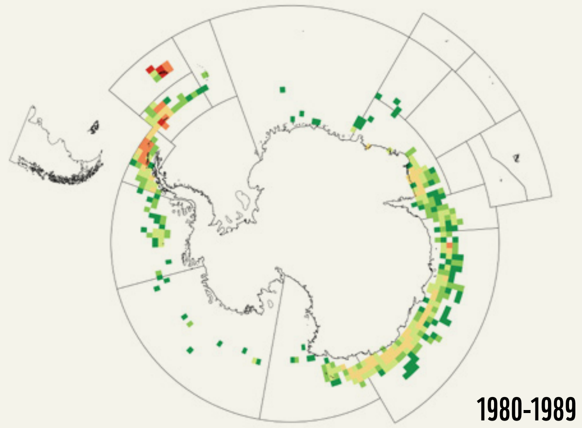
Humpback whales may consume between 1 and 1.5 tonnes of krill a day during the foraging season.[44]

SHIFT IN SPECIES DISTRIBUTIONS WILL IMPACT CCAMLR-MANAGED COMMERCIAL FISHERIES

Rapid regional warming is underway in the Scotia Sea and Antarctic Peninsula, where the vast majority of krill fishing effort is concentrated.

Each year, international commercial fisheries in this region harvest around a quarter of a million tonnes of krill for use in health supplements, pet food and fishmeal for aquaculture.[23] CCAMLR monitors these fisheries and sets catch limits, which are considered conservative relative to population estimates. Fishing effort and catch yields are distributed primarily throughout Statistical Area 48 (Figure 3), which is further divided into subareas.

Small scale management units (SSMUs) have been established by CCAMLR for the future management of catch limits and fishing activities, based on the distribution of krill, krill predator foraging range and the fishery.[19] To date, however, there has been no agreement on the allocation of catch limits at this scale.[24]



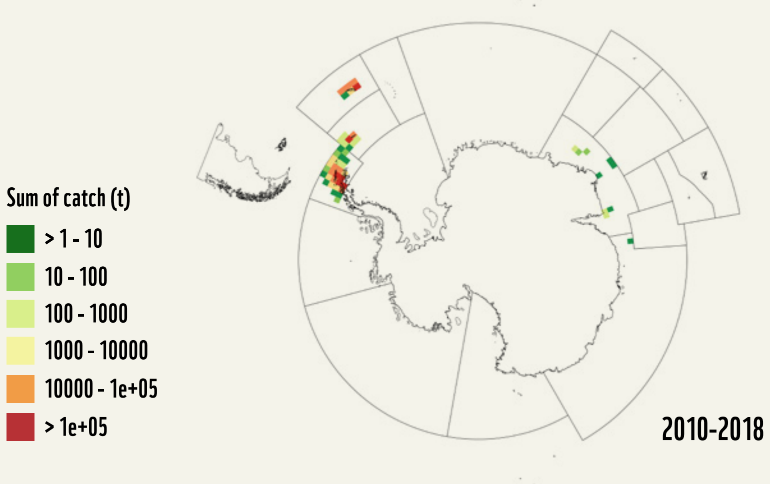


Figure 3: Krill fishing has focused on the Antarctic Peninsula and Scotia Arc in recent years, as shown by the spatial distribution of krill catch in the 1980s (top) and 2010 to 2018 (bottom).[23]

Southward shifts in krill distribution are expected to result in increased spatial and temporal overlap between commercial fisheries and krill-feeding baleen whales, penguins and seals.

These overlaps may increase the likelihood of mortality from prey competition, entanglement and vessel strikes.[25]

For whale species feeding almost exclusively on krill—such as Antarctic blue (*Balaenoptera musculus intermedia*), humpback (*Megaptera novaengliae*) and Antarctic minke whales—these southward shifts in krill distribution are likely to impose high energetic costs on migrating whales, with effects on body condition, reproductive fitness and population abundance.[26] WWF collaborators are developing biochemical tools to more accurately track whale population growth (see case study, p.35) in an effort to detect potential declines as the ocean warms.

Ocean temperatures along the Antarctic Peninsula and the Scotia Sea have risen by more than 2.7°C since the 1970s—about five times the global rate of warming.[6]

Without immediate global action to reduce emissions and halt the destruction of sea ice habitat, further krill declines and range contraction are expected as the planet warms, as well as changes in the timing of krill reproduction.[1]

We are currently on a path to a global average temperature increase of 2.9-3.4°C by 2100.[46] Scientists have been forced to invent new categories of climate risk to account for “catastrophic” and “existential” effects of a potential 5°C rise in temperature— which have a one in twenty chance of occurring if we continue on our current emissions trajectory.[27,28]

The 2015 Paris Agreement emphasises the need to keep global average temperature rise below 2°C relative to pre-industrial times. Similarly, the IPCC SROCC reveals the benefits of ambitious mitigation and effective adaptation for sustainable development and, conversely, the escalating costs and risks of delayed action to address the climate crisis.

