POLICY FORUM

OCEAN GOVERNANCE

Mobile protected areas for biodiversity on the high seas

Protecting mobile marine species and habitats under climate change will require innovative and dynamic tools

By Sara M. Maxwell[1], Kristina M. Gjerde[2], Melinda G. Conners[3], Larry B. Crowder[4]

A new agreement is being negotiated under the 1982 United Nations Convention on the Law of the Sea (UNCLOS) to provide legally binding mechanisms to protect the marine environment and to conserve and ensure the sustainable use of marine biodiversity on the high seas (international waters in areas beyond national jurisdiction) (*1*). One of the suggested objectives in the current draft text is to "apply an approach that builds ecosystem resilience to the adverse effects of climate change" when applying area-based management tools (ABMTs), including marine protected areas (MPAs). Yet even though climate change is resulting in shifts in species' ranges (*2*) and in the behavior of the human users of mobile, commercially valuable species (*3*), protection of highly mobile species and the dynamic habitats on which they depend is not currently a focus of negotiations. With the final language to be determined as early as 2020 (*1*), we urge negotiators to include new dynamic management tools, including mobile MPAs (mMPAs), whose boundaries shift across space and time, that could help to safeguard marine life and build ecosystem resilience by protecting dynamic habitats as well as migratory marine species in a changing ocean.

Large MPAs (>10,000 km^2), which have been increasing globally in number, will be an important addition to the toolbox for protecting habitat and building resilience of many high-seas species and ecosystems (*4*). However, key habitats of highly mobile species are unlikely to be protected by static boundaries alone. Some migratory species range entire ocean basins (*5*); in addition, animal distributions may change considerably, either over short time scales due to seasonal or interannual climate variability, or over the long term as a result of climate change (*2*). In the past decade, dynamic spatial management of ocean resources, which responds to changes in marine systems or resources on short time scales (days to seasons), has been a critical tool for managing fisheries in national waters. It has also been applied to reduce biodiversity impacts, such as through the closure of fishing areas based on oceanographic conditions that correlate with high bycatch, or reduced vessel speeds when whales are detected in shipping lanes (*6*).

For many wide-ranging species, dynamic ABMTs without static boundaries may be the only practical option for sufficient protection, although few UN negotiators are familiar with the advances in science and technology that make dynamic ABMTs possible for the high seas. By recognizing, defining, and enabling flexible dynamic area-based approaches, UN negotiators have a unique opportunity to complement the efforts of international sectoral organizations [e.g., regional fishery management organizations (RFMOs)] to achieve sustainable ecosystem-based management (e.g., by avoiding bycatch of vulnerable migratory species), as well as increasing the effectiveness of traditional MPAs during this time of unprecedented challenges attributable to climate change (*2*).

MOBILE PROTECTION ON THE HIGH SEAS

On the high seas, dynamic ABMTs occur infrequently and under the management of individual countries, and only for fisheries (countries cannot control the high-seas area itself but can control the activities of their flagged vessels). In the Australian multispecies longline fishery, mandated fishing zones that extend into the high seas are determined using forecasted southern bluefin tuna (*Thunnus maccoyii*) habitat in near-real time to not exceed quotas (*7*). TurtleWatch is a voluntary program updated weekly and applied by the United States to its longline vessels in the North Pacific to reduce sea turtle bycatch based on turtles' sea surface temperature preferences (*8*). These examples highlight that most of the technological limitations to the application of dynamic ABMTs that were recognized nearly 20 years ago (*9*) have been overcome through advances in animal tracking, satellite imagery, computing capacity, and communication. These have led to the ability to tailor management efforts by determining where species or dynamic habitats such as fronts occur (*6*) or by detecting mobile human users (*10*). Dynamic ABMTs could become a vital conservation tool for the high seas if legal, political, and scientific obstacles can be addressed through the UNCLOS implementing agreement for marine biodiversity.

Including mMPAs—dynamic management that focuses on the comprehensive conservation objectives inherent in MPAs—as a potential tool in the ABMT toolbox will be critical for moving to an approach that enables comprehensive protection of marine biodiversity as species, habitats, and ecological communities shift in a changing environment. Some studies have suggested that current MPAs, including those

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Campbell albatross (*Thalassarche impavida*) are found on Bull Rock, Cape Colony, Campbell Island, New Zealand.

