Antarctic Affairs. Vol 4 (2017) 1-8
ISSN: ISSN 2451-7755 (Print) - Journal homepage: www.antarcticaffairs.org

Progress Toward the Establishment of Marine Protected Areas in the Rapidly Changing Western Antarctic Peninsula

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ABSTRACT

The Western Antarctic Peninsula region is one of the fastest warming areas in the world. The waters surrounding the Peninsula and associated islandshost a large biodiversity and are one of the most important areas for Antarctic krill (Euphausia superba) in the Southern Ocean. The large concentration of krill in this region supports large breeding populations of penguins, seals and whales. Some evidence, however,showsdecreases in krill populationsdue to the reduction in the duration of sea ice caused by climate change, and regional populations of chinstrap and Adélie penguins are also in decline. In addition, krill catches in this area, where the krill fishery concentrates,are the highest they have been in almost two decades. Argentina and Chile are leading the process to establish a CCAMLR Marine Protected Area (MPA) in the region. Backed by a series of international data gathering and technical workshops in which CCAMLR members agreed to conservation objectives for the region, these leading countries are preparing a series of MPA scenarios for the region, likely to be presented to CCAMLR in 2017.

Key Words

Marine Protected Area, Antarctic Peninsula, CCAMLR, Climate Change, Antarctic krill

Introduction to the Antarctic Peninsula Region

The Antarctic Peninsula is the northernmost part of the Antarctic continent, extending north towards the tip of South America roughly 1,000 km away. The Peninsula is approximately 1,500 km long, with the Weddell Sea to the east and the Bellingshausen Sea to the west. Deep channels between the Peninsula's glacially sculpted embayments help transport nutrients toward the shelves (Ducklow et al. 2007), helping to drive the region's incredible productivity, which supports the largest Antarctic krill (Euphausia superba) aggregations in the Southern Ocean (Atkinson et al. 2004).The Peninsula and islands of the Scotia Arc and Scotia Sea support great biodiversity (Griffiths 2010), including type B2 killer whales which are found nowhere else on earth. Antarctic krill in the area sustain large breeding and foraging populations of penguins, seals and whales (Ducklow et al. 2007). The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the international body responsible for conserving Antarctic marine living resources, began discussions on creating a network of marine protected areas (MPAs) in the early 2000s. In 2011, CCAMLR agreed toa framework for the designation of MPAs in the Convention Area, dividing the area into nine "planning domains", providing a mechanism by which to plan and report on the development of MPAs. The Antarctic Peninsula area was included in "Domain 1, Western Peninsula - South Scotia Arc" (Figure 1).

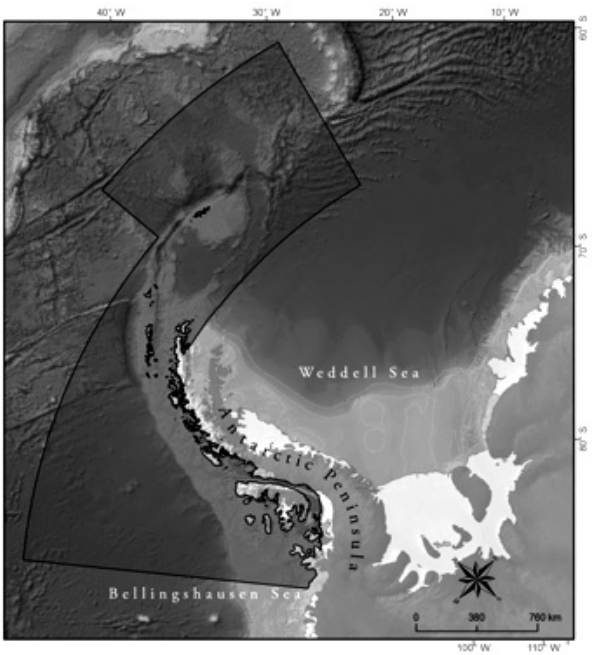

Figure 1. *Location of Domain 1, between the Weddell Sea to the east, the Bellingshausen Sea to the west, and the North Scotia Arc to the north. Map provided by Valeria Falabella, Wildlife Conservation Society.*

Human Activity

The Antarctic Peninsula and Scotia Sea region is one of the busiest areas of Antarctica, hosting a number of human activities that are likely impacting Antarctic habitats and biodiversity. With beautiful mountainous areas and incredible biodiversity, this region is the main tourist destination in Antarctica, and sees more scientific research than any other Antarctic region. The Western Antarctic Peninsula is also the fastest warming area in the Southern Ocean and one of the fastest warming areas in the world (Clarke et al. 2007). In addition, animals in this region are experiencing an increasing incidence of parasitism and disease. For example, chinstrap penguins (Pygoscelis antarctica) at Deception Island were recently found to be the first Antarctic penguin species to carry ticks (Montero et al. 2016). Domain 1 has seen in the past episodes of overexploitation of seals and whales and of some species of fin fish such as mackerel icefish (Champsocephalus gunnari) and marbled rockcod (Notothenia rossii). Some populations of seals and whales have now almost fully recovered (Ainley et al. 2010), but the populations of marbled rockcodand other notothenioids (fish with proteins in their bloodstream that prevent freezing) are still in the slow process of recovering (Marschoff et al. 2012).