In 2018, commercial fisheries managed by CCAMLR caught 312,989 tonnes of krill in the Southern Ocean—the largest catch recorded since 1991.[23] *The vast majority was harvested in the Scotia Sea and Antarctic Peninsula, overlapping with critical habitat for whales, penguins and seals.*

The vessel *Antarctic Sea* fishing for krill along the Antarctic Peninsula.

Currently, CCAMLR does not include information on climate change or fine-scale krill distribution in its assessment of risks to manage krill fisheries.

3. MARINE PROTECTED AREAS – A NATURE-BASED CLIMATE RESPONSE

MARINE PROTECTED AREAS ARE A POWERFUL TOOL FOR REDUCING HABITAT LOSS, PRESERVING BIODIVERSITY AND INCREASING NATURE'S RESILIENCE TO MULTIPLE STRESSORS, INCLUDING CLIMATE CHANGE.

The ocean covers over 70% of the planet's surface and plays a critical role in sustaining all life on Earth.

Over a billion people rely on marine species and ecosystems for food, livelihoods and resources.[29] MPAs are a type of management tool used to conserve habitats and biodiversity within a designated zone by regulating or banning human activities, such as commercial fishing. These reserves provide areas of reduced stress, allowing organisms to recover and build resilience to future disruptive events.[10,11] However, the effects of climate change, including rising temperatures and ocean acidification, place further pressure on marine ecosystems and may limit their ability to adapt to changing environmental conditions.

MPAs offer a nature-based solution to support global efforts towards climate change adaptation and mitigation.[30] Recognising this, global policymakers have pledged to protect 10% of the world's marine and coastal areas by 2020 as part of the UN Sustainable Development Goals (SDGs) framework. The International Union for the Conservation of Nature (IUCN) goes further, recommending that 30% of the ocean be protected from extractive activities.[31] WWF recommends protecting 30% of all oceans including the Southern Ocean by 2030.

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Crabeater seals (*Lobodon carcinophaga*) primarily feed on krill.

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A humpback whale dives to feed on krill. Individual humpback whales can be identified by marks and patterns of their tails, or flukes. Key foraging areas along the Western Antarctic Peninsula overlap with krill fisheries.

Currently, only 8% of the ocean is protected, and no-take reserves—where fishing or extractive activities are not allowed—constitute less than 2% of the world's oceans.[30]

A WELL-INTEGRATED MPA NETWORK PLAYS A CRUCIAL ROLE IN BUILDING RESILIENCE FOR BOTH HABITATS AND SPECIES IN THE FACE OF ENVIRONMENTAL CHANGE.[10,30,32]

In the Antarctic, climate change is already transforming the structure and function of marine ecosystems. Geographic shifts in distribution due to warming have been detected for krill,[9] Antarctic minke whales[20] and emperor penguins.[16] Catch yields in commercial fisheries are projected to decline as a result of climate-driven habitat shifts.[1] Such changes are likely to result in spatial and temporal mismatches in prey availability, with consequences for individuals' reproductive fitness and species abundance.

The IPCC SROCC warns that fisheries management strategies will not be able to address the causes or symptoms of ecosystem change. Thus, MPA networks are needed to help maintain vital ecosystem services, enable future adaptation and protect vulnerable biodiversity.[1] To maximise the benefits provided by MPAs, large, spatially-connected MPA networks are needed to protect a representative portion of diverse habitats and to ensure adequate space for migratory species and larval dispersal.[33]

A SOUTHERN OCEAN NETWORK OF MPAS IS CRITICAL FOR BIODIVERSITY CONSERVATION AND CLIMATE ADAPTATION.

In 2002, CCAMLR committed to implement a representative network of MPAs in the Southern Ocean by 2012.[12]

The South Orkney Islands Southern Shelf MPA was adopted in 2009, setting a precedent for the use of spatial closures as part of a precautionary management approach. Further advancing this process, a framework for establishing a network of MPAs in the CAMLR Convention Area—Conservation Measure 91-04—was adopted in 2011 (Box 1).[34] The decision exemplifies CCAMLR's mandate for applying ecosystem-based management in the context of protecting biodiversity and restoring depleted populations, as stipulated in the CAMLR Convention (see IX.2(g), CAMLR Convention).

