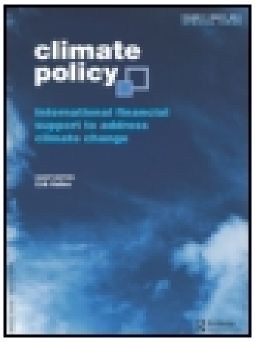

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Protecting Antarctic blue carbon: as marine ice retreats can the law fill the gap?

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ABSTRACT

As marine-ice around Antarctica retracts, a vast ‘blue carbon’ sink, in the form of living biomass, is emerging. Properly protected and promoted Antarctic blue carbon will form the world’s largest natural negative feedback on climate change. However, fulfilling this promise may be challenging, given the uniqueness of the region and the legal systems that govern it. In this interdisciplinary study, we explain: the global significance of Antarctic blue carbon to international carbon mitigation efforts; the urgent need for international legal protections for areas where it is emerging; and the hurdles that need to be overcome to realize those goals. In order to progress conservation efforts past political blockages we recommend the development of an inter-instrument governance framework that quantifies the sequestration value of Antarctic blue carbon for attribution to states’ climate mitigation commitments under the 2015 Paris Agreement.

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Blue carbon; Antarctica; Antarctic Treaty System; Paris Agreement; non market approach

Key policy insights

- Blue-carbon emergence around Antarctica’s coastlines will potentially store up to 160,000,000 tonnes of carbon annually.
- Blue-carbon will emerge in areas of rich biomass that will make it vulnerable to harvesting and other human activities; it is essential to incentivise conserving, rather than commercial exploitation of newly ice-free areas of the Southern Ocean.
- Antarctic blue carbon is a practical and prime candidate to build a cooperative, inter-instrument, non-market mitigation around; this should be considered at the ‘blue COP’ UN Climate change discussions in Spain.
- Allowing Antarctic fishing states to account for the carbon storage value of blue carbon zones through a non-market approach under the Paris Agreement could provide a vital incentive to their protection under the Antarctic Treaty System.
- The Scientific Committee on Antarctic Research would be the ideal body to facilitate the necessary connections between the relevant climate and Antarctic governance regimes.

Introduction

As marine-ice around Antarctica retracts a vast sink of ‘blue carbon’ (carbon captured and stored by marine ecosystems (Nellemann & Corcora, 2009, p. 19)) in the form of living biomass is emerging. Properly promoted and protected, continental shelf blue carbon promises to act as a rebound buffer by forming the world’s largest

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natural negative feedback on climate change. However, fulfilling this promise may prove challenging, given the uniqueness of the region and the legal systems that govern it.

Antarctica is globally unique as a space dedicated to international cooperation where countries have put their territorial claims 'on hold' and therefore no one state is able to exercise sovereign rights over fisheries. As a result, marine ecosystems are governed by consensus under the Antarctic Treaty System (ATS). That system is heavily conservation focused, but it does envision and permit 'rational use' (harvesting) of marine living resources in the Southern Ocean. Efforts to implement precautionary conservation measures for emergent Antarctic blue carbon zones will therefore likely face resistance from states that fish, or plan to fish, off Antarctic coasts. Indeed, the sheer size and scale of marine ice-loss and the resulting biodiversity rich zones that will emerge there suggest a rush to exploit, not protect these critical natural carbon sinks.

In this paper, we explore one possible way of shifting the cost–benefit calculus of fishing states away from exploitation towards conservation of Antarctic blue carbon. Specifically, we encourage the exploration of an inter-instrument framework for Antarctic blue carbon accounting and attribution. This would permit states to account for conservation activities in blue carbon zones as part of their nationally determined contributions (NDCs) under the 2015 Paris Agreement. Indeed, under Paris' parent convention, the United Nations Framework Convention on Climate Change (UNFCCC, 1992), Article IV (1) (d), states are committed to:

> promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases … including biomass … oceans … coastal and marine ecosystems.

The protection and promotion of Antarctic blue carbon clearly fits within the scope of this international legal obligation. It is also a suitable international cooperative exercise that would form the ideal basis for a workable non market approach to climate change mitigation. Establishing such a platform would provide a commensurate incentive for the long term conservation of vital emerging ecosystems in the Southern Ocean. The collaborative achievement of these existential imperatives is consistent with the philosophy and governance approach of both climate and Antarctic regime systems and in the interests of all states.

This paper proceeds as follows:

- First, we explore how climate change is affecting Antarctica's coasts, namely through ice-shelf retraction and the emergence of blue carbon in ice-free zones.
- Second, we explain the need for and challenges to extending legal protections over this important carbon sink.
- Third, we consider the source of regime blockages within the present Antarctic governance system and how they may be overcome through concessional incentive measures.
- Finally, we suggest a way to generate conservation incentives for the protection of Antarctic Blue carbon for the protection of the global climate system by linking the Antarctic governance regime with the Climate one.

There would, unquestionably, be diplomatic, technical and legal hurdles to realizing such an outcome. Some of which we will raise and discuss here – all deserve further attention and work. However, the legal and environmental conditions have aligned to make the exploration of such a governance platform for Antarctic blue carbon sequestration both timely and essential. Given the existential threat of climate change there is much more to gain than lose in the attempt.

