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OF ANTARCTIC MARINE LIVING RESOURCES

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DE LA FAUNE ET LA FLORE MARINES
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THE CASE FOR INCLUDING THE ROSS SEA CONTINENTAL SHELF AND SLOPE IN A SOUTHERN OCEAN NETWORK OF MARINE PROTECTED AREAS

Submitted by ASOC

The Case for Including the Ross Sea Continental Shelf and Slope in a Southern Ocean Network of Marine Protected Areas

Abstract

Both the Convention for the Conservation of Marine Living Resources (CCAMLR) and the Environmental Protocol to the Antarctic Treaty provide for the establishment of marine protected areas (MPAs) for purposes of scientific study and to conserve unique features and components of the Antarctic marine ecosystem. This paper summarizes the case for including the Ross Sea within CCAMLR's network of MPAs, following the discussion at the Working Group on Ecosystem Monitoring and Management (WG- EMM) meeting in South Africa this year. The Antarctic and Southern Ocean Coalition (ASOC) proposes, in part because the area meets several other internationally recognized biodiversity criteria for MPAs, that the Ross Sea shelf and slope become part of the CCAMLR network, allowing marine science to continue without interference from other, extractive uses that would alter ecosystem structure and dynamics.

ASOC submits that protection of the Ross Sea continental shelf and slope is a high priority, as an area embedded within one of the regions recognized by CCAMLR through the bioregionalisation process in 2008, and by the Antarctic Treaty Consultative Meeting (ATCM) and Committee on Environmental Protection (CEP), as priority areas for MPA designation. This paper outlines how the Ross Sea shelf and slope fulfill the criteria for selecting sites under the auspices of the Antarctic Treaty and CCAMLR for the designation of marine protected areas to conserve and enable the continued assessment of the structure and dynamics of a unique marine ecosystem. For perspective, this paper makes comparisons with the special area criteria under the Convention for Biological Diversity (CBD) and United Nations Educational Scientific and Cultural Organization's (UNESCO) World Heritage Sites.

The Ross Sea is of high global importance in terms of its biodiversity, evolutionary significance, disproportional presence of many charismatic high-latitude species, and potential as a climate refuge and reference area for the detection of the effects of climate change on marine ecosystems. According to an independent analysis of human impacts on the world's oceans, the Ross Sea is the least affected large continental shelf ecosystem remaining on Earth (Halpern et al. 2008). If protected it would be the highest latitude habitat represented in a comprehensive and representative network of Southern Ocean MPAs, and has for decades been an area in which investigations have led the way in disclosing interannual, decadal and long-term effects of climate change on the hydrography and biota of a high latitude system. The Ross Sea benthos is especially rich and the abundance of its top predator species is unique. As the Continental shelf and slope contain most of the spawning/breeding, feeding, molting and wintering areas of these predators, ASOC submits that the Ross Sea should be protected as a unit.

1. Introduction

CCAMLR (2008) endorsed 11 areas previously identified as priorities for the development of MPAs on the basis of high physical heterogeneity, which is indicative of areas of high biodiversity (see Thrush et al. 2010). ASOC notes that the process agreed by the CCAMLR Commission enables completion of an initial representative network of marine spatial protection and management by 2012. ASOC encourages all CCAMLR Parties to engage in and support this process, recognizing the provisions of CCAMLR and the Protocol to the Antarctic Treaty on Environmental Protection providing for the establishment of MPAs for

purposes inter alia of scientific study and comparison with other localities affected by human activities (see Article IX (g) of CCAMLR and Article 3(2)(a) of Annex V to the Environmental Protocol).

Two of the 11 priority areas identified by WG-EMM in 2008 and agreed to by CCAMLR that year are the Northern Ross Sea / Eastern Antarctica and the Ross Sea Shelf. We speak herein of the latter, which would become the highest latitude area within the proposed network of Southern Ocean MPAs.

