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Polar opposites? Marine conservation tools and experiences in the changing Arctic and Antarctic

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ABSTRACT

1. The polar regions are undergoing vast changes in the land and seascape. They serve as major components of the Earth's climate system and are particularly vulnerable to climate change impacts. Warming temperatures, combined with increased human use and resource extraction, are putting increasing pressure on these vulnerable regions.

2. While the Arctic and Antarctic are distinct from one another in their governance and human use, the 2014 World Parks Congress provided a platform for joint learning on progress and options for protecting marine areas in these unique regions. Though they remain among the remotest places on earth, their important role for global biodiversity, climate processes and economic activity have made them a focus for conservation efforts.

3. Establishing a robust, integrated network of protected areas is one important tool for protecting ecosystem function and enhancing resilience as these regions face climate change impacts as well as increasing pressures for resource exploitation. This paper describes some major efforts to establish marine protected areas (MPAs) in the Arctic and Antarctic and analyses the similarities and differences in marine protection initiatives in the Earth's polar regions. As a basis for the analysis the authors focus on the following two themes: pressures – what are they and how fast are they growing; and governance – are there appropriate governance structures to establish and manage MPAs at appropriate geographic scales?

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INTRODUCTION

The Arctic and Antarctic are mirror images in many respects. The Arctic is an ocean surrounded by land, and the Antarctic is a continent surrounded by an ocean. The planet's polar regions also have some striking similarities. They are both remote places where ecosystems are comparatively undisturbed, but also little-studied. The regions are experiencing major climate-driven changes, hold vast natural resources, and are of increasing economic interest. In light of these

pressures, it is important that both poles be considered as priorities for marine conservation. This paper looks at both polar regions, focusing on the nature, extent and speed of the climate and environmental changes that are occurring, and the adequacy of the governance structures to initiate and implement approaches to marine conservation.

A CHANGING ARCTIC

In one generation, the Arctic has transformed from being an icon of an enduring and unchanging icy world to an icon of change. People looking at a picture of a polar bear now often see a symbol loaded with the freight of a rapidly changing climate (DiFrancesco and Young, 2011). The rate of that change is unprecedented in the climate record for at least the past few thousand years, with average Arctic temperatures increasing at about twice the global average (IPCC, 2013; Miller *et al.*, 2013). This warming has led to massive retreats in the extent and thickness of summer sea ice, and the disintegration of ice shelves that have persisted for millennia (Polyak *et al.*, 2010; Bronen and Chapin, 2013). Species are uniquely adapted to the region and highly sensitive to changes in its environmental conditions (Eamer *et al.*, 2013), and many changes in the distribution of marine species and decline in some species (e.g. ivory gulls, polar bears, beluga whales) have been documented (Spencer *et al.*, 2014), although trends are not available for many species due to insufficient data (Laidre *et al.*, 2015). These rapid environmental changes are just the beginning and are in turn affecting the livelihoods and cultures of Arctic peoples, making travel more hazardous, compromising food security, and eroding confidence in their ability to understand the natural environment (Cochran *et al.*, 2013).

While the ice in the Arctic is the superstructure on which many Arctic marine ecosystems are built (Eamer *et al.*, 2013), the conservation of Arctic ecosystems necessarily goes beyond the boundary of the Arctic Circle to encompass the wide distribution of species and migration patterns. The eight nations of the Arctic Council, as well as the Permanent Participants (international indigenous peoples' organizations represented at the Council) use a definition that more closely conforms to ecological boundaries (Figure 1). As of 2010, approximately 11% of the Arctic boundary delineated by the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) working group is protected (Figure 1(a), CAFF, 2010), however, the marine environment is highly underrepresented. With the increase in human activity and economic

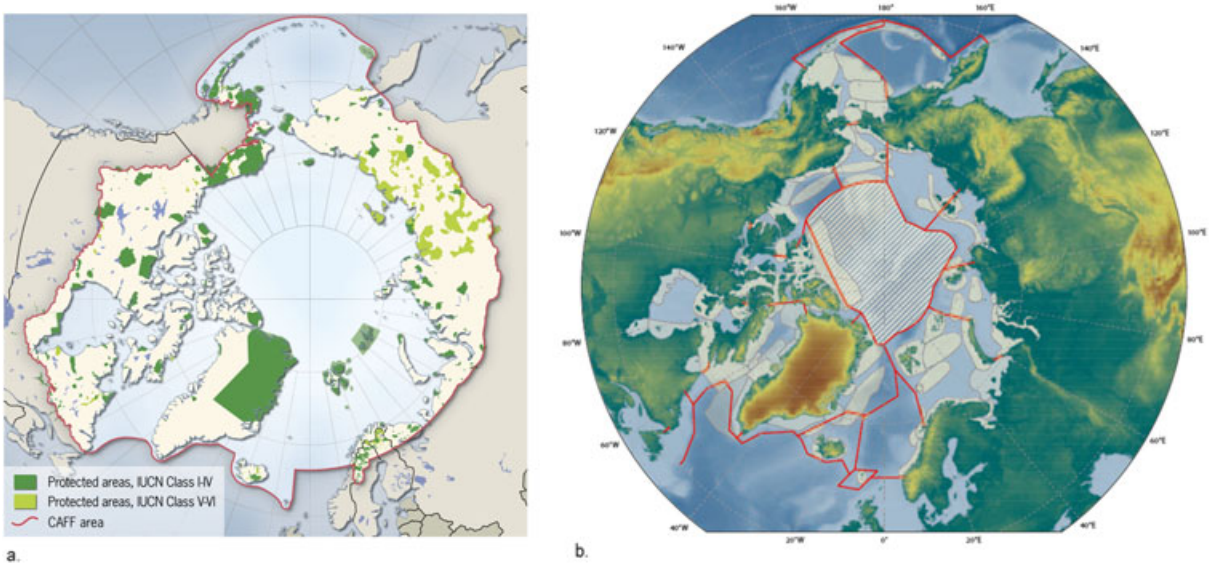

Figure 1. (a) Protected Areas in the Arctic classed after their IUCN category (CAFF, 2010), and (b) areas of heightened ecological significance and boundaries of Arctic Large Marine Ecosystems (AMAP/CAFF/SDWG, 2013).

opportunity in the Arctic, many efforts are being made nationally and internationally to protect the marine environment.

Economic drivers in the Arctic

With the loss of Arctic sea ice, coupled with increasing global resource demand, industries in the Arctic marine environment are growing. These include oil and gas, mining, fishing, cruise tourism, shipping, and scientific exploration. The various economic activities, if not well-managed, have the potential to cause damage to the natural environment and alter the social structure in this remote region.

The United States Geological Survey estimates that within the Arctic Circle, 90 billion barrels of oil, 1669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids may remain to be found, of which approximately 84% is expected to occur in offshore areas (Bird *et al.*, 2008). Despite findings that say such resources are best left unexploited if the worst effects of climate change are to be avoided (McGlade and Ekins, 2015), there are active offshore exploration programmes in the Russian and Norwegian sectors of the Arctic, and leases exist off the United States, Canada and Greenland.

Shipping is threaded through all the human use activities in the marine environment. Ice free shipping areas are becoming more prevalent, allowing for new shipping routes through the Northern Sea Route along Russia's coast and the Northwest Passage along Canadian and Alaskan waters. It is estimated that shipping through the Arctic could reduce east–west transit times between Asia, Europe and North America by up to 40% (Conley *et al.*, 2013). While shipping activity remains low, Russia predicts a 30-fold increase in shipping by 2020 (Allianz, 2014). The growth in shipping increases risk to the environment through pollution, marine accidents, invasive species, disruption to marine mammals, as well as to the coastal indigenous communities that continue to practise subsistence ways of life (Box 1). The region is poorly charted, with limited communications and infrastructure restricting capacity for emergency response.

Box 1. The Bering Strait: An Ecological, Cultural, and Economic Hotspot

The Bering Strait is a 53 mile wide international passage between the Unites States of America and Russia. The surrounding region is one of the most biologically productive and diverse areas in the Arctic, in addition to being culturally significant and home to the coastal indigenous communities that surround the area. Vessels transiting into and out of the Arctic necessarily transit through this choke point presenting a new set of risks as well as an opportunity for sound management. The risks include ship strikes to whales, groundings, noise disturbance to marine mammals, human footprint from tourism, and pollution. The indigenous communities are also being affected by the proximity of large commercial traffic in areas where they operate small hunting vessels as animals are displaced. In the US, local through federal efforts are being made to increase communications infrastructure, including automatic identification systems (AIS) coverage for vessels. Internationally, cooperation with stakeholders is necessary to provide vessels with the necessary information and tools to safely navigate the area, including traffic separation schemes, ship reporting systems, buffer zones, areas to be avoided, and ship speed regulations. The US Coast Guard has proposed ship routing measures extending from the Aleutian Islands throughout the Bering Strait, including four precautionary areas.

The increasing pressures in this region have sharpened the need for conservation management responses. The retreat of summer sea ice is one of the most important drivers of change in the Arctic. Therefore, conserving the ice-dependent ecosystems of the Arctic will be highly dependent on conservation of those areas where sea ice is projected to persist. Summer sea ice is projected to persist for decades in the area among and above Canada's Arctic archipelago and north-west Greenland (Mahlstein and Knutti, 2012), even under pessimistic scenarios from the 2013 Intergovernmental Panel on Climate Change Fifth Assessment Report (Figure 2). Protecting the 'last ice area' has been the focus of conservation groups such as the World Wildlife Fund, as this area will become increasingly important for ice-obligate and ice-associated wildlife, and to the cultures and livelihoods of those who depend on this life.