Climate change, blue carbon and Antarctica's coasts

Approximately three quarters of Antarctica's coastline is bounded by continental ice sheets that extend seaward from the Antarctic landmass into the Southern Ocean (Rignot, Jacobs, Mouginot, & Scheuchl, 2013). On broad geological timescales, the Antarctic ice-shelf volume has been relatively stable. However, decadal time-series data show rapid and unexpected reductions in Antarctic sea ice volume linked to climate change (Greene, Blankenship, Gwyther, Silvano, & Wijk, 2017; Rintoul et al., 2018). The effects of this extreme mass loss are varied, but it has already led to the retreat, collapse and calving of large portions of West Antarctic continental ice-shelves, which are in an accelerating rate of decline. Volumetric thinning of the East Antarctic sheet (Lenaerts et al., 2016) has also been predicted to generate a ‘trigger point’ whereby the shelf stability becomes undermined and fails to form a barrier for glacial meltwater from the grounded ice it holds back (Lenaerts et al., 2016). Continued unabated warming could result in accelerating the breakup of the Eastern ice sheet as well as the Western one (Deconto & Pollard, 2016; Golledge et al., 2019; Rignot et al., 2019).

While our understanding of these changes in Antarctica is developing, it has become clear that our response must not only be an exercise in adapting to their consequences, but also to take advantage of new opportunities for climate change mitigation. That is because of the potential for life in the permanently ice-free areas of ocean to absorb carbon dioxide from the atmosphere, and bury some of it permanently on the seafloor – creating a huge blue carbon sink.

The emergence of Antarctic blue carbon and its role in carbon storage, and eventually sequestration is complex and still being explored. Figure 1 provides an overview of the process, important concepts and terms. In summary, as marine ice decreases in any spatial zone, its ability to absorb carbon dioxide increases, in part due to the replacement of high albedo ice with seawater (Stammerjohn, Martinson, Smith, & Iannuzzi, 2008), but also as a result of the succession of biological organisms into newly ice-shelf free zones and increased growth in zones of sea ice loss (Peck, Barnes, Cook, Fleming, & Clarke, 2009). Where this succession becomes permanent, carbon storage on the seafloor begins. This is motivated by the transfer of atmospheric carbon, through organisms in the water column, into the skeletons and tissues of zoobenthic organisms (animals living on the seabed) and eventually buried in shelf sediments. In this context ‘carbon storage’ involves a whole-of-ecosystem process, which transfers carbon via the food-chain to the animals on the seafloor (termed benthos). This process results in ocean life forming a major carbon reservoir, referred to as ‘blue-carbon’, which is the most rapidly increasing carbon store and negative feedback on climate on the planet (Nellemann & Corcora, 2009, p. 19).

Antarctic continental shelves are very large and in deeper water experience uniquely minimal levels of (anthropogenic or natural) disturbance, making them particularly effective as carbon sinks (Barnes, 2015, 2017; Barnes, Fleming, Sands, Quartino, & Deregibus, 2018). Climate change may amplify this potential (Turner & Comiso, 2017), in part through the natural increase in the abundance and longevity of phytoplankton where sea-ice is being lost over shallow continental shelf waters [see figure 2]. Further, the loss of more permanent ice-shelves and glacier retreat permits colonization of whole benthic (seabed) assemblages, including sedentary and sessile animals (for instance corals, sponges and bryozoans). The result is a profound increase in the ecological diversity and capacity of the system to accumulate blue carbon, in a similar manner to the forestry term of a carbon-stock (Barnes et al., 2018).

The need for legal protection of Antarctic blue carbon

Maximizing the carbon sequestration potential of Antarctic polar blue carbon would have profound benefits for global climate mitigation efforts. The emergence of blue carbon ecosystems around Antarctica is expected to store as much as 80 million tonnes of carbon per year from the atmosphere; little work has been undertaken on sub-Antarctic continental shelves but blue carbon gains may prove to be in excess of 160 million tonnes (Barnes et al., 2018). However, realizing the mitigation potential of blue carbon will require a precautionary, *whole-of-ecosystem* approach; especially in the newly ice-free areas. Indeed, our current state of knowledge suggests that the negative feedback potential of newly ice-free coastal regions around the Antarctic continent justifies a commercial harvesting moratorium for these areas.

Governance of Antarctic coastlines

The terrestrial and marine systems south of latitude 60° South are governed by the Antarctic Treaty System (ATS), of which the 1959 Antarctic Treaty is the cornerstone. (Haward, 2016) The Antarctic Treaty was established, in part, to diffuse cold war tensions about the territorial status of Antarctica (Haward & Cooper, 2012). This was achieved by states agreeing to put their territorial claims ‘on-hold’ for the duration of the Treaty (Antarctic Treaty, Art IV(1)). States have subsequently committed to cooperatively using and governing the continent in the interests of peace, science and international cooperation. None of those acts may prejudice any asserted, assumed or contested sovereignty there. This cooperative, scientific approach was advanced further under