2. Summary of IMCC Workshop Report

An international Ross Sea workshop held in Fairfax, Virginia in May 2009, as part of the International Marine Conservation Congress (IMCC), supported CCAMLR's and the Antarctic Treaty Parties' efforts to identify likely areas of high biodiversity through the information presented by the 30 participants. Participants included most of the researchers from the three countries (Italy, New Zealand, and United States of America) who have principally been conducting marine research in the Ross Sea over recent decades. Included were benthic and pelagic ecologists, oceanographers, marine mammal, seabird and fishery biologists, and sea ice and climate experts. Researchers who could not attend reviewed and contributed to the final report. The report was submitted to the CCAMLR Working Group on Ecosystem Monitoring and Management (WG-EMM; CCAMLR 2009), and a revision and further compilation and assessment of related data were submitted to and discussed at the 2010 WG-EMM meeting (Ainley et al. 2010a, Ballard et al. 2010).

The workshop participants concluded that:

- Overall, the state of the Ross Sea foodweb is comparable to what it has been for millennia except for the loss of blue and sperm whales (now recovering very slowly) along the slope, and a decreasing prevalence of large Antarctic toothfish and its predators in recent years (see Devries et al. 2008; Ainley 2010; Ainley et al. 2009, 2010a; CCAMLR 2009). As a living museum, in which more than 500 species were first described from Ross Sea specimens dating back 170 years, the Ross Sea represents a unique baseline of species occurrence patterns and habitat associations, which is important in the face of changing ocean climate.
- The Ross Sea possesses a fauna, especially its notothenioid fishes, that comprises a unique, marine example of an evolutionary radiation on par with those recognized in freshwater and terrestrial World Heritage Sites such as the Galápagos Islands, African Rift Lakes, and Lake Baikal;
- On the basis of projections made from current models in the International Panel on Climate Change (IPCC), the Ross Sea is likely to be the last ocean area on Earth, perhaps within the current century, that will embrace a cryopelagic community of organisms; and
- The Ross Sea is the best-studied stretch of high latitude, continental shelf marine area in the Southern Hemisphere. Past and ongoing studies include: a) the geologic history, geophysical characteristics, and characterization of its seafloor substrate; b) circulation; c) polynya-facilitated biogeochemical processes leading to extremely high primary production; d) benthic-pelagic coupling whereby water column production enriches the benthic community; e) diverse assemblage of benthic fauna, depending on substrate, slope, current velocities and biological interactions, and varying in age from thousands of years to successional stages of iceberg scour events; and f) paradoxically (in today's world) low level of zooplankton abundance in the context of g) an unusually robust pelagic assemblage of numerous large fish, flying birds, penguins, pinnipeds and toothed and baleen whales.

3. ASOC's Proposal

Waters overlying the Ross Sea continental shelf comprise ~1.3% of the Southern Ocean (433,000 of 32.9 million km2 south of the Antarctic Polar Front including those beneath ice shelves); including the slope brings the area in question to 647,000km2, or ~2% of the Southern Ocean, in total an area that is small in size from a global and Southern Ocean perspective but of enormous importance biologically and, at a larger perspective, to society and science. As shown by the IMCC Workshop Report (CCAMLR 2009, Ainley et al. 2010a), the biodiversity and other values of the shelf and slope area of the Ross Sea (e.g. Thrush et al. 2010), easily fulfill the criteria contained in the Madrid Protocol for establishment of Antarctic Specially Protected Areas (ASPAs) and Antarctic Specially Managed Areas (ASMAs), and under CCAMLR's Article II and other provisions; United Kingdom 2007).

ASOC proposes that CCAMLR take the necessary steps, for scientific, ecological and world heritage reasons,[1] *to include the entire Ross Sea shelf and slope within one of the MPAs chosen to preserve Southern Ocean biodiversity and ecosystem function.*

Such an MPA would:

- Afford special protection to the last remaining near-pristine open-ocean ecosystem on Earth (see summaries in Halpern et al. 2008, Ainley 2010), **so that collaborative, international marine science may continue toward understanding oceanic foodweb structure and processes, and responses to climate change, without being confounded by other forms of human activity**. Such science has been pre-eminent in this region for five decades, and includes biological and extensive oceanographic, geological and glaciological research (see Smith et al. 2007, 2010). Due to its long-term record, Ross Sea data were the first or among the first to indicate the importance of short-term (EL Niño Southern Oscillation - ENSO), decadal (Southern Annular Mode) and longer-term (global climate change) influence on high southern latitude hydrography, sea ice and biota (see discussion in Dayton 1989, Ainley et al. 2005, Jacobs 2006, Stammerjohn et al. 2008).
- Protect exemplary benthic and pelagic biodiversity of high evolutionary significance (e.g., Bradford-Grieve, J. and G. Fenwick 2001, Clarke and Johnston 2003, Simon et al. 2010). The Ross Sea represents the type locality of more than 500 marine vertebrate and invertebrate species dating back 170 years, which constitute an unequivocal record of species presence (see also below). A portion of the Ross Sea shelf, unlike anywhere else in the high latitude Antarctic, has been a biotic refuge, including an extensive polynya, during glacial maxima, as shown by extensive sediment coring (Anderson 1999, Thatje et al. 2008).
- Protect what according to Intergovernmental Panel on Climate Change (IPCC) models will become a refuge for sea ice associated communities in the face of sea ice disappearance in the remainder of the Southern Ocean predicted to occur this century (see discussion in Ainley et al. 2010b).
- Preserve essential habitat of 32% and 26% of the world populations of Adélie and emperor penguins (summer, molting, and portion of wintering habitat); 30% of the world population of Antarctic petrels (summer feeding grounds), 6% of Antarctic minke whales (annual feeding grounds), perhaps 50% of Ross Sea killer whales (summer foraging grounds); and approximately 45% of the South Pacific sector Weddell seal population (year round habitat; see Ballard et al. 2010).
- Ensure the preservation of the primary habitat for sub-adult growth and adult spawning recovery of an ecologically and scientifically important Antarctic toothfish population (Hanchet et al. 2008, Brooks and Ashford 2008).

[1] Although the statutes of the UN CBD and UNESCO are not applicable to the high seas of the Southern Ocean, their criteria for identifying Ecologically and Biologically Significant Areas and World Heritage Sites, respectively, are fulfilled by the intrinsic values of the Ross Sea (see Table 1).

4. Conclusions

In order to reliably predict how marine ecosystems are likely to respond to climate change, and to develop ways to keep them healthy, it is essential to understand the workings of a fully functional ecosystem that is influenced as little as possible by human activities. For this reason alone, as no comparatively pristine marine ecosystems remain on Earth (NSF 1998, Halpern et al. 2008), it is essential that the Ross Sea is made a priority for protection and continued research and monitoring. Conferring comprehensive protection on the Ross Sea would preserve incomparable aesthetic, wilderness, and spiritual values, as well as provide a continuing opportunity for critically needed research and monitoring.

The Ross Sea provides an unparalleled opportunity for the conservation and rational use of a comparatively pristine marine ecosystem to:

- Investigate climate change and its ecological effects without interference by other, more direct anthropogenic impacts. Indeed, climate change clearly has been altering long-term the sea ice and oceanographic properties of the Ross Sea (Stammerjohn et al. 2008), as well as its biota (Dayton 1989, Ainley et al. 2005, 2010), in a well documented fashion. The Ross Sea serves as counterpoint to the Antarctic Peninsula region, where, so far, sea ice has been increasing and decreasing, respectively, the two areas comprising the 'Antarctic Dipole', a complementary system of atmospheric pressure centers that are responding in opposite directions to influences of global climate change and the Antarctic Ozone Hole (Russell et al. 2006, Thompson and Solomon 2002; and

- Investigate the dynamism inherent in both bottom-up and top-down forces that structure this foodweb, rather than mainly the bottom-up processes that now exclusively control the depleted, pyramid-structured, resource-driven marine ecosystems elsewhere. (e.g., Worm et al. 2006, Daskolov et al. 2007, Österblom et al. 2007, Watermeyer et al. 2008a, b).