Conservation management for other features that promote resilience to the multiple emergent pressures in the Arctic will also be needed. This will be important not only for wildlife, but for future sustainable economies for Arctic peoples, such as fisheries and tourism. A multi-stakeholder approach will allow governments, industry, and local people to improve and better manage sensitive areas in the Arctic. These responses must

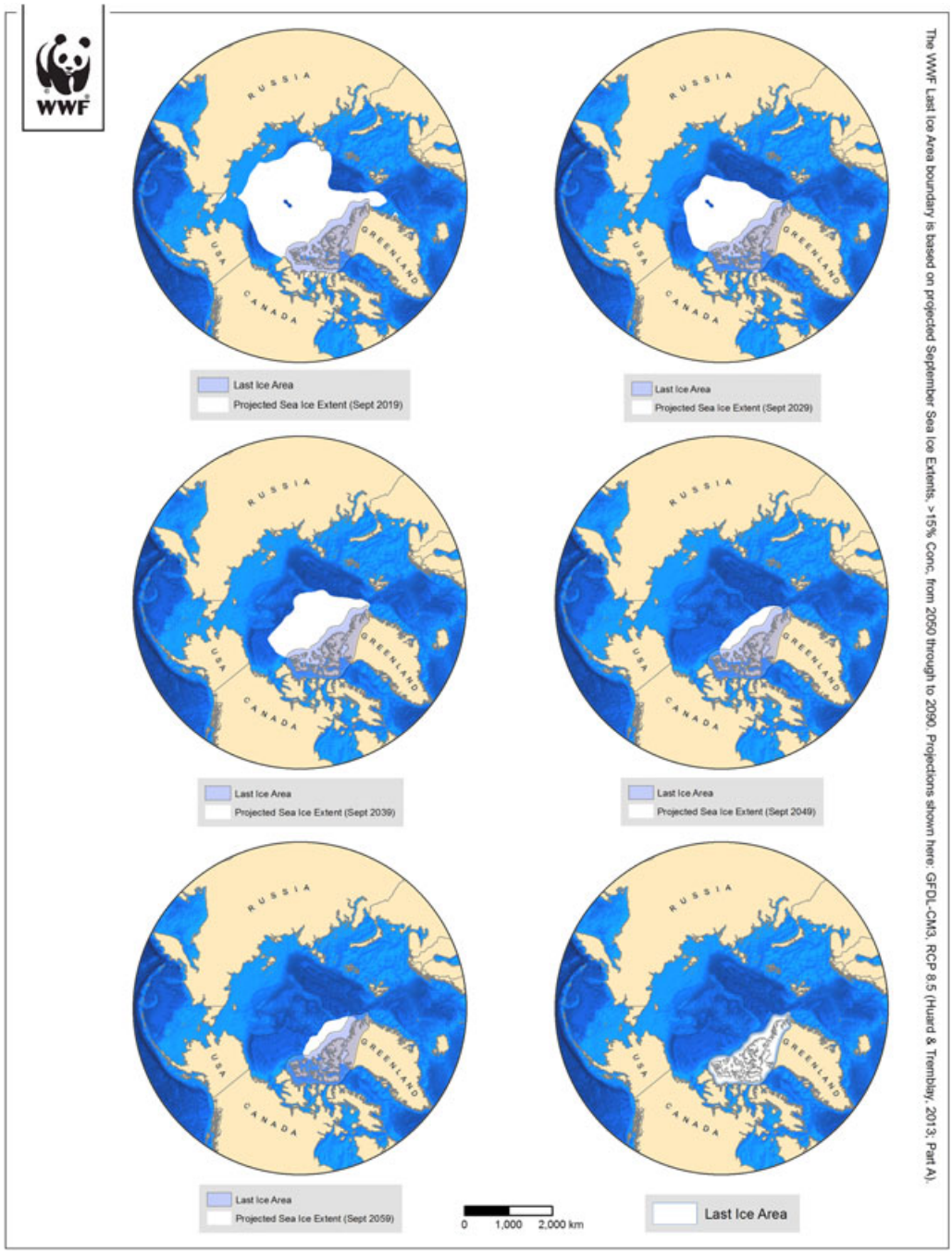

Figure 2. Projected Sea Ice Extent, 2019-2059 (Huard and Tremblay, 2013)

not only attempt to conserve existing valued ecosystem components, but must address the rate of climate and human induced pressures, and be designed at a geographic scale to sustain both ecological and community resilience.

ARCTIC GOVERNANCE AND PROTECTION

Arctic Council

For the past 20 years the Arctic Council's assessments and scientific research have been vital for informing

policy in the region, whether for conservation, decision-making or global commerce. Efforts to create an effective MPA network in the Arctic date back to the mid-1990s. From 1996–2010, the Circumpolar Protected Areas Network (CPAN) Group promoted development of a representative protected areas network to maintain ecosystem health and biodiversity in the Arctic region, including both marine and terrestrial areas. More recently, the Arctic Council identified areas of ecological and cultural significance that may be threatened by expanded shipping (see Figure 1(b) from AMAP, CAFF, SDWG, 2013), which further aided in the development of a framework for a regional MPA network (PAME, 2015). In addition, the circumpolar biodiversity monitoring programme is identifying a suite of common biodiversity measures to be monitored across the region to allow for coordinated reporting of biodiversity in MPAs, thus allowing a better understanding of status and trends in Arctic biodiversity (Livingston *et al*., 2011). This work has established a basic foundation for future actions by the Arctic Council and its member states to conserve key areas and manage industrial impacts.

The framework development by the Arctic Council's Protection of the Arctic Marine Environment working group (PAME) for a pan-Arctic network of MPAs focuses on linking and strengthening the efforts of individual Arctic states to create their own MPA networks to conserve biodiversity, and strengthen the ecological resilience that underpins human well-being (PAME, 2015). While the Arctic Council MPA framework focuses on the development of networks within national jurisdiction, it notes the important linkages to both high seas and terrestrial areas.

The pan-Arctic MPA network has four inter-related goals:

1. To strengthen ecological resilience to direct human pressures and to climate change impacts, to promote the long-term protection of marine biodiversity, ecosystem function and special natural and cultural features in the Arctic.
2. To support integrated stewardship, conservation and management of living Arctic marine resources and species and their habitats, and the cultural and socio-economic values and ecosystem services they provide.
3. To enhance public awareness and appreciation of the Arctic marine environment and rich maritime history and culture.
4. To foster coordination and collaboration among Arctic states to achieve more effective MPA planning and management in the Arctic.

National-level protection measures

The Arctic Council MPA Framework document makes clear that it is composed of individual Arctic State MPAs and MPA networks. However, states are taking widely varying approaches to the development of MPA networks, based on diverse political considerations, governance and conservation issues. MPAs established in national waters in the Arctic also vary significantly in scale and are summarized in Table 1.

Russia is actively planning an MPA network in the Arctic, participating with NGOs on a workshop in 2015 to identify ecologically and biologically significant areas (EBSAs) as defined by the Convention on Biological Diversity. Five new federal MPAs are currently in the process of being established (PAME, 2015), building on a 2008 national gap analysis that identified 37 key Arctic marine areas in need of protection. The process of creating a protected area in Russia can be quite streamlined compared with other jurisdictions, as little as two years from compiling supporting documentation to establishment (Onufrenya, WWF Russia; pers. comm. 2015).

In Canada, the process is less streamlined. Three federal departments have legislation authorizing them to establish MPAs -- the Department of Oceans and Fisheries (which manages Marine Protected Areas), Parks Canada (which manages National Marine Conservation Areas) and

Table 1. Summary of MPAs in Arctic nations (PAME, 2015)

Country	Number of MPAs	Marine area (km^2)
Canada	40	29,892
Greenland (Denmark)	5	96,889
Iceland	30	3,420
Norway	8	83,410
Russia	15	100,700
United States	14	226,094

Environment Canada (which manages Migratory Bird Sanctuaries and National Wildlife Areas) (PAME, 2015). The 2011 National Framework for Canada's Network of Marine Protected Areas calls for establishment of five Arctic bioregional networks of MPAs. In Canada, the establishment of protected areas in the Arctic will almost certainly encounter the constitutionally protected rights of Indigenous peoples, Inuit and Inuvialuit. Consultation requirements (and in Nunavut, negotiation of an Inuit Impact and Benefit Agreement) ensure a lengthy process for protected area establishment (Daoust *et al.*, 2010). For instance the first MPA established in Arctic Canada, Tarium Niryutait, took 12 years from the first public consultations to establishment.

In the United States, MPAs can be established by several federal and state agencies, but there is no unified MPA planning process. Most recent MPA proposals in Alaska have been led by NGOs. In 2014, NOAA initiated a process that allows communities to develop bottom-up nominations of areas they wish to be considered for designation as National Marine Sanctuaries. Nominations must demonstrate the biological and/or cultural significance of the area, the current and potential economic uses and benefits of the area that depend upon natural resource conservation and management, and broad-based community support (NOAA, 2014). In 2014, NOAA received a Sanctuary nomination from an NGO for the federal waters (3–200 nm) of the entire Aleutian Island archipelago (554 000 square miles), but declined this nomination owing to lack of sufficient community-based support. Other NGOs are also actively promoting the protection of the Bering Sea Canyons through an MPA. For consistency with international reporting, US MPAs listed in Table 1 include only those established to protect natural or cultural heritage, not those established for sustainable production.

Greenland currently has five MPAs, based on the criteria in the Arctic Council's MPA Framework, along with other area-based conservation measures to protect fauna, flora or ecosystems, such as areas designated as seabird breeding sanctuaries and regulation of activities near and at seabird colonies in the breeding season. Greenland has also identified marine areas and coastlines vulnerable to oil spills as well as key habitats, migration routes, and the population size and ecology of sensitive species and resources to inform environmental impact assessments for hydrocarbon exploration and exploitation activities and as part of the Arctic Council's identification of areas of ecological and cultural significance that may be threatened by expanded shipping. Greenland is also conducting a study to identify important biodiversity areas (including hotpots), including a ranking based on both internationally accepted criteria (such as the EBSA criteria) and national criteria (such as importance for ecosystem services) (PAME, 2015).