on the high seas, will continue to protect biodiversity under climate change scenarios (*4*); others suggest that current MPAs will be ineffective, particularly in tropical and temperate regions (*11*), reflecting substantial uncertainty around the nuances of how species are responding to climate change. As species and habitats shift across space and time, mMPAs could be used to protect dynamic oceanographic habitats critical for ecosystem function, such as fronts, currents, or eddies, or to protect individual species or groups of species. mMPAs can further serve to protect connectivity corridors between static MPAs and thereby help to "future-proof" such MPAs against shifts due to climate change by offering protection when key species or habitats shift outside static boundaries. Dynamic habitats have already been described on the high seas through the Convention on Biological Diversity's (CBD) Ecologically and Biologically Significant Area process (*12*) (see the figure and the supplementary table). Initiatives such as the Migratory Connectivity Project (MiCO) of marine species can be built upon to track the movement of species across their ranges and jurisdictional boundaries (*13*). Like traditional MPAs, mMPAs could be managed to protect species and habitats from multiple threats, including those that involve multiple sectors (e.g., industrial fishing, shipping, seismic surveys) as well as those from diffuse or multiple sources, such as ocean noise. Within mMPA boundaries, human activities would be restricted, similar to static MPAs, but these boundaries (and the applicable measures inside them) would move, tailored to the movement of the habitat or species being protected. Protecting species that move has been a tenet of conservation biology for decades, but having protections follow them in near-real time has not been possible because we lacked the ability to, for example, communicate to users where the boundaries were as they moved. These hurdles, however, have been overcome in the digital age.

IMPLEMENTATION WITHIN UNCLOS

We recommend that dynamic ABMTs, including mMPAs, should be recognized as a potential tool within the UNCLOS implementing agreement by defining ABMTs to clearly include (or at least not exclude) spatially or temporally variable measures and include as an objective the protection of ecosystems, natural habitats, and populations of migratory species throughout their range. To do this, we recommend the following: (i) A Conference of the Parties (COP) to the implementing agreement should be empowered to establish ABMTs, including mMPAs, and call on states parties to adopt relevant conservation measures (applicable to their flagged vessels and nationals). (ii) The COP should also be able to recommend that sectoral management organizations (e.g., RFMOs, International Maritime Organization) adopt dynamic ABMTs for specific species or habitats based on globally agreed conservation priorities, criteria, and guidelines adopted under the agreement. (iii) A scientific expert body should have a key role in reviewing proposals and advising on implementation.

Potential sector-based dynamic ABMT measures might include changes in ship-routing measures on short time scales based on the distribution of whales, discharge limitations in areas identified as key foraging grounds of sensitive species, and intermittent gear restrictions to avoid bycatch. Such measures could be implemented directly by states parties, as is the case with the Australian longline fishery and TurtleWatch in the United States (*7*, *8*), as well as recommended for adoption more widely by the relevant international sectoral organization. MPAs, including mMPAs, could include more comprehensive conservation measures that address multiple threats across sectors and be informed by a targeted management, monitoring, and research plan, as with traditional MPAs. Including a specific obligation to adopt dynamic measures in a global agreement could "institutionalize" dynamic ABMTs at the international level, while also advancing the currently inconsistent implementation of several existing obligations: to "protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life" under UNCLOS; to establish effective protected areas and take other measures to "promote the protection of ecosystems, natural habitats, and the maintenance of viable populations of species in natural surroundings" under the CBD; and to adopt measures to conserve migratory species and their habitats listed in the Convention on Migratory Species and its sister agreements (*14*).

Dynamic ABMT boundaries could be defined in a number of ways. These might include demarcating boundaries by explicit environmental characteristics, such as sea surface temperature bands, rather than by static latitude and longitude coordinates; by determining the presence of specific species by visual or acoustic detection; or by predicting habitats or species occupancy through modeling or forecasting (*6*). Such areas have distinct geographic boundaries,

