Mona Samari ∞ Cassandra Brooks ∞ Elsa Cabrera ∞ Rodolfo Werner

Paulina Uribe ∞ Sian Prior ∞ Claire Christian

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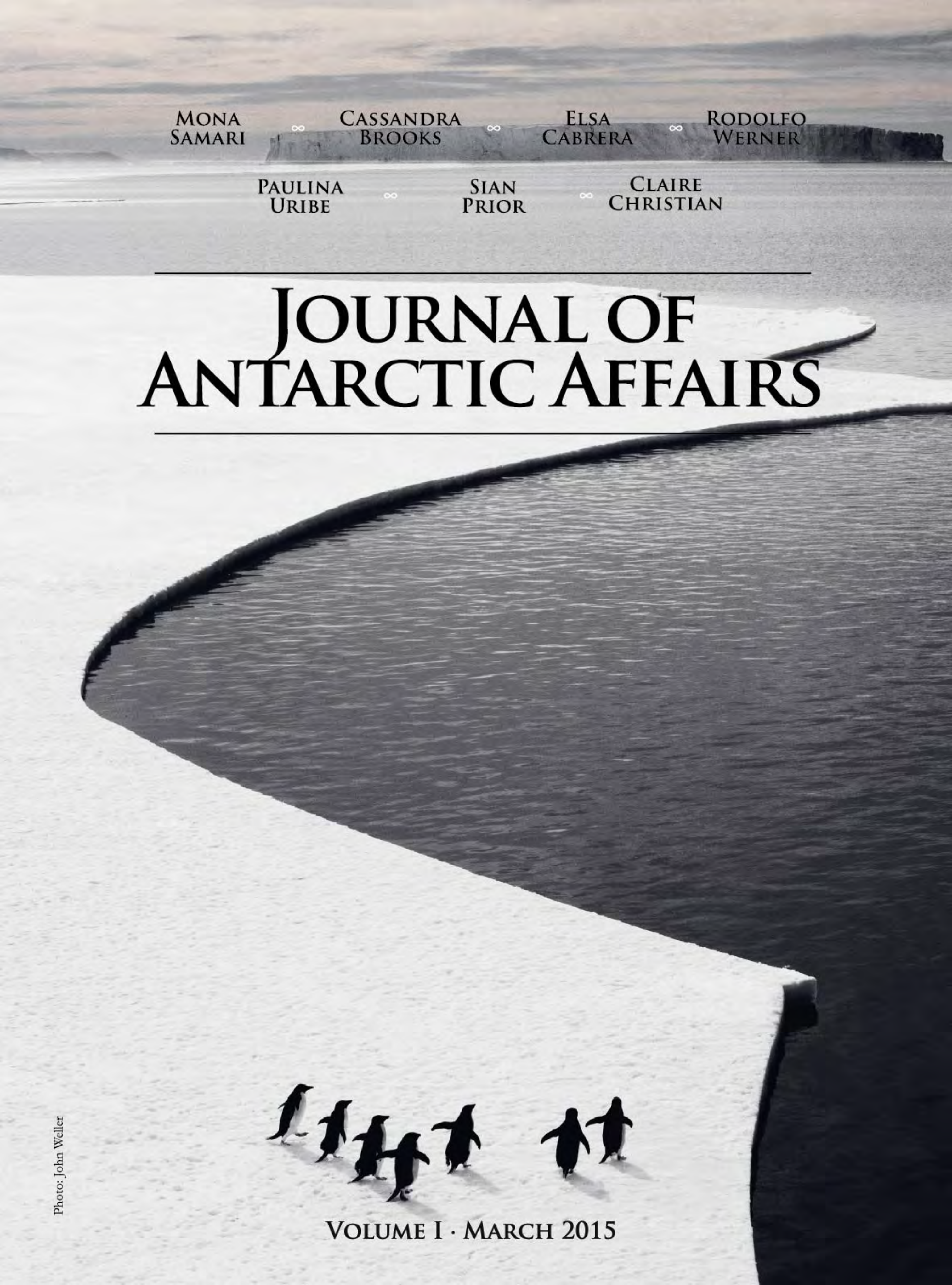

Photo: John Weller

Journal of Antarctic Affairs

The Journal of Antarctic Affairs is the academic magazine of the Antarctic and Southern Ocean Coalition (ASOC) and Agenda Antártica, which aims to publish and disseminate the most prominent and influential research in relation to Antarctica. The Journal publishes articles, reviews and official documents in English and Spanish twice a year. The purpose of the journal is also to stimulate research that contributes to environmental protection of Antarctica and the Southern Ocean.

AGENDA ANTÁRTICA

Agenda Antártica is a non-governmental organization (NGO) based in Buenos Aires that works for environmental conservation of the Antarctic continent and the Southern Ocean, the promotion of research in Antarctica and the preservation of peace in the southern region. Agenda Antártica was founded in 2012 and is constantly developing research, outreach and advocacy at national, regional and international forums through publications, seminars, social networking and promotion of telecommunications. For more information about Agenda Antártica, visit: www.agendaantartica.org

ANTARCTIC AND SOUTHERN OCEAN COALITION (ASOC)

The Antarctic and Southern Ocean Coalition (ASOC) was founded in 1978 by five environmental organizations in the US, UK, Australia and New Zealand, promoting a World Park vision for protecting Antarctica and the Southern Ocean. ASOC has worked since 1978 to ensure that the Antarctic Continent, its surrounding islands and the great Southern Ocean survive as the world's last unspoiled wilderness, a global commons for the heritage of future generations. ASOC has observer status at the meetings of the Antarctic Treaty and CCAMLR. The Secretariat of the ASOC, which includes 21 organizations in 11 countries, is based in Washington, D.C. For more information about ASOC, visit: www.asoc.org

Cover photo *Photographer: John Weller - Title: Adelie penguins on the fast ice edge*

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Journal of Antarctic Affairs

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Message from the Managing Editor

Dear readers,

Welcome to the Journal of Antarctic Affairs! This academic space aims to disseminate and promote research, issues, opinions and any topic of interest related to the Antarctic continent and the Southern Ocean. This journal publishes semiannual articles, reviews and documents in both English and Spanish. The purpose of the Journal of Antarctic Affairs (JAA) is also to stimulate research that favors the environmental protection of Antarctica and the Southern Ocean.

The JAA is a combined effort made by two organizations dedicated to the environmental protection of Antarctica, the Antarctic and Southern Ocean Coalition (ASOC) and Agenda Antártica.

This first volume is a southern gem, not only because of the authors writing, but also due to the range of topics covered. Firstly, one of the most important political challenges for Antarctica these days is the creation of Marine Protected Areas (MPAs) in the seas surrounding the White continent. Environmentalist Mona Samari presents an excellent summary of the proposals, negotiations and importance of creating marine reserves in the Ross Sea and East Antarctica. On the other hand, scholar Cassandra Brooks focuses on one of the reasons why MPAs are crucial: the impact of fishing toothfish, one of the most important predators in the Antarctic ecosystem. Brooks takes us on a journey through the history of this fishery, its commercial importance and above all, the environmental consequences on the ecosystem of the Southern Ocean, and more specifically, the pristine Ross Sea.

Another unavoidable topic addressed in this journal is the decision of the International Court of Justice (ICJ), which decreed illegal whaling carried out by the Japanese government took place in Antarctic seas, and not for scientific purposes. Elsa Cabrera, from the Cetacean Conservation Center in Chile gives us the details of this ruling, the context surrounding the verdict of the ICJ and the current situation of whaling in the Southern Ocean.

One of the biggest concerns today is the decline of many colonies of certain penguin species, particularly in the area adjacent to the Antarctic Peninsula. Argentine biologist, Rodolfo Werner, explains in detail the threats that these birds face focusing on the one which most endangers their livelihood: the reduced availability of their main nourishment, i.e. krill. Commercial interests in both the pharmaceutical and nutritive industries are increasingly driving the fishing of Antarctic krill. Dr. Werner presents the current situation of the management of this fishery, the challenges of the industry and explains the consequences of these economic activities on the Antarctic environment.

Krill, the nutritive base of much of the fauna present on this continent, has unique characteristics in its composition, which renders it difficult to find this species outside of Antarctica. Recent research reveals that this is mainly due to the feeding habits of the krill, focusing primarily on microalgae. The microalgae of Antarctica, which are truly one of a kind, have captivated the interest of the scientific community as of late. Chilean biologist Paulina Uribe shares in the journal an investigation of benthic diatoms on the coast of Covadonga Bay, which notes the resistance of these algae to sun exposure.

The modification of the Polar Navigation Code is a crucial issue that is on the agenda these days. Conservation NGOs have requested more controls on the vessels going to Antarctica. However, they have not been able to achieve this in the latest modifications, which came to form the new polar code. Dr. Sian Prior explains in detail this debate and the importance that the new code has for the environmental protection of Antarctica.

In the review section of the journal, Claire Christian shares with us a detailed review of the recent film everyone is talking about: Antarctica: A Year on Ice. The film was released in November 2014 and has garnered international success since then. For those interested in Antarctica, this film cannot be missed.

Many thanks to all of the authors and donors, as well as to the Editorial Board of the Journal.

I hope you will enjoy this journey to the world's southernmost continent.

Have a nice Drake!

Juan José Lucci

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ASOC Prologue

ASOC was founded in 1978 by five environmental organizations in the US, UK, Australia and New Zealand, promoting a World Park vision for protecting Antarctica and the Southern Ocean. Today ASOC has 21 full member groups in 11 countries.

Its initial objectives were to (1) convince governments to conclude negotiation of the world's first "ecosystem as a whole" treaty on fishing, (2) prevent oil, gas and minerals development in the Antarctic by blocking conclusion of the proposed Minerals Convention, and (3) open up the Antarctic Treaty System to be more transparent, including participation by NGOs and specialist international bodies. These goals were achieved when the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was created in 1981. CCAMLR incorporates, as a fundamental principle, the 'ecosystem-as-a-whole' principle. In the mid-1980s when ASOC was invited to attend CCAMLR as the environmental NGO/representative of civil society. Access to the meetings, as well as the Antarctic Treaty Consultative Meetings (ATCM) has today evolved to allow full participation of expert observers such as the International Union for Conservation of Nature (IUCN), scientific bodies such as the Scientific Committee for Antarctic Research (SCAR), UN agencies today, and private sector associations such as IAATTO, COLTO and Aker. Most important, in 1989 France and Australia refused to accept the proposed Minerals Convention, altering the consensus on which all decision-making in the Antarctic Treaty System is based.

Following the demise of the Minerals Convention, ASOC set a new goal of convincing governments to negotiate a World Park regime to ban all mining and create a modern environmental protection regime. This was achieved in 1991 when the Protocol on Environmental Protection was agreed, including an indefinite ban on all minerals activities and legally binding environmental protection and environmental assessment rules. The Protocol was ratified in 1998 after a concentrated international advocacy effort.

Since the mid-1980s ASOC has been the principal force pushing for implementation of CCAMLR's ecosystem principles, including campaigns to stop illegal fishing and prevent by-catch of albatross and petrels. A recent campaign in concert with the Pew Environment Group focused on protecting krill, the base of the marine food chain, with the goal of an innovative ecosystem-based Small Scale Management Unit system being put into place. This work is ongoing as a part of our regular work at CCAMLR.

In 2005 ASOC member organizations formed a new governance structure, with ASOC incorporated in Washington, DC, a new Statute to guide policy making and governance, and an elected international board. This was achieved in 2006. ASOC now has an elected international Board of Directors (10 people at present), an annual dues schedule, and a Council of 21 dues-paying member groups, which elects the Board. ASOC has 501(c)(3) tax-exempt status with the IRS. ASOC is totally supported by dues, public donations and foundation grants.

Mission Statement:
ASOC is a global coalition of NGOs and individuals working together for the conservation and protection of Antarctica and the Southern Ocean as the world's last great wilderness, a global com-

mons and a shared heritage in perpetuity. ASOC's overriding objective is to ensure that this unspoiled wilderness survives intact for its global scientific, wildlife and esthetic values to leave a heritage of future generations.

ASOC works to achieve these goals within a framework that supports peaceful activities and globally significant scientific research. ASOC is the only non-governmental organization working full time to preserve the Antarctic continent and its surrounding Southern Ocean. Our mission is to speak for the region and its magnificent species.

Our work takes three main forms: participating actively in the international treaties that govern Antarctica, advocacy to achieve specific conservation goals, and raising awareness among the broader public and the media about key environmental issues and solutions in the Antarctic. As an invited observer to the Antarctic Treaty System, ASOC monitors all issues that impact the Antarctic and puts forward proactive proposals to protect the environment.

- Negotiation of a Polar Code by the IMO to improve Southern Ocean vessel safety and pollution prevention requirements for all vessels operating there.

- Designation by CCAMLR of a network of large marine reserves and marine protected areas (MPAs) in the Southern Ocean - the crown jewel being the Ross Sea .

- Inducing Parties to the Antarctic Treaty and CCAMLR to take account of climate change in their fisheries and MPA management decisions, and in all logistics for science.

- Rigorous implementation of the Environmental Protocol to achieve high environmental protection standards, including regulation of commercial tourism, management of bio-prospecting, protection of wilderness areas, and limits to the 'human footprint'.

In order to achieve its objectives, ASOC employs skilled Antarctic protection advocates to work at the ATCM, CCAMLR and IMO, and works closely with our Council members, all of which have important expertise on Antarctic issues, as well as other key partners including the Antarctic Ocean Alliance, for which ASOC serves as the fiscal sponsor. These teams prepare detailed policy and advocacy papers based on the latest scientific research, and carry out advocacy and presswork leading up to and during the meetings.

Working in partnership with one of our Council members, Agenda Antártica, ASOC values the opportunity to bring new articles and detailed information about the world's last great wilderness, Antarctica and the Southern Ocean, to Spanish and English speakers around the world.

Mark Epstein

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SOUTHERN OCEAN MARINE PROTECTION POST RIO+20
The Future We Could of had (but could not reach consensus on)

Mona Samari

Abstract

The international community has failed to fulfil a number of important commitments and obligations to protect the biodiversity of the world's oceans by establishing representative networks of Marine Protected Areas (MPAs) across the world's oceans by 2012, as part of the implementation target of the Millennium Development Goals (MDGs). Parties renewed their commitment at the Rio +20 meeting - with the inclusion of a reference to the need for the establishment of MPAs in the 2012 Rio outcome document titled "The Future We Want." To date, the impact of overfishing on the biodiversity of the marine environment constitutes one of the principal reasons called upon for the creation of marine protected areas in the high seas, however there is growing consensus for the implementation of spatial management measures - such as MPAs - to be considered in a broader context, rather than solely that of fisheries. Within the framework of precautionary and ecosystem-based approaches, MPAs (in particular areas closed to certain fishing activities) could constitute valuable means to not only reduce the impact of fishing on vulnerable marine habitats and species, but also serve as a buffer for uncertainty and for stressing factors - such as carbon sequestration, climate change and ocean acidification - by according ecosystems and habitats the protection they might require. Antarctica has evolved for millennia without a permanent human population. Some areas with little to no human interference or impact - such as the Ross Sea and East Antarctica- provide scientists with the chance to gain greater understand of how species and ecosystems respond to environmental change. By eliminating or limiting certain types of human activities, MPAs and Marine Reserves (MR) can reduce the number of variables that scientists would need to consider.

Keywords

Marine protected areas, precautionary and ecosystem based approaches, climate change, Southern Ocean, MDGs.

"Blind pessimism is a blindly optimistic doctrine. It assumes that unforeseen disastrous consequences cannot follow from existing knowledge too or, rather, from existing ignorance (...) There would be no existing ship designs to stick with, nor records to stay within, if no one had ever violated the precautionary principle."

David Deutsch, The Beginning of Infinity.

Introduction

Covering nearly half the planet, the high seas is considered as the last great global commons on earth, yet it is neither as pristine nor as immune to human threats as was once believed. Only 0.79% of the high seas is currently granted protection - compared with 12% of land areas - and it is yet to benefit from the existence of an international organisation or agreement to govern its use or conservation. Sprawling an impressive 20,330,000 sq km, the Southern Ocean - which contains some of the most intact marine ecosystems left on Earth and over 10,000 species - represents approximately 10 % of the world's ocean. But intact does not necessarily mean resilient enough to withstand the multiplying effects of climate change, ocean acidification, illegal fishing and increasing commercial fishing interests.

One of the crown jewels of the Antarctic is the Ross Sea. The ocean equivalent of Africa's Great Plains because of its bountiful, diverse marine life and near pristine ecosystem. There are few remaining marine ecosystems like the Ross Sea that retain a full complement of top predators in such abundance. Similarly, the Oates or East Indian region in the Eastern Antarctic Coastal region is incredibly important for its role in generating Antarctic Bottom Water (AABW), cold dense water that drives global ocean circulation. The region however remains, in part, enveloped in mystery, as scientists continue to strive to understand the dynamics between the oceanography and the seafloor environment.

Although differing in available scientific data, the establishment of MPAs in these two regions would constitute the foundational keystones for a Southern Ocean system of marine protected areas and marine reserves. The adoption of both MPAs combined would have heralded the creation of the largest marine protected areas ever seen – almost the size of India - marking not only a new era for the establishment of MPAs for the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), but also the full realisation of the application of the precautionary and ecosystem based approach in regional fisheries management worldwide.

Although the application of the precautionary principle is generally hampered by a combination of lack of political will, as well as the wide range of interpretations placed on it in other international fora, Article II of the CAMLR Convention enshrines the precautionary and ecosystem approach as the foundational pillar of the CCAMLR decision making process.

Conservation groups - including partners of the Antarctic Ocean Alliance - placed high hopes on CCAMLR's mandate to shepherd through two large-scale and ambitious proposals for protection in the Ross Sea and East Antarctica - however - the outcome of the 2014 CCAMLR meeting calls into question whether we are now witnessing the unwitting foil to the Rio+20 outcome document by facing "the future we could of had, but cannot reach consensus on."

CCAMLR: A commission with Conservation enshrined at its core

For over 50 years, international treaties such as the Antarctic Treaty System (ATS) have ensured that Antarctica remains a beacon for peaceful activities and scientific study for all. The ethos of international cooperation in Antarctica extends to the body which governs Antarctic waters, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which entered into force in 1982 as part of the ATS, with the central objective of conserving Antarctic marine life while managing its rational use according to several conservation principles.

In its Preamble, it refers to the need for international co-operation and to the prime responsibilities of the Antarctic Treaty Parties for Antarctic environmental protection, recognising the need to establish machinery for co-ordinating measures. The Madrid Protocol added in 1991 to the Antarctic Treaty also provides a vehicle for application of the Biodiversity Convention[1].

CCAMLR was not established as a fishery management body, but rather as an organisation with a broader mandate to ensure the conservation of Antarctic marine living resources, including the rational use of the resources. According to some scholars, because of its ecosystemic approach to conservation, the commission is often regarded as the best available model of sound conservation and management of marine living resources, even if not considered strictly as an RFMO[2].