Iceland has approximately 30 MPAs within its EEZ, with conservation purposes including the protection of vulnerable bird species, cold-water corals and hydrothermal vents. One area, Surtsey, is a World Heritage Site. The MPAs are either multiple use areas or no-take zones depending on the objective of the protection. In addition, extensive areas in Iceland's EEZ are either temporarily or permanently closed to fishing in order to protect fish stocks, spawning grounds or benthic species (PAME, 2015).

Norway has developed an ecosystem-based management plan for the Barents Sea–Lofoten area that identifies particularly valuable and vulnerable areas, as well as important areas for biodiversity and for biological production. Norway has also submitted the marine part of seven national parks and four nature reserves in Svalbard as OSPAR MPAs (OSPAR, 2012). In addition, a network of smaller marine protected areas is planned to maintain biodiversity and provide reference sites for research and monitoring. A plan for marine protected areas has been developed, but sites have not yet been selected (PAME, 2015).

Global and high seas protection measures

In February 2014, the World Wildlife Fund formally submitted a proposal to the OSPAR Commission for an Arctic high seas MPA in the North-east Atlantic. The case focuses on the globally unique biodiversity of the Arctic sea-ice ecosystem and seeks to establish a protection regime in the ice-covered Central Arctic waters

north of the EEZs of Greenland (Kingdom of Denmark), Norway, and Iceland. In June 2015, the United Nations took a major step in agreeing to begin developing a legally binding treaty to conserve and sustainably use marine biological diversity in areas outside national jurisdiction. While the completion of this treaty remains many years away, it is a significant milestone toward high seas governance that may provide new opportunities for protection of the Arctic high seas.

In July 2015, the United States, Canada, Russia, Denmark and Norway signed a declaration to prohibit those countries from commercial fishing in the area of the central Arctic beyond national jurisdiction until sufficient science and international mechanisms are in place to sustainably manage such a fishery (US Department of State, 2015). These five Arctic nations will then negotiate with the other Arctic nations as well as with major commercial fishing nations, such as China, Japan and Korea, to develop an agreement inclusive of all these countries (Kirby, 2014). This agreement is an important first step in high seas protection in the Arctic, and may be a model for other types of high seas protection.

Identification of EBSAs

In May 2014, the Convention for Biological Diversity, in collaboration with CAFF and the support of the Government of Finland, held a workshop in Helsinki to identify ecologically or biologically significant areas (EBSAs) in the Arctic marine environment. EBSAs are special areas that support the healthy functioning of the ocean and the ecological services it provides. However, participating countries (except Russia) declined to identify EBSAs within their EEZs, so the geographic scope was limited to the high seas and Russia's EEZ. The Helsinki workshop built on a 2010 workshop held by International Union for Conservation of Nature and the Natural Resources Defence Council (IUCN/NRDC, 2011) to identify areas meeting the EBSAs criteria in the Arctic marine environment. These efforts allowed for a useful exchange of information on how each country identifies areas meeting the EBSAs criteria and will help inform future decisions for representative networks of MPAs.

International maritime organization designations

Environmental risk assessments can also help guide management of the use of the marine and coastal environment to protect human safety, and regional ecological benefits. An example can be seen in the Aleutian Islands Risk Assessment (AIRA), a 10 year process that developed following the *Selendang Ayu* accident in December 2004. As a result of the AIRA, the US Coast Guard recommended to the International Maritime Organization (IMO) areas to be avoided (ATBA) in the Aleutians Islands to reduce the risk of marine accidents and pollution, and allow better response planning to maritime emergencies. The ATBA were officially adopted on 1 January 2016. The designation of a particularly sensitive sea area (PSSA), another IMO designation, can be used as a domestic measure with the benefit of appearing on international charts. There are currently 14 PSSAs established around the world, though none have yet been established in the Arctic.

LOCAL COMMUNITIES AND INDIGENOUS PEOPLES

The Arctic is a sparsely populated region, but one where indigenous peoples and other communities rely largely upon the natural world for their livelihoods and cultural identity. An estimated four million people live in the Arctic boundary defined by the Arctic Monitoring and Assessment Program (ADHR, 2014). An estimated 400 000 of these Arctic Circle residents are indigenous people (United Nations Permanent Forum on Indigenous Issues, 2009) although differences in how Arctic countries classify the term 'indigenous' and in data collection make estimates uncertain (AHDR 2014). Indigenous communities have a long history of adapting to change. However, the current rate of climate change – with impacts including coastal erosion, severe storms, melting ice and changes in species distribution – poses a significant threat to traditional livelihoods.

The fact that the Arctic is inhabited makes local considerations in developing MPAs important, especially where those MPAs are in or near coastal areas. Globally, there are significant benefits to local communities from MPAs (FAO, 2014) but

MPAs in the Arctic used by or adjacent to human populations have a much shorter track record than those in other parts of the world, so demonstrating benefits is a more difficult task. In addition, limited economic opportunities in the Arctic motivate some indigenous people to advocate for resource exploitation. Despite this, Arctic peoples have in some cases been ardent proponents of MPAs, seeing them as ways to protect subsistence or economic resources, as well as cultural values. For instance, Ninginganiq National Wildlife Area in Nunavut, Canada, was proposed by local people to protect an important area for bowhead whales. In Alaska, several areas have recently been withdrawn from oil and gas development due, at least in part, to pressures from indigenous communities that use those areas for fishing and whaling (Alaska Marine Conservation Council, 2015).

As noted above, the indigenous peoples of the Arctic have rights that are variously recognized by national governments, some of which have returned to those peoples portions of their former rights to land and self-governance. Some multilateral instruments also recognize the special role of indigenous peoples in conservation. For instance, the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) references rights to self-governance on indigenous traditional territories, that by extension may well have implications for marine areas used by indigenous peoples. There are also references in both UNDRIP and the Convention on Biological Diversity that encourage the contribution of traditional ecological knowledge (TEK) to protected area governance and management (UN, 2008; Gómez-Baggethun *et al*., 2013).

ARCTIC OUTLOOK

The US Chairmanship of the Arctic Council (2015–2017) presents an important opportunity to advance common goals for marine conservation in the region. The US has identified improving economic and living conditions; Arctic safety, security and stewardship; and addressing the impacts of climate change as priorities for its two-year chairmanship. MPAs are one of the specific initiatives under the ocean stewardship theme, and have a role to play in the other two themes. The recent completion of the Arctic Council's MPA Framework also provides a sound foundation for future collaboration in this area, but progress will need to be accelerated if MPAs are to make a significant contribution to the protection of Arctic resources given the rapid physical, ecological, social and economic changes that are imminent.

A CHANGING ANTARCTIC

Like the Arctic, Antarctica and the Southern Ocean are experiencing a period of rapid environmental and climate change. The Southern Ocean hosts the largest ocean current, connecting the Atlantic, Indian and Pacific Oceans. This important influence on global climate systems also influences climate in Antarctica. The climate picture in Antarctica is complicated by large signals resulting from the ozone hole, making it difficult to detect a signal due to increasing greenhouse gas concentrations (Hawkins and Sutton, 2012).

Owing to these and other complexities, researchers still have a poor understanding of the impacts of climate change on the environment of the Antarctic and how it will evolve (Turner *et al*., 2009). Nonetheless, significant change is being observed in certain Antarctic systems. Since the 1950s, surface air temperatures have risen significantly at many of the stations on the Antarctic Peninsula, although warming has slowed markedly over the last decade (SCAR, 2015).

Anomalously, and in stark contrast to the Arctic, Antarctic sea ice has shown an increase in its winter maximum extent (Simmonds, 2015). Reasons as to why may include freshwater injection from melting ice from West Antarctica, stronger southerly winds in the Ross Sea caused by the ozone hole and lower sea surface temperatures (Fan *et al*., 2014). However, modelling studies predict an acceleration of Southern Ocean warming through the 21st century. This, coupled with atmospheric warming is likely to lead to a decline in sea-ice area (Liu and Curry, 2010).

The loss of ice from ice shelves around Antarctica has increased to a rapid $310 \pm 74\,km^3$

per year over the period 2003 to 2012 (Paolo *et al*., 2015). Some ice shelves in the Amundsen Sea and Bellingshausen Sea have lost up to 18% of their thickness in less than two decades. Thinning of the ice shelves removes their buttressing effect, allowing continental ice streams to move faster towards the coast, leading to an increase in iceberg discharge. If this acceleration continues, destabilization and collapse of parts of the West Antarctic ice sheet are likely (McMillan *et al*., 2014; Rignot *et al*., 2014; Spence *et al*., 2014).

Changes in Southern Ocean biodiversity are also being recorded. At least 75% of emperor penguin colonies are assessed as being vulnerable to future low sea-ice concentration, and 20% will probably be quasi-extinct by 2100. The global population is expected to decline by at least 19% after a phase of slight increase until 2050 (Jenouvrier *et al*., 2014). Climate-mediated impacts are predicted in Adélie penguin populations (Ballerini *et al*., 2015) and Ropert-Coudert *et al*. (2015) documented the breeding failure of an entire Adélie colony in response to unusual and extreme weather events.

Direct and indirect impacts of various environmental changes to the three major marine habitats (sea ice, pelagic and benthic and their biota) are shown to be complex, and most of them are assumed to be non-linear (Constable *et al*., 2014; Gutt *et al*., 2015).