CCAMLR'S FRAMEWORK FOR MPAS (CM91-04) (2011)

- Be established based on the best available scientific evidence;
- Contribute to protecting key ecosystem processes, habitats and biodiversity;
- Include scientific reference areas to monitor the long-term effects of fishing and climate change;
- Protect vulnerable areas, including unique, rare or highly biodiverse areas;
- Protect areas to maintain resilience to the effects of climate change.

Box 1.

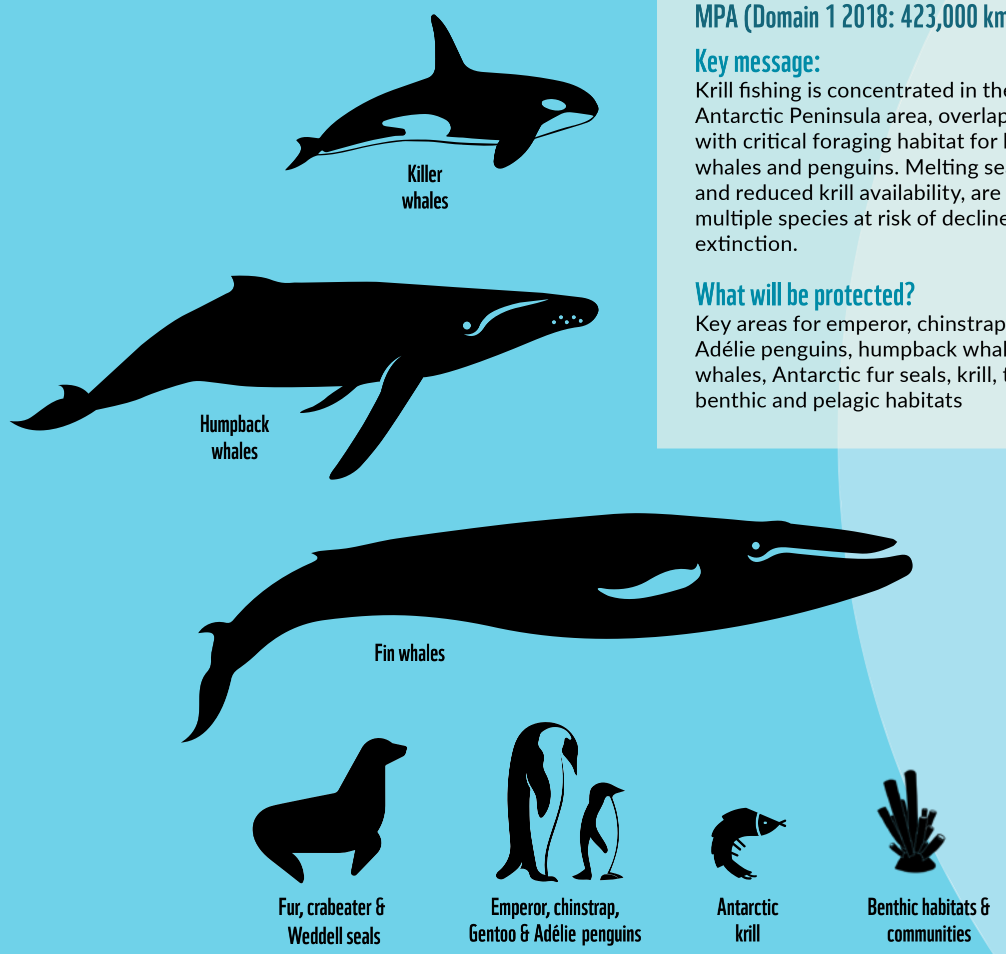
Humpback whales using a technique to feed on krill called 'bubblenet feeding'.

CCAMLR's commitment to an MPA network will significantly advance global ocean protection and climate change mitigation frameworks, including SDG14 and the Paris Agreement.

A Southern Ocean network of MPAs will protect an array of important benthic and pelagic habitats, as well as wildlife populations spanning multiple taxonomic groups and trophic levels. Including scientific reference areas within MPA boundaries will enable scientists to monitor marine ecosystems and study the effects of climate change. This provides policymakers with the scientific data necessary to implement dynamic management strategies in response to changing environmental conditions.