A Tale of Two Proposals: Ross Sea and East Antarctica

Though CCAMLR does also control and manage the extraction of fisheries from its convention area, its process of making decisions is not so dissimilar from those of RFMOs and, as such, it has come under the international spotlight over recent years for the inability of its members to reach consensus on the establishment of a network of marine protected areas. Furthermore, CCAMLR's 2009 pledge to meeting the World Summit on Sustainable Development's goal by designating a network of marine protected areas in the Southern Ocean by 2012[3], was once again put into question when at the conclusion of the 2014 CCAMLR meeting, member states were unable to agree on the adoption of two large scale marine protected areas for the Ross Sea and East Antarctica.

In 2008, CCAMLR identified 11 priority areas to focus its work on developing and designating MPAs in the Southern Ocean, in line with their mandate to apply the ecosystem approach to ensure that activities in the Southern Ocean do not decrease the overall health of Antarctic ecosystems. Those priority areas were then refined in 2011 to nine planning domains, which includes the Ross Sea and East Antarctica.

At the 2014 CCAMLR meeting, New Zealand and the US once again put forward a joint proposal to designate a Ross Sea MPA of 1.32 million km2 (with 1.25 million km2 area proposed as "no take") and; Australia, France and the EU put forward a proposal for an MPA to protect a cluster of four marine protected areas in East Antarctica, covering approximately 1,041,802km2 of East Antarctic waters, which allows for exploratory and research activities within the MPA if the latter are consistent with the maintenance of the MPA's objectives.

According to the Antarctic Ocean Alliance, the failure of CCAMLR members to reach consensus on the two proposals - despite completing a series of important milestones towards their establishment over the course of four years - calls into question CCAMLR's very ability to deliver on its numerous conservation commitments and obligations.

Both proposals have undergone a number of iterations since their inception - the size of the Ross Sea proposal has decreased from 2.3 million km^2 in 2013, to 1.32 million km^2 and the size of the East Antarctica proposal has decreased from 1.63 km^2 in 2013 to 1.2 million km^2 in 2014, yet consensus has so far eluded the annual negotiations despite several compromises and attempts over the course of four years.

According to AOA partner organisation Greenpeace: "The question of whether CCAMLR can deliver on its conservation mandate is in very serious doubt after another disappointing failure at this year's meeting (...)".

Nonetheless, the issue of effective management of the high seas, including the Southern Ocean, goes beyond just CCAMLR members. The responsibilities of states to contribute and cooperate in the protection of the marine environment and its biodiversity are defined within international conventions and agreements such as the United Nations Convention on the Law of the Sea (UNCLOS), the UN Fish Stocks Agreement, the Convention on Biological Diversity (CBD), the resolutions of the UN General Assembly (UNGA) and the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas.

Antarctica: Pristine in Part but Not Immune

The increasing interest in marine protected areas as a complement to traditional fisheries management strategies stems from many concerns[4]. Scientists have already identified the Southern Ocean as the first region in the world that is likely to experience widespread ocean acidification because it is already relatively under saturated in aragonite, a form of calcium carbonate[5] . Furthermore, there are worrying indications of the impacts of black carbon in the Antarctic, which is formed through the incomplete combustion of fossil fuels in the area.

Climate change and ocean acidification are affecting all part of the earth[6], and some of the impacts in Antarctica are among the most pronounced on the planet. These two effects of atmospheric greenhouse gas pollution, which are occurring in tandem with fishing, will continue to place increasing pressure on the marine ecosystems of the Southern Ocean. There is strong potential for impacts to be mutually reinforcing, resulting in greater ecosystem stress.

According to the Intergovernmental Panel on Climate Change, the Ross Sea is predicted to be the last part of the Southern Ocean with year-round sea ice. The sea ice is expected to continue to expand over the next few decades, stabilise, but then decline thereafter. Consequently, the Ross Sea region is likely to provide a refuge for many iconic ice dependent species in the medium term as other parts of the Antarctic experience warming temperatures.

According to the Fourth Assessment Report of the IPPCC (2007), human induced climate change, mainly from increased carbon dioxide (CO2) and other greenhouse gas emissions, is affecting all parts of the Earth, and regions of the ice-dominated Antarctic are some of the most rapidly changing on the planet[7-8]. However, the impacts of climate change are not uniform across the region. Wintertime warming along the western Antarctic Peninsula has increased 1.01°C per decade from 1950-2011[9], the most rapid rise in annual observed temperature anywhere on the planet. Yet other parts of the continent show little change or even a slight cooling[10]. There is also strong evidence that the persistent seasonal ozone hole over Antarctica (which was first discovered in the early 1980s) may exacerbate the impacts of climate change, mainly by increasing the strength of the westerly winds that surround the continent[11].

In the East Antarctic, the climate trend is not clear. No major warming or cooling has taken place[12-13], yet changes in sea ice have been significant[14]. Since the 1950s, sea ice extent has declined[15], but conversely, as of the 1970s, the sea ice season has increased by more than 40 days[16]. These changes have had dramatic effects on the animals that live there, most notably seabirds. The Wilkes region in East Antarctica has proved to be an ideal site for studying historic, modern and future glacial conditions. It is the only place in the Antarctic where the onset of glaciation can be traced from the shelf to the abyssal plain. This allows researchers to better reconstruct the East Antarctic Ice Sheet's (EAIS) icy history, including how long ago it formed and providing insight for future predications in a changing climate[17].

The Hunt for Krill

Climate change is not the only stress factor for the continent, as commercial fishing demand has resulted in growing interest in Antarctica's rich marine biodiversity. As demand for krill products increases worldwide, new countries are taking an interest in the fishery and advances in harvesting technology have enhanced the efficacy of fishing[18]. Because krill is among the last of the global fisheries not exploited at full capacity, it carries potential for expansion in the future[19], which could increase pressure on Southern Ocean ecosystems. Currently unexploited areas with large krill populations, like the East Antarctic coastal region, could soon be worth the voyage for increasingly motivated distant water fishing fleets.

The East Antarctic coastal region supports significant Antarctic krill populations, which are estimated to be almost 39 million tonnes, though this is likely to be an underestimate[20-21-22]. Krill fisheries began during the 1970s off the East Antarctic and peaked in the mid-1980s before declining and finally ceasing in the 1994/95 season[23]. A total of 750,000 tonnes of krill have been harvested from this area. The current krill catch limit is 620,000 tonnes for the East Antarctic, but at present krill fishers prefer to target the waters off the Antarctic Peninsula and the Scotia Sea rather than making the extended journey to the East Antarctic.

Illegal, Unreported and Unregulated (IUU) fishing

IUU fishing continues to cause a major problem worldwide, and the Southern Ocean is not immune to this practise in its waters. Significant progress has been made in reducing the level of IUU catch through the cooperation of CCAMLR, its Member nations and legal fishers. However, a number of IUU fishers still operate primarily in the South Indian Ocean and directly off the East Antarctic coastal region. The FV Snake vessel was first included on the CCAMLR NCP-IUU Vessel List in 2004 and has been persistently engaged in illegal and unregulated fishing in the CCAMLR Convention Area and more recently, in the ICCAT convention area.

IUU fishing and the uncertainty associated with toothfish populations severely compromise fisheries management and has led to the rapid decline of some toothfish stocks[24]. Moreover, like many deep dwelling fish, toothfish live a long time, grow slowly as adults and mature late in life, all characteristics that make them vulnerable to overfishing. Local depletions of toothfish may easily occur, as has happened over BANZARE Bank. Scientists have yet to understand the Antarctic toothfish's life history in the East Antarctic, which further compromises management.

The conservative catch limits remain in place today, as IUU fishing remains a problem and is unlikely to further decline. In recent years, IUU fishers have increasingly used deepwater gillnets in the area, making IUU estimates nearly impossible to calculate[25]. Gillnets are banned by CCAMLR because they pose a significant environmental threat due to their high levels of bycatch and the risk of "ghost fishing," which refers to nets that have been cut loose or lost in the ocean and continue catching marine life for years. The amount of toothfish caught in IUU gillnets remains unknown, but is likely substantial.

On December 25 2104, the Sea Shepherd conservation ship, Sam Simon, located a discarded gillnet at 62° 16' South, 081° 14' East, inside the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) area of management. Using the coordinates and photographic evidence provided by fellow Sea Shepherd ship, the Bob Barker, Sam Simon Captain Sid Chakravarty was able to identify the gillnet – a method of fishing outlawed by CCAMLR since 2004 - as the property of the Interpol-listed vessel, Thunder.

The gillnet was reportedly abandoned by the Nigerian-flagged Thunder when it fled from the Bob Barker on December 17, after the poaching vessel was found inside the CCAMLR area of management without a license to fish. Operation Icefish is Sea Shepherd's 11th Southern Ocean Defence Campaign, and the first to target IUU toothfish fishing operators in the waters of Antarctica.

Learning from the past:
The Growing Need for Precautionary and Ecosystem Management

At present, the Antarctic Ocean Alliance believes that the current protective measures in place are insufficient to adequately conserve the unique Southern Ocean ecosystems and biodiversity and that no-take marine reserves and Marine Protected Areas will help minimise, or even eliminate, some of the most pressing threats to the Southern Ocean ecosystem. The AOA has identified 19 critical areas the Southern Ocean (over 40% of the Southern Ocean) that warrant protection in a network of large-scale MPAs and no-take marine reserves based on combining existing marine protected areas, areas identified within previous conservation and planning analyses and including additional key environmental habitats.

In regions of high uncertainty, marine reserves provide the greatest protection for marine life and ecosystems[26-27-28]. A marine reserve protects biodiversity, including the ecological structure and function at the genetic, species, habitat and ecosystem level[29]. These reserves protect against the potentially negative impacts of human activity, conserving ecological integrity[30]. They also provide control sites to help scientists understand ecological changes as well as the impacts of fishing elsewhere, and they can serve as important areas for long-term scientific research.

The precautionary approach is one of the basic principles of the 1995 FAO Code of Conduct for Responsible Fisheries and involves the application of prudent foresight to deal with uncertainties in fisheries systems. The ecosystem approach to fisheries (EAF) has evolved based on an appreciation of the interactions that take place between fisheries and ecosystems[31]. Because uncertainty can be expected to be greater when widening fisheries management to include ecosystem considerations, the precautionary approach gains even greater importance within EAF.

The Precautionary Principle only began to appear in international legal instruments in the mid-1980s. This Principle aims to provide guidance in the development and application of international environmental law, where there is scientific uncertainty. It is reflected in Principle 15 of the Rio Declaration, which indicates that: where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation[32].

The precautionary principle as enshrined and widely practiced in international law is a fundamental element of the CAMLR Convention as it was originally conceived. CCAMLR's capacity to achieve conservation objectives cannot be limited by the state of scientific knowledge. Furthermore, management decisions should take account of uncertainties associated with incomplete knowledge and should be 'precautionary' in the absence of complete knowledge.

One of the closest existing approaches to a broader environmental/ecosystem approach is found in the Preamble of the Convention on Conservation of Antarctic Marine Living Resources (CCAMLR), which recognises the need to protect the integrity of the ecosystem of the seas surrounding Antarctica and to increase knowledge of its component parts. The substantive articles extend its scope to all marine living resources in the area within the whole Antarctic ecosystem (that is, that lying within the Antarctic convergence, a natural, not a manmade boundary) defined as "the complex of relationships of Antarctic marine living resources with each other and with their physical environment". Clearly, birds are included within these resources[33].

Through its MPA process thus far, CCAMLR has shown that it has the capacity for leadership by setting a target date to create a network and designating the South Orkney Islands Southern Shelf as a marine reserve in 2010. Furthermore, there has been a concerted effort from a number of CCAMLR Members to advance work on other concrete MPA proposals, such as for the Weddell Sea region, and a number of scientific workshops have been organised to analyse the best available science to identify additional areas for protection.

Overview: East Antarctica

The East Antarctic coastal region is an essential part of a network of Southern Ocean marine protected areas, containing foraging hotspots for birds and mammals, nursery grounds for krill and fish and rich seafloor communities, many of which have yet to be described.

The region spans the coast along the Eastern Antarctic Ice Sheet from Enderby Land to Terre Adélie – from 30°E to 150ºE and from the coast out to 60ºS – and is contained within the Eastern Antarctic planning domain adopted at CCAMLR in 2011. The western boundary extends to the eastern margins of the Weddell Gyre and encompasses most of the South Indian Ocean out to the east towards the western edge of the Ross Sea region planning domain.

East Antarctic coastal region also contains unique features, including the Cosmonaut Polynya, Bruce Rise and the d'Urville Sea-Mertz Seamounts. The AOA welcomes Australia, France and the EU's proposal for a representative system of marine protected areas in the East Antarctic, but has identified additional marine reserves that should be considered for inclusion in this network in coming years, as MPAs need to be large enough to avoid fragmenting the ecosystem, particularly in cases of high uncertainty[34]. Species assemblages in the East Antarctic coastal region remain poorly understood, and scientists do not know how connected or restricted these communities are. For example, in other regions of the Antarctic, species assemblages may be unique according to depth or to a specific canyon or individual seamount, while in other areas these assemblages may be connected over grand scales[35-36].

Because the East Antarctic coastal region is data-poor, AOA believes that it is appropriate for CCAMLR to employ the precautionary approach when designating protected areas. Areas that are less well known may be equally or even more ecologically important and should be included in the network.

In areas where less biological data is available, seafloor and pelagic habitats can be used as proxies for biological diversity. In addition, including replicate features and habitats within the network of MPAs and marine reserves can help ensure that the region's biodiversity is conserved. In data poor regions, large areas should remain free from exploitation until more knowledge is gained about the function and dynamics of the ecological system[37]. Juvenile Antarctic toothfish originating in Prydz Bay are likely part of a larger South Indian Ocean population. Protecting them, and making other areas off limits to fishing, will help supply the areas that are open to fishing.

The East Antarctic coastal region comprises an ecosystem that has been shaped by grand features and processes. The Eastern Antarctic Ice Sheet flows off the Antarctic continent into the Southern Ocean, an icy surface abruptly giving way to the marine environment. Coastal currents, like the Prydz Bay Gyre, mingle with the expansive fronts of the Antarctic Circumpolar Current, a clockwise current that circulates the continent. Coastal polynyas, areas of open water amidst the sea ice, form up and down the coast of East Antarctica.

Further offshore is the Cosmonaut Polynya, one of only two major open ocean polynyas currently in the Southern Ocean. Millennia of glacial streams have carved deep canyons into the continental shelf and slope all along the East Antarctic coastal region. In the eastern stretches of the region, the Gunnerus Ridge rises from the depths, with a seamount off its northern end. In the central region of the East Antarctic, the Bruce Rise forms one of only two marginal plateaus in the Southern Ocean. Off the continental shelf of Prydz Bay, a large trough mouth fan and a myriad of associated canyons form a unique habitat.

Along the shores of the East Antarctic, millions of seals and seabirds make their home, feeding mostly on Antarctic and crystal krill as well as silverfish. Leopard and crabeater seals pup on the pack ice just offshore. Other birds, seals and whales come to feed in the region's waters, especially Prydz Bay. The bay also supports nursery grounds for krill and Antarctic toothfish, the top piscine predator in the Southern Ocean.

The Wilkes subregion encompasses the area off Wilkes Land, from 110ºE to 137ºE90 and has largely been studied for its geological value. A hundred million years ago, the marine edge of WilkesLand was joined to what is now Southern Australia as part of the supercontinent Gondwana. But by 30 million years ago, they fully separated and have been slowly spreading: Antarctica to the south and Australia to the north. The Wilkes Land continental edge and adjacent seafloor has lent tremendous insight into the geological history of Antarctica[38], including a record of the initial opening between Australia and Antarctica. The EAIS, which is the largest ice sheet in the world, is typically grounded to the land above sea level. However, along the eastern continent-ocean margin of Wilkes Land the EAIS is grounded below sea level, which has made it more sensitive to climate change in the past and perhaps in the future.

The Oates or East Indian region intersects the East Antarctic planning domain between 137ºE and 150º E within the bounds of the D'Urville Sea, is the best-studied area of the East Antarctic coastal region. This area is incredibly important for its role in generating Antarctic Bottom Water (AABW), cold dense water that drives global ocean circulation. Coastal polynyas drive productivity in the region, particularly the Mertz Glacier Polynya, a major and consistent polynya that persists from year to year[39]. The coastal region has a narrow continental shelf and slope heavily carved with canyons. According to CCAMLR 2011 Fishery Reports, multiple vulnerable marine ecosystems have been identified on this slope.

Given the depth of knowledge about this particular region and its importance in the formation of AABW, it is a prime reference area for monitoring the impacts of climate change on ocean processes [40]. For example, the recently calved Mertz Glacier, which released a 2,500 km sq iceberg, provides a unique opportunity to study the seafloor and oceanographic changes that follow this type of disturbance. The break up and subsequent glacial melting may be freshening the water in the area, changing the salinity and potentially slowing down the rate of AABW formation, which could have global oceanographic consequences[41].

East Antarctica is a large region and while some areas and features have been well studied, such as the Oates or East Indian region others, the Dronning Maud (West Indian) region remain enveloped in mystery. Nonetheless, the region's unique oceanographic and seafloor features - which scientists are still trying to understand -coupled with its biological value to seabirds, seals and other species make the East Antarctic coastal region a prime area for protection.

Overview: Ross Sea Region

Since its discovery in 1841, the Ross Sea continues to be an important region for science and exploration. When explorers set out to reach the South Pole, during the heroic age of Antarctic exploration a century ago, they based their operations in the Ross Sea. The Ross Sea penetrates the Antarctic continent to higher latitudes than anywhere else. This feature combines with the annual break up of sea ice and persistent areas of incredibly biologically productive ice-free water called polynyas to enable navigation to the Ross Shelf. These are just three of the key features of the Ross Sea that contribute to its diverse and unique ecology making it a high seas gem in need of comprehensive protection.

The near-pristine Ross Sea is one of the last open-ocean, continental shelf ecosystems in which the food web has not been subjected to serious or permanent change as a result of human activities. It is recognised as the least impacted open ocean marine area on Earth[42]. The region offers unprecedented opportunities for science and for understanding how a large-scale, fully functioning ecosystem works and is influenced by climate change and ocean acidification.

The Ross Sea region is one of the areas the Antarctic Ocean Alliance identified for inclusion in a system of Southern Ocean marine protected areas and marine reserves. Its designation as a marine reserve has been justified extensively by the work of scientists, governments and non-government organisations (NGOs) over the past seven years, highlighting the environmental importance of the region.

The region includes waters lying between 150° East and 150° West, bounded by the Antarctic continent to the south and the 60° south parallel to the north. This area corresponds to the Ross Sea planning domain defined by CCAMLR in 2011. This region includes the whole continental shelf and slope, the Balleny Islands, the seamounts of the Pacific – Antarctic Ridge and other important seamounts such as the Scott and Admiralty seamounts, which are considered to be ecological hotspots. The Ross Sea is one of two areas of the Southern Ocean with a wide and deep continental shelf – the other being the Weddell Sea. In most other parts of the Antarctic coast the shelf is narrow or absent.