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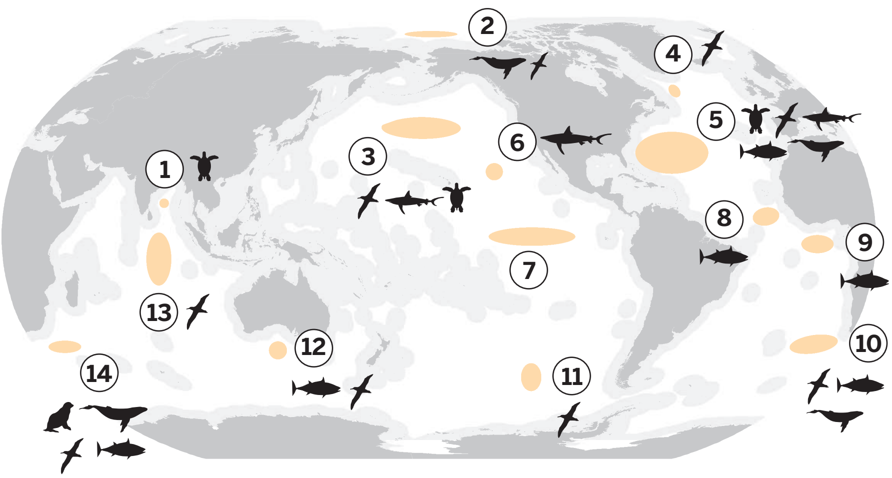
although they move in space and time; for mMPAs, the criteria or conditions that define where boundaries are placed could be persistent, allowing for mMPAs to meet the International Union for Conservation of Nature (IUCN) definition of an MPA. Notably, management measures may only be necessary during certain times (e.g., during a species' breeding season) and in certain places, potentially resulting in a smaller footprint of restrictive management of human activities, as has been shown for dynamic management more broadly (*15*). Managing for direct impacts on marine species and habitats can improve species resiliency by reducing the direct threats that lead to population decline, thereby providing a buffer against indirect impacts from climate change such as changes in prey distribution.

Dynamic ABMTs cannot directly address a number of issues, such as movements of species or habitats of concern across political boundaries such as Exclusive Economic Zones, potential for lack of monitoring and enforcement (including illegal, unreported, and unregulated industries), or ineffective management. Nor will they displace the need for more traditional, stationary ABMTs including static MPAs to protect fixed habitat features such as seamounts, less mobile species, or areas of cultural significance. Conflicts may arise around communicating boundaries as they shift over time, but all management relies on effective communication with human users, and existing dynamic management applications have applied technologies successfully, including sophisticated websites, smartphone and tablet applications, and simple email and cell phone communications (*6*). Additionally, in offshore pelagic environments such as the high seas, safe operation requires most vessels to be of a length that legally requires automatic ship identification systems (AISs). Now that AIS data are widely available, we have the capacity for effective near–real time monitoring, and potentially enforcement, without the need for at-sea enforcement missions, although some legal frameworks may need to be enhanced to require AIS use by all vessels on the high seas (*10*).

In domestic waters, dynamic management is increasingly applied, and this experience can underpin its application on the high seas (*6*). Thus, the new treaty being considered by UN negotiators presents an opportunity to embrace global commitments under the CBD, the UN Sustainable Development Goals, and the upcoming post-2020 global biodiversity framework by advancing beyond the traditional static geographic constraints on ABMTs and MPAs. By enabling dynamic ABMTs, including mMPAs, the global community can together build resilience and maintain, conserve, and restore increasingly vulnerable migratory marine species in the context of a changing ocean. ■

Dynamic habitats on the high seas

Protection of species or habitats in such areas may benefit from dynamic area–based management tools or mobile marine protected areas. Areas are identified from the Convention on Biological Diversity's Ecologically or Biologically Significant Marine Areas (www.cbd.int/ebsa/).



1 Olive Ridley sea turtle migration corridor
Mass migration corridor for globally significant population of vulnerable sea turtles.

2 Deep Arctic Marginal Ice Zone and seasonal sea-ice cover
Dynamic habitat critical to many species; ice structure altering rapidly under climate change.

3 North Pacific Transition Zone
Productive migratory species habitat, shifts across seasons and years; shifting north under climate change.

4 Labrador Sea Seabird Foraging Zone
Productive wintering and foraging area for more than 40 million seabirds annually.

5 Sargasso Sea
Highly dynamic, unique, and biodiverse. Critical habitat for species across taxa.

6 Northeast Pacific white shark aggregation area
Seasonal aggregation area for white sharks, potentially for mating or foraging.

7 Equatorial High-Productivity Zone
Unique and highly productive, influenced by El Niño–Southern Oscillation events. Susceptible to climate change influence.

8 Canary-Guinea Current Convergence Zone
Strong upwelling area, supports commercially important fishes.

9 Equatorial production area
High-productivity migratory, spawning, and nursery habitat for commercially important fishes.

10 Subtropical Convergence Zone
High-productivity oceanographic feature that supports endangered seabirds and other species.

11 Southeast Pacific Rise Grey Petrel Feeding Area
Critical foraging area for Near Threatened seabird species from October to February.

12 South of Great Australian Bight
Critical foraging albatross and migrating tuna habitat.

13 Central Indian Ocean Basin
Important seabird foraging area, heavily influenced by seasonal productivity during austral winter.

14 Agulhas Front
Highest productivity in Indian Ocean; supports diversity of seabirds, mammals, and tunas.

GRAPHIC: N. DESAI/*SCIENCE*

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