Table 1

Summary of attributes of the Ross Sea, as detailed in CCAMLR (2009) and Ainley et al. (2010a), applied to the detailed criteria with which to recognize and preserve special areas under the Madrid Protocol, Convention for Biological Diversity, and designation of World Heritage Sites under UNESCO. As a high seas area, the Ross Sea does not qualify under CBD and World Heritage Sites/UNESCO but the comparison provides perspective; see also ASOC (2007) and United Kingdom (2007). See Appendix for definitions of numbered criteria under the three respective international agreements.

Madrid Protocol	**CCAMLR**[2]	**CBD**	**World Heritage**	**Special Attribute Justifying Protection**	**How Ross Sea Complies**
I.2.a	X	II.a; II.g	III.a	Uniqueness / rarity; inviolate from human interference; naturalness	Least affected continental shelf/slope on the planet (Halpern et al. 2008; see also Ainley 2009)
I.2.b	X, X	II.b	III.d	Representative example of major marine ecosystem; special importance to life history; important natural habitat	Largest expanse of continental shelf in the Antarctic; a biotic refugium during past glaciations, and likely to be one of the last stretches of ocean having significant amounts of pack ice, year-round, in the foreseeable future. Representative section of the Antarctic Slope Front, first described by Ross Sea studies.
I.2.c		II.c	III.d	Unusual and important assemblage of species	Home to 38% of Adélie penguins, 26% emperor penguins, 30% Antarctic petrels, 6% Antarctic minke whale, ~45% Pacific sector Weddell seals; a rich benthos, comprised of 5 major community types; a benthic biodiversity hotspot (Clarke and Johnston 2003).

[2] CCAMLR criteria are not numbered. Two X marks in one box indicate that there are two different CCAMLR criteria that are represented by the "special attribute" column for that row.

Madrid Protocol	CCAMLR[3]	CBD	World Heritage	Special Attribute Justifying Protection	How Ross Sea Complies
I.2.d		II.a, c, f	III.c	Type locality, endemism; outstanding example on-going biological processes in evolution	Type locality for: one bird, 40 species of fish, and >450 species of benthic animals. 7 species of fish are endemic, and >40 species of invertebrates have so far been found nowhere else; unique genetic strains of Weddell seals, Adélie penguins
I.2.e	X		III.d	Particular interest on-going research; outstanding value point of view of science	Longest hydrologic record in Southern Ocean; 4 longest time series of wild populations (seals, penguins, benthos, toothfish); intensive history of research on climate change at geologic and contemporary time scales; major climate projects ongoing, such as ANDRILL
I.2.f			IIII.b	Outstanding geological, glaciological or geomorphological features	Largest Antarctic continental shelf; largest ice shelf; largest polynya; major contributor to ABW production; active volcano
I.2.g		II. g	III.a	Outstanding aesthetic and wilderness value	Least affected stretch of continental shelf ocean on Earth; pack-ice ecosystem bordered by Antarctica's only major mountain range
I.2.h				Recognized historic value	First-explored part of the high latitude Southern Ocean (Ross) and of Antarctica itself: Ross, Borchgrevink, Amundsen, Scott, Shackleton, Byrd, Hillary; historic huts and other remains from heroic era expeditions

[3] CCAMLR criteria are not numbered. Two X marks in one box indicate that there are two different CCAMLR criteria that are represented by the "special attribute" column for that row.

		II.e	III.b	Biological productivity; significant on-going ecological processes	Most productive stretch of the Southern Ocean (Arrigo et al. 1998).
		II.c, d	III.b	Vulnerability, fragility, sensitivity; significant on-going ecological processes	Pack ice ecosystem, likely to be one of the few remaining on the planet under current global warming scenarios. Most organisms are slow growing, long-lived, thus sensitive to extraction.

Figure 1. Distribution of Ross Sea benthic communities; green, Pennell Bank; pink, deep shelf mixed; purple, deep shelf mud; blue, Victoria Land coastal; aquamarine, McMurdo Sound. Data from Bullivant (1967) and Barry et al. (2003), as summarized in Ainley et al. (2010a).