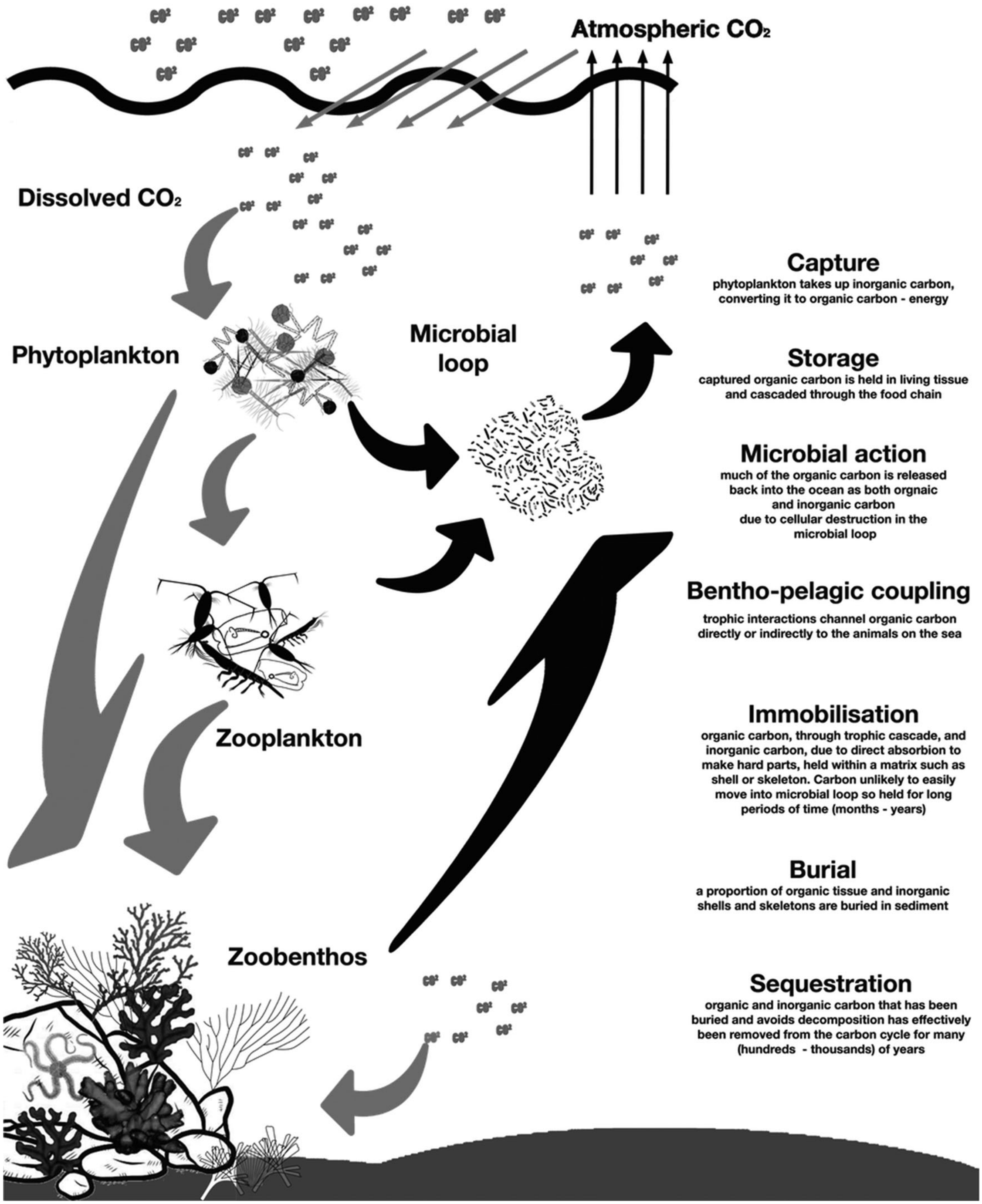

Figure 1. Antarctic Blue-carbon Cycle. A graphical representation of the Antarctic Blue Carbon Cycle from carbon capture to sequestration on the seafloor.

the 1991 ATS Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol). Parties to the Madrid Protocol agree to preserve Antarctica as a 'natural reserve' devoted to peaceful scientific exploration for the progress of all humanity. (Madrid Protocol, Art 2/Preamble) However these protections are less stringent in the marine areas surrounding the Antarctic continent.