HUMAN PRESSURES IN THE ANTARCTIC

With no indigenous population, the primary activities undertaken in the Antarctic are scientific research (supported by more than 100 research stations and bases operated and managed by 29 national Antarctic programmes), fishing and tourism.

Marine resource exploitation in the Southern Ocean has been occurring for two centuries. Exploitation of fur seals and elephant seals dates back to the early part of the 19th century, with populations of South Atlantic fur seals harvested to near-extinction by the mid-1820s. Southern Ocean whaling commenced in the early part of the 20th century and peaked in the 1930s, reducing populations of blue, fin, sei and humpback whales to 10% of their former population levels by the 1950s (NOAA Fisheries, 2014).

Large-scale fishing for finfish began in the late 1960s. By the late 1970s certain species had been severely overfished in some areas. Growing interest in the exploitation of krill (*Euphausia* sp.) – a keystone species in the Southern Ocean food web preyed upon by numerous species of fish, penguins, seabirds, whales and seals (Croxall *et al*., 1999) – in the late 1960s and early 1970s lent a sense of urgency to the need to establish a marine resource management regime for the Southern Ocean (Miller, 1991).

Today, Antarctic governmental presence continues to expand. Since 1995, seven new Antarctic stations have been constructed with a further four bases having been rebuilt or extended.

Tourism activities in Antarctica (which are regulated through a combination of industry self-regulation and government-enforced rules that implement measures agreed by the Antarctic Treaty Consultative Parties) are largely ship-based, with the majority of landings taking place in the Antarctic Peninsula. Tourism expanded rapidly in the 1990s and early 2000s reaching a peak in the 2007/08 season when more than 30 000 passengers travelled to Antarctica on-board 55 vessels, which made over 300 Antarctic voyages. These numbers have not been repeated since, though a steady increase in the last few years suggests that they could be matched in the next two austral summer seasons (IAATO, 2015).

ANTARCTIC GOVERNANCE AND PROTECTION

The Antarctic comprises a continent (approximately 14 million km^2) largely covered by an ice sheet up to 4 km thick, surrounded by the vast Southern Ocean (approximately 20 million km^2). A series of territorial sovereignty claims in Antarctica made by seven countries between 1908 and 1943 gave rise to significant international tension over the region, addressed through the Antarctic Treaty in 1959 (UN, 1961). The Antarctic Treaty, which is indefinite in its duration, sets aside disputes over

territorial claims and promotes peaceful use and scientific cooperation in the region (Watts, 1992).

Issues such as environmental protection, mining and fishing are not addressed by the Antarctic Treaty itself. To regulate such issues the Antarctic Treaty Parties have negotiated a number of separate free-standing agreements (known collectively as the Antarctic Treaty System). This includes the 1972 Convention on the Conservation of Antarctic Seals (CCAS; UN, 1978); the 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR; International Legal Materials, 1980), and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (the Protocol; International Legal Materials, 1991).

In response to overfishing in the 1960s and 1970s and a growing interest in krill harvesting, CCAMLR was negotiated among 15 countries in the late 1970s and was agreed at a conference in Canberra, Australia on 19 May 1980. The Convention entered into force on 7 April 1982. Article II of the Convention states its objective as the conservation of Antarctic marine living resources, with the term 'conservation' including rational use.

The Convention broke new ground in that: its area of application extends north beyond the Antarctic Treaty area (Figure 3) (which is limited to 60° South latitude); it was concluded prior to major fisheries being fully established; and it adopted an ecosystem-wide approach to fisheries management (Constable *et al.*, 2000). Such an approach does not concentrate solely on managing commercially fished species, but seeks to avoid situations in which fisheries have a significant adverse effect on 'dependent and related species.'

The Convention establishes a Commission as the decision-making body. Decisions are taken by consensus among the Commission's 25 Members

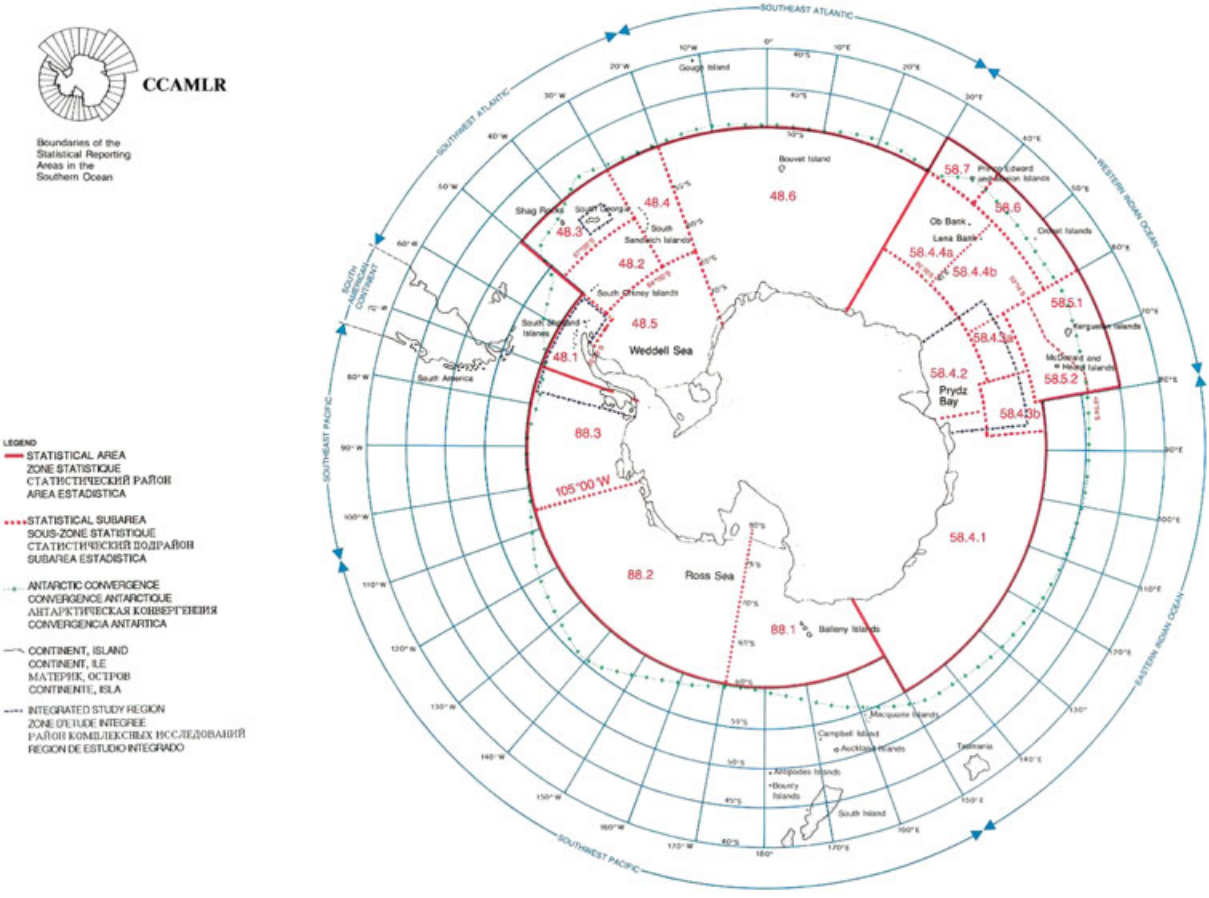

Figure 3. CCAMLR Boundary (www.ccamlr.org)

(24 State members plus the European Community). A further 11 countries have acceded to the Convention. Based on the best available scientific information provided by an advisory Scientific Committee, the Commission agrees annually a set of conservation measures to implement the Convention including to protect vulnerable or special areas as well as to determine access to and harvesting of marine living resources in the Southern Ocean.

PROTECTING THE ANTARCTIC MARINE ENVIRONMENT

The consideration of large-scale, high-seas MPAs in the Southern Ocean is a relatively new development for the Parties to CCAMLR. However, other spatial tools for managing activities or conserving areas of the Southern Ocean have been prescribed in or developed under the various instruments of the Antarctic Treaty System (Grant, 2005). The 1972 Convention on the Conservation of Antarctic Seals (CCAS) provided for marine areas to be closed to commercial sealing activity, the establishment of seal reserves and the designation of special areas to avoid disturbance to seals. Three seal reserves have been established including one that runs almost the entire length of the front of the Ross Ice Shelf (Roberts, 1977). These reserves remain extant, though no commercial sealing activities have taken place since the Convention came into force.

In addition, three medium to large scale MPAs have been designated within the CCAMLR Convention area within areas of national jurisdiction around three sub-Antarctic island groups. In 2002, Australia designated a 65 000 km^2 marine reserve around Heard Island and McDonald Islands (HIMI) extending 12 nautical miles (22 km) from the coastline that prohibits all extractive uses. In March 2014, a further 62 000 km^2 were added to the marine reserve on the basis of high conservation value. In 2012, the Government of South Georgia and the South Sandwich Islands (SGSSI) created one of the world's largest, sustainably managed MPAs that encompasses the entire SGSSI Maritime Zone north of 60°S. The MPA covers a total area of 1.07 million km^2, prohibits all bottom trawling and bans bottom fishing at depths less than 700 m and greater than 2250 m. No-take zones, extending 12 nautical miles from the coast, were created around South Georgia, Clerke Rocks, Shag and Black Rocks and the South Sandwich Islands, totalling 20 431 km^2. In April 2013, the Government of South Africa announced the declaration of the 180 000 km^2 Prince Edward Islands MPA as a special nature reserve. The area includes a 12 nautical mile no take zone; four restricted zones, in which fishing effort is limited; and a controlled (low impact) zone, linking the four restricted areas.