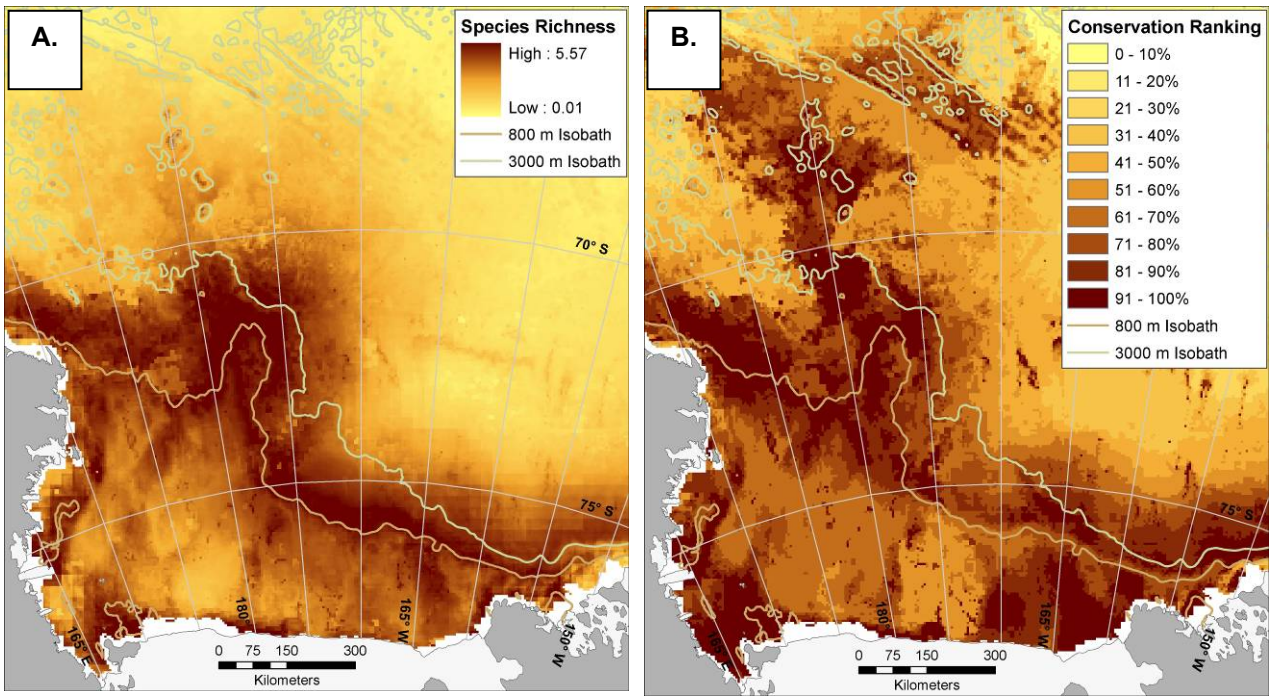

Figure 2. Results from Ballard et al. (2010): (A) Modeled species richness (sum of individual species' Maxent-modeled probabilities of occurrence) of mesopredators of the Ross Sea: Ross Sea Killer Whale, Minke Whale, Crabeater Seal, Weddell Seal, Emperor Penguin, Adélie Penguin, Antarctic Petrel, Snow Petrel, and Light-mantled Sooty Albatross; (B) Relative conservation importance for same species; results from Zonation core area analysis with all species given equal conservation priority (darker colors represent higher conservation ranking). Species, formerly present but now rare and listed as endangered by IUCN, i.e. blue and sperm whales (Ainley 2010), are not included; Antarctic toothfish are also not included in the model, because specific locational data were not available for mature, neutrally buoyant adults (>120-130cm).