MARINE PROTECTED AREAS
A NATURE-BASED CLIMATE RESPONSE

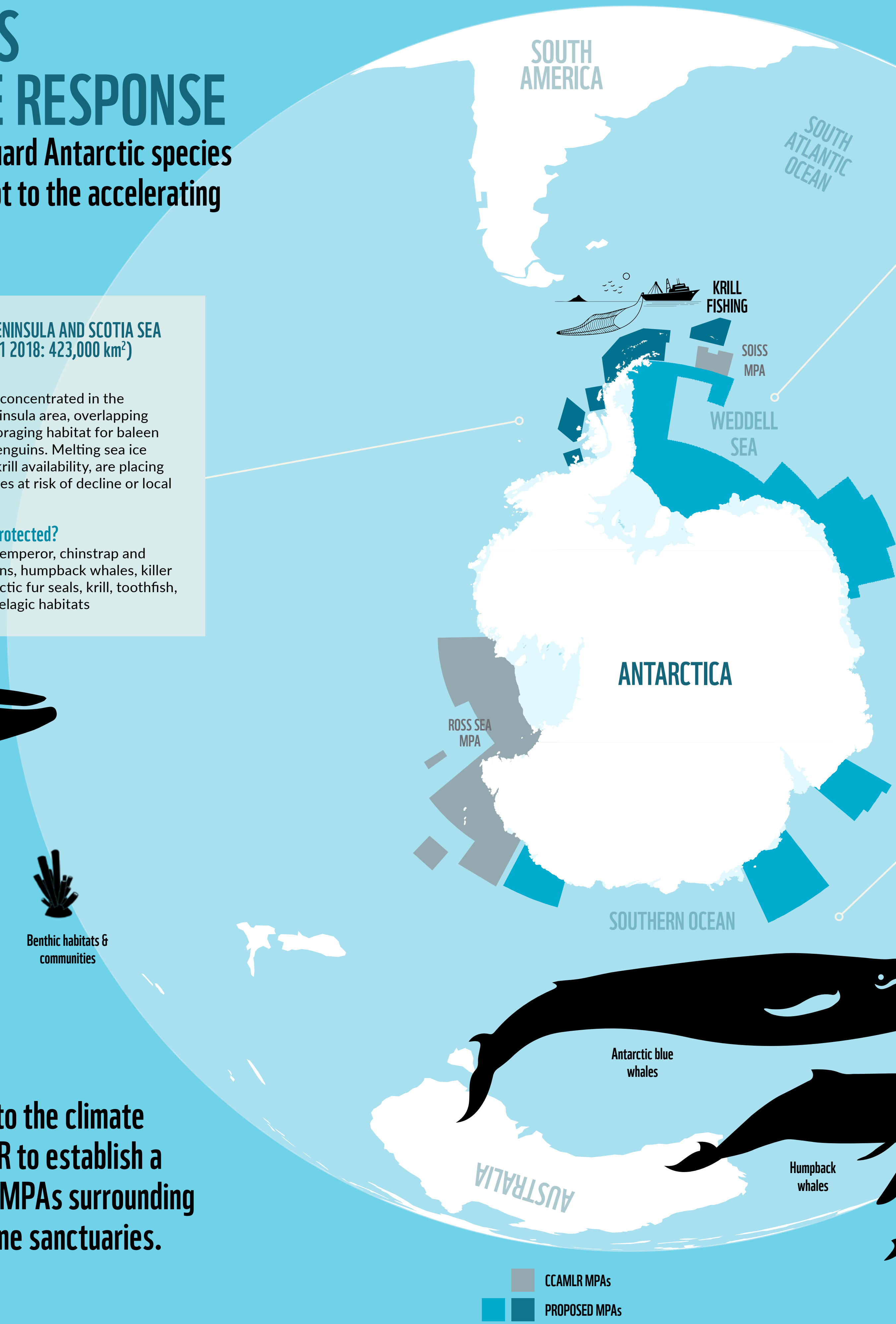
The proposed innovative MPA network will safeguard Antarctic species and habitats by providing space for nature to adapt to the accelerating effects of climate change.



ANTARCTIC PENINSULA AND SCOTIA SEA MPA (Domain 1 2018: 423,000 km^2)

Key message:
Krill fishing is concentrated in the Antarctic Peninsula area, overlapping with critical foraging habitat for baleen whales and penguins. Melting sea ice and reduced krill availability, are placing multiple species at risk of decline or local extinction.

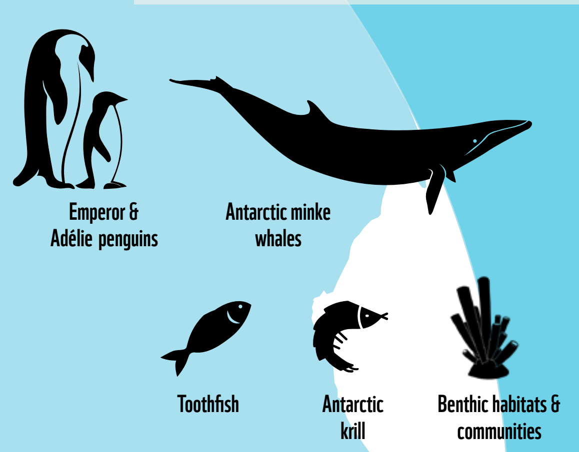
What will be protected?
Key areas for emperor, chinstrap and Adélie penguins, humpback whales, killer whales, Antarctic fur seals, krill, toothfish, benthic and pelagic habitats



WEDDELL SEA MPA (2018: 2 million km^2)

Key message:
The region contains near pristine benthic and pelagic habitats that are important for biodiversity and global ocean circulation.