It is the largest continental shelf ecosystem south of the Antarctic Polar Front, and boasts a biodiversity far greater than that of many other polar areas[43]. It is home to large proportions of the world's populations of some of the most well-known and iconic Antarctic species, including whales, seals and of course, penguins. There are few remaining marine ecosystems like the Ross Sea that retain a full complement of top predators in such abundance.

An estimated one quarter of the total phytoplankton production south of 50° south is contributed by the Ross Sea, making it one of the most productive stretches of the ocean south of the Polar Front. This unusually high productivity is owed to an abundant nutrient supply of nitrogen, phosphorus and iron from melting ice, atmospheric deposition and ocean depths, regional climate patterns driving the upwelling of nutrient-rich water, and the large Ross Sea polynya. The immense phytoplankton blooms support large populations of zooplankton and other prey species such as three species of krill, a small shrimp-like crustacean, and Antarctic silverfish, which in turn support huge numbers of seafloor creatures and top predators[44].

Notothenioid fish, ranging from the key prey species silverfish to the top predator Antarctic toothfish, also demonstrate the incomparable nature of the Ross Sea. These fish, found only in the Southern Ocean, have proteins akin to antifreeze in their blood that prevent them from freezing. They fill ecological niches across all habitats from the seafloor to the sea surface, comprising almost two thirds of all the fish species found in the Ross Sea[45]. As such they represent a unique evolutionary case study for scientists to understand how new species emerge and develop different adaptations to fill ecological niches

In addition to providing a possible refuge for many Southern Ocean species, a fully protected large-scale marine reserve in the Ross Sea region offers an outstanding natural laboratory to study how a relatively undisturbed large marine ecosystem responds to environmental change with the onset and acceleration of climate change and ocean acidification free from the convoluting influence of other forms of human activity. Many scientists support full protection in order to facilitate empirical research that can be used to study how different species and communities adapt or fail to adapt to changes in sea ice and ocean temperature. Observed changes can be compared with climate and physical modelling, to contrast areas experiencing no direct impact from humans with areas experiencing direct impacts[46].

Furthermore, the Ross Sea region now boasts one of the largest and longest time series of scientific data anywhere in the Southern Ocean[47]. As time goes on, and climate impacts increase, this data will increase in value, providing that climate and ecosystems research can be conducted, without the distortions caused by fishing.

Marine Protected Areas: 21st Century Conservation Management Tools

There is no single definition of a Marine Protected Area (MPA) in International Law, although a commonly accepted notion is the one provided by the IUCN: "any defined area or subtidal terrain within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection that its surroundings[48].

A growing body of scientific research has demonstrated that MPAs and marine reserves are effective tools for increasing the health and resilience of ocean ecosystems[49]. MPAs and Marine Reserves (MRs) can confer significant benefits in the context of climate change and ocean acidification. MPAs and MRs can provide reference areas where the effects of climate change and ocean acidification can be researched and differentiated from the effects of natural variability and human activities.

Antarctica has evolved for millennia without a permanent human population. Some areas with little to no human interference or impact - such as the Ross Sea - provide scientists the chance to understand how species and ecosystems respond to environmental change. By eliminating or limiting certain types of human activities, MPAs and MRs can reduce the number of variables that scientists would need to consider.

In addition, the establishment of MRs and MPAs can enhance species and ecosystem resilience to climate change and ocean acidification by reducing stress from human activities. Climate change and ocean acidification will continue to impact the environmental conditions within MPAs, but if other ecosystem stressors – fishing, pollution, and resource extraction, among others – are limited, species will be better equipped to withstand environmental changes.

Furthermore, the effectiveness of any MPA however depends on its size and location in relation to lifehistory characteristics and habitat requirement of the species to be protected. MPAs can be used, in combination with other management measures, as part of an adaptive management scheme in that respect. Rather than solely controlling fishing mortality for targeted species, reserves should be designed to allow permanent and/or temporal closures to cover critical habitats such as nurseries, spawning and feeding grounds or to protect the stocks during crucial lifehistory events such as migrations and spawning aggregations[50].

CCAMLR's many great achievements in the past embody the cooperative and collaborative spirit of the Antarctic Treaty System between CCAMLR Members. CCAMLR's development of a representative system of MPAs and MRs will further this legacy as the collective responsibility of all CCAMLR Members, and not as the responsibility of individual Members proposing them. CCAMLR MPAs designated to protect the Southern Ocean's unique biodiversity for the good of humanity will not belong to any country, but will provide opportunities for cooperation between all CCAMLR Members through the development and implementation of management plans and research and monitoring activities.

Applying the precautionary approach to management decisions has become central to the setting of catch limits, developing exploratory fisheries, addressing bycatch and protecting vulnerable marine ecosystems. MPAs are one of the most effective conservation mechanisms available to CCAMLR to ensure a truly precautionary approach.

Professor Alex Rogers, Professor of Conservation Biology at the University of Oxford, UK, said that the debates at CCAMLR are indicative of a wider "global dichotomy" about how countries approach ocean resources, with a conservation and ecosystem-based-management approach versus less constrained exploitation. Rogers warns that "time really is running out on these issues. If we don't get protection in place now, exploitation of these systems will increase. Even a delay is a serious issue."

A combination of political will, momentum and conservation focused tools under international agreements provide an unprecedented window of opportunity for CCAMLR member states to put in place meaningful, long-term protection for this relatively untouched part of the world at the 2015 CCAMLR meeting.

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References

1. Do we need Marine Protected Areas on the High Seas?Analysis of the legal implications of the establishment of Protected Areas on the High Seas - LLM in Natural Resources Law and International Environmental Law / Monica Patricia Martinez Alfaro 2013.
2. See Sands, P. and Peel J, Principles of International Environmental Law, p.443.
3. CCAMLR 2009.
4. Marine protected areas as a precautionary approach to management mark h. Carr and peter t. Raimondi.
5. McNeil, BI and RJ Matear2008).
6. IPCC. 2007. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
7. Meredith MP and JC King. 2005. Rapid climate change in the ocean west of the Antarctic Peninsula during the second half of the 20thcentury. Geophysical Research Letters 32:L19604.
8. Stammerjohn SE, DG Martinson, RC Smith,X Yuan and D Rind. 2008. Trends in Antarctic annual sea ice retreat and advance and their relation to El Nino–Southern Oscillation and Southern Annular Mode variability. Journal of Geophysical Research 113: C03S90.
9. Turner J, T Maksym, T Philips, GJ Marshall and MP Meredith. 2012. The impact of changes in sea ice advance on the large winter warming on the western Antarctic Peninsula. International Journal of Climatology. DOI: 10.1002/joc.3474.
10. Stammerjohn et al. 2008.
11. Thompson DWJ, S Solomon, PJ Kushner, MH England, KM Grise and DJ Karoly. 2011. Signatures of the Antarctic ozone hole in Southern Hemisphere surface climate change. Nature Geoscience 4: 741-749.
12. Vaughan DG, GJ Marshall, WM Connolley, JC King and R Mulnavey. 2001. Devil in the Detail. Science 293 (5536): 1777-1779.
13. Houghton JT, Y Ding, DJ Griggs, M Noguer, PJ van der Linden and D Xiaosu. 2001. Climate Change 2001: The Scientific Basis. Cambridge: Cambridge University Press.
14. Curran MAJ, TD van Ommen, VI Morgan, KL Phillips and AS Palmer. 2003. Ice core evidence for Antarctic sea ice decline since the 1950s. Science 302(5648): 1203-1206.
15. bid.
16. Parkinson CL. 2002. Trends in the length of the Southern Ocean sea-ice season, 1979-1999. Annals of Glaciology 34(1): 435-440.
17. Escutia C, L De Santis, F Donda, RB Dunbar, AK Cooper, G Brancolini and SL Eittreim. 2005. Cenozoic ice sheet history from East Antarctic Wilkes Land continental margin sediments. Global and Planetary Change 45: 51-81.
18. Nicol S, J Foster and S Kawaguchi. 2012. The fishery for Antarctic krill – recent developments. Fish and

Fisheries 13: 30-40.
19. Nicol et al. 2012.
20. Pauly T, S Nicol, I Higginbottom, G Hosie, and J Kitchener. 2000. Distribution and abundance of Antarctic krill (Euphausia superba) off East Antarctica (80-150°E) during the Austral summer of 1995/1996. Deep Sea Research III 47: 2465-2488.
21. Nicol S and J Foster. 2003. Recent trends in the fishery for Antarctic krill. Aquatic Living Resources 16: 42-45.
22. Jarvis T, N Kelly, S Kawaguchi, E van Wijk and S Nicol. 2010. Acoustic characterisation of the broad-scale distribution and abundance of Antarctic krill (Euphausia superba) off East Antarctica (30-80°E) in January-March 2006. Deep-Sea Research II 57: 916-933.
23. CAMLR. 1990a. Statistical Bulletin Volume 1 (1970-1979). Hobart, Australia.
24. Agnew D, D Butterworth D, M Collins, I Everson, S Hanchet, KH Kock and L Prenski. 2002. Inclusion of Patagonian toothfish Dissostichus eleginoides and Antarctic toothfish Dissostichus mawsoni in Appendix II. Proponent: Australia. Ref. CoP 12 Prop. 39. TRAFFIC East Asia, TRAFFIC East/Southern Africa-South Africa. TRAFFIC Oceania, TRAFFIC South America.
25. CCAMLR. 2010. Report of the Twenty-ninth Meeting of the Scientific Committee. Hobart: Australia.
26. Bohnsack JA. 1999. Incorporating no-take marine reserves into precautionary management and stock assessment. In Providing scientific advice to implement the precautionary approach under the Manguson-Stevens Fishery Conservation and Management Act, VR Restrepo, ed. NOAA Technical Memorandum NMFSF/SPO-40. Pp 8-16.
27. Novaczek I. 1995. Possible roles for marine protected areas in establishing sustainable fisheries in Canada. In Marine protected areas and sustainable fisheries, NL Shackell and JHM Willison, eds. Centre for Wildlife and Conservation Biology, Acadia University, Wolfville, Nova Scotia, Canada. Pp 31-36.
28. Lester SE, BS Halpern, K Grorud-Colvert, J Lubchenco, BI Ruttenberg, SD Gaines, S Airamé and RR Warner. 2009. Biological effects within marine reserves: a global synthesis. Marine Ecology Progress Series 384: 33-46.
2 9. Do we need Marine Protected Areas on the High Seas?Analysis of the legal implications of the establishment of Protected Areas on the High Seas LLM in Natural Resources Law and International Environmental Law / Monica Patricia Martinez Alfaro 2013.
30. Idem.
31. McLeod E, R Salm, A Green and J Almany. 2009. Designing marine protected area networks to address the impacts of climate change. Frontiers in Ecology and the Environment 7(7): 362-370.
32. Schlacher TA, MA Schlacher-Hoenlinger, A Williams, F Althaus, JNA Hooper and R Kloser. 2007. Richness and distribution of sponge.
megabenthos in continental margin canyons off southeaster Australia. Marine Ecology Progress Series 340: 73-88.
33. Brandt A, C De Broyer, I De Mesel, KE Ellingsen, AJ Gooday, B Hilbig, K Linse, MRA Thomson and PA Tyler. 2007. The biodiversity of the deep Southern Ocean benthos. Philosophical Transactions of the Royal Society B-Biological Sciences 362(1477): 39-66.
34. Bohnsack 1999.
35. Australian Antarctic Division. 2012. Geology: Prehistory of Antarctica. Accessed on 23 August 2012
36. Smith MB, J-P Labat, AD Fraser, RA Massom and P Koubbi. 2011. A GIS approach to estimating interannual variability of sea ice.
concentration in the Dumont d'Urville Sea near Terre Adélie from 2003 to 2009. Polar Science 5(2): 104-117.
37. Rintoul SR. 2007. Rapid freshening of Antarctic Bottom Water formed in the Indian and Pacific oceans. Geophysical Research Letters 34(L06606): doi:10.1029/2006GL028550.
38. Kusahara K, H Hasumi and GD Williams. 2011. Impact of the Mertz Glacier Tongue calving on dense water formation and export. Nature Communications 2: 159.

39. Halpern B.S., Walbridge S., Selkoe,K.A., Kappel C.B., Micheli F., D'Agrosa C., Bruno J.F., Casey K.S., Ebert C., Fox H.E., Fujita R., Heinemann D., Lenihan H.S., Madin E.M.P., Perry M.T., Selig E.R., Spalding M., Steneck R. and Watson R. 2008. A global map of human impact on marine ecosystems. Science 319: 948-951. Supporting Online Material for A Global Map of Human Impact on Marine Ecosystems, Halpern et al., (2008) http://www.sciencemag.org/content/ suppl/2008/02/12/319.5865.948.DC1/Halpern_SOM.pdf
40. Eastman J. T. And Hubold G. 1999. The fish fauna of the Ross Sea, Antarctica. Antarctic Science. 11: 293-304.
41. Ballard, G., Jongsomjit, D. and Ainley, D.G. 2010. Ross Sea Bioregionalization Part II: Patterns of co-occurrence of mesopredators in an intact polar ocean ecosystem. CCAMLR Report, WG-EMM-10/12. Hobart, Tasmania
42. Eastman. 2005.
43. Constable A.J., Doust S. 2009. Southern Ocean Sentinel – an international program to assess climate change impacts on marine ecosystems: report of an international Workshop, Hobart, April 2009. ACE CRC, Commonwealth of Australia, and WWFAustralia.
44. Timeframes of datasets: Adelie Penguin, 1959-2011; Toothfish, 1972-2011; Weddell seals, 1960-2011; Benthic communities, 1965-2011; Hydrography, 1957-2011.
45. Do we need Marine Protected Areas on the High Seas?Analysis of the legal implications of the establishment of Protected Areas on the High Seas LLM in Natural Resources Law and International Environmental Law / Monica Patricia Martinez Alfaro 2013.
46. Lubchenco J, SR Palumbi, SD Gaines, and S Andelman. 2003. Plugging a Hole in the Ocean:the Emerging Science of Marine Reserves.Ecological Applications 13(1): S3-S7.
47. Do we need Marine Protected Areas on the High Seas?Analysis of the legal implications of the establishment of Protected Areas on the High Seas.
48. LLM in Natural Resources Law and International Environmental Law / Monica Patricia Martinez Alfaro
49. Monica Patricia Martinez Alfaro 2013.

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Fishing at the bottom of the Earth: The Ross Sea Antarctic toothfish

Cassandra M. Brooks

Abstract

In October of 2014, nations gathered to discuss protection of the Ross Sea, Antarctica a region publicized as The Last Ocean due to its high ecological and conservation value. Instead of designating a marine reserve, nations agreed to continue fishing in this most remote stretch of ocean. Vessels venture into these ice-choked waters, risking life and limb, for Antarctic toothfish, the top fish predator in the Southern Ocean. These huge fish, sold on the market as "Chilean sea bass" are also known as "White Gold" for the incredible price they fetch in up-scale markets across the world. These incredible fish thrive at the edge of possibility – only surviving the frozen Antarctic waters due to the anti-freeze in their blood. Like many deep-dwelling fish, they are long-lived, late to mature and slow-growing, making them more vulnerable to overexploitation. The largest fish have already been removed from the Ross Sea, with potential impacts cascading throughout the ecosystem. While ending the fishery may not be politically feasible, designating a marine protected area, which includes regions off-limits to fishing, would be a powerful management tool to ensure that toothfish and the greater Ross Sea ecosystem endures for many generations to come.

Keywords

CCAMLR, Antarctic toothfish, Chilean Sea Bass, Ross Sea, Southern Ocean.

Introduction

The address is 181 Macquarie Street, Hobart, Tasmania. It is not an unassuming building, but even its castle-like appearance hides the importance of what happens here every October. The gravity of the building is better embodied by the line of flags, which announce the castle as the home of the Commission for the Conservation of Antarctic Marine Living Resources, or CCAMLR. CCAMLR is a treaty between 24 nations and the European Union that governs marine life, including fishing access, in the Southern Ocean, 10% of the entire global ocean.

In October of 2014, these nations gathered here again to discuss protection of the Ross Sea, a small region of the Southern Ocean that is deemed by many to be the most pristine large ocean ecosystem left on the planet. But for the third year in a row, the Commission could not agree to designate the Ross Sea, Antarctica as an international marine protected area (MPA). Instead, they agreed to continue fishing in this most remote stretch of ocean. But what are they fishing for and why would anyone send vessels to travel such great distances into this dangerous and ice-choked corner of the Antarctic?

The Last Ocean

The Ross Sea, long celebrated for its contributions to science and protected by its icy remoteness, abounds with life and beauty. One-third of all Adélie penguins and one-quarter of all Emperor penguins make their home there. Antarctic minke whales abound. In most of the world's oceans, top predators have been removed through overfishing, but in the Ross Sea predators still thrive, including Weddell and leopard seals, a unique subspecies of orca and the Antarctic toothfish – the top fish predator in the Southern Ocean. The Ross Sea can support all this life because it is the most productive stretch of ocean on Earth, with a phytoplankton bloom so large it can be seen from outer space.

While most of the world's oceans have suffered severe overfishing and pollution, the Ross Sea has remained largely unscathed. Scientists consider it a living laboratory, which may offer a last chance to study how a healthy marine ecosystem functions. For more than a decade, these scientists have fought alongside conservationists, celebrities, artists, media and the public, all advocating for a Ross Sea marine reserve. Because of its ecological and conservation significance, the Ross Sea has come to be called The Last Ocean.

The most remote fishery on Earth

A rusty longline vessel pushes through the ice, working to deploy up 15-kilometer-long lines of hooks. The captain is racing alongside perhaps 20 other vessels from a dozen different countries to catch as many fish as his lines can haul before the fishery reaches the total allowable catch and is shut down for the season. With no rules requiring vessels to be ice-strengthened, many become lodged in the ice, stuck and drifting for days. The lucky ones eventually break free, while others sink or catch fire, as happened to two Korean fishing vessels in 2010 and 2012, leaving two dozen dead. These were not the first lives lost while fishing "White Gold" in the Ross Sea, nor will they likely be the last. The deep-dwelling Patagonian toothfish was first discovered in the 1970's along the coast of Chile.

The fish were caught as by-catch, which was usually discarded, while fishermen were targeting other more marketable species. An American fish merchant on the lookout for new fishes to sell in the United States happened to spot the huge beast of a fish - toothfish can grow in excess of two meters and 100 kilograms - and began marketing them as "Chilean sea bass."

With heavy marketing pressure and their clever new name, toothfish quickly went from fish sticks to fancy. The fish's fatty white flesh proved to be a chef's dream. It could take on any flavor and was almost impossible to overcook. The dish was suddenly found on menus of upscale restaurants throughout the United States. To provide more fish to the market, fishing vessels began searching for toothfish beyond Chile and into the Southern Ocean. Populations of Patagonian toothfish were found around almost every subantarctic island. But pirate fishermen - known as illegal, unregulated and unreported, or IUU - also wanted their share of this lucrative trade. Throughout the 1990's IUU fishers ravaged the Southern Ocean toothfish populations. Local populations crashed and fishing vessels were pushed further south, until they finally penetrated the icy waters of the Ross Sea to find the Antarctic toothfish, the Patagonian toothfish's southern cousin. The Antarctic toothfish population in the Ross Sea now supports the most remote fishery on the planet.

