OVERLINE

The decline of science-based management in the Southern Ocean: Conservation or compromise?

Antarctic policy-makers face a critical challenge in fulfilling science-based mandates to preserve Southern Ocean ecosystems.

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Ancient Greeks insisted that a great southern continent must exist in symmetry with the north or the Earth would topple over. Scientists have since documented that the Antarctic is vital to Earth systems as it stores ~90% of the Earth’s freshwater, regulates global climate, and drives ocean circulation (*1*). The Southern Ocean also harbors the world’s healthiest marine ecosystems (*2*), but faces increasing impacts from climate change and fishing. With an internationally lauded precautionary, ecosystem-based mandate to conserve Southern Ocean ecosystems (*3*, *4*), the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR) has committed to adopting marine protected areas (MPAs) in the waters around Antarctica (*5*).

Yet after more than a decade of negotiations and scientific planning, CCAMLR has not succeeded in meeting its mandate to protect Southern Ocean ecosystems. Here, we expand on findings from multi-year participant observations (*5*) to reveal that conflict over geopolitics and access to marine resources has blocked MPA adoption or resulted in MPAs proposed with compromised conservation value. By disregarding the best available science, States have distorted the foundational rules of their Convention, broken trust, and divided the Commission. With negotiations due to resume at the upcoming 2016 annual CCAMLR meeting, we offer recommendations aimed at implementing effective Southern Ocean MPAs, upholding CCAMLR’s mandate, and maintaining its global leadership.

Celebrated as an extraordinary case combining global diplomacy, environmental protection, and scientifically-based marine resource management, the Antarctic Treaty System (ATS) effectively sets aside the Antarctic as a global commons dedicated to peace and science (*6*). The Convention on the Conservation of Antarctic Marine Living Resources (CAMLR Convention) is the arm of the ATS that governs the use of marine life in the ocean surrounding the continent (Figure 1). Its primary objective is conservation, defined to include ‘rational use,’ which permits fishing by CCAMLR’s 24 Member States (plus the European Union), but only under principles of precautionary, ecosystem-based management (*3, 7*). All management decisions require consensus and must be based on the ‘best available science,’ requiring that management measures take full account of the best scientific information available as determined by CCAMLR’s Scientific Committee (SC-CAMLR)—an advisory body composed of international multi-agency scientists (*7, 8*).

In 2002, CCAMLR committed to designating a network of MPAs in the Southern Ocean (*5*). MPAs are broadly recognized as an invaluable tool to assess, manage, and mitigate negative human impacts and maintain biodiversity (*9, 10*). Through a series of workshops starting in 2005, CCAMLR scientists identified priority areas for protection (*5*). Commission States also adopted a measure mandating that, inter alia, MPAs (a) be established based on the best available science, (b) protect key ecosystem processes, habitats and biodiversity, and (c) include scientific reference areas to monitor the long-term effects of fishing and climate change (*11*).

Climate change and overfishing are the two main threats to Southern Ocean ecosystems. The Antarctic is changing rapidly (*12*) with potential global repercussions for sea level rise, ocean circulation, and climate regulation. Locally, climate change is driving fluctuations in ice cover, shifts in population distributions and alterations in primary productivity (*13)*. In some areas, declines of ice-dependent Antarctic krill (*Euphasia superba*) are potentially causing cascades throughout the ecosystem (*13, 14*). Despite these rapid changes, fishers advocate for increased catches (*15*). Considered unsuitable for direct human consumption, fishers now target krill for omega-3 and fishmeal (*16*). With reductions in ice and declines in krill, fishing vessels are increasingly encroaching upon penguin and whale foraging grounds (*15*), compounding climate change stressors (*14*). To meet rising market demands for toothfish (*Dissostichus eleginoides* and *D. mawsoni*), sold as lucrative ‘Chilean sea bass,’ fishers have pushed for higher catches and expanding fishing grounds (*5, 15*). Yet, the ecological repercussions of removing toothfish, the region’s top fish predator, remain unknown (*17)*.

Moving towards an MPA network, CCAMLR adopted the world’s first high seas MPA near the South Orkney Islands in 2009 (*18*)(Figure 1). Protecting ~94,000 km2, this MPA remains the only 100% no-take reserve in international waters. While the stated goal of the MPA is biodiversity conservation, conflicts between preservation and fishing access produced a compromised result. The modified MPA excluded areas of highest ecological value to avoid conflict with commercial krill fisheries operated by several CCAMLR States (*5*)(Figure 1, S1). After adoption, Japan, with the endorsement of South Korea and Russia, stated that “the amended MPA constitutes a good precedent” (19, para 7.4) because fisheries were not restricted. While other States objected to “the notion… that MPAs and fishing activities should be mutually exclusive” (*19,* para 7.7), this precedent of compromising ecosystem conservation despite the best available science continues to influence CCAMLR’s MPA negotiations.