While the Parties to the Antarctic Treaty have formally acknowledged the primary role of CCAMLR in the designation of MPAs (ATCM, 2014), Annex V to the 1991 Protocol on Environmental Protection to the Antarctic Treaty (the Protocol) potentially provides another tool for MPA designation. It provides that 'any area, including any marine area,[1] may be designated as an Antarctic Specially Protected Area (ASPA) to protect outstanding environmental, scientific, historical, aesthetic or wilderness values, any combination of those values, or ongoing or planned scientific research' or as an Antarctic Specially Managed Area (ASMA) 'to assist in the planning and coordination of activities, avoid possible conflicts, improve cooperation between Parties or minimize environmental impacts.'

To date three ASMAs and 11 ASPAs have been adopted with a marine component. However, these are all coastal and relatively small areas ranging from under 1 km^2 to just over 3500 km^2. None of the management plans for these areas explicitly exclude or prohibit fishing, nor do they (with two exceptions – ASMAs 1 and 7) recognize fishing as a permitted activity within their boundaries. In 2013, CCAMLR decided that any proposal to undertake commercial harvesting

[1]The notion of 'any marine area' is constrained, however, by the geographical limitations of the area of application of the Protocol. As noted above, the Protocol and the Antarctic Treaty extend only to 60° South, whereas the area of application of CCAMLR extends further north (Figure 3).

within an ASMA should be submitted to CCAMLR for its consideration and that the activities outlined in that proposal should only be taken with the prior approval of CCAMLR (CCAMLR, 2013a).

In its early consideration of high seas MPA matters (i.e. areas beyond national jurisdiction), CCAMLR gave brief consideration to making use of the ASPA and/or ASMA tools provided for by the Protocol (CCAMLR, 2005). As recently as 2013, Ukraine explicitly noted its preference for CCAMLR to delegate responsibility for MPA designation to the 1991 Environmental Protocol (CCAMLR, 2013b). However, the majority of CCAMLR members gave preference to designating MPAs within CCAMLR's own procedures rather than using mechanisms of an external (albeit related) treaty (notwithstanding the geographical limitations noted in footnote 1).

Prior to its consideration of large-scale MPA proposals, the CCAMLR Commission had implemented other spatial management mechanisms, including the designation of monitoring sites to support its Ecosystem Monitoring Programme (CEMP; Agnew, 1997). While there are currently no formally designated CEMP sites under CCAMLR, seven of the 13 currently active CEMP monitoring locations south of 60°S are within ASPAs or ASMAs and are afforded protection through that mechanism.

CCAMLR has also developed and implemented mechanisms for identifying and reporting vulnerable marine ecosystems (VMEs). VMEs (defined as assemblages of marine benthic organisms susceptible to anthropogenic disturbance, especially arising from bottom fishing activities) are typically found in deep-sea regions, and may be associated with seamounts, hydrothermal vents, deep-sea trenches and oceanic ridges. The CCAMLR VME Registry (http://.www.ccamlr.org/en/document/data/ccamlr-vme-registry) records the locations and characteristics of VMEs and associated areas in the Convention area.

Despite the range of spatial protection mechanisms that have been developed over the history of the Treaty system, to date only very small areas of the Southern Ocean have been afforded long-term protection explicitly for reasons of conservation.

CCAMLR AND MPAS

CCAMLR's consideration of MPA matters has been a complex, lengthy and sometimes a fraught process, with scientific, administrative and political aspects. CCAMLR's ability to designate areas for conservation purposes arises from Article IX of the Convention. Article IX(2)(g) provides that Conservation Measures can include 'the designation of the opening and closing of areas, regions or sub-regions for the purposes of scientific study or conservation, including special areas for protection and scientific study'.

Since 2005, the CCAMLR Commission has undertaken significant scientific analyses and planning toward the implementation of MPAs in the Convention Area.[2] A 2005 CCAMLR Southern Ocean MPA workshop articulated the objective of designating MPAs as ensuring the conservation of biodiversity and maintenance of ecosystem structure and function. It also noted that the types of areas in need of designation should include representative areas (defined by the principles of comprehensiveness, adequacy and representativeness), vulnerable areas, scientific areas and areas to protect ecosystem processes (CCAMLR, 2005).

In subsequent workshops, bioregionalization and systematic conservation planning were adopted as key methodologies to support designation of MPAs in the Southern Ocean (Australia *et al.*, 2006; UK, 2006; CCAMLR, 2007). Bioregionalization is defined in the CCAMLR MPAs Workshop Report (2005) as '…a process to classify marine areas from a range of data on environmental attributes.' The process results in a set of bioregions, each reflecting a unifying set of major environmental influences that shape the occurrence of biota and their interaction with the physical environment.

[2]These efforts have been undertaken in the context of the objective of the 2002 World Summit on Sustainable Development to achieve a representative network of MPAs by 2012 (WSSD, 2002), and the recent decision of the 2012 United Nations Conference on Sustainable Development, which noted the importance of 'conserving, by 2020, 10 percent of coastal and marine areas, especially areas important for biodiversity and ecosystem services, through representative and well-connected systems of protected areas' (United Nations, 2012)].

Existing data on coastal and oceanic provinces, including benthic and pelagic features and processes, were collated and analysed to prepare a broad-scale bioregionalization of the Southern Ocean, and the identification of 11 priority areas based on areas indicative of high biodiversity (CCAMLR, 2008). Further work resulted in the replacement of the 11 priority areas with nine planning domains representing a broad range of bioregional types within each area (Figure 4(a)) to facilitate the development of a representative system of MPAs (CCAMLR, 2011a)

On the back of this extensive bioregionalization exercise, and following a proposal from the UK, the CCAMLR Commission established in 2009, the world's first high seas MPA, the South Orkney Islands Southern Shelf Marine Protected Area (CCAMLR Conservation Measure 91-03). The MPA covers an area of 94 000 km^2 to the south of the South Orkney Islands in CCAMLR's planning domain 1 (Figure 4(b)).

Although adopted by consensus among Commission members, the establishment of this MPA was not straightforward. First, some members wanted greater coordination among the various spatial management tools being employed (areas closed to fishing, CEMP sites, ASMAs, ASPAs and VME Risk Areas). In many ways this MPA was adopted at the time without a common understanding as to its status. Second, concerns were raised over potential restrictions on fishing activity. The indentation in the north-western boundary of the South Orkney MPA was removed on the insistence of fishing nations who expressed an interest in crab fishing in the area, although such fishing activity on a commercial scale has never been realized (Brooks, 2013). Finally, some members expressed concern at the lack of a management plan, and research and monitoring plan for the area. In 2014, the UK submitted a draft research and monitoring plan to CCAMLR, though this has not yet received consensus support. This delay has led some CCAMLR members to question the capacity of members to prepare effective research and monitoring plans more generally (CCAMLR, 2014).

To provide guidance on what an MPA should involve and how it should be managed, CCAMLR adopted, in 2011, Conservation Measure (CM) 91-04, which provides a general framework for the establishment of CCAMLR MPAs. This was intended to address the concerns of those Parties that had routinely questioned whether CCAMLR had the necessary procedures for, and approaches to designating MPAs (beyond the broad provisions of Article IX(2)(g) of the Convention).

CM 91-04 provides that CCAMLR MPAs 'shall be established on the best available scientific evidence and sets out a series of objectives that MPAs should aim to achieve, including: the protection of representative examples of marine ecosystems, biodiversity and habitats; the protection of key ecosystem processes, habitats and species, and the establishment of scientific reference areas for monitoring natural variability and long-term change.'

The Conservation Measure also requires that MPA proposals shall specify the objectives of the MPA, the spatial boundaries, the activities that are restricted, prohibited or managed in the area, and its period of designation. CM 91-04 outlines the requirements for management plans and research and monitoring plans, and in its framework arrangement, allows for MPAs to take different approaches in their process for establishment, and in their management mechanisms. A further benefit of the adoption of CM 91-04 is that it avoids the need for CCAMLR to attempt to define MPAs, and to avoid importing definitions from outside of CCAMLR.

Nevertheless, the brevity of guidance provided in CM 91-04 on the nature of management plans and research and monitoring plans, and who is responsible for developing and implementing them remains contentious and has required considerable further elaboration by CCAMLR's Scientific Committee and Commission since 2011 (SC-CAMLR, 2011, 2012, 2014; CCAMLR, 2011b). The Commission has agreed that there will be different needs for monitoring and management plans according to the specific MPAs and therefore, advice should be considered on a case-by-case basis and in accordance with the objectives for each MPA (CCAMLR, 2011b).