The Antarctic Krill Fishery

Interest in krill fisheries began in the 1960s, with the highest catches occurring in the early 1980s, reaching over half a million tons. The concern over the large catches of Antarctic krill is what triggered the establishment of CCAMLR in 1982. In the early nineties, catches dropped dramatically due to the break-up of the Soviet Union, which forced this heavily subsidized fleet to cease operations. Catches in the Antarctic krill fishery are now the highest they have been in almost two decades and may be expanding further (Nicol et al. 2012). Krill catches have tripled in recent years, reaching a maximum of 293,815 tons in the 2013/14 fishing season (CCAMLR 2015).

Historically, fishing has taken place during the summer when penguins are constrained by how far they can travel to forage, resulting in an overlap between fishing operations and the foraging range of penguins (Hinke et al. 2017). The potential impact of fishing becomes more concerning since krill fishing activity in Statistical Area 48 (the fishing area surrounding the Peninsula, as defined by the Food and Agricultural Organization of the United Nations) has been approximately occurring in only a quarter of the area open to fishing. Additionally, in the past 10 years, the spatial distribution of the fishery has become more concentrated in the region of the Bransfield Strait off the Antarctic Peninsula (Subarea 48.1) close to land-based predators, such as penguins.

Ecosystem Changes

The combination of local human activities and climate change are acting together to impact the distribution and abundance of marine species in the region.

Some of the most pronounced effects of climate change on Earth, like warming and acidifying seas (Jones et al. 2017), and changes in sea-ice concentration and duration (Stammerjohn et al. 2008) are found in the Western Antarctic Peninsula. Because Antarctic krill rely on sea ice to complete their life cycle, the reduction in the extent and duration of sea ice in winter may be a leading cause of the decline in the abundance of krill in the Peninsula region. According to Atkinson et al (2004), there has been a reduction in krill abundance in the region of as much as 81% between 1976 and 1990. Science also shows climate change is having direct negative effects on Adélie penguin (Pygoscelis adeliae) chick growth, via regional climate and local weather patterns (Cimino et al. 2014).

In recent years, a reduction of the populations of Adélieand chinstrap penguins in the Western Antarctic Peninsula and Scotia Sea area has been reported. Populations of these species have declined more than 50% during the last 30 years at study colonies in the South Shetland Islands, which is consistent with the trend observed in the population of both species throughout the Scotia Sea (Trivelpiece et al. 2011).Significant declines in the breeding population of chinstrap penguins in Deception Island's largest colony, known as Baily Head, have recently been confirmed (Naveen et al. 2012). Changes in the abundance of Antarctic krill (the main prey of both species) could be a cause of the reduction of penguin populations.

During the austral summer of 2015-2016, a mortality event of gentoo penguin (Pygoscelis papua) chicks occurred in the southwestern Bransfield Strait. Initial observations were reported by members of the International Association of Antarctica Tour Operators (IAATO) and were later confirmed by researchers at the U.S. Palmer Long-Term Ecological Research program. Autopsies suggested starvation, rather than disease, as the cause of death. In parallel, it was reported that during December 2015 and January 2016,intense fishing was concentrated directly in front ofCuverville Island, where the large mortality of gentoo chicks was observed. Cuverville hosts the largest gentoo breeding colony in the area. There have been similar reports of dead gentoo penguins at Neko Harbor, near Cuverville in the same season (CCAMLR 2016).

Management of the Antarctic Krill Fishery

CCAMLR is generally regarded as leading the way in ecosystem-based fisheries management, implementing marine resources management based on conservation principles. The current management system for Antarctic krill divides the krill "trigger level" of 620,000 tonnes (an interim precautionary catch limit) into the subareas around the Antarctic Peninsula, in order to help alleviate the pressure of localized fishing. CCAMLR has also committed and begun to develop feedback management procedures for the krill fishery. Feedback management (FBM) is a system of managing the krill fishery at small spatial scales, using information on the status of the ecosystem, such as how certain predator populations are responding to fishing and environmental changes, to continuously alter the levels of fishing in a given spatial area. For further references on CCAMLR management of the Antarctic krill fishery, see Gascon and Werner (2009), Werner (2015), The Pew Charitable Trusts (2016).