The remarkable Ross Sea Antarctic toothfish

Prior to their explosion on the seafood market, scientists marveled at the Antarctic toothfish's amazing physiology and life history adaptations. They thrive in the subzero waters of the Ross Sea by producing antifreeze proteins that keep their blood from turning to ice. Instead of swim bladders, which most fish use to control their buoyancy in the water column, toothfish produce lipids (or fats) to achieve perfect buoyancy with zero effort. Unfortunately for toothfish, it is also these lipids that make them such a rich and palatable fish. Like other deep-dwelling fish, toothfish live a long time, 40 years or more, and grow slowly, only maturing in their teen years.

In recent years, scientists have begun to reveal even more of the remarkable secrets of the Ross Sea toothfish's life history. While still unconfirmed, evidence suggests they make a remarkable spawning migration starting at the depths of the Ross Sea continental slope, then catching the Ross Gyre out 500 km north to the Pacific Antarctic Ridge System. Here they likely spawn, release their eggs, and catch the same gyre to return to the Ross Sea. Despite the increasing knowledge about the Ross Sea Antarctic toothfish, much remains unknown. Incredibly, no one has ever found a larval fish or an egg. No one knows when or how often the fish spawn, but it's likely not every year. No one knows how big the population actually is. These gaps in knowledge, in addition to their deep-dwelling vulnerable characteristics, make a sustainable fishery difficult, if not impossible to achieve.

Harvesting the Last Ocean

Fishers now remove more than 3000 tons of Antarctic toothfish every year, with effects rippling through the system. Long-line fishing targets the biggest (and oldest) fish, removing this key life history stage from the population. Analyses of the catch in the Ross Sea have already revealed the loss of the largest fish from the Ross Sea population, and scientists have no longer been able to catch large toothfish for research in the McMurdo Sound region of the Ross Sea, south of the commercial fishing grounds. In many other fish species, the largest fish produce the most offspring and their removal can be devastating to the population, with potential effects cascading throughout the ecosystem. Toothfish prey on silverfish, squid, and other fish, and are thought to be a significant proportion of the diets of Weddell seals and Ross Sea killer whales. Scientists are already beginning to report fewer sightings of these whales in the Ross Sea.

Beyond the risks of targeting a top predatory fish, many scientists would argue that because of their life history characteristics, deep-sea fisheries are simply not resilient to heavy commercial exploitation. In the past we've realized this far too late, long after the deepwater fishes had been over-harvested.

Meanwhile, consumer demand for toothfish may continue to grow due to more toothfish stocks achieving the Marine Stewardship Council eco-label and green listing from consumer information programs such as the Monterey Bay Aquarium's Seafood Watch. These controversial ratings, which suggest that the Ross Sea toothfish fishery is sustainable, were achieved despite heavy opposition from the scientific and conservation communities. As outlined above, many scientists believe that we still do not know enough about the life history of Antarctic toothfish or about the impacts of the fishery on the ecosystem. These ratings also do not properly consider the lack of rules around vessel safety, which pose a risk to human life but also to marine life through the risk of spills. Finally, these certifications have no metric for considering the intergenerational values of protecting one of the last remaining healthy ocean ecosystems.

NAVIGATING A WAY FORWARD

A plan for a Ross Sea MPA will again come up for discussion in 2015 during CCAMLR's annual meeting. The plan, in its current form, would not reduce the amount of fish caught in the Ross Sea, nor would it interfere with the major fishing grounds. The MPA would, however, close almost the entire Ross Sea continental shelf and a large portion of the continental slope as well as the region around the biologically rich Balleny Islands and seamounts north of the Ross Sea.

While protecting the Ross Sea in its entirety may be a political impossibility, the closures proposed would still enhance precautionary management for the Antarctic toothfish. The MPA plan has reference areas for understanding (and potentially managing for) the effects of climate change while also looking to assess the effects of fishing on the population and ecosystem. The large swaths of the Ross Sea designated as off limits to fishing would protect at least some of the toothfish population, hopefully ensuring that the Ross Sea stock doesn't follow the collapsing trend of so many other fisheries across the world.

This fish, that exists at the edge of possibility, surviving in the icy southernmost reaches of the ocean and playing a key role in the Ross Sea ecosystem, deserves to thrive. Beyond overcoming the political barriers of achieving an Antarctic MPA - which requires consensus among CCAMLR's 25 member nations - individual people across the world have been fighting to help protect this remarkable fish.

More than half of the toothfish caught in the Southern Ocean wind up in the United States, sold as a luxury item to those who can foot the bill. Due to the global outreach effort via conservation groups like the Last Ocean, the Antarctic and Southern Ocean Coalition, the Pew Charitable Trusts and the Antarctic Ocean Alliance, citizens from all reaches of the globe have petitioned in favor of ending fishing in the Ross Sea. Further, due to pressure from non-profits advocating for sustainable seafood, like Greenpeace and Fishwise, an increasing number of markets throughout the United States now refuse to sell Ross Sea Antarctic toothfish.

With these collective efforts, under the watch of the world's eye, as the Ross Sea MPA plan comes up for discussion for the fourth time, CCAMLR decision-makers may do more than set another toothfish quota in the Ross Sea. Recognizing the power of an MPA as a fisheries management tool and in setting aside an extraordinary stretch of ocean for the sake of future generations, perhaps CCAMLR will find the political will to see a Ross Sea MPA through.

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Whales in the Courtroom, The Historic Ruling of the International Court of Justice Against Japan's Scientific Whaling in Antarctica

Elsa Cabrera

Abstract

The ruling of the International Court of Justice on March 31, 2014 is the first judgment to determine that the scientific hunting program of the Japanese in Antarctica does not meet the purpose of scientific research under the statutes put forth by the International Whaling Commission (IWC). Therefore, the aforementioned program of the Japanese government has infringed upon the global moratorium of commercial hunting and the Southern Ocean Whale Sanctuary. The stance that Japan has adopted in respect to the irreversible ruling made by the International Court of Justice has set a precedent that will have profound implications in the conservation and management of Antarctic biodiversity, as well as on the principles that govern existing programs of scientific research in the Southern Ocean.

Keywords

Whaling in Antarctica, International Court of Justice, Scientific Whaling, JARPA, International Whaling Commission (IWC).

Background

On May 31, 2010, Australia presented a lawsuit against the second phase of Japan's scientific hunting program; otherwise know as JARPA II,[1] to the International Court of Justice (ICJ). Subsequently, on December 15, 2010, New Zealand joined the lawsuit as a supporter of Australia. In the document presented by Australia to the ICJ, it was affirmed that "the intention of Japan to continue their large-scale whaling program under the second phase of the Program of Research Under Special Permits (JARPA II) infringes on the obligations assumed by Japan under the International Convention for the Regulation of Whaling[2]".

Although Article VIII of the International Convention for the Regulation of Whaling (ICRW) provides for the issuance of special hunting permits for scientific research purposes, since the implementation of the global moratorium over the commercial hunting of whales in 1986[3], the Japanese government has taken advantage of the article to generate self-granted whale catch quotas of Antarctic minke whales (Balaenoptera bonaerensis) on a large-scale. The products obtained during these whaling operations are then later commercialized in the domestic Japanese market.

In this regard, the Australian lawsuit questioned the scale of these whaling operations noting that during the first decades of the existence of the IWC (1946-1986), that the Japanese government captured on a global scale an annual average of 28 whales for scientific research purposes. In contrast, 6,900 minke whales were captured under the first phase of JARPA (1987-2004)[4] and the annual self-granted quota assigned in 2005, under JARPA II, consisted of 850 Antarctic minke whales (±10%), 50 fin whales (Balaenoptera physalus) and 50 humpback whales (Megaptera novaeangliae).

The position presented by the government of Australia to the ICJ is not isolated. The support of New Zealand as a backer in the lawsuit against Japan has aggregated more than 40 adopted resolutions by the IWC that are against special permission for whale hunting. The support has also brought together dozens of diplomatic protests, which call for the end of the whale massacres carried out by the Japanese government, as well as for an increased focus on non-lethal research of whales.

In the lawsuit submitted to the ICJ, the Australian government affirmed its hopes for an open statement that declares that the government of Japan is violating its international obligations under the International Convention for the Regulation of Whaling. The claim also requested that the Court give orders to the government of Japan to stop the implementation of JARPA II, to renounce their special permits and to offer guarantees that no future action of the country will go against its obligations under international law.

The Case Before the International Court of Justice

The oral phase of the Australian lawsuit against the scientific hunting of Japan in Antarctica was conducted before the ICJ between June 26 and July 16, 2014. The arguments made by the Australian government, which particularly stood out during this phase, include:

The whaling operations carried out by Japan in the Antarctic violate the ICRW, in particular, the global moratorium on commercial whaling and the Southern Ocean Whale Sanctuary.

The issuance of special permits for scientific hunting under the IWC constitutes an exception to the provisions of the IWC.

The Japanese government's interpretation of Article VII is worrisome, for the government considers that no State or international organization can interfere in the issuance of special permits for capture. JARPA II does not comply with the basic characteristics to be considered a scientific research program, but on the contrary, qualifies as an operation of commercial character motivated by market forces, the processing capacity of the Japanese whaling fleet and other political factors unrelated to scientific research.

In response, the Japanese delegation testifying before the ICJ focused on defending the application of Article VII of the ICRW by stating that special permits for the scientific research of whales are a right of IWC members that may not be restricted or limited by any States or international organization.

According to the arguments put forth by the Japanese defense, nothing can limit the right of countries to self-grant scientific whale hunting quotas, since the provision of Article VII are not exceptional, but special and independent of the regulations established by the IWC for commercial hunting. According to the government of Japan, nothing can restrict or cancel this special right. Similarly, the Japanese defense was emphatic in saying that the ICJ cannot define the characteristics or methodologies of its scientific hunting program in Antarctica.

The oral presentation made by New Zealand in its part as supported of the lawsuit of Australia against Japan for the scientific hunting of whales in Antarctica, focused on the collective character of the regulatory system of the IWC and the necessity of cooperation from all members in order to successfully complete the objectives established at the ICRW; to conserve whale populations for future generations. In particular, New Zealand's delegation affirmed in front of the ICJ that Article VII is one part of this collective system of regulation, and is not a loophole for countries to issue themselves special permits for scientific whale hunting without any control or supervision of the international community.

Science Under the Scrutiny of International Public Opinion

One of the central points of the oral phase in the lawsuit of Australia against Japan before the ICJ was the commercial nature of the Japanese whaling program in Antarctica, JARPA II. The delegations from Australia and New Zealand presented evidence showing that the final objective of JARPA and JARPA II is to keep the Japanese whaling industry active in the hopes that the global moratorium on commercial whaling will be lifted.

After the implementation of the moratorium in 1986, Japan started the first phase of the scientific whaling program in Antarctica (JARPA). This phase originally considered the annual catch to be equal to 850 Antarctic minke whales. However, international pressure forced the Asian nation to reduce this figure to 300 whales, which was subsequently increased to 400 whales. In 2005, Japan launched the second part of the research program, JARPA II, which expanded the target species to

50 fin whales[5] and 50 humpback whales[6], as well as increased by more than 100% the annual quota of minke whales (850, ±10%). This latter figure coincides with the share originally considered by Japan following the adoption of the moratorium, as well as the processing capacity of the Japanese whaling fleet in Antarctica.

Australia and New Zealand also presented evidence to the ICJ which revealed that the final objective of Japan's Antarctic whale research as commercial and non-scientific. The issuance of special permits for scientific hunting began immediately after the implementation of the global moratorium on commercial hunting of whales. Capture operations are performed in the same areas as commercial whaling and utilize the same fleet and staff for both tasks. In turn, the operations are isolated from other whale research programs in the Southern Ocean, while the meat and by-products obtained are sold to generate economic gains.

Japan's inability to explain the basis that justifies the scale of their annual catch was perhaps one of the most decisive factors for the final ruling of the ICJ in this historic trial. The absence of scientific arguments to explain the annual catch of 850 whales, including fin, humpback and Antarctic minke whales, was evident when the Japanese defense presented a formula to the ICJ without explaining the reasoning behind it saying, "I don't have the slightest idea what that [formula] means. Mathematics has never been my forte[7]".

Subsequently, the only cetacean research expert put forth to testify by the Japanese defense[8] said to ignore how they calculate the hunting quotas for the three species included in JARPA II, questioning the inclusion of fin and humpback whales inside the scientific research program. The specialist recognized that according to one of the founders of the IWC, the number of whales hunted in the form of special permits should not exceed ten specimens annually[9].

THE HISTORIC VERDICT OF THE ICJ

After 26 years and 10,900 whales hunted in the Southern Ocean in the name of science, on March 31, 2014, the government of Japan faced a resounding defeat when the International Court of Justice ruled, in a historic verdict unprecedented in international law, that the whaling operations of Japan in Antarctica do not fulfill the purpose of scientific research under the statutes that govern the work of the IWC.

Among others, the ruling of the ICJ asserted that the evidence presented by Australia and New Zealand shows that the government of Japan has implemented programs of scientific hunting of whales in Antarctica for logistical and political reasons, rather than for scientific research. In particular, the judgment of the ICJ states that JARPA II violates the moratorium on commercial whaling and the Southern Ocean Whale Sanctuary.

As Australia had requested, the ICJ ordered Japan to revoke any special permit for the scientific whale hunting in the Southern Ocean and to refrain from issuing any new permits[10]. While the first reaction of the Japanese government was to declare that it would abide by the ruling, it soon became apparent that their true intentions in the Antarctic in relation to whaling would remain unchanged. On April 18, 2014, the government of Japan announced that it would resume the sanctioned scientific hunting of whales in the Southern Ocean starting in December 2015 under a new program of scientific research called NEWREP-A[11].

Geopolitical Whaling

The determination of Japan to resume the scientific hunting of whales in Antarctica after the historic ruling of the ICJ occurred days after a key meeting held in Tokyo between senior Japanese officials, including the Minister of Fisheries and Agriculture for Japan, Yoshimasa Hayashi, and pressure groups associated with the fishing industry. During the meeting, Mr. Hayashi reaffirmed the importance of ensuring access to marine resources[12].

The relationship between the interests of the Japanese fishery on the high seas and the controversial whaling of Japan in Antarctica is nothing new. In 2002, the current Deputy Commissioner of the Japanese government to the IWC, Joji Morishita, revealed in an interview that compromising the sustainable use of wildlife could create a domino effect and restrict the right of Japan to exploit marine resources[13]. Later in 2005, Morishita said that the diplomatic power of Japan could come into question if they lose their right to exploit whales in an extractive manner, which would have implications on other issues[14].

Despite the fact that the government of Japan argues that its motivation behind whaling in Antarctica is scientific, it would seem that the country is more motivated by political and economic interests aimed to secure unrestricted access for the Japanese fishing industry from distant waters to biological marine resources in the Southern Ocean in the long term. Evidence suggests that the continuation of "scientific" whale hunting for Japan in Antarctica is key in the fulfillment of this objective.

The new Japanese whaling plan in Antarctica forms an integral part of this strategy, since its main objective is the application of a formula known as the Revised Management Procedure (RMP), whose sole purpose is to calculate quotas for the commercial hunting of whales. Considering that the area where the Japanese government seeks to implement NEWREP-A prohibits the commercial hunting of whales regardless of their conservation classification after having been appointed as a sanctuary under the IWC in 1994, it is clear that the political objective of the new Japanese whaling plan is to advance towards the gradual elimination of the sanctuary and the commercial whaling moratorium in order to resume commercial whaling operations in the Southern Ocean.

The historic defeat of Japan before the ICJ in March 2014 could be rapidly reversed if Japan manages to implement its new whaling plan in Antarctica. This would consolidate the interests of the Japanese state through its fishing industry to gain access to the marine resources of a strategic area like the Southern Ocean.

In a manner similar to what was expressed by Morishita in 2005, the triumph of whaling politics of Japan in Antarctica could have profound implications for the conservation and management of living marine resources in the Antarctic, the principles of scientific research programs and the strategic interest of the people and States of Latin America in the Antarctic area and adjacent areas.

References

1. Second Phase of the Japanese Whale Research Program Under Special Permit in Antarctic (JARPA II).
2. Government of Australia. Application Instituting Proceedings to the International Court of Justice. (http://www.icj-cij.org/docket/files/148/15951.pdf).
3. The global moratorium regarding the commercial hunting of whales was adopted by the IWC in 1982 and was put into effect in 1986.
4. Ibid 2
5. Between 2004 and 2014, 18 fin whales were captured under JARPA II.
6. International pressure prevented the capturing of whales of this species during the implementation of JARPA II.
7. Alan Boyle, professor at the University of Edinburgh (Scotland) and defense lawyer for the government of Japan during the ICJ trial.
8. Lars Walløe, professor at the University of Oslo (Norway).
9. Birger Bergensen, Norwegian anatomist and the first president of the IWC.
10. Ruling of the International Court of Justice on Whaling in Antarctica (Australia vs. Japan: New Zealand intervening). March 31, 2014. http://www.icj-cij.org/docket/files/148/18136.pdf
11. ABC News, April 15, 2014, "Japan Pro-Whaling Lobby Vows to Continue Hunts"
12. Ibid 11.
13. Asahi Shimbun. November 29, 2002. "Japanese whaling policy leads many observers to wonder what motivated the Japanese to continue hunting whales at the risk of antagonizing Western countries", by Takashi Kanamitsu.
14. Interview with Joji Morishita on Australian radio, July 25, 2005.

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Penguins And Krill: Life in a Changing Ocean

Rodolfo Werner

Abstract

Populations of Adélie and chinstrap penguin in the West Antarctic Peninsula/Scotia Sea have declined more than 50% during the last 30 years. Changes in the abundance of their main prey - Antarctic krill - as a result of climate-driven changes could be the cause of this reduction of penguin populations. As the extent of the impact of climate change on krill populations remains uncertain, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR; www.ccamlr.org) should keep a precautionary approach in the management of the krill fishery to secure the protection of penguins. This paper provides an overview of current challenges in the management of the Antarctic krill fishery so as to maintain krill availability to penguins in key areas.

Keywords

Antarctic krill fisheries; Penguin population declines; Commission for the Conservation of Antarctic Marine Living Resources; Antarctica; feedback management; climate change.

1. Introduction

The Commission for the Conservation of Antarctic Marine Living Resources ("CCAMLR") is generally regarded as a model for regional cooperation in the area of fisheries, implementing laws for the management of marine resources based on conservation principles. One of the central and continuing tasks of CCAMLR is the ecosystem management of the Antarctic krill fishery.

"Krill" is a term applied to describe over 80 species of open-ocean crustaceans known as Euphausiids. Euphausia superba is the species commonly referred to as "Antarctic krill," which are shrimp-like crustaceans. Adult krill aggregate into huge schools or swarms, that may extend for kilometers with thousands of krill packed into each cubic meter. This swarming behavior is what makes krill attractive to commercial harvesting

Antarctic krill are central to the Antarctic marine food web, as most organisms are either direct predators of krill or are just one trophic level removed from it. For many marine mammals and sea birds (especially penguins), krill is the most abundant food source. Areas of highest krill concentration are often close to the land-based breeding colonies of krill-eating seabirds and seals. These predators depend on krill being within reach of their colonies in order to feed and rear their offspring during the Antarctic summer.