Further delays in the designation of MPAs beyond the South Orkney MPA have arisen as a

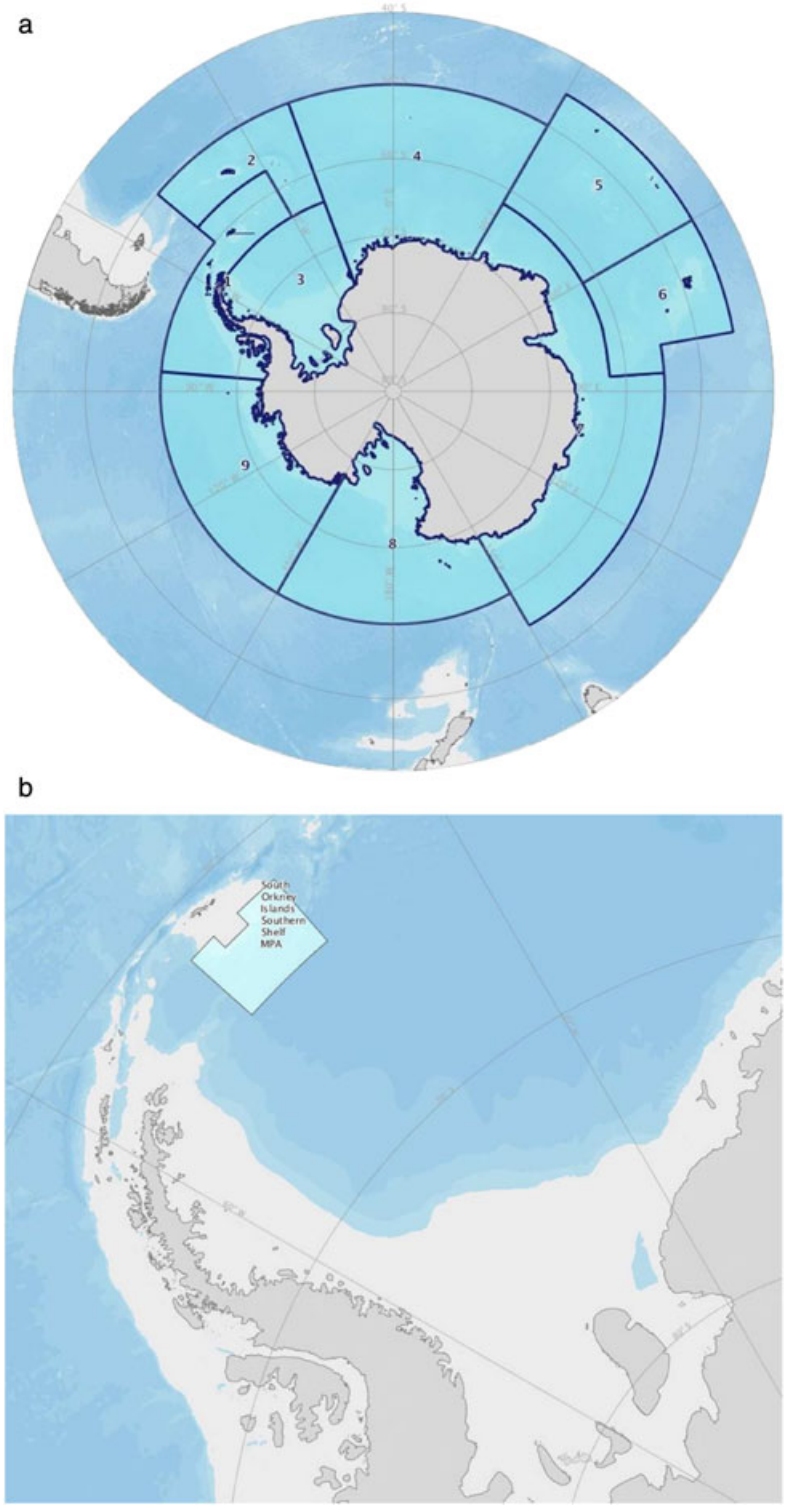

Figure 4. (a) CCAMLR's nine marine planning domains, and (b) South Orkney MPA designated in 2009 (CCAMLR, 2011a).

result of disagreements within the Commission over the duration of MPAs and the process for reviewing them after their designation period ends. Some Members have argued that MPAs should not be in perpetuity and periods of designation ranging between a few years and several decades continue to be debated (CCAMLR, 2012a, 2013c).

Disagreement also continues on the process that should be followed once the designation period ends. Some members suggest that consensus should be required to de-designate the area while others suggest that the site should automatically be de-designated with consensus needed to re-establish it, and only then on the basis of hard evidence that its designation has resulted in some clear environmental benefit (CCAMLR, 2012b, 2013d).

Mechanisms for designating and de-designating terrestrial protected areas and for reviewing and updating their management plans are well established and have been implemented within the Antarctic Treaty Consultative Meeting for many years (CEP, 2014). Furthermore, CCAMLR itself has well established review procedures in relation to fisheries proposals that it employs annually, before areas open and closed to fishing and catch limits are decided at each annual Commission meeting.

The apparent concern among some that once established, all MPAs are set in stone is not borne out by the flexible management arrangements employed elsewhere within CCAMLR and the wider Antarctic Treaty System. Within the debate it is not clear whether some members are failing to grasp protected area review processes or are fuelling debate over such issues purely as filibustering tactics.

CURRENT MPA PROPOSALS

Ross Sea proposal

In 2011, two separate proposals were put forward to the Scientific Committee for MPAs in the Ross Sea (Domain 8): one from New Zealand and one from the USA. Following encouragement from the Scientific Committee to do so, the proponents melded the proposals into a single, largely no-take MPA proposal, which was re-tabled in 2012.

The 2012 joint proposal (CCAMLR, 2012c) was presented as aiming to protect the high biological diversity and largely intact ecosystems of the region, and noted that the area includes globally significant ecological, environmental, scientific and historical values. The proposal extended across 2.27 million km^2. A no-take (other than for research purposes) General Protection Zone formed the largest component of the MPA extending across 1.6 million km^2. A Special Research Zone was identified where tightly controlled research toothfish fishing would be permitted, and also a smaller spawning protection zone, where directed research fishing would be permitted only between December and March to protect winter spawning.

The proposal included 95% of the range of the Antarctic silverfish (*Pleuragramma antarcticum*) which underpins the food web of the Ross Sea shelf ecosystem, preferred foraging grounds of top predators, including penguins, seals and whales, and juvenile habitats and spawning areas for Antarctic toothfish (*Dissostichus mawsoni*). It was proposed that it could also act as a climate reference area. Current commercial catch displaced by the MPA would be redistributed to areas outside the MPA, including areas with current zero catch limits.

Since 2012, attempts to gain the necessary consensus support for the Ross Sea MPA proposal have resulted in significant amendment to the boundaries of the proposal. The spawning protection zone has been removed, the benthic protection zone in the north-west reduced as well as a smaller area around Scott Island. At the 2015 CCAMLR meeting, the proponents added a substantial krill research zone to the western edge of the proposed area, in response to informal negotiations with China (though the new zone adds nothing more than what is already permitted under current measures). Commercial toothfish fishing would be prohibited across most of the proposed area, although research fishing would be permitted throughout, and directed exploratory toothfish fishing allowed in the Special Research Zone (Figure 5). The current size is around 1.5 million km^2. The Ross Sea proponents also agreed that the MPA would automatically expire after the

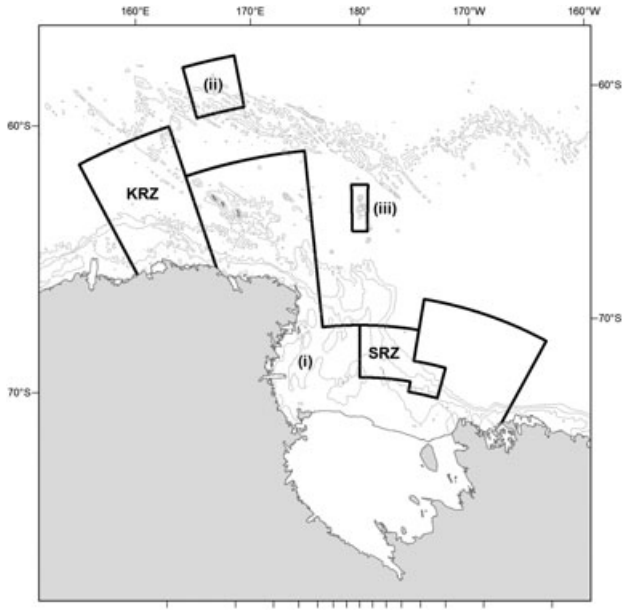

Figure 5. The Ross Sea Region Marine Protected Area, including the boundaries of the General Protection Zone, composed of areas (i), (ii), and (iii), the Special Research Zone (SRZ), and the Krill Research Zone. Depth contours are at 500 m, 1500 m, and 2500 m (CCAMLR, 2012c).

agreed period of designation. The current proposal suggests 50 years, but this is yet to be agreed.

East Antarctic proposal

A multiple-use 1.8 million km^2 representative system of seven MPAs in the East Antarctic Domain was proposed by France and Australia in 2011. The proposed East Antarctic Representative System of MPAs (EARSMPA) encompassed representative examples of the diverse biodiversity and geological features in the domain (DoE, 2013) (Figure 6). The proposed system included unique continental ridge, canyon and seamount features, with associated distinctive deep water flora and fauna, and important feeding areas for marine mammals, penguins and other seabirds. It would also have provided for the establishment of ecosystem-sized reference areas to allow for the study of the effects of climate change on Antarctic and Southern Ocean ecosystems, as well as fishing in the region (CCAMLR, 2011a; Antarctic Ocean Alliance, 2012).

The proposal was based on a comprehensive and inclusive scientific assessment representing the best scientific evidence available (CCAMLR, 2011b), and was in accordance with CM 91-04. Each of the seven MPAs contained representative areas of biodiversity of the region and three were suggested as reference areas to allow for the study of the impacts of fishing activities and climate change on the ecosystem to assist in the development of effective management measures (CCAMLR, 2011a). The system was framed as a multiple-use system where activities, including fishing, could be undertaken when those activities did not undermine the objectives of the individual MPA or the representative system as a whole.

In the process of negotiating the consensus required within CCAMLR, this proposed system has been reduced to three areas – MacRoberston, D'Urville Sea-Mertz and Drygalski – each extending from the Antarctic coastline to a northern boundary corresponding to the Southern Antarctic Circumpolar Current Front (CCAMLR, 2014)[3] (Figure 7).

ANTARCTIC OUTLOOK

Since 2005, CCAMLR Parties have devoted a considerable amount of time to MPA matters and CCAMLR is now well positioned to develop a network of MPAs across the Southern Ocean. The scientific basis, and the legal and administrative arrangements are largely in place. However, after a decade of cautious and considered deliberations on the science and processes required, CCAMLR has nonetheless failed to achieve its self-imposed 2012 deadline (CCAMLR, 2009) for designating a network of Southern Ocean MPAs.