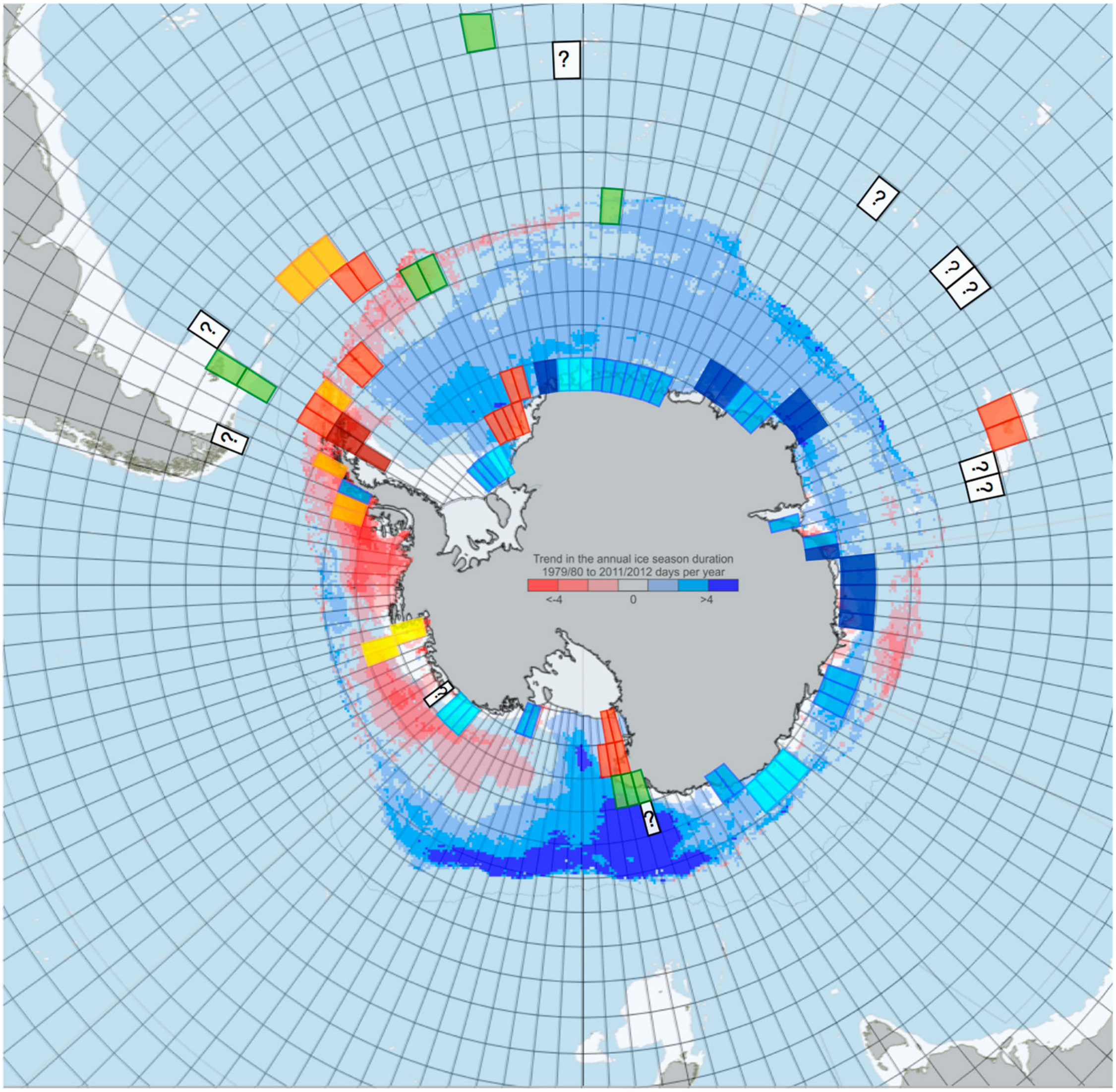

Figure 2 Trends in blue carbon (squares) and sea ice change: Overview: Red = sea ice loss and blue carbon gain; Blue = sea ice gain, blue carbon loss; White? = results pending. Description: 3° × 3° cells are coloured to indicate increasing standing stock of carbon (yellows to red), decreased standing stock due to likelihood of giant iceberg scouring of the sea floor (light to dark blue), and regions where sampling has occurred but results pending (white with question marks). The shading indicates annual change in sea-ice duration around Antarctica where the scale −4 to + 4 relates to the average number of days lost or gained per year (respectively) of sea ice from 1979 to 2012.

Source: Sea ice data taken from Cavalierie et al. 'Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, Version 1' Data set 1996 to present, updated annually DOI: 10.5067/8GQ8LZQVL0VL. Figure adapted from: Barnes et al. (2018).

Fishing off Antarctica's coasts

When the *Antarctic Treaty* was negotiated in the late 1950s, there already an existing, and long-standing, fishing industry operating in the Southern Ocean (Tin et al., 2008). To assuage concerns about the impact of territorial concessions on fishing rights, the parties agreed that the Antarctic Treaty would not affect high seas rights within the Treaty Area. Art VI of the Antarctic Treaty clarifies that its jurisdiction applies to:

> the area south of 60 ° South Latitude, including all ice-shelves, but nothing in the present Treaty shall prejudice or in any way affect the rights, or the exercise of the rights, of any State under international law with regard to the high seas within that area.

The Madrid Protocol adheres to this jurisdictional delimitation, effectively limiting its natural reserve protections to areas that are *not* 'the high seas' areas within the Treaty Area (Madrid Protocol, Arts 1(b) & 4). However, this creates legal uncertainty in Antarctic circumpolar waters, because high seas are defined under international law as those marine areas not falling within the territory, jurisdiction or sovereignty of any one state (Convention on the High Seas, 1958, Arts 1, 2 & 86).

Some states whose territorial claims precede the Antarctic Treaty (i.e. 'claimant states') have made qualified declarations extending their on-hold territorial claims to circumpolar waters (Kaye & Rothwell, 2002). However, the status of these claims remains untested and unenforced beyond the act of registration (Rothwell, 2002). As Joyner (2009) explains:

> claimant states are not pushing application of their domestic laws establishing these [maritime] zones on other governments involved in Antarctic affairs. Non-claimant states generally do not recognise the validity of any of these maritime claims, primarily because they believe that no true coastal states are present and no 'new' claims are permitted under the Antarctic Treaty. Most states regard circumpolar waters legally as high seas.

Thus, while it may be technically incorrect to describe the marine areas seaward of the Antarctic continental ice sheet as 'high seas', the result is practically the same. That is, for activities such as fishing, the natural reserve protections of the Antarctic Treaty and Madrid Protocol practically extend only to the edge of the Antarctic coastline.

The governance of circumpolar waters and marine ecosystems

While Antarctic circumpolar waters are not afforded the same protections as terrestrial systems, they are managed under other ATS instruments. Notably the 1980 ATS Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), Article 1, provides for the conservation of Antarctic Marine Resources:

> of the area south of 60° South latitude … and the Antarctic Convergence which form part of the Antarctic marine ecosystem.

By ascribing its subject matter-jurisdiction to biological and marine ecosystems– territorially confined by a northern boundary line of the Antarctic convergence – the CCAMLR artfully avoids upsetting the on-hold status of territorial claims under the *Antarctic Treaty*. In fact, Art IV of the CCAMLR affirms that no actions made pursuant to the CCAMLR amount to a claim or denial of territorial sovereignty in the *Antarctic Treaty* area. By fixing only a northern boundary, and limiting its subject matter to marine ecosystems only, the Convention's effective southern jurisdictional boundary is the perimeter of the Antarctic coastline, that is, the edge of the continental ice sheet or Antarctica's physical landmass.

Whilst CCAMLR's primary objective is the 'conservation of Antarctic Marine Resources' (Article II), unlike the Antarctic Treaty, that conservation includes 'rational use' of those resources; that is, harvesting of marine resources and associated activities. This provides a point of distinction with the treatment of the continental terrestrial system as a nature reserve under the Madrid Protocol. In other words, the blue-carbon that emerges following ice shelf loss becomes legally accessible to commercial harvesting precisely at the time when its growth is so important to carbon capture, storage and ultimately sequestration.