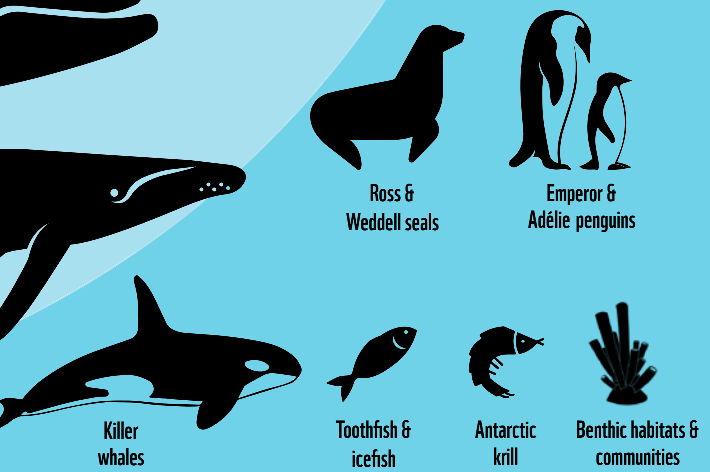
What will be protected?
Key areas for Antarctic krill, emperor and Adélie penguins, Antarctic silverfish, toothfish, Antarctic minke whales, Antarctic blue whales, ecologically-significant sponge communities, benthic and pelagic habitats.



EAST ANTARCTICA MPA (2019: 1 million km^2)

Key message:
Designated Vulnerable Marine Ecosystems (VMEs) are closed from fishing, but large areas are needed to protect foraging habitat for far-ranging species, such as humpback whales, penguins and seals

What will be protected?
Key areas for emperor and Adélie penguins, areas of high productivity, foraging fur and elephant seals, nursery areas for Antarctic silverfish, designated VMEs, benthic and pelagic habitats.



To protect the Antarctic and respond to the climate crisis, WWF urgently calls for CCAMLR to establish a comprehensive, effective network of MPAs surrounding the continent—including no-take marine sanctuaries.

4. COLLABORATIVE SCIENCE IN ACTION IS ADDRESSING THE CLIMATE CRISIS

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INNOVATION IN ANTARCTIC CONSERVATION SCIENCE

WWF's international collaborators are gathering critical data to support management of Antarctic wildlife and highly precautionary fisheries using innovative technology and approaches.

Governing bodies like CCAMLR rely on solid science to make informed policy decisions and achieve conservation impact.

WWF contributes directly to this process by supporting research on Antarctica's marine wildlife and their habitats, conducting workshops to exchange knowledge, co-designing solutions and helping to build capacity for the next generation of scientists.

Across WWF, we work with a range of research teams including the University of California Santa Cruz, British Antarctic Survey, Australian Antarctic Division, Centre National de la Recherche Scientifique, Plymouth Marine Laboratory, and tourism operators such as One Ocean Expeditions to help gain access to field sites while sharing the science in action with the public.

New technologies are allowing us to go above and beyond to study critical habitats for Antarctic wildlife. Unoccupied aircraft systems (UASs), also known as drones, are revolutionising marine science and conservation. These innovative tools are being deployed in almost every subdiscipline of marine science and conservation,[35] including studies of whales and penguins across Antarctica. Alongside drone technology, digital tags are providing information on distribution, movement patterns and behaviour of wildlife to better understand their seasonal habitat use and ecology.[19]

These projects allow us to understand how ecosystems are reacting to human-caused stressors, such as commercial fishing and climate change. Working with our collaborators, we bring this important knowledge to policymakers in order to support the adoption of an MPA network to protect 30% of the Southern Ocean by 2030.

Collaboration is the most effective way to work on a continent that is remote, wild and expensive to study. WWF helps fill gaps in crucial funds and works with partners to amplify key scientific findings.

CASE STUDY: DRONE IMAGERY PROVIDES INSIGHTS INTO WHALE HEALTH IN PROPOSED PROTECTED AREAS

WWF is collaborating with Duke University Marine Robotics and Remote Sensing Lab to quantify changes in the body condition of baleen whales. This technology will also be used to assess how penguins and seals are responding to a changing climate in the Western Antarctic Peninsula.