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V. Appendix

I. CCAMLR and the CEP, under their respective treaties and given their particular roles, have different but complementary guidelines for specially protected status to be accorded marine areas in the Southern Ocean. While ASOC is not formally proposing that the Ross Sea become an ASPA or ASMA, as could be designated under Annex V, Article 3, of the Madrid Protocol of the Antarctic Treaty, it is instructive to view how the Ross Sea compares under those criteria:

1. Any area, including any marine area, may be designated as an Antarctic Specially Protected Area to protect outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or ongoing or planned scientific research.
2. Parties shall seek to identify, within a systematic environmental-geographical framework, and to include in the series of Antarctic Specially Protected Areas:
   (a) areas kept inviolate from human interference so that future comparisons may be possible with localities that have been affected by human activities;
   (b) representative examples of major terrestrial, including glacial and aquatic, ecosystems and marine ecosystems;
   (c) areas with important or unusual assemblages of species, including major colonies of breeding native birds or mammals;
   (d) the type locality or only known habitat of any species;
   (e) areas of particular interest to on-going or planned scientific research;
   (f) examples of outstanding geological, glaciological or geomorphological features;
   (g) areas of outstanding aesthetic and wilderness value;
   (h) sites or monuments of recognised historic value; and
   (i) such other areas as may be appropriate to protect the values set out in paragraph 1 above.

Several already-designated ASPAs in the Ross Sea region include small amounts of marine habitat (e.g. Cape Hallett 106, Cape Crozier 124, and Terra Nova Bay 161), as does the Antarctic Pack-ice Seals Agreement under the Antarctic Treaty (Edisto Inlet, Cape Hallett; SW corner of the Ross Sea, including McMurdo Sound), and the recently agreed South Orkneys marine protected area designated by CCAMLR, which protects <1% of the Southern Ocean (CCAMLR Conservation Measure 91-3).

ASPAs are roughly equivalent to IUCN Category I and ASMAs to Category V, according to the 2nd Antarctic Protected Areas Workshop Report 2000.

The guidelines under CCAMLR are highlighted in SC-CAMLR-XXVII (3.55), which registers agreement that the existing benthic and pelagic bioregionalisations developed by the 2007 Bioregionalisation Workshop were adequate, although further refinement may be undertaken; and that a number of methods could be used for designing a representative system of [reserves], including, *inter alia*, bioregionalisation and/or systematic conservation planning. It further mentioned the use of MARXAN as one but not the only software tool, and in the case of the information presented in these paper on the Ross Sea MAXENT is being used (Fig. 2). CCAMLR, in its 2005 marine protected area workshop identified four types of reserves that would suit its spatial protection goals (United States 2005):

- representative areas;
- vulnerable areas;
- scientific areas; and
- areas of noteworthy ecosystem processes

These categories were divided to address further conservation goals that reflected CEP priorities:

- protect unique, rare, highly diverse areas;
- protect critical life-history areas;
- increase resilience to climate change;
- areas kept inviolate from human disturbance; and
- multiple use areas to coordinate activities.

II. While the CCAMLR and CEP work on marine reserves has been progressing, the UN Convention for Biodiversity has begun to consider Biological and Ecological Important Areas, including those on the high seas, which should be protected in perpetuity. This Convention does not specifically apply to the Southern Ocean, owing to its status under the Antarctic Treaty, and Annex I of CBD Decision IX/20) provides useful criteria for selecting areas while using CCAMLR attributes as well as Madrid Protocol attributes for ASPAs for spatial protection as enumerated above. These criteria are:

(a) Uniqueness / rarity;
(b) Special importance for life history of species;
(c) Importance for threatened, endangered or declining species / habitats;
(d) Vulnerability, fragility, sensitivity, or slow recovery;
(e) Biological productivity;
(f) Biological diversity; and
(g) Naturalness.

III. Finally, the United Nations (UNESCO) has developed criteria under which World Heritage Sites can be designated under national jurisdiction,[4] and again these are included within the language of Madrid Protocol attributes for ASPAs and CCAMLR's marine protection provisions. While it is not possible to formally designate such sites under the Antarctic Treaty, owing to the fact that there is no recognized national sovereignty south of 60^{o} S under the Treaty, these criteria are applicable to the Ross Sea. Several areas similar in spatial extent to the Ross Sea (e.g., Lake Baikal, African Rift Lakes) have been designated as World Heritage Sites elsewhere on Earth:

(a) Superlative natural phenomena or areas of exceptional beauty and aesthetic importance;
(b) Outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
(c) Outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; and
(d) Important and significant natural habitats for in-site conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

[4] http://whc.unesco.org/en/criteria/