CCAMLR management of Antarctic marine living resources

As noted, CCAMLR adopts a conservation-focused approach to fishing in the Southern Ocean, aiming for the protection and preservation of marine species and the marine environment through an ecosystem-based and precautionary management approach. Indeed, CCAMLR contains a range of tools which can be deployed to conserve Antarctic blue carbon zones.[1] However, such conservation measures may only be formulated and adopted by reference to the primary objects and principles set out in Article II of the Convention, namely:

(1) stock maintenance (stability of recruitment); (Art II(3)(a))
(2) ecological relationship maintenance; (Art II(3)(b)) and
(3) intergenerationally sustained conservation. (Art II(3)(c))

Notably, the objects and principles set out in Article II are all defined in relation to *Antarctic* marine living resources (Art II(1),(3), Art V(2), Art IX). That Article, and its implementation as conservation measures, makes no reference to the protection or conservation of the ecosystem outside of the treaty area. Indeed, climate change is not mentioned anywhere in the CCAMLR text. That is, perhaps, understandable given the time period and regional and global context in which it was drafted; climate change was not a factor that dominated international relations or fisheries management negotiations.[2] As a result the impact of marine conservation on climate change, the atmosphere and global environment were not included in the Convention text as something upon which conservation measures can be established. Only the conservation and maintenance of the marine environment of the Southern Ocean is relevant.

The south-looking focus of the CCAMLR is reflected in the primary declaration on climate made within that body: Resolution 30/XXVIII of 2009 (CCAMLR, 2009). That resolution declares that:

> climate change is one of the greatest challenges facing the Southern Ocean … [which] will continue to warm over this century … experience increased acidification with possible impacts on its marine ecosystems … management action can help build resilience and protect the unique Southern Ocean environment against potentially irreversible impacts of climate change, and ensure the continued conservation and rational use of the Antarctic marine living resources.

To this end, Resolution 30/XXVIII urges 'consideration' of climate change impacts on CCAMLR management (i.e. rational use). It further encourages the collection of data about climate change as part of research activities to be 'communicated' to other international bodies. However, the Resolution stops short of calling for conservation measures *within* the Treaty Area for the purposes of reducing the impacts of climate change *outside* of it.

In 2011, the CCAMLR parties did appear to move towards a more global view of conservation measures in the implementation of a Marine Protected Area (MPA) Framework, with the aim of conserving marine biodiversity in the Convention Area (CCAMLR, 2011; Christian, 2018). The Convention Measure establishing the MPA network does not explicitly refer to Resolution 30/XXVIII. However, it does envision the network being established 'on the basis of the best available scientific evidence' to achieve, *inter alia*, 'the protection of areas to maintain resilience or the ability to adapt to the effects of climate change' (Para. 2(vi)). Again, this is somewhat inward looking. Indeed, the wider resolution text is addressed to fostering resilience and adaptability only within the 'Convention Area'.

Despite the ostensible jurisdictional limitations of CCAMLR, there is a clear relationship between the global climate and Antarctic Marine ecosystem. Yet, to date, there seems to be little appetite within CCAMLR for establishing conservation measures within the Convention by reference to their contribution to the ecosystem outside of it. In fact, absent appropriate incentives for states, reliance on considerations not expressly provided for in the Convention is likely to form the basis for opposition, rather than consensus to cooperative conservation measures. Legal uncertainties or technical impediments have often been a lens for opposition that is more properly explained by concerns over the loss of fishing rights (Jacquet, Blood-Patterson, Brooks, Ainley,2016; Nyman, 2018).

CCAMLR operates upon consensus decision-making, which is significantly influenced by states with active fishing interests in the Southern Ocean (Brooks, 2013). Beyond this is the traditional convention of using MPAs to protect specific zones, strata, activities or species therein. While proposing large moratorium zones is not unheard of (CCAMLR, 2012), acceptance of such proposals is uncommon. These factors have served to slow implementation of the comprehensive MPA regime envisioned in 2011, even when proposals have clearly been designed to protect vital Antarctic ecosystems (Brooks et al., 2016). Russia and China have been especially strident in this regard, opposing the establishment of MPAs in areas of rich biodiversity. This is largely a result of concerns about the impact of the measures on present and future fishing rights (Jabour & Smith, 2018; Jacquet, Blood-Patterson, Brooks, & Ainley, 2016; Nyman, 2018).

Importantly though, not all MPA proposals have failed to achieve consensus within the CCAMLR, the most notable exceptions perhaps being proposals to conserve 94,000/km^2 around the South Orkneys and 1.55 m/km^2 of the Ross Sea (Barnes et al., 2015). However, it is generally understood that these were successful because the specific zones were drawn so as to avoid current or future commercial harvesting interests. For instance, China, which originally opposed the Ross Sea MPA, only agreed to it after a krill-fishing zone was carved out – despite not actually engaging in krill fishing at the time (Jabour & Smith, 2018; Nyman, 2018, note 46).

Similar concessional balancing between commercial and conservation values has also led to the adoption of more temporary protection measures for new ice-free zones within the Southern Ocean. These include the 2017 agreement by the CCAMLR parties to implement a ten-year 'Special Area for Scientific Study' (SASS) over 'newly exposed marine areas around the Antarctic Peninsula and Larsen C Ice Shelf following ice-shelf retreat or collapse' (CCAMLR, 2017). However, this was adopted upon the caveat that the SASS only limits (not prohibits) harvesting while data is gathered to 'understand the ecosystem processes in relation to climate change'. Furthermore the SASS is directed to determining how the area may be 'rationally used' – rather than conserved – in the future. Thus, whilst the SASS may provide a much better understanding of the carbon sequestration potential of the relevant areas it retains a focus on long-term harvesting.