Interest in krill fisheries began in the 1960s, with the highest catches occurring in the early 1980s, reaching over half a million tons. 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 of Antarctic krill have increased substantially in recent years, reaching a maximum of 282,000 tons in the 2013/2014 fishing season, and concentrating repetitively in certain areas over and over. The Antarctic krill fishery may become the largest global fishery, with the potential to affect significantly the trophic structure of the Antarctic marine ecosystem.

This paper describes current challenges in the management of Antarctic krill fisheries in the context of declining penguin populations, resulting most likely as a result of climate-driven changes.

2. Penguins, climate change and the Antarctic krill fishery

The reduction of the populations of Adélie and chinstrap penguin in the West Antarctic Peninsula/ Scotia Sea area1 requires that the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) continues to advance in the management of the krill fishery. New and alarming evidence has been published in recent years about the reduction of the populations of Adélie (Pygoscelis adeliae) and chinstrap penguins (Pygoscelis antarctica) in the West Antarctic Peninsula/Scotia Sea area. 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[1]. Significant declines in the breeding population of chinstrap penguins in Deception Island's largest chinstrap colony known as Baily Head have been confirmed recently by researchers from the Antarctic Site Inventory[2]. Changes in the abundance of Antarctic krill (the main prey of both species) could be the cause of the reduction of penguin populations. Previous studies indicate that as a result of climate-driven changes, particularly sea-ice reduction, abundance of krill in this area may have reduced by as much as 80% from existing population levels in the 1970s[3].

CCAMLR have been applying a precautionary approach in the management of the krill fishery[4-5]. In the context of the observed reduction of penguin populations in the West Antarctic Peninsula/Scotia Sea, and as the extent of the impact of climate change on krill populations remains uncertain, it is fundamental that krill fisheries management is conducted so as to maintain krill availability to penguins in key areas. This is of particular importance since there is still insufficient knowledge about the impacts of the fishery on krill populations and krill dependent predators.

The breeding distribution of penguins and the foraging range during breeding (when they behave as central place foragers) is an important element in any consideration related to krill fisheries management. Current krill fisheries are operating close to shore in areas where penguins forage. Thus, krill fishing has the potential to have significant localized impact on krill availability in penguin foraging areas, especially during the breeding season. As knowledge of whether or not krill live in local stationary populations or migrate over larger areas using the ocean currents is incomplete, it is important that a precautionary approach be taken regarding fishing activities in these important foraging areas.

Key penguin species for which data exist in the Antarctic Peninsula/Scotia Sea are chinstrap, Adélie and gentoo. Historically, fishing has been taking place during the summer when penguins are constrained on where and how far they can travel to forage, resulting in an overlap between fishing operations and the foraging range of penguins. The level of overlap will depend, amongst others, on the species being considered as well as the specific location and time period. Nevertheless, in recent years, the fishery is changing its temporal scale and becoming more of a winter fishery. Also, fishing is concentrating on particular sites not necessarily in line with historical fishing patterns. The potential impact of fishing becomes more concerning since for the last 15 years krill fishing activity in FAO Statistical Area 48 has been approximately occurring in only a quarter of the area open to krill fishing and has been occurring in a concentrated way. Specifically, current krill fishing takes place in Subareas 48.1 (Antarctic Peninsula), 48.1 (South Orkneys) and Subarea 48.3 (South Georgia). Catch limits for krill apply also to Subarea 48.4 although no fishing has taken place in this subarea in recent years.

Most existing data on penguin foraging is from the summer, the peak of the breeding season for penguin species resident to the Antarctic Peninsula /Scotia Sea. Winter feeding grounds for penguin species in this area are still unknown. Some species will distribute along the ice edge, moving northward as the winter progress (e.g., chinstrap penguins) but satellite tagging data will be needed to validate this and determine winter feeding grounds for all penguin species. Information on penguin foraging in winter is crucial so as to determine the level of overlap between the krill fishery and penguins over time since krill distribution and abundance changes also seasonally and interannually.

3. Important element to secure the protection of penguins

3.1 Feedback management

Feedback management requires monitoring to allow management to be adjusted as relevant information becomes available. Having embraced the precautionary approach in managing fisheries, CCAMLR needs to adjust fishing activities (i.e. krill catch, and its geographical and temporal distribution) in response to the changes of monitored indicators. In 2010, CCAMLR's Scientific Committee (SC-CCAMLR) recognized that the management of the krill fishery was facing important challenges that still needed to be resolved. Consequently, the work on krill was prioritized with a special focus on the development of feedback management, amongst others.

Recent developments with regards to a feedback management strategy for the krill fishery are encouraging. CCAMLR has considered initial elements that include the development of a list of candidate feedback management approaches and the identification of an agreed suite of indicators. This is of particular importance in Antarctica since in a changing ecosystem such as the Southern Ocean the only adjustment that CCAMLR can exert is through managing fisheries.

Although candidate feedback approaches that are currently being discussed may be feasible to be implemented in the near future, in the meantime it would be important to take increased precaution in the distribution of local catch limits, especially taking into account the uncertainties related to the impact of climate change and to the estimation of krill total removals by the fishery.

3.2 The need to revise and expand CEMP

Monitoring is central to feedback management and therefore, it is critical to have an effective CCAMLR Ecosystem and Monitoring Program (CEMP). CEMP was designed to monitor the effects of the krill fishery on krill predators as opposed to those produced by environmental changes. Currently, monitoring data, which includes predator, environmental and prey (krill) parameters, are being gathered from a network of determined sites (CEMP sites) in relation to a limited number of krill-dependent predators in land-based colonies which were selected as indicator species[2].

The sites monitored and the data submitted to CEMP have been decreasing in recent years. In addition, climate change could potentially induce rapid changes within the ecosystem, impacting the way indices generated by CEMP are being used to detect fisheries impacts. As already recognized by CCAMLR, in its current configuration CEMP does not allow distinguishing the impacts of fishing from those associated with environmental change, its main objective at the time of its creation. Consequently, a review of CEMP, including the requirements for its monitoring reference sites is urgently needed.

The implementation of feedback management in Area 48 based on the current monitoring of CEMP would require a highly precautionary approach with regards to krill catches and/or to spatially restrict catches, focusing only in those areas where existing monitoring occurs. To distinguish between climate change and fisheries impacts, it may be necessary to establish reference (control, i.e. complementary no fishing) sites and/or additional parameters. A spatial subdivision of the fishery could be a valuable approach for the development of feedback management procedures in the krill fishery. Following this, some areas could be closed to fishing (control or reference areas), whereas in other areas, with similar ecological features, fishing could be allowed, setting area-specific catch limits. Comparison between no-take areas and fishing areas could help to assess the effects of fishing. Also, CCAMLR should take advantage of all existing monitoring opportunities, including selected land-based monitoring sites, fishing and research vessels to collect data.

An expansion of CEMP will necessarily include the establishment of new monitoring sites in areas known to be fished so as to obtain the required baseline monitoring information. Collecting baseline information on land-based predators is time consuming, and thus it would be important to ensure the continuity of current monitoring sites that have been creating relevant time data series.

Current CEMP sites are the result of national research programs3 of member countries and are not necessarily established with the intention of providing data for feedback management purposes. In addition, there are other areas in the Antarctic Peninsula/Scotia Sea where research programs to monitor land-based predators are being conducted by Parties to the Antarctic Treaty and CCAMLR, and by other research bodies. Although information arising from these projects could represent potentially an important contribution to CEMP, currently no data are being provided. It becomes relevant therefore to coordinate monitoring activities with the Committee on Environmental Protection (CEP) of the Antarctic Treaty Consultative Meeting (ATCM). Of particular importance would be that CCAMLR establishes some cooperation with the Council of Managers of National Antarctic Programs (COMNAP) so as to identify projects that could provide data to help expand the spatial extent of CEMP, which would facilitate the development of a feedback management system.

In the case of penguins, in addition to sites that are systematically being monitored, it would be important to conduct surveys to reduce uncertainty in estimates of penguin abundance, and subsequently estimates of krill consumption by penguins, in other penguin colonies.

In recent years, it has become clear that to increase availability of data on predator abundance throughout Area 48, CCAMLR could combine the use of satellite remote-sensing aerial surveys, visits to penguin breeding colonies using ships of opportunity, and remote cameras to provide broad-scale information on the size and trends of regional predator populations. To make progress in these areas, it is recommended that CCAMLR engages IAATO members (International Association of Antarctic Tourist Operators) in supporting monitoring of penguin colonies visited by tourists during the penguin breeding season (i.e. by sponsoring equipment, facilitating logistics, etc.).

With regards to the understanding of foraging distribution of land based predators in general, tracking instruments have been deployed only at a restricted number of breeding sites, thus substantial work is needed with regards to making predictions for colonies where no tracking data exist, or colonies where tracking data are only available for certain times of the year. The data gathered so far indicate that some species have restricted movements while others travel long distances, and that foraging movements may vary substantially across seasons and between life-history stages. This type of information will be key for the implementation of feedback management, and especially, for the establishment of MPAs in Area 48.

3.3 General considerations in the establishment of marine protected areas (MPAs) in the context of the krill fishery

Besides of adopting spatial area limitations to protect important penguin foraging areas, CCAMLR would need to establish some reference areas in the development of a feedback management strategy for the krill fishery. In the case of existing study locations, such as CEMP sites, it would be important to determine which sites could be included in potential MPAs to be protected from the impact of the fishery and which sites should remained exposed to fishing operations to register any potential impact from the krill fishery. Other locations (sites) that are not part of CEMP but are currently being monitored by Members should also be considered for protection when designing MPAs in the context of a feedback management strategy. Also areas that have been historically not fished as opposed to other areas that were heavily fished over the years will need to be considered in the analysis. Finally, Antarctic Specially Protected Areas (ASPAs) and Antarctic Specially Managed Areas (ASMAs) established by the ATCM, which are important for their own reasons, should be given full protection from the fishery.

4. Remaining challenges in the management of the krill fishery

4.1 The Trigger Level and climate change

The life history and demography of Antarctic krill are intimately tied to seasonal sea ice conditions, climate, and the physical forcing of ocean currents. Key spawning, recruitment and nursery areas of krill are located in the Southwest Atlantic sector (West of the Antarctic Peninsula). The climate in this area is warming rapidly, and as a result, the extent and duration of winter sea ice has declined. The reproduction and survival of krill are significantly affected by sea ice cover[6] and it has been shown that summer krill densities correlate to both the duration and the extent of sea ice during the previous winter[3]. Accordingly, krill biomass seems to have been reduced in this area for at least the period from 1976 to 2003[3].

Climate change impacts on the Antarctic ecosystems are of major concern, and thus, management decisions would need to consider how climate change affects the marine ecosystem. This is of particular importance, since climate change, combined with changes in oceanography, has the potential to induce rapid change within ecosystems, resulting in important implications for the management of the Antarctic krill fishery.

In April 2011, the workshop on “Antarctic Krill and Climate Change” that took place in Texel, Netherlands, discussed krill biology in the context of climate change and the potential implications for krill fisheries management. Participants reviewed trends in the effects of climate change, such as ocean warming, sea-ice decline and ocean acidification, and the potential implications for krill stocks. The workshop noted that environmental changes will act in concert to modify the abundance, distribution and life cycle of krill. In addition, it was concluded that the impact of climate change is predicted to increase considerably in the Southern Ocean over the next few decades, and that the resulting changes will likely impact negatively on krill[7].

Workshop participants considered recruitment, driven by the winter survival of larval and juvenile krill, to be the most susceptible to climate change amongst the population parameters determining the distribution and biomass of krill. The workshop also concluded that it seems inappropriate to consider stable recruitment of krill in the context of the impacts of climate change, especially in the Antarctic Peninsula and Scotia Sea area. It was concluded that while CCAMLR further investigates this particular aspect, precaution should be implemented in the light of an increasing krill fishery[7]. The "trigger level" (620,000 tonnes) currently operates as the maximum allowable krill catch in Area 48 and was established on the basis of summing the maximum historical krill catch in each subarea, which amounts to 619,500 tonnes (for more information on the trigger level see[5]).

Related impacts from climate change have increased significantly since 1991 (when the trigger level was introduced). Thus, the conditions under which the trigger level was introduced have changed and it is no longer valid to rely on the original catches on which the trigger level was established.

Clearly, if monitoring data were to indicate that predators were decreasing in Area 48, possibly because of ecosystem changes related to climate change, CCAMLR would need to modify the distribution and intensity of fishing. For example, is the drop in population numbers of chinstrap and Adélie in the Antarctic Peninsula/Scotia Sea already a good indicator that should trigger a change in the distribution and intensity of fishing in this area? This question highlights the need to undertake a good quantitative study of the factors that might be inducing a drop in penguin numbers, including an analysis on the effect of fishing on these declines.

It is important to take into account the uncertainties related to the impact of climate change on the abundance of krill in important penguin foraging areas. In recent years, the krill fishery has concentrated heavily in coastal areas. In 2009/2010 catches were concentrated in the Bransfield Strait (in Subarea 48.1) with 80% of the total catch in Subarea 48.1 occurring mainly in two Small Scale Management Units (SSMUs)4. In addition, catches that year were 20 times greater than the average historical catch in these SSMUs. Fishing in the 2012/2013 and 2013/2014 concentrated again in the Bransfield Strait, leading to the closing of Subarea 48.1 when the catch limit was reached during both fishing seasons. This is the third time since the establishment of CM 51-07 that the Subarea was closed before the end of the fishing season after reaching the catch limit in this area. In addition, total catches in the 2013/2014 season (data available until September 2014) have reached an historical maximum of 282,000 tonnes which is almost three times the catches in the year 2000. This highlights the need for CCAMLR to adopt additional measures to prevent excessive concentration of krill catches in coastal areas (potentially leading to a localized depletion of krill availability).

4.2 Old data and the need for a new CCAMLR Synoptic Survey

CCAMLR has already recognized that there is a lack of up-to-date information on the spatial distributions and trends in krill biomass, fishable biomass and the magnitude of the krill movement throughout Area 48. Estimates of pre-exploitation biomass of krill (B0) are uncertain for a variety of reasons. Of greatest concern is the fact that the last krill synoptic survey for Area 48 conducted by CCAMLR members occurred in 2000. Moreover, it is now understood that krill are increasingly impacted by climate change. Therefore, CCAMLR Members should take the necessary steps to conduct a new krill synoptic survey to obtain a new biomass estimate for Area 48. Besides of krill biomass information at the basin scale, a synoptic survey could help in foreseen effects from climate change, sea ice reduction, fishing operations, ocean acidification, etc. for areas that might not be covered by regional surveys. Similar conclusions have been reached at a recent cross-sector workshop on krill fishing and conservation in the Scotia Sea and Antarctic Peninsula region[8]. In addition, one of the key findings of this workshop is the need to formulate a research and development strategy to support progress in the management of the Antarctic krill fishery so that the limited available resources can be targeted appropriately. This strategy should allow the identification of priority objectives for research and development in support of CCAMLR's management of the krill fishery.

To complement the results from a krill synoptic survey, new cost effective methods being developed could provide information on krill biomass and distribution in Area 48 in a timely manner. Besides data provided by krill fishing vessels, it would be important to dedicate research cruises in areas outside historical fishing ground to provide a comprehensive coverage of Area 48. The appropriate assessment of krill biomass and distribution would be key for the implementation of the feedback management in Area 48.

4.3 The need to estimate total krill removals

CCAMLR set catch limits for its fisheries at a level that is considered sustainable. This is conducted under the assumption that the reported catch from a fishery reflects the total removals by that fishery from the exploited population. In the krill fishery there are still some problems related to estimating total removals of the krill based on the uncertainties associated to estimating the green weight and the krill escapement mortality.

4.4 Green weight

Green weight is defined as the total weight of krill landed on the vessel, which is assumed to be equivalent to total removals.

CCAMLR has yet to adopt a standardized reporting method for krill catches. As was noted by the SC-CCAMLR in 2011, all methods for estimating green weight of krill have associated uncertainty, and the absolute uncertainty in catch estimates increases in proportion to the catch[9]. This uncertainty is not accounted for in the current management process for krill and does not only affects assessments of krill stocks, but also the estimations of the impact of krill removals on predators. Moreover, it raises important enforcement issues.

Currently, CCAMLR Members are required to report green weight and the method used to estimate it. Nevertheless, the level of accuracy in estimated green weight continues to differ between methods and seasons. In addition, the methods used to estimate green weight by different Members have a variable uncertainty that is still not accounted for.

4.5 Krill escape mortality

Krill escape mortality occurs when krill gets squeezed through the nets while fishing, an unknown percentage of which gets killed or seriously injured, without being counted as caught. In practical terms, krill escape mortality is calculated as the amount of krill escaping through the trawl mesh multiplied by the proportion of animals that die as a result of this process.

The issue of krill escape mortality from krill nets raises further concerns about the capacity to effectively measure krill removals during fishing operations. Many different factors such as krill density, type of gear, speed of trawling, and mesh size are likely to affect escape mortality. Krill trawl net escapement mortality represents an important source of uncertainty, which further undermines CCAMLR's capacity to determine the real impact of fishing operations on the ecosystem. Although some initial experiments have been conducted during the last couple of years, there are no conclusive estimates on the level of krill escape mortality. The further investigation on krill escape mortality is fundamental for the assessment of total krill removals by fishing operations.

4.6 Scientific observer coverage

Over many years, the Scientific Committee has recommended 100% scientific observation across all vessels in the krill fishery as the best way to achieve systematic observer coverage, meaning a level of coverage that ensures data collection across all areas, seasons, vessels and fishing methods. A robust scientific observation program is necessary to understand the overall behavior and impact of the fishery and is also fundamental to collect biological data a factor that currently limits CCAMLR's ability to monitor and manage the krill fishery.

For many years, the Scientific Committee has been advising on the need to have deployment of 100% scientific observer coverage on board krill vessels. Clearly the reasons that have been impeding this observer scheme are political and not scientific. For example, back in 2007, Members of CCAMLR's Working Group on Ecosystem Monitoring and Management (WG-EMM) expressed already their frustration that the collection of scientific observer data, which was granted a high priority by the Scientific Committee, was being impeded by non-scientific arguments [10].

At CCAMLR XXVIII- 2009 CCAMLR adopted CM 51-06 that made mandatory the deployment of scientific observers on board krill vessels. This CM resulted in 30% mandatory observer coverage in the first year, and 50% in the second year. This represented a key step forward in the establishment of a comprehensive scientific observation program.

At the recent meeting of WG-EMM in July 2014, the need to improve data quality, including securing the training of scientific observers, was discussed. Also, the Working Group agreed that scientific observers could provide guidance in assisting the crew to estimate the green weight of krill caught, highlighting the need for 100 % krill fishing observers in this context. Furthermore, some krill fishing operators are concerned that transshipment operations are not necessarily covered by observers due to the current level of coverage, allowing for catch underreporting. Thus, a 100% observer coverage is not only recommended to improve the availability of krill fishing data to WG-EMM, but also to secure, full observation coverage during transshipment operations.