In 2012, CCAMLR considered MPA proposals in the Ross Sea and East Antarctic. As one of the world’s healthiest marine ecosystems and among the most productive and best-studied regions of the Southern Ocean (*2, 20*), the Ross Sea was a top priority for protection. Both the Ross Sea and East Antarctic MPA proposals were designed to protect ecological structure and function, with reference areas for evaluating climate change and fishery impacts, and both were deemed by SC-CAMLR to be based on the best available science (*5*).

Yet by 2015, the areas proposed for protection in the Ross Sea and East Antarctic were reduced by 30% and 50%, respectively, with ecologically important areas omitted to enable fishing access (Figure 1, S2). Research fishing zones, which permit commercial fishing for toothfish and/or krill with additional requirements (e.g. increased fish tagging), were added to the Ross Sea MPA. These fishing zones encompassed critical foraging grounds for seabirds and whales, and jeopardized a key scientific reference area that had been proposed to measure fishery ecosystem impacts (*5*)(Figure S2). Even though the East Antarctic MPA proposal employs a multi-use approach, it omitted no-take zones and the area of highest conservation value, Prydz Bay, was removed during negotiations (Figure 1).

Temporal concessions, or ‘sunset clauses,’ have also marred negotiations. MPAs are usually established in perpetuity and their duration has been directly linked to ecosystem benefits (*9*). The largely terrestrial protected areas adopted via the Antarctic Treaty are permanent as are nationally designated subantarctic MPAs. While duration was not discussed during the 2009 South Orkney MPA negotiations, it has emerged as a major barrier to consensus with many CCAMLR fishing States asserting that MPAs must include an expiration date. China proposed a limit of 20 years (*15*, para 8.77), shorter than the lifespans of most Antarctic top predators and inconsistent with the stated goals of the MPAs as well as CCAMLR’s provisions for rational use. As of 2015, the proposed Ross Sea and East Antarctic MPAs have 50- and 30-year expiration dates, respectively (*15*).

Current MPA proposals only prohibit fishing in 3.2% of CCAMLR’s waters (Figure 1) for a fixed period of time and yet consensus still lags. States have become entrenched in their positions for or against MPAs, breaking trust. States blocking the adoption of MPAs continue to do so even after concessions were made to directly meet those States requests (*15*). Negotiations have been tainted by geopolitical disputes elsewhere in the world (*21*). States proposing MPAs have been accused of political rather than conservation motivations (17).

This stalemate may reflect the emerging scramble for Southern Ocean resources (*21*). While CCAMLR was historically comprised mainly of States without active fisheries in the Southern Ocean, it is now dominated by fishing States (Figure S1)(*5*) whose national positions reflect intent on economic gain, asserting power, and securing future access (*21*). The idea of ‘rational use’—defined in the Convention as a mandate to employ precaution in resource exploitation, a critical part of conservation—is now being turned on its head by several States to defend an unequivocal right to fish and to argue against MPAs that in any way restrict fishing (*17, 22*). If the current proposals are adopted, their concessions will compromise MPA effectiveness, thus undermine the conservation mandate of CCAMLR, and the implementation of science-based marine management broadly. The Commission has a critical window of opportunity to protect Southern Ocean ecosystems, uphold the principles of peace, science, and protection embedded in the ATS, and maintain its reputation as the leader in international ocean management. We offer five recommendations for the upcoming meeting:

Endorse only well-designed MPAs. MPAs that are designed with the best available science and combine no-take areas with effective enforcement lead to more diverse and productive ecosystems that provide resilience and insurance against uncertainty (*9, 10*). Ineffective MPAs that only ‘protect’ unfishable ocean areas, in violation of CCAMLR’s own mandated best practices (*11*), undermine CCAMLR’s credibility and the value of MPAs as a management tool.

Establish MPAs in Perpetuity. MPAs need to be managed for long-term conservation (*9*). CCAMLR’s MPA rules specify, “the period of designation…shall be consistent with the specific objectives of the MPA” (*11*, para 3v). Proposed ‘sunset clauses’ are insufficient for achieving MPA conservation objectives. Further, they will not meet internationally established criteria for protected areas (*23*) and thus may not qualify towards global MPA targets.

Uphold CCAMLR’s Mandate. The Convention was designed as a conservation convention with fisheries management grounded in precautionary and ecosystem-based approaches (*5, 7, 17, 22*). The use of closed areas ‘for purposes of scientific study or conservation’ (7, Article IX.2g) is an essential component of ecosystem-based management (*17*). Any redefinition of ‘conservation’ as an unequivocal right to fish compromises not only the purpose of MPAs but also the integrity of the Southern Ocean ecosystem and the high seas beyond (*4*).

Demonstrate Leadership. In adopting proposed MPAs in the Ross Sea and East Antarctic, CCAMLR could protect more than 2 million km2 or 6% of the Southern Ocean. With proposals for additional MPAs underway, CCAMLR could become the first international marine management organization to meet global protection targets agreed to by the Convention on Biological Diversity, (10% of waters protected by 2020) (*24*), to which almost all CCAMLR States are members. This precedent would inform the current United Nations’ development of a legally binding agreement for the conservation of marine biodiversity beyond national jurisdiction (*24*) and influence governance of emerging resource frontiers (e.g. the Arctic).