Drones carry onboard cameras that photograph and film the animals from above. Images are then processed using purpose-built machine learning algorithms, which generate accurate measurements of individuals.[36] These data enable scientists to evaluate body condition and infer animal health.[37,38] By measuring changes in the width of whales throughout the feeding season, we can estimate the rate of energy acquisition and determine the most critical periods for foraging. Integrating this information with high-resolution remote sensing data allows us to determine not only the time of year that is most critical to whales, but also the areas and habitats that whales use during these times of year. For baleen whales already facing prey declines and potential competition from commercial krill fisheries, information on population health and habitat use is vital for informing ecosystem assessment and relevant management plans.[39]

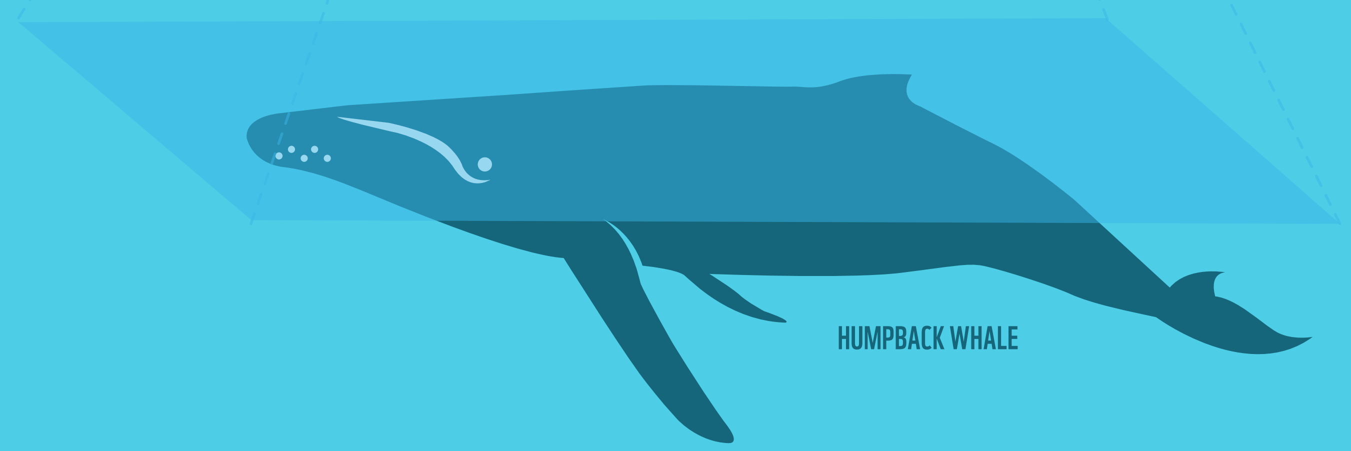
Studying whales from above allows us to observe how Antarctica's habitats are changing, sometimes in surprising ways. In March 2019, the research team captured the first drone imagery of dwarf minke whales (*Balaenoptera acutorostrata subspp*), a species rarely observed in the Antarctic. These new sightings raise several questions: Have dwarf minkes always migrated to Antarctica, but previously been misidentified as Antarctic minke whales? Or are they new migrants that have changed their distribution due to climate change? Future studies will seek to answer these questions and expand our knowledge of this elusive species.

Drone platforms enable an extraordinary array of research possibilities and offer a chance to transform our understanding of whale ecology in Antarctica.

The team from Duke University Robotics and Remote Sensing Lab deploy a custom built drone to study humpback and Antarctic minke whales.

STUDYING WHALES & PENGUINS FROM ABOVE

Unoccupied aircraft systems (UASs), also known as drones, are revolutionising marine science, conservation and management.[35]



Quadcopter (Whales)

- Drones carry onboard cameras that photograph and film the animals. Images are then processed using purpose-built machine learning algorithms, which generate accurate measurements of individuals.
- These data enable scientists to evaluate body condition and infer animal health.
- Combined with high-resolution remote sensing data, we can pinpoint when and how the whales use Antarctic habitats.
- Information on population health and habitat use is vital for informing conservation management plans, such as boundary-setting for MPAs.

Fixed-wing (Penguins)

- Fixed-wing drones offer an opportunity to increase the efficiency and accuracy of penguin population surveys. A drone can cover an entire island of breeding colonies in under half an hour.
- Purpose-built algorithms count penguins from drone imagery for more accurate population estimates.
- Better abundance data can help us detect declines sooner and implement timely conservation measures.