Madrid protocol

An alternative source of potential blue carbon protection within the ATS regime complex is the Madrid Protocol. While technically the Antarctic Treaty does not extend to the high seas areas off – or practically at the verge of – the edge of ice sheets, it does allow the parties to extend its reach into these areas. Specifically, the Protocol affirms that the high seas is to remain a regulated fishery, but allows the parties to create Antarctic Specially Protected Areas (ASPAs) *anywhere* within the Treaty Area 'including any marine area' (Annex V, Art 2). Unlike the CCAMLR conservation measures, ASPAs may be established based on their 'outstanding environmental [or] scientific' value, without reference to the Antarctic ecosystem. This would be wide enough to include the benefit of preserving Antarctic blue carbon for the global climate system. Unfortunately, there are also challenges to using the ASPA system to protect coastal blue carbon.

The first challenge is that the ASPA system is relatively underutilized and politicized (Shaw, Terauds, Riddle, Possingham, & Chown, 2014). Only of 1.5% Antarctic biodiversity regions are covered by ASPAs, which is 10% of the global average for regional biodiversity conservation (Hughes, Ireland, Convey, & Fleming, 2015).[3] Most of these are designed to protect (predominantly) terrestrial rather than marine systems, (Douglass et al., 2014) and are largely centred around the bases of nominating parties.[4] That has led some critics to suggest that they are being used as geopolitical tools to support the on-hold territorial claims to the continent, should such claims need to be revived (Hughes & Grant, 2017).

The second, more challenging, issue is that, despite the fact that ASPAs are not limited by the subject matter jurisdiction of CCAMLR, that body must provide 'prior approval' for any ASPA in marine areas. (Madrid Protocol, Annex V, Art 6(2)) In one way, this is beneficial, insofar as it leverages the specialist marine science expertise in that regime. On the other hand, it serves to infuse the decision-making process under the Madrid Protocol with the commercial considerations present within CCAMLR – especially concerns about locking-up protein rich areas of biodiversity. Indeed, despite its technical capacity, and a general consensus amongst the parties that CCAMLR should take the lead in nominating marine ASPAs, it has not done so to date. (Hughes & Grant, 2018). Indeed, very few ASPAs have any form of marine component at all.[5] Thus, while ASPAs provide suitable, technically compliant, alternatives to MPAs as a source of blue carbon protection under the ATS – especially those adjacent to the territorial coastline of Antarctica – they may face similar geopolitical obstacles to implementation.

Regardless of the legal vehicle adopted, commitment to conservation of marine based Antarctic blue carbon must necessarily come from within, and be driven by, CCAMLR. Recent history suggests a failure to reach consensus if conservation measures are framed solely around conservation. Antarctic marine ecosystems are considered a commodity by some key ATS states. Proposals to protect such ecosystems must, pragmatically, take account of such fishing interests, or find ways of generating alternative non-commercial incentives that are considered as equitable by all CCAMLR parties. As Brooks et al. (2016) note:

> Past conservation successes in CCAMLR depended on having an open political window of opportunity, trust within the Commission, and *alignment of incentives among member states* [emphasis added].

Towards an Antarctic blue carbon marine protected area

The need to protect and preserve Antarctic blue carbon is undeniably important and urgently needed. In such a scenario it is preferable to work within existing treaty regimes. Even if the global community had an appetite for new institutions, there is no certainty about how long it would take or whether it would lead to the weakening, rather than strengthening, of Antarctic governance, with important implications for the global climate.

Importantly, while the existing ATS regime may not provide automatic protection for Antarctic blue carbon, it can be operationalized to do so; that is, so long as the political will exists to collaboratively commit to conservation measures. Pragmatically, the less conflict there is with state and commercial interests, the more traction conservation efforts will likely have. One possibility is to seek protection for only those zones of blue carbon that have become ice-free after a set date, for instance the 1992 adoption of the United Nations Framework Convention on Climate Change (UNFCCC) or the 2015 adoption of the Paris Agreement. Either would include the new sink formed by the calving of the Larsen C iceberg, estimated to be worth a million tonnes a blue carbon annually.[2]

Isolating blue carbon protection to new zones of retraction may deal with the problem of existing national interests. However, the history of CCAMLR MPA diplomacy suggests that future fishing potential in these zones will be at the forefront of any negotiations to conserve them. Indeed, even the 2017 ice-carve area SASS that has been defined has been premised on states being allowed to fish in these newly ice-free zones. We accept the concern over future use is a more difficult obstacle to overcome, but one which may be possible if a way is found to allow states to count some or all of the sequestration potential of Antarctic blue carbon zones as part of their international obligation to mitigate their carbon emissions under the Paris Agreement.

The potential of the Paris Agreement

Under the 2015 Paris Agreement, states are to 'nationally determine' their contributions to international climate change mitigation, adaptation and resilience efforts (Art 4). These nationally determined contributions (NDCs) are designed to be iterative and flexible, with the expectation that various forms of domestic transition will allow each country to 'ratchet up' their NDCs over time.

The Paris Agreement also encourages cooperative approaches to carbon reduction. Article 6(1) of the Agreement permits parties to:

> pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity.

Importantly, the Paris Agreement does not specify the form of activity which may give rise to cooperative mitigation outcomes, nor the mechanism for its accounting. Any cooperative activity – or indeed cessation of activity – programme, scheme or policy which results in demonstrable carbon mitigation is potentially able to contribute to NDCs. In this respect the Agreement envisions (Art 6(8)):

> integrated, holistic and balanced non-market approaches being available to Parties to assist in the implementation of their nationally determined contributions.