The Working Group concluded that there was a general desire to increase the level of observer coverage, recognizing that it was important to identify specific impediments that Members might have to increasing the level of observer coverage. While agreeing on the need for 100% observer coverage, the Working Group concluded that this was a decision by the Commission. While a revision of observer coverage requirements (CM 51-06) was not adopted by the Commission in its last meeting in November 2014, there was agreement to discuss an incremental increase at WG-EMM in 2015.

5. Increased fishing notifications, an observed trend

As stated before, under the current fishing level, the trigger limit might be precautionary but this might change as catches increase due to factors such as the impact of climate change on krill populations and the lack of capacity to estimate total removals by the fishery. The situation becomes even more pressing by taking into account the continuing increase in the capacity of the krill fishing fleet. Not only do vessels using the continuous fishing system have a larger potential daily catching capacity, but also some conventional trawlers have increased their capacity (measured in tons of krill per day) by using two nets simultaneously and/or by improving their krill processing techniques on board.

In addition to these developments, new countries and new vessels are entering the fishery. Even though real catches are normally lower than notified catches, it is clear that the fishing capacity to exceed the trigger level already exists. Therefore, catches can increase up to the trigger level with no further protective provisions in place. Heightened interest in the fishery, increased demand for marine resources and changing technology may lead to more participants entering the fishery in the future. Unless managed properly, the fishery could result in localized depletion of krill that can lead to negative impacts on krill predators proximate to the fishery's operation, or to potentially wider ranging impacts to Southern Ocean food webs and ecosystems.

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7. References

1.Trivelpiece, Wayne Z., Jefferson T. Hinke, Aileen K. Miller, Christian S. Reiss, Susan G. Trivelpiece, and George M. Watters. Variability in krill biomass link harvesting and global warming to penguin population changes in Antarctica. PNAS 2011; 108, 7625–7628.

2. Naveen, R., H. J. Lynch, S. Forrest, T. Mueller, and M. Polito. First direct, site-wide penguin survey at Deception Island, Antarctica, suggests significant declines in breeding chinstrap penguins. Polar Biology 2012; 35:1879–1888.

3. Atkinson, A., V. Siegel, E. Pakhomov & P. Rothery. Long-term decline in krill stock and increase in salps within the Southern Ocean. Nature 2004; 432: 100-103.

4. Gascon, V. & R. Werner. CCAMLR and Antarctic Krill: Ecosystem Management around the Great White Continent. Sustainable Development Law and Policy 2006; Volume VII, Issue 1, Fall.

5. Gascon, V. & R. Werner. Preserving the Antarctic Marine Food Web: Achievements and Challenges in Antarctic Krill Fisheries Management. Ocean Yearbook 2009; Volume 23, published by Martinus Nijhoff.

6. Loeb, V., Siegel, V., Holm-Hansen, O., Hewitt, R. P., Fraser, W., Trivelpiece, W.Z. and Trivelpiece, S.G. Effects of sea-ice extent and krill or salp dominance on the Antarctic food web. Nature 1997; 387: 897-900.

7. Flores, H., A. Atkinson, S. Kawaguchi, B. A. Krafft, G. Milinevsky, S. Nicol, C. Reiss, G. A. Tarling, R. Werner, E. Bravo Rebolledo, V. Cirelli, J. Cuzin-Roudy, S. Fielding, J. J. Groeneveld, M. Haraldsson, A. Lombana, E. Marschoff, B. Meyer, E. A. Pakhomov, E. Rombolá, K. Schmidt, V. Siegel, M. Teschke, H. Tonkes, J. Y. Toullec, P. N. Trathan, N. Tremblay, A. P. Van de Putte, J. A. van Franeker, T. Werner. Impact of climate change on Antarctic krill. Marine Ecology Progress Series 2012; 458: 1–19.

8. S. Hill, R. Cavanagh, Ch. Knowland, S. Grant, and R. Downie. Editors. Bridging the Krill Divide: Understanding Cross-Sector Objectives for Krill Fishing and Conservation - Report of an ICED-BAS-WWF workshop on UNDERSTANDING THE OBJECTIVES FOR KRILL FISHING AND CONSERVATION IN THE SCOTIA SEA AND ANTARCTIC PENINSULA REGION, Woking, UK 9th & 10th June 2014 - 56 pages.

9. SC-CAMLR-XXX. Report of CCAMLR's Scientific Committee. 2012; Paragraph 3.14.

10. WG-EMM-2007. Report of CCAMLR's Working Group on Ecosystem Monitoring and Management. 2007: Paragraph 4.56

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Species Composition and Photoacclimation of Marine Antarctic Benthic Diatom Species.

Paulina Uribe

Abstract

Antarctic benthic diatom communities from coastal areas are exposed to drastic seasonal changes of light intensity and duration, and persist during the long polar winter at extreme low light intensities as food supply for the overwintering Antarctic fauna. However, due to the characteristics of these communities, there are few studies on the species composition and their low light photo-acclimation. In this study, the taxonomic species composition and their relative abundance of the benthic diatom community at different sites and depths at Bahía Covadonga (Bernardo O'Higgins Station) (63°19'15"S, 57°53'55"W) were assessed. The photosynthetic response of cultured species of the genus Navicula to different light intensities and their recovery capacity were determined by using a Modulated Pulse fluorometer (Water PAM) to register their Chlorophyll fluorescence after exposing the cells to different light intensities. The benthic diatoms community had a high species richness and diversity, with a characteristic and specific distribution among the different sites and depths analyzed. All species studied, from different depths showed low light photo acclimation and photoinhibition to light intensities >100 µMol Photons cm^{-2} sec^{-1}. Nitzschia species showed a higher tolerance and recovery capacity to high light intensities than those from the genus Navicula. The results suggest that this characteristic photosynthetic response may be related to the different distribution of the abundance of species over different illumination status on the sites and depths where they were collected. Nitzschia species could cope in environments exposed to higher radiation, with higher recovery ability than those from the genus Navicula. The possible relationship of these observations with motility and other cellular properties of diatom species is discussed.

Keywords

Antarctic benthic diatoms, photosynthetic response, photoacclimation, photoinhibition, recovery, Navicula, Nitzschia.

INTRODUCTION

Benthic diatoms are responsible for an important percentage (40-50%) of marine coastal primary production (Falkowski, 1997; Underwood, 1999). In particular, on Antarctic coastal areas benthic diatoms are exposed to drastic seasonal variations of radiation intensity and duration. During the long Polar winter they subsist under the marine ice layer, at extreme low light intensity (1 to 10 % incident light) (Robinson, 1995). Thus, they constitute the "winter forage" in the base of the coastal food web for a wide range of overwintering organisms such as small mollusks, crustaceans, and krill, as well as their consumers. In general, microalgae photoacclimation to high light consists of coordinated physiologic and chemical composition adjustments that equilibrate light acquisition and the use of CO_2 fixation and other metabolic process. This response is particularly importan t in avoiding Photosystem II damage, the reduction of microalgae light harvesting, the display of energy dissipation mechanisms, deviating excess energy and displaying a photoprotection response (Arrigo et al 2010). On the other hand, when exposed to low light, photoacclimation increases the ability of light harvesting, and the reduction of energy use on cellular maintenance processes and growth.

Photoacclimation on Antarctic oceanic phytoplankton diatoms such as Phaeocystis antarctica y Fragilariopsis cylindrus have been extensively studied (Robinson, 1995). However, many of the characteristics of coastal benthic diatoms, such as their species composition, distribution, and response to the fluctuations of light intensity and their tolerance and recovery capacity when exposed to high irradiance, have been studied less and remain misunderstood. The aim of this study is to assess the diatom species composition of the benthic community living in the coastal area of Bahia Covadonga, (Bernardo O'Higgins Antarctic Station), and to determine the characteristics of the photosynthetic response and recovery capacity of isolated and cultured species from the genus Navicula in reaction to different light intensities.

MATERIALS AND METHODS

Sampling site

Sampling was performed by scuba divers at two depths in the Covadonga Bay and several other sites around the Bernardo O'Higgins Antarctic Station (63°19'15''S, 57°53'55''W) during the summer of 2009 (Figure 1A). The sites were denominated Ice Front, in contact with the high tide (IF); Intertidal (IT), and Benthos (10-20 m) as detailed on Figure 1B. Pieces of colored ice, or small stones samples that were collected in plastic 50 mL Falcon tubes were taken to the station lab. There, the cells were collected by thawing the ice samples, and by scraping the stones. Cells were concentrated through filtration with a 11 μm nylon mesh, previously filtered with a 100 μm mesh for discarding the higher size fraction of the samples. Microalgae were recovered via 50 ml culture flasks in f/2- culture medium (Guillard and Ryther 1962) and were incubated at 4º C with natural illumination. For taxonomic identification, 5 ml samples were prepared with 50% ethanol, that were later oxidized with 30% Hydrogen peroxide and washed in distilled water (Battarbee, 1986). Samples were then mounted with NAPHRAX® and observed under phase contrast microscopes (Zeiss) at 100X magnification. Previous taxonomic studies were used to identify the species and genus level. (Round et al. 1990, Witkowski et al. 2000, Al-Handal 2008). Some species were confirmed by SEM (data not shown).

Species isolation

Benthic diatom species were isolated by taking one cell with the tip of an enlarged Pasteur pipette, and after 3 washing steps with sterile culture medium, were deposited on microplate wells (Nunc™), and kept in culture at 4ºC, at 5 - 50 µMol Photons m^{-2} s^{-1}, and a photoperiod of 14:10h D: L, (dark :Light) until growth was observed. The procedure was repeated many times on positive isolates in order to attain clonal cultures. When this was achieved, cultured species were identified, and kept in culture for experimental procedures. The isolated species used in this study were Navicula perminuta, isolated from Benthos samples (20 m), Navicula cancellata, taken from Intertidal samples, and sp1 (N. pusilla, not confirmed) and sp2 (not determined), isolated from samples taken from Ice Fronts (IF) and Intertidal (IT), respectively (Figure 2).

Photosynthetic parameters

To assess the photosynthetic condition of cells exposed to different light treatments, light response curves were performed using a Pulse Amplitude Modulated fluorometer (Water-PAM; Walz GmbH, Effeltrich, Germany). Thus, a 3 ml aliquot of cells from each species culture (in triplicate), were incubated for 5 hours under different light intensities: 0,5; 5; 10; 100 and 200 µMol Photons m-2 s-1, at 4ºC. Then, the cells from each treatment were individually transferred to a quartz cuvette, and minimum fluorescence (F0) was recorded. Upon application of a saturating light (>3,000 µMol photons m-2 s-1) pulse of 0.6 sec, maximum fluorescence (Fm) was recorded for each sample. With these parameters Fv / Fm, or Effective Quantum Yield ($ø_{II}$), was calculated. This is a measure of the Photosystem II efficiency, and is obtained from the equation (Fm – F0)/ Fm. From these values, the maximum rate of Electron Transport (rETRmax), the light utilization efficiency (Ek), and the saturating light coefficient (Ek), were calculated (Schreiber 2004). After 30 minutes of incubation of the samples in darkness for their photosystem recovery, the Chlorophyll fluorescence was measured again, and the recovery rate of the species was expressed as the percentage of the initial values of $ø_{II}$ at the different light intensities.

RESULTS

Benthic diatoms species composition

From 30 field samples examined, up to 51 pennate diatoms taxa from Bahía Covadonga were determined. Dominant genus were Navicula, Amphora, Cocconeis, and Gomphonemopsis. The Benthic community revealed a characteristic taxonomic composition of the different sites and depths analyzed that included few dominant common species. For instance, the small size species Navicula perminuta (7 - 12 µm) was found all over the sampling sites and depths and was the most abundant species (Table 1). However, Navicula perminuta showed higher abundance in benthos, than Intertidal sites, and Ice Front samples in a proportion 3:2:1, respectively (data not shown).

Other abundant species were Cocconeis costata, Cocconeis orbicularis, Navicula directa, Gomphonemopsis obscura, Pseudogomphonema kamtschaticum, Amphora gourdonii, Gomphonemopsis obscura, Planothidium hauckianum and Pseudogomphonema kamtschaticum. Less abundant large size diatoms species such as Trachyneis aspera and Pleurosigma obscura were found in Benthos sites at 10 and 20 m. The highest values of specific richness and diversity index (H’) were recorded in the Intertidal zone (IT), and the lowest was found in Ice Front samples (IF) (Table 2).

Photosynthetic response
As shown in Figure 3, all species analyzed showed higher efficiency of photosystem II at lower light intensities that reflects their low light photoacclimation. They were photoinhibited at higher light intensity values (200 μMol Photons $m^{-2}s^{1}$). However, at 0,5 μMol Photons m^{-2} s^{-1}, the species of the genus Navicula showed lower values of Effective Quantum yield (øII) (0,4 - 0,5) than the species of the genus (0,6 - 0,7), and the decay of the initial values with the increase of light intensity was more pronounced. Photoinhibition of Navicula species was observed at lower light intensity, compared to that of Nitzschia species (100 and 200 μMol Photons m-2 s-1, respectively). Consequently, Nitzschia species have shown a higher capacity to recover their photosynthetic performance after 30 minutes in darkness, compared to Navicula species. As shown in Figure 4, Nitzschia species had 70-80% of the initial Effective quantum yield (øII) and Navicula species (30-40%), at 100 μMol Photons m-2 s-1.

Values of photosynthetic efficiency (∂) and ETRmax of Navicula species were significantly inferior to those of, (p< 0,05). However, the saturating light coefficient Ek was similar in all of the species (Table 3).

DISCUSSION

The benthic diatoms community in Bahia Covadonga contained abundant pennate diatoms with a wide array of species. These species showed a particular and different distribution among the distinct sites and depths studied, from Ice Fronts contacting the high tides, to Benthos (20 m depth). The identified diatoms are characteristic of the Antarctic benthos. The most abundant diatoms found through this research coincide also with the large proportion identified in microalgae communities in other Antarctic coastal areas (Cibic et al 2007, Salleh 2011). The species composition data is similar to that found in other studies in Potter Cove, King George Island (Zacher, 2007, Wulff et al 2008; Al-Handal 2010). In particular, Navicula perminuta was described as the most abundant and widely distributed in all the sampling sites studied (Zacher, 2007).

Although all the species studied were low light acclimated, showing photoinhibition at light intensities over 100 μMol Photons m^{-2} s^{-1}, species of the genus Navícula displayed different and characteristic photosynthetic responses to increasing light intensities. Navicula perminuta and N. cancellata showed minor photosystem II efficiency (øII) than species, this difference was more noticeable at higher light intensity values (> 50 μMol Photons m-2 s-1). The same was observed for Navicula species photosynthetic efficiency (∂), and ERTmax compared to sp1 and sp2 (Table 3).

Navicula species also showed an inferior dark recovery capacity after the treatments at high light, suggesting some extent of photosystem II damage. This high light tolerance difference may be related to their variation in the distribution of species abundances among the sites and depths studied. Thus, Navicula cancellata was isolated from samples collected in the Intertidal zone, and the Navicula perminuta culture used in this study was isolated from benthos sample. Species of the genus were distributed in areas more exposed to environmental radiation, such as the Ice Fronts, and were rarely found in the Intertidal and benthos samples. These results suggest that these different responses are related to the specific habitats where the species were more abundant. According to this, Nitzschia species could cope with and tolerate more illuminated environments, with a higher photosystem II recovery ability than Navicula species. Differences in the capacity to cope with changes in the environmental light intensity on diatom species from different habitats have been extensively studied (Van Leeuwe 2005, Lavaud 2007) and the plasticity of the photosynthetic systems of diatoms from Antarctic phytoplankton and ice have been compared (Petrou 2011a, Mangoni 2009). Moreover, the specific sensitivity to changes in salinity and temperature that links the photosynthetic capacity and ecological niche have been characterized (Petrou 2011b). On the other hand, differences in the photosynthetic efficiency of the photosystem II, and their recovery capacity to UV and PAR radiation, have been observed in benthic diatoms (Wulff et al 2008).

Many other characteristics may have an effect on the photoacclimation response of benthic diatoms and are relevant to consider in further studies. Factors such as cellular motility, volume and shape may play a role in the ability of diatom species to cope with a changing environmental light. In support of this idea, a recent study on benthic diatoms from intertidal sediments (Barnett 2015) has shown, for the first time, a relationship between the photoprotective capacity and the motility of the diatom cells. Motile diatom species had a lower tolerance rank to high light than non-motile species. This is due to the fact that a photoprotective mechanism allows diatom cells to evade the effects of high light exposition.

It is important to note that in the present study, the more sensitive to high light intensity species, both Navicula cancellata and Navicula perminuta, are motile. On the contrary, the more tolerant species sp1 and N. sp2, are non-motile (data not shown). These observations of the cultures open an interesting perspective for further studies in order to better understand the capability of diatom species to cope with a changing environmental light, and to persist in Antarctic low light environments.

CONCLUSIONS

The benthic Antarctic diatoms of Bahia Covadonga showed a distribution of relative abundance, richness and diversity, which is characteristic of the different sites analyzed: Ice front, intertidal, and benthos (10- 20m), with few abundant species found in common. The benthic Antarctic diatoms species of genus Navicula were photoacclimated to low light. However, Nitzschia species could cope with and tolerate more illuminated environments, with a higher recovery capacity than Navicula species. These results showed that the species of the genus Navicula and Nitzschia studied displayed differences in their photosynthetic response plasticity.