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A colony of gentoo penguins on the Antarctic Peninsula.

CASE STUDY: DRONES AND ALGORITHMS ARE USED TO COUNT PENGUINS FOR BETTER POPULATION MONITORING

WWF and Duke University are working together to demonstrate how UASs can provide efficient, accurate and safe methods to study populations in areas that are difficult to survey—and detect emerging changes in penguin colonies as part of MPA monitoring efforts.

Adélie penguins are an ecological indicator species for the Western Antarctic Peninsula. By monitoring this species, we can learn how their populations are responding to environmental change. Monitoring is currently done using ground-based population surveys, in which scientists walk across the rocky terrain of the breeding colonies, counting birds by hand.

Fixed-wing drones offer an opportunity to increase the efficiency and accuracy of penguin population surveys. A drone can cover an entire island of breeding colonies in under half an hour, which also minimises disturbance to the animals compared to ground-based methods. This alone reduces the cost and effort needed and opens the door for more frequent surveys. With some island populations having tens of thousands of penguins, however, it can take weeks to count them manually from drone imagery. By developing algorithms and using multispectral and thermal imagery to automatically count penguins, we further reduce the time it takes to conduct population surveys as well as the amount of human error. This is particularly important for ensuring a high level of accuracy and consistency in long-term datasets.

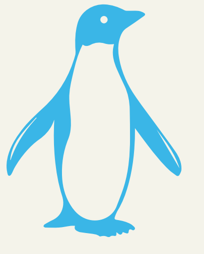
With climate change accelerating the loss of sea ice habitat crucial for Adélie penguins, these innovations in population monitoring are urgently needed. In addition to conducting more frequent surveys, improving data accuracy using drones and semi-automated algorithms can help expand our understanding of changes impacting this iconic Antarctic species.

CASE STUDY: NOVEL TECHNIQUES PINPOINT CRITICAL WINTER HABITAT TO PROTECT PENGUINS IN EAST ANTARCTICA

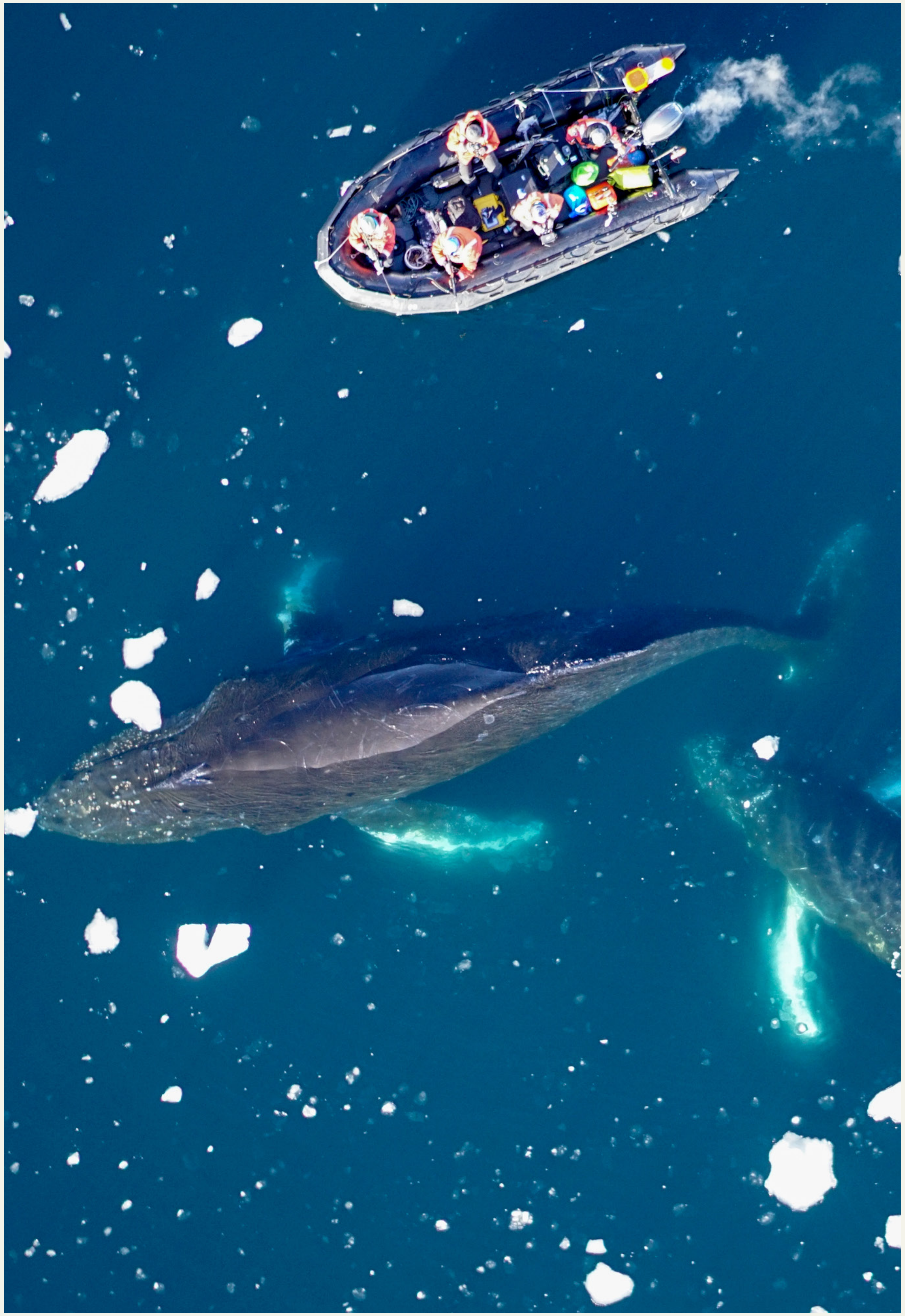
WWF is a long-time collaborator with the Centre National de la Recherche Scientifique (CNRS) in France. They are studying Adélie penguins in East Antarctica to identify biological hotspots in the Southern Ocean—areas which are important feeding grounds for the penguins—and to predict how these habitats might adapt to climate change.