To that end, Article 6.9 of the Paris Agreement establishes a non-market-approach (NMA) framework designed to, *inter alia*, 'enable opportunities for coordination across instruments and relevant institutional arrangements' (Art 6.8) As noted, that may include, as part of the state party obligations set out within the UNFCCC text, mitigation outcomes that result from cooperative conservation and enhancement of biomass, coastal and marine ecosystems; namely, *blue carbon*. (Art 4.1(d))

In this case, states would need to show that cooperatively restricting or prohibiting fishing or other industrial activities in blue carbon zones generates demonstrable additional greenhouse gas sink activity compared to a projected 'business as usual' approach.[6] As discussed, significant scientific evidence already exists to show this will be the case. Further work, however, is needed to project biomass development in zones of sea ice retraction, calculate present and future carbon-sequestration value of that biomass, and attribute the additional benefits of leaving it in place to those states who cooperatively agree to do so.

As of yet, conceptual and common guidelines for NMAs are yet to be agreed by the Paris Agreement parties. In fact, uncertainty and disagreement about Article 6 at the Katowice Climate Conference in December 2018 meant that no common vision has been achieved for Article 6 under the Paris Rulebook.

Further discussion on common guidelines on NMAs is expected at the 2019 Madrid Climate Conference, under the Presidency of Chile. The present lack of clarity around NMAs, in combination with the receptiveness to innovative approaches under the Paris Agreement more generally, indicate the timing may be right to explore options for an Antarctic blue carbon NMA framework. Notably, on the ATS side, those states who have slowed progress on adoption of MPAs in the Southern Ocean (: See note 54) are also leading carbon emitters and under international pressure to reduce greenhouse gas emissions and set ambitious NDCs (Hilton & Kerr, 2016; Martus, 2018). We therefore propose to allow CCAMLR parties to count Antarctic blue carbon sequestration towards their NDCs; doing so could provide a relatively low cost but politically attractive incentive for protecting Antarctic blue carbon.

Towards a blue carbon NMA

Given the flexibility and adaptability of the Paris Agreement, a cross-institutional NMA platform connecting it to the ATS need not be overly prescriptive at the outset. Like the 'ratcheting up' of commitments, an NMA platform could have the capacity to be refined over time, as scientific and policy knowledge and indeed ecosystem services develop. Indeed, inter-regime carbon under an Antarctic blue carbon NMA could be delayed to allow scientific evidence to be gathered under the current or modified CCAMLR Special Areas for Scientific Study. However, we urge current work towards an NMA platform that is capable of assessing:

- The estimated ecosystem service of blue carbon zones at any one time – based on current mapping survey techniques to identify and measure standing stocks of carbon in marine marine organisms, by habitat, by major area (Barnes & Sands, 2017; Barnes, Sands, Richardson, & Smith, 2019);
- The 'business as usual' level of marine resource harvesting that would ordinarily be permissible in these zones;
- The amount of carbon which would remain– and therefore be stored in the seafloor – if that harvesting was to occur; and
- By consequence, the relative amount of carbon each CCAMLR fishing state preserves for long term sequestration by agreeing to forego or restrict fishing activities in the proposed areas of blue carbon protection.

Beyond the broad platform elements suggested above, it is beyond the scope of this paper to formulate the technical mechanics of carbon accounting or transfer between regimes. That is a future task, one that would require both political commitments, but also dedicated research, negotiation and commitment from both regimes. That said, there are some basic structural and institutional issues that would need to be dealt to progress such an NMA.

Attribution and additionality

Firstly, any accounting regime would need to be based on genuine limits upon harvesting by states who would have otherwise fished in blue carbon zones. Clearly all states of the world could not claim mitigation outcomes, otherwise it would dilute the incentive for blue carbon protection, if not neutralize it altogether. Relatedly, ensuring additionality of enhanced carbon sinks and preventing double-counting of emission abatement efforts are common concerns within international climate change policy and an ongoing theme of Article 6 Rulebook negotiations (Schneider & Theuer, 2018).

Carbon leakage

Another potential issue is the potential for carbon leakage, in that there might be an incentive for a state that foregoes fishing activity (and thereby enhances blue carbon sinks) to then simply allow its emissions to increase in other ways (e.g. by reducing domestic efforts at emissions abatement). Avoiding carbon leakage would need to be a key design element of an effective NMA platform. This might be achieved, for instance, by states declaring enhanced carbon sink activities (from NMA platforms) as a distinct element of their NDCs under the Paris Agreement. That way, there should be limited opportunity for interchangeability between NMA activity in enhancing blue carbon sinks and emissions abatement at home.

Coordination across instruments

On the ATS side, an effective Antarctic blue carbon NMA would necessarily involve the participation of CCAMLR. CCAMLR is in a unique and powerful position to respond to climate change trends and predict future climate conditions in the Southern Ocean (Christian, 2018). It has an even stronger technical capacity to research, study, map and monitor living marine resources in the Southern Ocean. (i.e. CCAMLR, Art IX(1)) It also has the expertise and resources to map and attribute ecosystem service contributions arising from cessation of harvesting. CCAMLR might, for instance, contribute to, or endorse, attribution claims on a Paris Agreement based register; one restricted to the CCAMLR area of the Southern Ocean, or potentially in respect of all areas beyond national jurisdiction. Alternatively, CCAMLR might be the host institution for an NMA framework for blue carbon accounting as part of a coordinated, cross-instrument approach as envisioned under Paris Agreement Article 6.8 and 6.9.

One of the major roadblocks to CCAMLR involvement in carbon accounting might come from within that body itself. As with other ATS bodies, CCAMLR has tended to operate in a silo, and especially at arm's length from the wider United Nations system (Christian, 2018). Indeed, outside of the 2009 Resolution 30/XXVIII, CCAMLR has subsequently undertaken little in the way of inter- or intra-regime cooperation with other ATS organizations, or with the UN climate change regime (Hughes & Grant, 2017). That said, there has been a renewed emphasis on building collaborative frameworks over the last decade, much of which has been driven by the Scientific Committee on Antarctic Research (SCAR) (Hughes et al., 2018).