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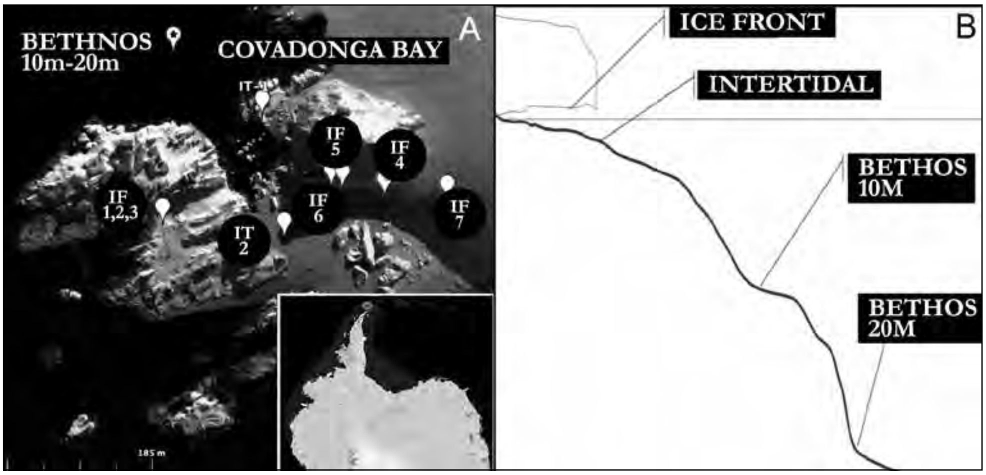
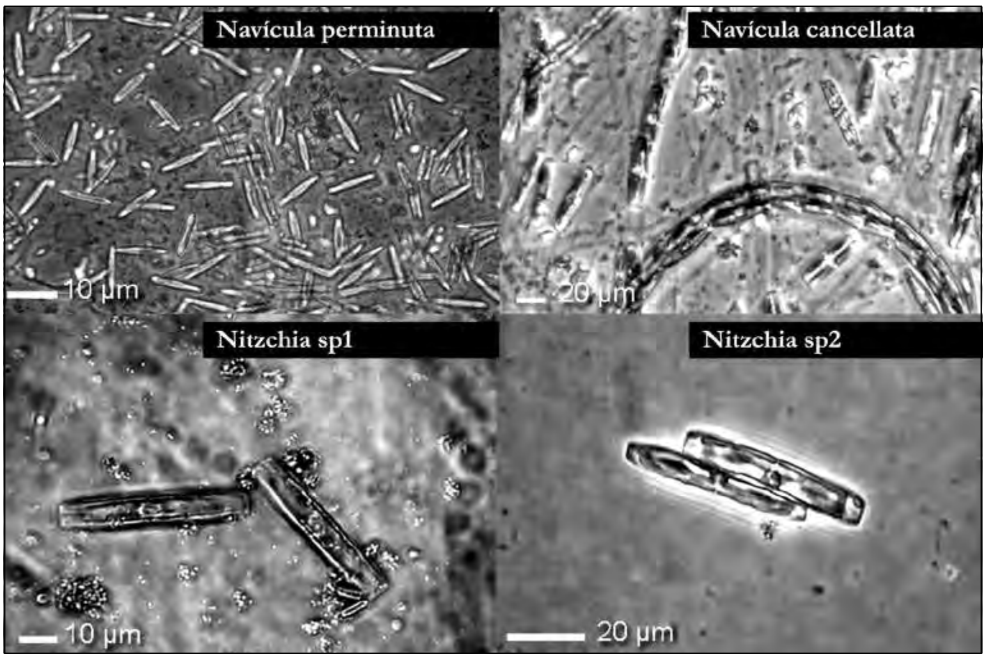
Figure 1



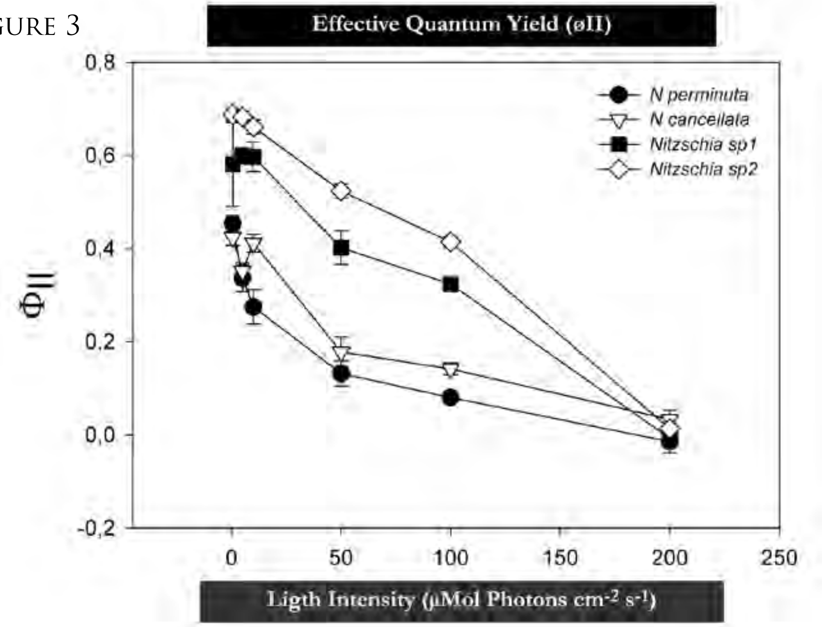
A. Sampilng sites in Bahía Covadonga, Antarctic Station Bernardo O'Higgins IF: Ice Front; IT: Intertidal. B. Detail of sampling sites and depths.

Figure 2



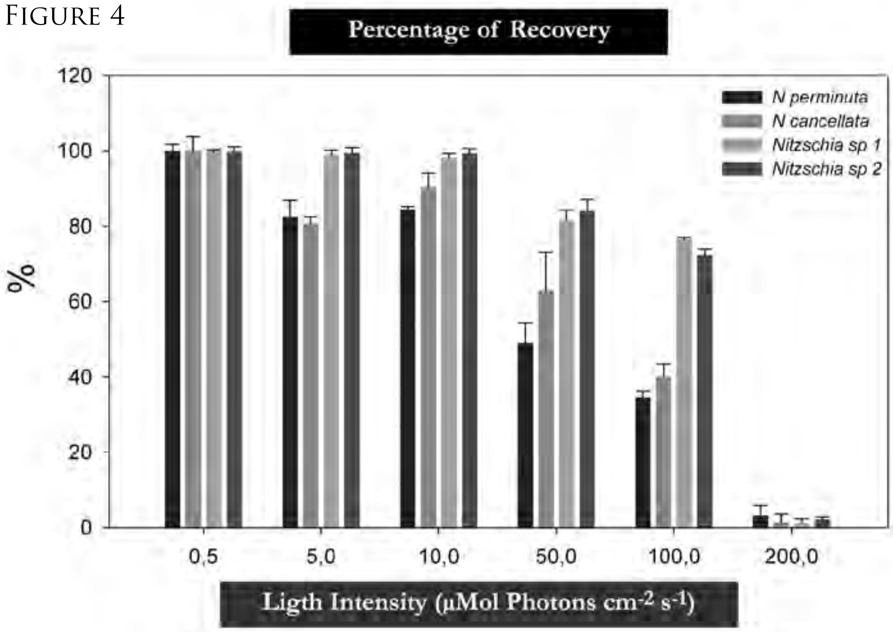
Isolated species in culture analyzed in this study-.

Figure 3



Photosynthetic response. Effecive Quantum Yield (øII) of Navicula perminuta (black circles), Navicula cancellata (clear triangles) Nitzschia sp1 (black squares) y Nitzschia sp2 (clear diamonds) to different light intensities.

Figure 4



Dark Recovery capacity. Percentage of recovery of the photosynthetic response to different light intensity, after 30 min. of dark incubation.

#TABLE 1: *Most abundant benthic diatom species identified in Bahia Covadonga.*

ICE FRONT	INTERTIDAL	BENTHOS
Pinnularia krookii	Navicula perminuta	Navicula perminuta
Navicula perminuta	Navicula gracilis	Cocconeis imperatrix
Nitzschia pusilla	Gomphonemopsis obscura	Cocconeis costata
Nitzschia spp.	Planothidium hauckianum	Opephora olsenii
Navicula glaciei	Navicula directa	Amphora gourdonii
Odontella litigiosa		Navicula directa
Synedra kerguelensis		Navicula cancellata
Cocconeis orbicularis		
Pseudogomphonema kamtschaticum		

#TABLE 2: *Richness and diversity index of benthic diatoms at Bahia Covadonga.*

	RICHNESS	DIVERSITY (H')
ICE FRONT	9	1,7
INTERTIDAL	13	2,4
BENTHOS	10,1	1,3

#TABLE 3: *Photosynthetic parameters of species from genus Navicula and Nitzschia.*

SPECIES	Photosynthetic Parameters		
	ETRM	ALPHA	EK
NAVICULA PERMINUTA	7,9	0,3	26,3
NAVICULA CANCELLATA	12,5	0,4	34,9
NITZSCHIA SP 1	53,3	0,5	104,7
NITZSCHIA SP 2	34,3	1,3	27,0

REFERENCES

-Al-Handal AY & Wulff A (2008). Marine benthic diatoms from Potter Cove, King George, Antarctic. Botanica Marina 51: 51–68

-Al-Handal AY, Riaux-Gobin C & Wulff A. (2010).Marine benthic diatoms from Potter Cove, King George.

-Arrigo K, Mills M, Kropuenske L, van Dijken G, Alderkamp A & Robinson D. (2010). Photophysiology in Two Major-Southern Ocean Phytoplankton Taxa: Photosynthesis and Growth of Phaeocystis antarctica and Fragilariopsis cylindrus under -Different Irradiance Levels. Integrative and Comparative Biology, volume 50, number 6, pp. 950–966

Barnett A, Méléder V, Blommaert L, Lepetit B, Gaudin P, Vyverman W, Sabbe K, Dupuy C & Lavaud J. (2015). Growth form defines physiological photoprotective capacity in intertidal benthic diatoms. ISME J. 9: 32-45.

-Battarbee R W. (1986). The eutrophication of Lough Erne inferred from changes in the diatom assemblages of 210Pb and 137CS dated sediment cores. Proceedings of the Royal Irish Academy 868:141-168.

-Cibic T, Blasutto O, Hancke K, Johnsen G. (2007). Microphytobenthic species composition, pigment concentration, and primary production in sublittoral sediments of the Trondheimsfjord (Norway). J. of Phycol. 43:126–1137.

-Falkowski PG, & Raven J. (1997). Aquatic Photosynthesis, Blackwell, Oxford 375 pp.

-Guillard RR & Ryther JH.(1962). Studies of marine planktonic diatoms I. Cyclotella nana Hudstedt and Detonula confervacea Cleve. Can J Microbiol 8:229–239

-Lavaud J. (2007). Fast regulation of photosynthesis in diatoms: mechanisms, evolution and ecophysiology. Funct Plant Sci Biotech 267: 267–287.

-Mangoni O, Carrada G, Modigh M, Catalano G, & Saggiomo V. (2009). Photoacclimation in Antarctic bottom ice algae: an experimental approach. Polar Biol 32:325–335

-Petrou K, Doblin MA & Ralph P. (2011b). Heterogeneity in the photoprotective capacity of three Antarctic diatoms during short-term changes in salinity and temperature. Mar Biol 158: 1029-1041.

-Petrou K, Ralph PJ. (2011a). Photosynthesis and net primary productivity in three Antarctic diatoms: possible significance for their distribution in the Antarctic marine ecosystem. Mar Ecol Prog Ser 437: 27-40

-Robinson D Arrigo K, Iturriaga R, & Sullivan C. (1995). Light absorption and photosynthesis by Antarctic algae from under ice habitats with restricted spectral distribution of irradiance. Journal Phycology 30: 345-356.

-Round FE, Crawford RM. & Mann DG. (1990) The Diatoms - Biology and Morphology of the genera. Cambridge University Press. Reprinted 2000.

-Salleh S, McMinn A. (2011). Photosynthetic response and recovery of Antarctic marine benthic microalgae exposed to elevated irradiances and temperatures. Polar Biology 34:855-869

-Schreiber U. (2004). Pulse-amplitude-modulated (PAM) fluorometry and saturation pulse method. In: Papagiorgiou GG (ed) Advances in photosynthesis and respiration, vol 19. Springer, Dordrecht, pp 279–319.

-Underwood GJ, & Kromkamp J. (1999). Primary production by phytoplankton and microphytobenthos in estuaries. Adv Ecol Res 29: 93–153.

-Van Leeuwe M, van Sikkelerus B, Gieskes W & Stefels J. (2005). Taxon-specific differences in photoacclimation to fluctuating irradiances in an Antarctic diatom and a green flagellate. Mar Ecol Prog Ser 288:9–19.

-Witkowski A, Lange-Bertalot H. & Metzeltin D. 2000, Diatom flora of marine coasts I. In: H. Lange- Bertalot (ed.), Iconographia diatomologica 7, 925p.

-Wulff, A, Zacher K, Hanelt D, Al-Handal A, & Wiencke C. (2008). UV radiation - a threat to Antarctic benthic marine diatoms? Antarctic Science. 20:13–20.

-Zacher K, Hanelt D, Wiencke C, & Wulff A. (2007). Grazing and UV radiation effects on an Antarctic intertidal microalgal assemblage: a long term field study. Polar Biology. 30: 1203 – 1212.

Development of a new legally binding instrument for shipping in Antarctic waters

Sian Prior

Abstract

In November 2014, the first part of a new legally-binding mandatory instrument was adopted in response to the increasing numbers of ships operating in Arctic and Antarctic waters. Part I of the International Code for Ships Operating in Polar Waters or "Polar Code" addressed the safety of shipping in polar waters and identifies the measures required over and above standard shipping regulations to ensure ships can operate safely. The Code will only apply to cargo vessels of 500GT or over and cruise ships in the first instance, but it is anticipated that further work will be undertaken to identify the needs of other vessels that already operate in these polar waters, in particular fishing vessels and private vessels. Part II of the Code which addresses pollution prevention from shipping, i.e. the impact that increased shipping in polar regions will have on the polar environment, is expected to be adopted in 2015 with the whole Code coming into force early in 2017. This article briefly sets out the history of the Code, summarises the motivation behind the development of the Code, and identifies a number of important developments for shipping in Antarctic waters and also identifies some of the gaps that will remain.

Key words

Polar Code, shipping, incidents, safety, pollution.

A brief history

It was over 15 years ago, that work was first undertaken to develop a code for shipping that would apply to vessel operations in both Arctic and Antarctic waters, however despite early work and a Decision[1] by Antarctic Treaty Consultative Parties (ATCPs) on the need to develop guidelines for Antarctic shipping, in 2002 the International Maritime Organization (IMO) adopted Guidelines[2] that applied only to ships operating in the Arctic. Progress on developing similar guidance for ships operating in Antarctic waters was slow, and in 2004, the Antarctic Treaty Consultative Meeting (ATCM) adopted a Decision[3] on guidelines for ships operating in both the Arctic and Antarctic and agreed to send this to the IMO with a view to amending the existing Arctic Guidelines. Work to amend the Guidelines took place during 2008 / 2009 and in December 2009, the IMO adopted new Guidelines which covered both Arctic and Antarctic waters. During this work it became apparent that there was strong support for a mandatory and legally binding instrument, and in February 2010, the IMO started a major new initiative – the development of a legally binding Polar Code to cover both Arctic and Antarctic waters. The work was complex covering many aspects of international shipping in polar waters, and the timescale for completion was inevitably long, however late in 2014, the IMO adopted Part I of the new International Code for Ships Operating in Polar Waters or "Polar Code" which focuses on safety of shipping in Polar Waters. Part II of the Code, on pollution prevention, is anticipated to be adopted in mid-2015, with both Part I and Part II taking effect from January 2017.

The threat to and from polar shipping

A range of hazards are experienced in polar regions which are not routinely experienced in other parts of the world, and unless these are addressed, not only will shipping in polar regions be a more hazardous activity, the threat to polar habitats and wildlife will be higher. The following is not comprehensive, however it highlights some of the hazards that might be experienced in polar regions and which are not relevant in more temperate or tropical waters where the majority of international shipping currently operates and for which existing international shipping regulations were developed.

Ice is the most obvious hazard for shipping in polar waters. Ice comes in many forms - ice fields, ice bergs, chunks of ice in the water, or ice accumulating on the vessel and outside equipment. The type of ice can vary considerably with glacier ice being much harder than first year ice which has only recently formed. Ice can lead to collision and damage, ships becoming beset or trapped in ice as the mobile ice converges due to currents and wind, changes in the stability of a vessel if ice accretes on the vessel structure, and interference with outside equipment and outside operations on a vessel. Other hazards include operations in cold temperatures which can affect the operation of equipment, while some equipment can be affect by operating at high latitudes. The lack of accurate charting, particularly as ice sheets recede providing access to previously inaccessible sites, is another hazard as is the lack of infrastructure, particular for search and rescue operations but also for environmental response.

The polar regions also differ to the rest of the world in how they might be affected by international shipping. In polar regions, there are huge populations of wildlife feeding in concentrated areas due to the high productivity of the oceans, and all are completely dependent on the living resources in the oceans – there is no food on land for marine mammals and seabirds which can congregate in thousands, tens of thousands, even millions for some seabirds. Even a small oil spill adjacent to a penguin colony could be devastating.

Oil discharges and spills and chemical spills will also persist for much longer in the colder polar waters, thus having a greater impact on wildlife, both directly through oiling and indirectly because of the impact on food.

The polar regions are some of the most undisturbed regions on the planet – that isn't to say that they are completely undisturbed, but comparatively there has been less impact in the polar regions than other waters. As a result they are more vulnerable to impacts and changes, as they haven't had to respond to previous exposures to pollutants, to introduced species, etc.

Special measures in place in Antarctic waters

It has already been recognised that polar waters require special measures over and above the routine environmental safeguards in place to limit the impact of international shipping on the marine environment. A range of additional measures have been adopted to provide suitable protection of the unique polar waters, which demonstrate greater sensitivity to a range of harmful substances which can arise for vessels operating in polar waters. For example, since the adoption in the 1970s of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), the waters south of 60o South have been designated as an Antarctic Special Area for the purposes of Annex I addressing oil discharges, Annex II addressing noxious liquid discharges, and Annex V on garbage. More recently, a new regulation[4] was adopted preventing the use or carriage of heavy fuel oil in ships operating in Antarctic waters, because of the potential impact on the environment should there be a spill; and guidelines[5] were adopted on the management of ballast water discharge which has the potential to introduce non-native or alien species which could become invasive into the Antarctic. Until the adoption of the Polar Code, however there was no comprehensive instrument focused on shipping in polar regions.

Much of the drive for the development first of Polar Guidelines and later for the mandatory Polar Code, was concern about the impact that the dramatic increase in shipping in Antarctic waters along with the opening up of the North-west Passage and Northern Sea Route in the Arctic to cargo vessels would have. Antarctic waters, particularly around the Antarctic peninsula have become more accessible to cruise, research and fishing vessels due to a decrease in summer sea ice, and though some areas have been within reach for some time, they are now accessible earlier in the season and for longer than has been possible in the past. Shipborne tourism along the Antarctic Peninsula grew exponentially between 1989 / 90 and 2007 / 08 when it reached a peak of over 46,000 visitors, and while numbers dropped between 2008 and 2012, they have increased again in recent summer seasons.

Over the past two decades, tourism has increased rapidly, diversified significantly and expanded into areas not previously visited. Larger vessels have been used to transport larger numbers of passengers, and vessels are not always flagged by parties to the Antarctic Treaty. Alongside these increases, there has also been a significant number of vessel incidents including a number resulting loss of life or loss of the vessel (see Table 1). It is not only cruise ships that are a concern, the loss of life in Antarctic waters in recent years has been associated with incidents involving fishing vessels and private vessels. The numbers of fishing vessels seeking permits to fish in Antarctic waters has increased, with numbers up 17% between 2011/12 and 2013/14, despite levels of permitted fishing remaining relatively stable.