Since tabling their original drafts, the sponsoring countries of the Ross Sea and East Antarctica MPA proposals have demonstrated significant willingness to respond to the concerns and have amended their proposals accordingly. These changes include considerable reductions in size and duration, while attempting to retain the scientific rationale on

[3]As the proposal is still in negotiation details of specific boundaries are not yet in the public arena. Permission to view details may be requested from the CCAMLR Secretariat.

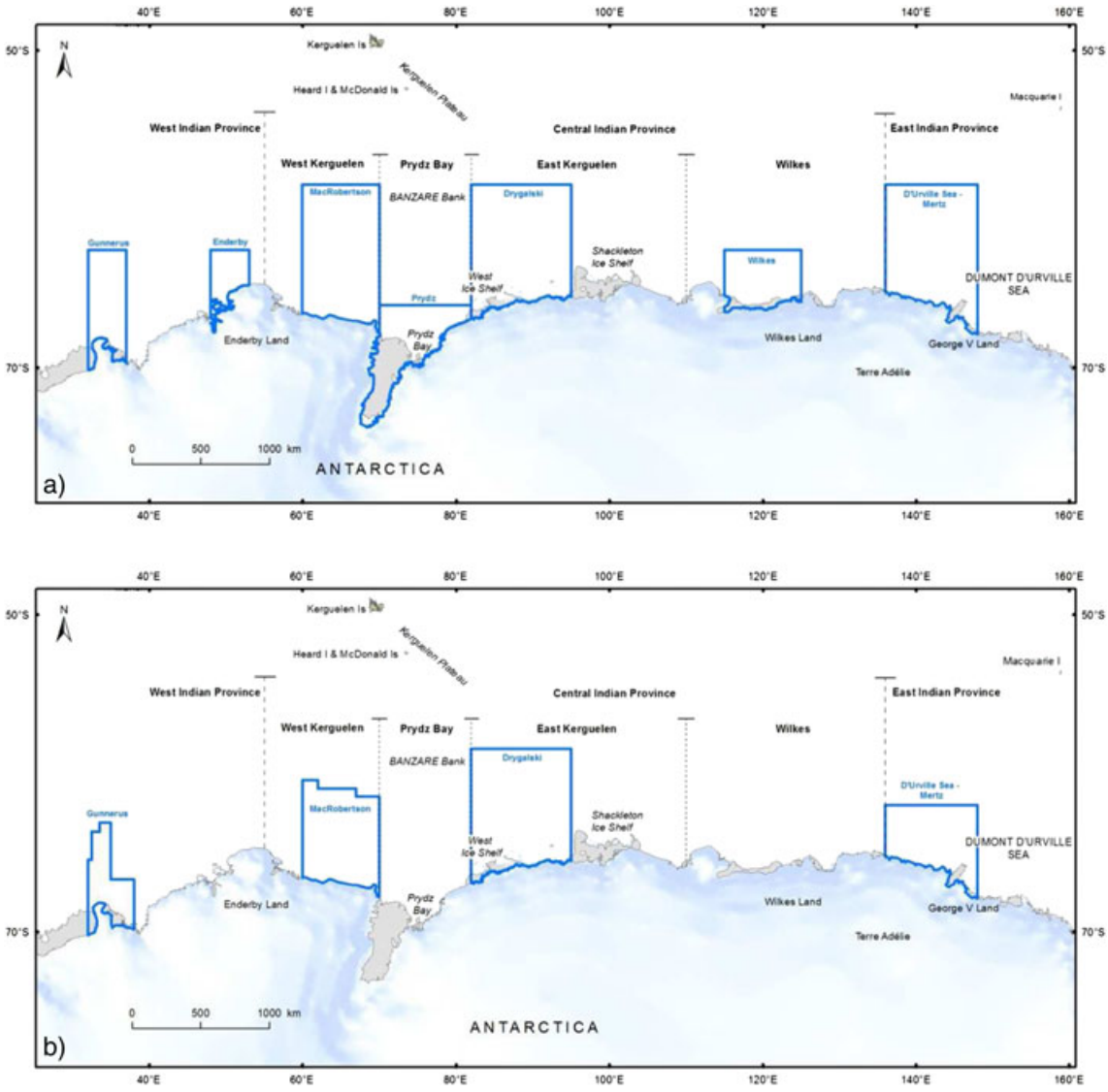

Figure 6. a) Initial proposal for East Antarctic Representative System of MPAs, 2011, and b) Amended Proposal for East Antarctic Representative System of MPAs, 2015. Maps courtesy of the Australian Antarctic Division © Commonwealth of Australia.

which they are based. Revisions of the proposals have helped several Commission members to reverse their initial opposition, but Russia continues to withhold its support.

The ongoing tension over MPA designations highlights the differing philosophies on the very purpose of the Convention among its Member States; i.e. those wishing to protect the right of access to and exploitation of marine resources, and those wishing to take a conservationist approach that allows for some marine harvesting. These philosophical differences (which stem from the motivations of those who negotiated the regime in the late 1970s) (Stokke, 1996) have been exacerbated by recent entrants to CCAMLR who have attempted to interpret Article II as prioritizing 'rational use' over long-term conservation. Brooks (2013) points out that the primary concern of those opposing current MPA proposals (based on how many countries voiced their concern in the 2013 Commission meeting and how many times the concern was raised) is the potential that MPAs have for interfering with fishing activity, both now and in the future. The designation of large-scale, no-take

MPAs is likely to continue to be a slow process while these fundamental differences in approach to the Convention remain.

COMPARING POLAR MPA EXPERIENCES AND APPROACHES

Geography and governance

As noted above, geographically the two poles are mirror images of one another. The Arctic is a semi-enclosed sea, surrounded by the Arctic nations of the United States, Russia, Canada, Iceland and the Kingdom of Denmark (Greenland) with a resident population of about 4 million people who have occupied the area for thousands of years. By contrast, Antarctica is a continent surrounded by ocean that saw no human activity until the 1800s and has no permanent population.

These realities have led to very different governance structures for the two regions. Much of the Arctic is contained within the exclusive economic zones of individual countries, with a high seas 'doughnut hole' in the Central Arctic. There has been an increasing level of cooperation between the Arctic states over the past two decades, especially through the Arctic Council, accompanied by a few formal treaties on specific aspects of cooperation.

Antarctica is governed through the Antarctic Treaty System, which has evolved under the auspices of the 1959 Antarctic Treaty, and includes a suite of agreements including CCAMLR, which regulates Southern Ocean activities. All decisions made at the annual Antarctic Treaty Consultative Meetings and meetings of the CCAMLR Commission are taken by consensus, which means that any one nation has the power of veto.

One of the most obvious differences between the Arctic and the Antarctic is the presence of indigenous peoples and other permanent communities in the Arctic. Communities and peoples have land, governance, and usage rights that must be considered in the Arctic context. Co-management arrangements with indigenous communities have been adopted in some parts of the Arctic, and are likely to be a particularly relevant tool in this region.

As described earlier, significant progress in establishing MPAs has been made by some Arctic nations, and efforts to link national level MPAs in the Arctic into a regional network are beginning, convened by the Arctic Council. In Antarctica, despite a decade of discussion on the scientific basis and procedures for designating MPAs, as well as several MPA proposals being tabled, the requirement for consensus decision-making has so far prevented meaningful progress in designating Southern Ocean MPAs outside the EEZs of individual countries.

The scale of MPAs in the two regions is also worth contrasting. In the Arctic, many of the existing and proposed MPAs are relatively small, with the total area of existing MPAs encompassing less than 1 million km^2. In the Antarctic, by contrast, the two MPA proposals currently being considered began at a size closer to 2 million km^2 each; though political negotiation over the last few years has seen a gradual reduction in their scale. While MPAs in both polar regions primarily focus on protecting communities of diverse biodiversity and habitats, geographic features and ecological processes, the larger sized areas being proposed in Antarctica provide a greater opportunity to realize broad ecosystem-focused objectives, including fostering ecosystem resilience in light of climate change.

Common pressures

Climate change and ocean acidification

The poles are already experiencing significant climate change impacts, including loss of sea ice in the Arctic, thinning of ice shelves in Antarctica, and impacts to vulnerable species at both poles.

Ocean acidification is a lesser recognized but equally significant threat to ocean life, particularly at the poles. As the ocean continues to absorb atmospheric carbon dioxide, seawater pH is lowered. This change in ocean chemistry is affecting marine life, particularly the ability of shellfish, corals and small creatures in the early stages of the food chain to build skeletons or shells. A recent NOAA-led study in Alaska found that many marine fisheries valuable commercially

and for subsistence are located in waters that are already experiencing ocean acidification, and will see more in the near future (Mathis *et al.*, 2015). In 2015, based on additional work in the Beaufort sea, Mathis *et al.* noted that 'ocean acidification is happening faster in the Arctic than anywhere else on the planet….the Beaufort Sea is out front in terms of how the water chemistry is changing' (Mathis *et al.*, 2015; Thurton, 2015).

Ocean acidification is also expected to become one of the biggest challenges for the Antarctic marine ecosystem in future decades (Orr *et al.*, 2005). The Scientific Committee on Antarctic Research has identified ocean acidification as a major potential threat to the Southern Ocean and will publish a major report on the issue during 2016.

Managing polar fisheries

In addition to working within their EEZs and through the Arctic Council, many Arctic nations have worked through bi-lateral or multi-lateral forums on conservation initiatives. In 2009, the US adopted the Arctic Fishery Management Plan, implementing a precautionary approach to fisheries management by banning commercial fishing in 400 000 square miles north of the Bering Strait, including the Beaufort and Chukchi Seas until there is sufficient scientific information to manage the fishery (NOAA Fisheries, 2011). In 2012, more than 2000 scientists signed a letter urging the Arctic nations to take a similar approach, closing the Arctic high seas to commercial fishing (Semeniuk, 2012). A first step toward implementing this approach was taken in July 2015, when the United States, Canada, Russia, Denmark and Norway signed a declaration that banned signatory countries from fishing in the central Arctic in areas beyond national jurisdiction until the necessary science and management measures are in place for sustainable fisheries management.