The researchers use a combination of techniques to gain a clear picture of penguin activity and determine how habitat use differs between seasons. At breeding areas, individual birds are tagged with small devices called data loggers, which collect and store data until they are retrieved by the scientists. During the winter months, when penguins are at sea, the loggers track location and depth as the animals move between foraging areas. In the summer, fine-scale location information is collected using a different type of logger, while miniature camera tags identify the types and abundance of the penguins' preferred prey species. This information will help policymakers to better protect Adélie penguins by ensuring that proposed MPA designs encompass both summer and winter foraging habitats.

Adélie penguins face an uncertain future in a rapidly warming Antarctic. A large colony of 20,000 pairs in East Antarctica has recently experienced devastating breeding failures, with no chicks surviving the 2013-14 season and only two surviving in 2017.[40] Regular monitoring allows us to detect fluctuations in the penguin population and recommend an appropriate management response. Robust data on penguin abundance and habitat use are also crucial for evaluating the effectiveness of conservation measures—including MPAs—implemented by CCAMLR in an effort to mitigate the effects of climate change.



The loss of all Adélie penguin chicks during the 2013-14 season represents the largest single breeding failure for this species on the entire Antarctic continent,[40] according to a long-term monitoring programme supported by WWF.



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CASE STUDY: DEVELOPING A PREGNANCY TEST FOR WHALES WHOSE RANGE OVERLAPS WITH KRILL FISHERIES

WWF is partnering with the University of California Santa Cruz (USA) to explore how changing environmental conditions affect populations of humpback whales. This work contributes to WWF's long-term Antarctic conservation programme, *Protecting Antarctic Giants*.

Humpback whale populations in the southern hemisphere are recovering after intense commercial whaling during the last century. For those feeding in the rich waters of the Western Antarctic Peninsula, their environment is experiencing the fastest warming anywhere on the continent. This provides a unique opportunity for scientists to study the links between population recovery and rapid environmental change.

Over the last three years, the team has developed biochemical techniques to detect and monitor pregnancy in humpback whales in the Southern Ocean—a "whale pregnancy test". First, skin and blubber biopsy samples are taken from individual females using a dart, which is minimally invasive and does not require capturing or harming the whale.[41] Using a series of biochemical techniques, a pregnancy hormone called progesterone is isolated from the blubber. Once the concentration of progesterone in each sample has been determined, these quantities can be related to animals of known pregnancy status. To date, the team has assessed the pregnancy status of over 400 Antarctic humpback whales.

The new method has determined that the humpback population is increasing quickly, and a portion of the whales are breeding annually.[41] It also found that pregnant females remain in Western Antarctic Peninsula feeding areas into the winter period, overlapping with peak krill fishing season.[19] This potentially places the whales at increased risk of accidental mortality, entanglement and vessel strike. However, CCAMLR-managed krill fisheries currently operate without fine-scale information on whale movement, habitat use or behaviour.[23] It is essential that science-based management incorporates this information into MPA Conservation Measures to ensure the continued recovery of humpbacks in Antarctica.

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Univ. of California, Santa Cruz PhD student Logan Pallin processing a biopsy sample from a humpback whale.

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