Regime bridging

SCAR is an interdisciplinary body established independently of, and prior to, the ATS (Summerhayes, 2008). Given its history and contribution to knowledge about Antarctic systems and governance, SCAR plays an active role in observing and providing expert advice to CCAMLR, Antarctic Treaty Consultative Meeting (Antarctic Treaty) and Committee for Environmental Protection bodies (Madrid Protocol, 1991, Art 11(4)). Importantly SCAR has official observer status at meetings of the Paris Agreement and UNFCCC and also participates in meetings of the Intergovernmental Panel on Climate Change (IPCC) in an *ad hoc* manner through its parent body the International Science Council. As Hughes et al. (2018) note:

> Ultimately, efforts to enhance Antarctic environmental protection would be further strengthened by developing greater synergies between the governance bodies on the one hand and the science community on the other hand. Fortunately, there are mechanisms already in place linking scientific evidence to governance, with SCAR playing a key role.

Those essential characteristics would also make SCAR a key nexus body to link science evidence about the ecosystem service of Antarctic blue carbon within global governance and an essential component of an ATS/Paris Agreement NMA framework.

Conclusion

As we have discussed, the rapid change to Antarctica's coastlines is both a consequence of climate change and a potential buffer against its progress. Much will depend on the governance decisions we make now and whether they ultimately focus on the conservation opportunities or commercial values of the emergent blue carbon in newly ice-free areas. The history of MPA negotiation suggests that Antarctica's very nature as a complex marine ecosystem will act as a disincentive to its protection. Equally challenging will be the scale of what needs to be conserved. Predicted blue carbon areas around the Antarctic coastline are vast, dwarfing the size of the few MPAs that have been agreed to date. Blue-carbon protection requires that we consider more than one strata or isolated area; benthic sea-life supports and is supported by a complex ecosystem which is expanding, and in flux. Truly maximizing its negative feedback capacity will require ecosystem-wide protection, most of which has not been studied to even a baseline level of understanding.

As we have shown, barriers to conservation will likely be political and diplomatic in nature. Given what is at stake, it is important to deal with such barriers head on rather than hoping that states will put global interests above their own. That simply hasn't been the experience to date, either in the ATS framework, or within the UN climate change regime. Perceptions about and concerns for economics and inequity are common in both, and solutions must take account of these issues from the outset or risk further failures.

We have presented one promising way forward; one that seeks to counterbalance the potential for resistance from fishing states through the incentivisation of carbon crediting from ice-melt areas around the Antarctic coastline. Whether this is enough of an incentive is uncertain, but the timing and the circumstances suggest it is worth exploring the opportunities presented by the as-yet-uncharted Article 6 of the Paris Agreement, especially in relation to 'integrated, holistic and balanced' mitigation efforts aimed to 'enable opportunities for coordination across instruments'.

We emphasize that an inter-regime NMA to account for Antarctic blue carbon should not be viewed as an alternative to domestic NDC commitments. Rather, the proposal recognizes the real potential of emergent Antarctic blue carbon for global mitigation efforts. It also recognizes that achieving that aim involves certain states foregoing short term domestic commercial interests. What is being given up may be a future interest, but it is undeniably a lucrative one, which will become more commercially attractive as global fish stocks decline and the Southern Ocean becomes easier to exploit by technological means. It seems appropriate to find a way to account for such concessions. As noted, CCAMLR conservation measures have been most readily adopted when they are viewed as equitable and ensure an 'alignment of incentives' amongst the parties. In many ways, this is what the refocusing of the Paris Agreement is about; encouraging compliance by providing everyone with carrots, rather than just threatening a small group with sticks.

Notes

1. That includes the designation of the opening and closing of areas, regions or sub-regions for purposes of scientific study or conservation, including special areas for protection and scientific study: see CCAMLR Art IX(1)(f) & Art IX(2)(g).
2. The jurisdictional limits on CCAMLR rational use considerations arise in part as a result to concerns about the clash of the CCAMLR with other fisheries treaties outside north of 60S during its negotiation. Further, while Antarctica's and Antarctic systems' contribution to the global environment – including oceans, climate and atmosphere – was already recognised at the time of drafting in the 1970s, the focus of the parties centred on fishing and there was little conceptual engagement with how massive ecosystem changes within the convention area might occur in the near future that would alter its global ecosystem role. See ATCM, 'Summary of Preliminary Views Expressed by Delegations to the Second Extended Prepatory Meeting on the Question Posed in the United State's Paper ANT/EPM/6 on Antarctic Marine Living Resources Issues' Antarctic Treaty IXth Consultative Meeting ANT/EPM2/5 27 July 1977; ATCM Final Meeting report Antarctic Treaty Report of Ninth Consultative Meeting, 23, 29, 42, 45, 74.
3. n.b no new ASMAs have been agreed since 2014 meaning this data remains current at the time of publication.
4. This is, in part due to the fact that the nominating party is responsible for managing the protected area.
5. Currently there are 72 ASPAs, with 8 having a marine component. See Wauchope, Shaw, and Terauds (2019).
6. Additionality has been a longstanding and persistent issue in global emissions agreements, and the source of much debate in relation to the voluntary mechanisms established by Article 6 of the Paris Agreement. Concerns over experience with additionality under the Kyoto Protocol and its Clean Development Mechanism have indeed stalled the finalisation of an agreed mechanism to date (Schneider & Theuer, 2018).

Disclosure statement

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