Fin-fish fisheries in the Southern Ocean are largely well managed and spatially constrained at present with relatively stable catch limits set annually by CCAMLR. There are 13 licensed fisheries currently targeting economically lucrative toothfish species (*Dissostichus eleginoides* and *D. mawsoni*) with the majority of the catch occurring around the sub-Antarctic islands of South Georgia, Kerguelen, and Heard and McDonald (all of which lie within the CCAMLR Convention Area), as well as in the Ross Sea; the latter being the most significant high seas fin-fish fishery in the Southern Ocean. Each of the major fishing areas are subdivided into smaller scale management or research units within each of which catch and/or by-catch limits and 'move-on' rules are established annually.

The growing krill fishery, which is largely focused in the Scotia Sea and the Antarctic Peninsula, however, is less well regulated and efforts are underway to improve management controls. Debate continues within CCAMLR over several aspects of the fishery including: means to adequately distribute the krill fishing effort to avoid over-exploitation of important feeding grounds (Hewitt *et al.*, 2004); the need for scientific observers to be placed on all krill fishing vessels (as is the case in the fin-fish fisheries); and the need for increased biomass and other scientific surveys on which to base catch limits (Nicol *et al.*, 2012).

Strategic and economic values and interests

The economic and strategic interests that many countries have in the polar regions can pose obstacles to conservation. In addition, broader global tensions among Arctic and Antarctic nations may influence decisions in the polar regions. The enormous potential economic value of Arctic resources has attracted significant interest from both Arctic and non-Arctic nations. These include energy, fishery and mineral resources, as well as expanding shipping routes due to newly ice free areas. The economic resources in Antarctica, while largely restricted to living marine resources and tourism, are also significant with the former having a past history of overexploitation.

Given the Arctic's increasing perceived value, it is hardly surprising that more nations are expressing interest in influencing Arctic decision-making. In 2013, China, India, Japan and

South Korea were all granted observer status to the Arctic Council, joining Singapore, which has been an observer since 2011 (Teo, 2013). Observer status allows countries to listen in on meetings and, to a certain extent, participate in activities. France, Germany, Italy, Spain and the UK also have observer status. The multiplicity of interests may complicate efforts to implement conservation efforts in the region, but they may also contribute valuable research.

Russia's annexation of Crimea in March 2014 and recent military activities along its border with Ukraine has strained relations with many western countries, leading to the exclusion of Russia from the G8 group of nations, now the G7. Despite these tensions, efforts have been made within the Arctic Council and CCAMLR to continue the open dialogue that has prevailed in the past. Russia's involvement in the Ukraine has resulted in travel bans on many officials, as well as bans on the export of technologies and services that would help Russia tap its energy resources in the Arctic (Myers, 2015).

China is also seeking to expand its influence in both polar regions, recently gaining observer status to the Arctic Council. Both China and Russia have indicated their desire to minimize, if not prevent, any further restrictions on their Southern Ocean fishing aspirations. China joined Russia in 2014 in opposing the two current Antarctic MPA proposals. Russia has made clear its desire to 'strengthen the economic potential of Russia by means of using the existing .... biological resources of the Southern ocean', and openly stated that designation of an MPA 'must not swallow up the main areas for harvesting marine bio-resources in the Southern Ocean' (Lukin, 2014). At the 2014 CCAMLR meeting, China has also openly voiced its 'concern' over the current MPA proposals citing 'fundamental and technical differences between members' and standing with Russia in withholding consensus (CCAMLR, 2014); though it should be noted that China's opposition at least to the Ross Sea MPA appears to have softened since an agreement was reached with China to add a krill fishing zone to the MPA during the 2015 meeting of the CCAMLR Commission.

Energy and mineral exploitation are major economic activities in the Arctic. In the Antarctic, mineral resource activities are prohibited by Article 7 of the Environmental Protocol to the Antarctic Treaty. However, there remains a degree of ambiguity as to the extent to which this prohibition applies to the deep sea bed south of 60° South (Scott and Vanderzwaag, 2015). To date, no Party to the Antarctic Treaty has attempted to formally raise this dilemma nor to test it either legally or practically. As such it is not possible to make any thorough assessment as to how much of a motivation it might be for Parties to oppose MPA designation on the grounds of current or future desires to exploit mineral resources of the Southern Ocean. Russia has, however, explicitly included 'the complex study of the mineral, hydrocarbon and other forms of the natural resources of Antarctica' within its Government Antarctic strategy to 2020 (Lukin, 2014).

Importance of an ecosystem approach to management

Given the broad scope of environmental changes faced by both polar regions, MPAs are but one part of a broader ecosystem approach to management that is essential to protect ecosystem functions. An ecosystem approach also includes such non-spatial protection measures as the International Maritime Organization's Polar Code and the Arctic Council's oil and gas guidelines, as well as spatial protection measures that are not MPAs, such as area-based fishery management measures and efforts to create shipping lanes in newly ice-free areas of the Arctic. The Convention on Biological Diversity's Aichi Target 11 on MPAs notes that MPA networks comprise both MPAs and 'other area-based conservation measures.' These other measures are currently being defined by IUCN, but may include such tools as seasonal closures and some fishery management areas. The success of all of these ecosystem approaches can greatly influence the long-term effectiveness of MPAs, and are part of a broader ecosystem approach to management (Figure 7).

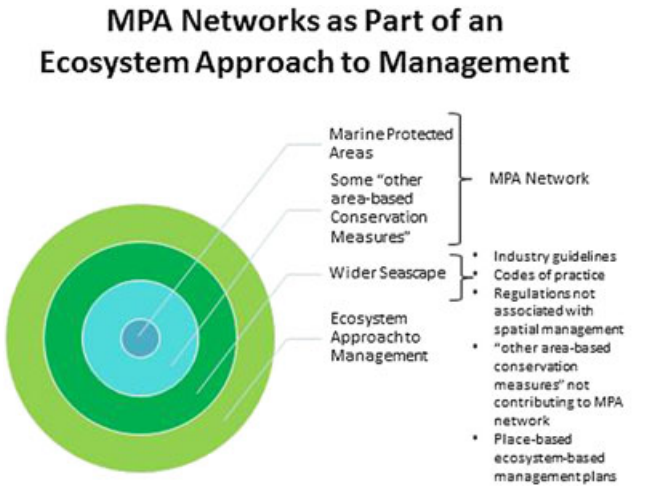

Figure 7. MPAs and an Ecosystem Approach to Management (PAME, 2015).

A major step, for example, is the recent approval by the International Maritime Organization (IMO) of the Polar Code, the first mandatory protective measures for mariners in polar waters. Effective in January 2017, the code includes provisions on safety and operations, ship design, training, and identifies environmental protective measures such as the ban on dumping oil, oily wastes, noxious materials, and garbage, and avoiding areas populated by marine mammals. The complex process to establish the code by Arctic nations, parties to the Antarctic treaty and the global maritime community requires consensus agreement among nations. Key gaps in the process include its failure to include representation of Arctic indigenous communities; the lack of provisions on the use of heavy fuel oil and emissions of black carbon; and the fact that it does not apply to fishing vessels and vessels under 500 gross tonnage (Jabour, 2014). The Arctic Council has identified a spill of heavy fuel oil as the greatest potential threat to Arctic marine resources (Arctic Council, 2009).

CONCLUSION

In the polar regions, climate change is creating a crushingly urgent need to act on marine conservation measures. In the Arctic, average warming is twice the global average, and warming in the Antarctic is also projected to accelerate in the coming decades. Resilience will be a key concept in establishing marine protection, to help conserve existing suites of ice-dependent species, and productive features of largely intact polar ecosystems that may support changing suites of species.

In both the Antarctic and the Arctic, divergent political and economic interests remain as barriers to conservation. In the Antarctic, significant governmental effort has been expended on developing the scientific basis and technical processes to support the establishment of a suite of high seas marine protected areas. The unique governance of CCAMLR is both an opportunity and a challenge to MPA establishment. The principle of establishing MPAs in the Southern Ocean has been accepted by all Parties to CCAMLR and leadership from key CCAMLR nations, combined with strong scientific basis, have led to proposals for very large MPAs and MPA networks that, if implemented, are at a scale that are likely to exceed MPA designations elsewhere on the high seas. Such proposals have significant potential to help build ecosystem resilience to climate change. However, the ideologically driven opposition to MPAs from just one or two states is sufficient to impede their establishment under a consensus system of governance.

In the Arctic, progress has been made within individual nation's EEZs to establish smaller scale MPAs. The Arctic Council's efforts on creation of a network of MPAs may help drive a more coordinated conservation agenda, and serve to connect migratory and shared species and habitats. However, local and global desires to develop the resource base in the region (primarily oil and gas) may impede the large- scale marine conservation efforts needed to sustain ecosystem functions. The continued cultural, social, and economic reliance of indigenous peoples in the Arctic on marine subsistence provides an impetus for conservation of marine resources where the governance and territorial rights of those peoples are recognized and implemented.

This examination of the current status of climate-induced change and marine conservation efforts in the polar regions highlights the critical

importance of MPAs as a management tool within the overall context of an ecosystem approach to management. Given the significant economic pressures in these regions, political leadership and public engagement are needed to promote effective MPA networks as an essential component of ocean management in the polar regions. These must be accompanied by other conservation management tools to ensure sustainable management of exploited resources and precautionary measures to limit the impacts of expanding industrial uses.

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