Status of the MPA process

A number of small MPAs are already scattered throughout Domain 1, including around the South Shetland Islands and the Palmer Archipelago. But these tiny areas (generally terrestrial with a small marine component), managed by the Antarctic Treaty Consultative Meeting, are inadequate to protect the Peninsula's krill populations, millions of breeding seabirds, marine mammals, and the greater ecosystem. As a first step in marine spatial protection, the South Orkney Islands Southern Shelf MPA was established by CCAMLR in 2009, also protecting a portion of Domain 1. In addition, based on a 2016 decision by CCAMLR,"Special Areas for Scientific Study" may be designated in any newly exposed marine area after the retreat or collapse of an ice shelf, glacier, or ice tongue (a narrow sheet of ice) in parts of the Peninsula region. While not MPAs, these areas would offer protection to coastal marine biodiversity for up to 10 years.

The process to designate additional MPAs within Domain 1has been led by Argentina and Chile since 2012. Since then, more than 180 spatial layers of scientific data were created in a collaborative process involving many CCAMLR members. These layers describe the spatial distribution of ecosystem processes, habitats and key species, while dozens of other layers contain data on human activities such as fishing, tourism, scientific, and logistic activities (CCAMLR 2016).

With a transparent spirit of cooperation, Argentina and Chile have organized several international meetings focused on Domain 1 to facilitate the collation, analysis, discussion and integration of data by interested CCAMLR Members.

In 2012, the First International Workshop on Domain 1 MPAs, held in Valparaíso, Chile, defined the conservation objectives for the area. In 2013, Argentina and Chile held a bi-national workshop in La Serena, Chile, where the two countries defined the necessary steps towards creating the MPA proposal, and agreed to use the program MARXAN as the systematic conservation planning tool. In 2015, Argentina organized the Second International Workshop on MPAs, held in Buenos Aires. This meeting was fundamental in laying the scientific and technical foundations for each conservation objective. Also, in the 2015 meeting, data layers were updated, new data sets were added, and a rangeof specific conservation target levelswere defined for analysis.

Finally, in July 2016, an informal workshop was convened around the meeting of CCAMLR's Working Group on Ecosystem Monitoring and Management in Bologna, Italy. During that meeting, Argentina and Chile presented the technical progress made during the previousyear. Amajority of CCAMLR members attended that workshop, which provided a good opportunity to discuss the sensitivity of MARXAN to different parameters, including the level of protection for each object ofconservation. Complementary analyses, using previous and newly available data (which were previously uploaded in the so called,"CCAMLR Domain 1 dataset"), were presented and discussed, validating the results obtained so far.

Next Steps

In July 2017, at the meeting of the CCAMLR Working Group on Ecosystem Monitoring and Management in Buenos Aires, Argentina and Chile presented a preliminary proposal, to advance toward a formal MPA proposal to then be endorsed by CCAMLR's Scientific Committee and be discussed at the Commission.

In July 2017, at the meeting of the CCAMLR Working Group on Ecosystem Monitoring and Management in Buenos Aires, it is expected that Argentina and Chile will present the results of the latest analyses, potentially including conservation scenarios for discussion to advance toward the preparation of a formal MPA proposal to then be endorsed by CCAMLR's Scientific Committee and discussed at the Commission.

The MPA implemented in the Antarctic Peninsula region should protect biodiversity hotspots as well as representative and unique benthic and pelagic habitats. An effective MPA for the Peninsula would ideally include no-fishing buffer zones in coastal areas where penguins forage during the breeding season, predominantly in the Bransfield and Gerlache Straits. Particularly, in these two areaswhere krill fishing activities have increased in recent years, predator populations are seeing major changes. In addition, the MPA should consider protecting sensitivespawning and nursery habitat for krill and for other commercially and ecologically valuable fish species (i.e. icefish, silverfish, and toothfish), as well as key breeding, foraging, and migration areas for seabirds and marine mammals. Although MPAs can't stop climate change and acidification, studies show that they can help build ecosystem resilience by eliminating fishing stresses.The MPA should also include climate change reference refuges, areas without fishing where the effects of climate change can be studied.

In the designation of CCAMLR MPAs withinDomain 1, the development of feedback managementfor the krill fishery will need to be considered to harmonize both processes. Thus, CCALMR will need to protect important predator foraging areas in Domain 1, while considering adding reference areas for feedback management of the krill fishery. In doing so, sensitive areas that should be protected from fishing will need to be identified to be compared to areasthat remain exposed to fishing. How the spatial conservation objectives of the Convention will interact with the management of the krill fishery in the Antarctic Peninsula area, one of the most impacted and fastest changing regions of the Antarctic, remains one of the ultimate challenges for CCAMLR.

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