With the network of Southern Ocean MPAs under negotiation, CCAMLR has a historic opportunity and global responsibility in 2016. In upholding CCAMLR’s charter, Member States could safeguard Southern Ocean ecosystems for current and future generations, and avoid ‘toppling over’ one of the most effective, scientifically-based, international environmental agreements.

References and Notes:

1. S. M. Grant, S. L. Hill, P. N. Trathan, E. J. Murphy, *Antarct. Sci.* **25**, 603-617 (2013).

2. B. S. Halpern *et al.*, *Science* **319**, 948-952 (2008).

3. D. G. Miller. “Sustainable Management in the Southern Ocean: CCAMLR Science” in *Science Diplomacy: Antarctica, Science and the Governance of International Spaces* (Smithsonian Institute Scholarly Press, Washington, DC, 2011).

4. C. M. Brooks *et al.*, *Stan. Envtl. LJ.* **33**, 289-324 (2014).

5. C. M. Brooks, *Polar J.* **3**, 277-300 (2013).

6. P. Berkman, M. Lang, W. Walton, O. Young, *Science Diplomacy: Antarctica, Science and the Governance of International Spaces*. (Smithsonian Institute Scholarly Press, Washington, DC, 2011).

7. The Convention on the Conservation of Marine Living Resources. (1980).

8. CCAMLR, Resolution 31/XXVII Best Available Science (2009).

9. G. J. Edgar *et al.*, *Nature* **506**, 216-220 (2014).

10. J. Lubchenco, K. Grorud-Colvert, *Science* **350**, 382-383 (2015).

11. CCAMLR, Conservation Measure 91-04. General Framework for the establishment of CCAMLR Marine Protected Areas (2011).

12. S. Stammerjohn, R. Massom, D. Rind, D. Martinson, *Geophys. Res. Lett.* **39**, L06501 (2012).

13. O. Schofield *et al.*, *Science* **328**, 1520-1523 (2010).

14. W. Z. Trivelpiece, J. T. Hinke, A. K. Miller, C. S. Reiss, S. G. Trivelpiece, G. M. Watters. *PNAS*. 108, 7625-7628 (2011).

15. CCAMLR, “Report of the XXXIV Meeting of the Commission” (2015).

16. S. Nicol, J. Foster, S. Kawaguchi, *Fish. Fish.* **13**, 30-40 (2012).

17. C. M. Brooks, D. G. Ainley, “Fishing the bottom of the Earth: The political challenges of ecosystem-based management” in *Handbook on Antarctic Politics* (Edward Elgar Publishing, 2016).

18. CCAMLR, Conservation Measure 91-03. Protection of the South Orkney Islands southern shelf (2009).

19. CCAMLR, "Report of the XXVIII Meeting of the Commission" (2009).

20. G. Ballard, D. Jongsomjit, S. D. Veloz, D. G. Ainley, *Biol. Conserv.* **156**, 72-82 (2012).

21. K. Dodds, M. Nuttall, The Scramble for the Poles. (Polity Press, 2016).

22. J. Jacquet, E. Blood-Patterson, C. M. Brooks, D. G. Ainley, ‘Rational use’ in Antarctic waters. *Mar Policy* 63, 28-34 (2016).

23. J. C. Day *et al.*, "Guidelines for Applying the IUCN Protected Area Management Categories to MPAs" (IUCN, Gland, 2012).

24. K. M. Gjerde *et al.*, *Aquat. Conserv.* **26,** (2016).

25. S. Hanchet et al., *Hydrobiologia* **761**, 397-414 (2015).

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Fig. 1. CCAMLR’s MPA concessions from 2012 to 2015. CCAMLR area boundary (encompassing 35,716,100 km2). MPAs are shown for the approved South Orkney (yellow) and the proposed Ross Sea (blue) and East Antarctic (purple) in 2012 (2.28 million km2; 1.8 million km2, respectively) compared to 2015 (1.55 million km2; 0.95 million km2, respectively). In the Ross Sea, ‘SRZ’ represents the Special Research Zone (~110,000 km2); ‘KRZ’ represents the Krill Research Zone (~322,000 km2). Weighted circles represent the Total Allowable Catch (TAC) for toothfish (green) and krill (orange) in CCAMLR subareas and divisions. Circle location is specified per subarea and does not represent the actual location of catch in the Southern Ocean (CCAMLR boundaries, adopted MPA, and fisheries data from <http://www.ccamlr.org>; Ross Sea MPA boundaries based on <https://www.mfat.govt.nz/ross-sea-mpa/tabs/proposal.php>; East Antarctic MPA boundaries based on <http://www.antarctica.gov.au/law-and-treaty/ccamlr/marine-protected-areas>).