Recent incidents in Antarctic waters

In 2012, the Antarctic & Southern Ocean Coalition submitted a paper to the Antarctic Treaty Consultative Meeting (ATCM)[6] identifying 20 vessel incidents, which occurred in Antarctic waters between 2006 and 2012, ranging from groundings and collisions with ice, to besetment in ice, mechanical failures, and on-board fires. The number and range of incidents in Antarctic waters in recent years, including a number resulting in loss of life or loss of the vessel, further highlights the need for a mandatory international Code to improve the management of shipping in polar waters to ensure both the safety of shipping activity and to provide appropriate environmental protection. One of the most significant incidents occurred in November 2007, when the cruise ship M/S Explorer was holed by ice and sank. Fortunately all passengers and crew were rescued, however it is recognised in the investigation by Liberian authorities that the sea conditions at the time that the vessel sustained the damage until the passengers and crew were safely transferred to another vessel contributed to the successful rescue[7] . If the weather conditions had deteriorated more rapidly it is speculated that the outcome might have been different.

In the summer season 2008/09, the MV Ushuaia ran aground at the entrance to Wilhemina Bay on the north-west Antarctic Peninsula, resulting in hull damage and the spillage of an unknown amount of fuel, and in February 2009 the Ocean Nova grounded, reportedly in extremely high winds, on the Western Antarctic Peninsula. Grounding seems to be a regular cause of incidents in Antarctic waters, probably because the coastline and coastal waters of Antarctica are not extensively surveyed. In February this year, the Japanese flagged ice breaker Shirase grounded off Molodezhnaya Station in East Antarctica and a krill fishing vessel, the Korean flagged Kwang Ja Ho was reported aground 450m off the Antarctic coas[8]. It seems from the brief information provided[9] that the Shirase's double-hull helped to ensure that the vessel remained viable and that there was no leak of oil, while the Kwang Ja Ho sustained damage to a freshwater tank and was able to refloat[10]. The lack of hydrographic information and therefore increased risk of grounding has been recognised and discussed by the Antarctic Treaty Consultative Meetings[11].

In January 2014, it was widely reported that the Russian-flagged Akademik Shokalskiy was finally moving again after being trapped in ice in Australia's rescue coordination zone in East Antarctica for 13 days. Three icebreaker / ice strengthened vessels responded to the incident but were unable to reach the Akademik Shokalskiy, with the Chinese-flagged Xue Long, also getting stuck in the ice for a few days.

More recently a number of fishing vessels and yachts have been lost involving the loss of a considerable number of lives and loss of vessels. In 2010, the No 1 In Sung fishing vessel was swamped with the loss of 22 lives and in 2011 the yacht Berserk was lost with 3 lives. Another private motorised yacht was also lost in 2012, the Endless Sea but fortunately the crew were rescued. A number of recent incidents have involved fire on board including on the whale processing vessel Nisshin Maru in February 2007, which

Table 1: Examples of recent shipping incidents in Antarctic waters (Note: this list is not intended to be comprehensive).

Date	Ship Name	Flag	Incident	Casualties	Spill status	Other
March 2014, East Antarctica	Tiantai	Tanzania	Ship lost-cause unknown, poor weather conditions at time of incident	Unknown	Fuel on board would have been lost	The Tiantai was an illegal fishing vessel presumed lost in the Southern Ocean
Dec 2013/ Juan 2014 East Antarctica	Akademik Shokalskry (cruise research)	Russian	Trapped in ice for 13 days	0		3 ice breakers unable to reach the ship
Apr 2013 Scotia Sea	Kai Xin (fishing)	China	Fire on board, loss of vessel	0	Fuel lost but possibily all consumed by fire	Carrying heavy fuel oil
Apr 2012 Antarctic peninsula	Endless Sea (yacht)	Brazil	Beset in ice/sank	0	fuel oil lost	
Feb 2012 Antarctic peninsula	Oil barge	Brazil	Capsized and sank in poor weather	0	No spill	Barge subsequently recovered
Jan 2012 Ross Sea	Jeong Woo 2 (fishing)	Korea	Fire on board, loss of vessel	3	Fuel oil lost-possibly consumed by fire	
December 2011 Ross Sea	Sparta (fishing)	Russia	Holed in ice	0		International rescue effort
Feb 2011 Ross Sea	Berserk (yacht)	Norway	Loss of vessel	3		Vessel had not been permitted to operate in the Antarctic
Dec 2010 North of Ross Sea	Insung N1 (fishing)	Korea	Sank	21	Fuel oil loss	
Feb 2009 Antarctic peninsula	M/V Ocean Nova	Bahamas	Ran aground	0		
Dec 2008 Antarctic peninsula	M/V Ushuaia (cruise)	Panama	Grounding in shallow water	0	Fuel oil leak	
Dec 2007 antarctic peninsula	M/S Fram (cruise)	Norway	Lost engine power hit glacier	0		
Dec 2007 Ross Sea	Agos Georgia (fiching)	UK	Loss of power	0		Spare parts air-lifted to vessel
Nov 2007 Antarctic peninsula	M/S Explorer (cruise)	Liberia	Collision with ice loss of vessel	0	Loss of fuel oil and other pollutants	Passengers safely removed to another veseel
Feb 2007	Nisshin Maru	Japan	Explosion and fire	1		
Jan 2007 Antarctic peninsula	M/V Nordkapp (cruise)	Norway	Grounding	0	Spill of marine diesel	

resulted in the loss of one life and loss of power for several days, the fishing vessel Jeong Woo 2 which caught fire and sank with the loss of 3 lives in 2012, and most recently the Chinese fishing vessel Kai Xin which caught fire and sank after the crew were rescued in the Scotia Sea.

Other incidents occurred due to loss of power which resulted in the fishing vessel Argos Georgia drifting in the Ross Sea for 15 days until replacement parts could be airlifted to the vessel; damage due to ice when the fishing vessel Sparta was holed and required a considerable international rescue effort in 2011, or bad weather which resulted in an oil barge delivering oil to a scientific base sinking, though it was eventually recovered intact.

It might be expected that lessons would be drawn from these incidents to help to shape the development of the new international Polar Code to ensure that ships, their crews and passengers are safe, and that the impact on polar environments and polar wildlife is kept as low as possible. ASOC is concerned however that a rigorous lesson learning exercise was not undertaken.

Safety of shipping in polar waters

Since an extensive body of regulation already applies to international shipping, the Polar Code does not attempt to repeat existing requirements, instead it focuses on the additional requirements required to ensure the safety of shipping in polar regions and to minimise the impact of shipping on the environment. The requirements will become mandatory through the adoption of a new Chapter to the International Convention for the Safety of Life at Sea 1974 (SOLAS). Initially, Part I of the Polar Code focuses only on the safety of cargo ships of 500Gt or more and passenger ships. It does not attempt to consider the additional requirements that might necessary for smaller cargo ships (under 500GT), fishing vessels, yachts and other ships not considered to be "SOLAS vessels". Work to consider the needs of these vessels will be undertaken in the coming years, and will be of importance for vessels operating in Antarctic waters, however it is not due to commence until 2016. A different approach has been taken with respect to preventing pollution (see below) and it is anticipated that new measures addressing pollution in polar regions will be adopted in May 2015 by amending MARPOL 73/78 and will apply to all vessels to which the MARPOL Annexes currently apply.

Adoption of the Polar Code means that for the first time there is now a mandatory legal instrument for vessel operations in the Southern Ocean (and the Arctic). The fact that there has been nothing has limited the possible action taken by a State in the event of an incident or non-compliance with the existing Polar Guidelines. A further, very welcome, outcome is the fact that the Code recognises that navigation in polar waters imposes additional navigational demands beyond those normally encountered and that in many areas chart coverage may not be adequate for coastal navigation. This is an important message for international shipping and inadequacy of chart coverage will need to be taken into account during voyage planning. Also important is that, once the Polar Code comes into force, all ships which operate in polar waters will have to hold a polar ship certificate confirming suitability for operation in polar waters and a polar water operational manual which will set out the ships operational capabilities and limitations. It is recognised that there will be different environmental conditions experienced throughout the polar regions and these will vary throughout the year. Ships of different operational capability will be able to access different areas and the capability of a vessel must be suitable for the environmental conditions expected in the intended area of operation, so for example, only ice breakers will be allowed to enter into the thickest ice.

Part I of the Code focuses on safety of shipping in polar waters and addresses a wide range of safety measures including the need for ships to have a polar certificate and requirements for each vessel to carry a polar water operational manual. It also includes specific provisions covering the structure and stability of ships including a ships' stability if damaged, a ships' watertight and weathertight integrity, machinery installations, fire safety and protection, life-saving appliances and arrangements, safety of navigation, communication requirements, voyage planning, and manning and training for masters, officers and crew.

Obviously all aspects of Part I of the Code are of utmost importance for the safety of ships operating in Antarctic waters, however from the perspective of environmental protection there are a number of areas where the Antarctic & Southern Ocean Coalition (ASOC) has advocated stronger provisions. One relates to types and structure of vessels and the ice conditions in which they can operate. ASOC is of the opinion that the baseline position should be that only ice strengthened vessels should be permitted to operate in ice with exemptions made on a case by case basis, for example if a ship is expected to operate largely in open water but may encounter some ice in water or very new ice. Guidance on the operational capabilities and limitations of vessels is still under development, however, ASOC is concerned that ships with no or very limited ice strengthening might be allowed to operate in a considerable thickness of ice, provided it is new or first year ice. Furthermore, ASOC is concerned that these vessels will not be required to have additional structural safety requirements in the event of damage to the structure of the ship, since the damage stability provisions of the Code will only apply to those ships anticipating operating in thicker ice. Instead of exempting some categories of ships from the damage stability provisions, ASOC would prefer to see the burden of proof reversed with an assumption that ships should be able to meet the provisions on damage stability when operating in ice, unless it is apparent from the voyage plan that a ship will not be operating in areas of high ice cover.

While voyage planning is a routine part of any shipping operation, through improvements in voyage planning the risks to polar wildlife can be further reduced, and the Code will introduce additional requirements which will be of significance to the management of the vessels in Antarctic waters. Masters will now have to consider the possible impact on their operation on marine mammal populations during voyage planning.

In addition to the standard procedures required by the Polar Waters Operational Manual, when planning the route, the Code requires that the Master should also consider the limitations of hydrographic information and aids to navigation. This will be of particular importance for Antarctic waters as a significant number of incidents in recent years have occurred as a result of groundings and new areas are becoming accessible as sea ice reduces, leading to a greater opportunity for vessels to enter completely uncharted waters. It will also be necessary for the Master to obtain up to date information on the extent and type of ice and to recognise the limitations in the available data, another measure to help reduce the chances of a serious incident.

As part of voyage planning, Masters will now have to access available information on marine mammal populations and migratory routes along the intended shipping route and identify measures to be taken if marine mammals are encountered. The intention is not to prevent encounters with marine mammals, indeed there are a number of vessels that might be actively seeking encounters with seals and whales, however it will require that a plan is in place to ensure that encounters follow appropriate procedures to minimise disturbance. ASOC had hoped that it might be possible to include consideration of seabird populations during voyage planning, particularly since there are major congregations of seabirds in the Southern Ocean, but this suggestion was not accepted. However information on designated areas along the route should be included in voyage planning, and it is likely that some designated areas will include seabird congregations. The voyage plan should also consider limitations associated with operation in areas remote from search and rescue capability.

Environmental protection

Part II of the Polar Code has yet to be adopted, however it is on course to be adopted through a series of amendments to MARPOL 73/78 during 2015. It is anticipated however that it will not provide significant additional protection for Antarctic waters because there are already a number of regulations in place which effectively ban the discharge of oil, noxious liquids and various forms of garbage into Antarctic waters. The Code will, however, improve the protection afforded to Arctic waters from the discharge of these wastes, bringing the requirements for Arctic waters more in line with the existing protections in place in Antarctica.

Adoption of a zero discharge philosophy could address the potential threat from a range of pressures, however while the aspiration of working towards the MARPOL 73/78's zero discharge philosophy is encouraged and has already been adopted in Antarctic waters for oils, chemicals and garbage, and in Canadian waters for a range of wastes, such an approach has not been routinely adopted throughout the Polar Code. In particular, while there will likely be some strengthening of existing provisions controlling the discharge of sewage wastes, a serious concern remains over the fact that untreated sewage will be able to be discharged more than 12 nautical miles from ice shelves, land fast ice and ice-covered seas. Not only does it seem to be inconsistent in this day and age to continue to allow untreated sewage to be discharged anywhere at sea, but it is possible that such discharges could be directly in the foraging grounds of marine mammals and seabirds.

A recent study[12] on the patterns of cruise ship traffic in the Antarctic peninsula region identified a wide range of "potential interactions" between tourism traffic and wildlife including disruption of marine wildlife moving between breeding colonies and feeding areas, underwater noise pollution, degradation through cumulative disposal of sewage and grey water, accidental discharge of garbage, oil and noxious liquids, introduction of non-native species, potential for collisions and groundings leading to oil spills. A number of these threats to marine wildlife have not been addressed during the development of the Polar Code despite the development of comprehensive lists of environmental impacts and possible solutions being identified and submitted for consideration during the development of the Code[13].

In particular, there has been no consideration of the threat posed by invasive species introduced via ballast discharges or through hull fouling; of grey water which is produced in large volumes on cruise ships and is currently completely unregulated at a global level; or of discharges of black carbon from ships' air emissions. Recognising the wide range of potential impacts in polar waters

and the particular vulnerability of the environment and wildlife,
other potential threats from shipping which should be considered further and appropriate measures introduced into the Code include emissions to air (of SOx and NOx), responding to oil and cargo spills, ship strikes of slow moving wildlife, and antifouling emissions.

Looking ahead

Although work on the first mandatory Polar Code is nearly complete and later in 2015 the full Code will have been adopted, it will only come into force from 2017. Furthermore, there are still a number of areas where further consideration and work is required. For example, guidance on assessing the capability and limitations of vessels in relation to different types and thickness of ice is still being developed, and work to address non-SOLAS vessels, such as fishing vessels, private yachts, cargo ships under 500GT has not yet commenced. A Polar Code for non-SOLAS vessels will be of great interest and importance for the future management of shipping in Antarctic waters, since these types of vessels make up a significant proportion of the current vessel activity at both poles.

As well as considering the requirements needed to ensure the safety of non-SOLAS vessels operating in polar waters, further measures for environmental protection are required. Measures associated with antifouling systems, grey water discharges and underwater noise, should be earmarked for further consideration during a second phase of work. Furthermore, some issues addressed in Part I of the code, such as ice strengthening for vessels operating in ice, and broadening voyage planning to encompass consideration of major bird populations in polar waters need to be considered. Clearly there is still much to be done before we can be confident that international shipping can operate safely and responsibly in polar regions.

References

1. ATCM Decision (1999). Guidelines for Antarctic Shipping and Related Activities.
2. MSC/Circ. 1056 MEPC/Circ.399 Guidelines for Ships Operating in Arctic Ice-Covered Waters. December 2002.
3. ATCM Decision (2004). Guidelines for Ships Operating in Arctic and Antarctic Ice-Covered Waters
4. MARPOL 73/78 Regulation 43 Special requirements for the use or carriage of oils in the Antarctic area.
5. Guidelines for ballast water exchange in the Antarctic Treaty area (Resolution MEPC.163(56).
6. ATCM XXXV IP 53 Follow-up to Vessel Incidents in Antarctic Waters. Submitted by ASOC.
7. Republic of Liberia, 2009. Report of Investigation in the Matter of Sinking of Passenger Vessel EXPLORER *(O.N. 8495) 23 November 2007 in the Bransfield Strait near the South Shetland Islands. Bureau of Maritime Affairs, 26 March 2009, Monrovia, Liberia.*
8. http://www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=11209540&ref=rss
9. ATT0220e Shirase icebreaker grounding.
10. http://www.news.odin.tc/index.php?page=view/article/1257/Fish-factory-Kwang-Ja-Ho-aground-and-refloated-Antarctic
11. Resolution 5 (2008) ATCM XXXI Hydrographic surveying and charting which notes the increased marine traffic in the Antarctic region and is concerned at the increased risk of harm to ships, persons and the environment in inadequately charted waters in the region.
12. Lynch, H.J., Crosbie, K., Fagan, W.F., and Naveen, R., 2009. Spatial patterns of tour ship traffic in the

Antarctic Peninsula region. Antarctic Science, 2009. Doi:10.1017/S0954102009990654.
13. See for example, DE 54/13/8 Additional MARPOL provisions for the Polar Code. Submitted by FOEI, IFAW, WWF, Pacific Environment and CSC; and DE 54/13/9 Wider environmental provisions for the Polar Code. Submitted by FOEI, IFAW, WWF, Pacific Environment and CSC.

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Antarctica: A Year on Ice

Claire Christian

Most everyone has seen a picture of Antarctica. In fact, if you picture Antarctica right now, you are probably imagining a forbidding landscape of frozen ice and huge glaciers, perhaps with a few penguins here and there. Yet, Antarctica is not a static place. In 2006, Antarctic research station staff member first posted a stunning video showing just how dynamic Antarctica can be. Using time-lapse photography, Powell captured the dramatic weather, gorgeous southern lights, and bustle of activity that takes place at research stations. Now, he has used some of that fascinating footage in a feature documentary, *Antarctica: A Year on Ice*. The film describes the challenges and joys of a typical year in Antarctica as experienced by some of the staff who choose to accept a year-long placement at McMurdo research station, which is run by the United States.

One of the questions the film sets out to answer is, What kind of person chooses to spend an entire year, some of which will be spent in complete darkness, in the coldest, driest, and windiest place on Earth? Many staff and scientists only spend a few months during the austral summer at McMurdo, enjoying the better weather and daylight, before heading back to the comforts of fresh food and home. A smaller number of hardy souls stay on, enduring the Antarctic winter and days where the sun never rises. The movie mostly explores the lives of support staff – firefighters, technicians, even the person who runs the store – and their backgrounds.

While the film covers similar territory as *Encounters at the End of the World* in this sense, in tone it is vastly different. *Encounters* seemed to view its subjects as circus oddities. Powell himself has spent many years working on the continent (he even met and married his wife there), and knows many of his interviewees well, and so approaches the film as more of an insider looking out. In doing so, he conveys both the humdrum and the sublime, introducing us to a fascinating group of people and an almost unimaginably difficult environment. In one startling scene, he shows how a small building away from the main station area has become packed with huge amounts of snow that blew in through the walls. It is one thing to know that Antarctica has bad weather. It is another to know that it is so harsh that it can push through invisible cracks in the walls. The physical effects of living through an Antarctic winter are also severe. Most people will experience T3 syndrome, a condition in which the thyroid produces too little of the T3 hormone, causing fatigue, depression and forgetfulness. It is thought to be caused by living in an extremely cold climate, and is also perhaps worsened by a lack of exposure to sunlight.

Despite these hardships, Antarctica offers an experience like no other. The McMurdo store manager, Keri Nelson, powerfully describes seeing the southern lights, an experience that was otherworldly and incredibly moving. Of course there's plenty of camaraderie, and even though most work long hours, there are also enviable opportunities to leave the plain buildings of McMurdo and gaze out over the glittering ice or enjoy the noisy company of penguins. Furthermore, Powell's incredible time-lapse footage is all the more stunning in high-definition on the big screen. Most of us will never get to visit the continent, but in the meantime, *Antarctica: A Year on Ice* paints a picture of a bizarre but beautiful world and the few who are lucky enough to experience it fully.

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