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Better integration of sectoral planning and management approaches for the interlinked ecology of the open oceans

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ABSTRACT

Open oceans are one of the least protected, least studied and most inadequately managed ecosystems on Earth. Three themes were investigated that differentiate the open ocean (areas beyond national jurisdiction and deep area within exclusive economic zones) from other realms and must be considered when developing planning and management options: ecosystem interactions, especially between benthic and pelagic systems; potential effects of human activities in open oceans on ecological linkages; and policy context and options. A number of key ecological factors differentiate open oceans from coastal systems for planners and managers: (1) many species are widely distributed and, especially for those at higher trophic levels, wide ranging; (2) the sizes and boundaries of biogeographical domains (patterns of co-occurrence of species, habitats and ecosystem processes) vary significantly by depth; (3) habitat types exhibit a wide range of stabilities, from ephemeral (e.g., surface frontal systems) to hyper-stable (e.g., deep sea); and (4) vertical and horizontal linkages are prevalent. Together, these ecological attributes point to interconnectedness between open ocean habitats across large spatial scales. Indeed, human activities – especially fishing, shipping, and potentially deep-sea mining and oil and gas extraction – have effects far beyond the parts of the ocean in which they operate. While managing open oceans in an integrated fashion will be challenging, the ecological characteristics of the system demand it. A promising avenue forward is to integrate aspects of marine spatial planning (MSP), systematic conservation planning (SCP), and adaptive management. These three approaches to planning and management need to be integrated to meet the unique needs of open ocean systems, with MSP providing the means to meet a diversity of stakeholder needs, SCP providing the structured process to determine and prioritise those needs and appropriate responses, and adaptive management providing rigorous monitoring and evaluation to determine whether actions or their modifications meet both ecological and defined stakeholder needs. The flexibility of MSP will be enhanced by the systematic approach of SCP, while the rigorous monitoring of adaptive management will enable continued improvement as new information becomes available and further experience is gained.

1. Introduction

People are continuously discovering more about the patterns and processes of open ocean ecosystems [1], yet countries have been slow to incorporate open ocean areas into their management plans and policies to meet international obligations for marine

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management and protection [2]. In this paper, the open ocean is defined as marine regions beyond the geologic continental shelf of coastal States, or areas found beyond the 200-meter bathymetric contour, including the whole water column and seabed. This area includes deep regions within the territorial sea and exclusive economic zones (EEZs) and on the outer continental shelf of coastal States, extended continental shelf of coastal States, as well as areas beyond national jurisdiction (ABNJ, the high seas and international seabed Area). Under the United Nations Convention on the Law of the Sea (UNCLOS), States are required to protect and preserve the marine environment, including rare and fragile ecosystems and the habitat of depleted, threatened or endangered species and other forms of marine life (UNCLOS Article 194 (5)). Furthermore, States have committed to protecting at least 10% of coastal and marine areas by 2020 through the Convention on Biological Diversity (CBD) Aichi target 11. The June 2012 UN Conference on Sustainable Development ("Rio+20") reaffirmed many of such goals, including a commitment to urgently address conservation and sustainable use of biodiversity in ABNJ [3]. Commitments also extend beyond general conservation mandates to sustainable use of living marine resources. This is another challenge for managing the open ocean given the data paucity and political pressures.

At present, countries are a long way from achieving these commitments. Currently less than 3% of the ocean is protected, only 0.17% in ABNJ [4–6], and only about 10% of ABNJ is managed approaching an integrated manner [7]. Previous arguments against open ocean marine protected areas (MPAs) were based on perceived (i) physical and biological complexity, and challenges related to (ii) design, (iii) enforcement and (iv) governance [8,9]. These apparent impediments are being overcome, and as more large open ocean MPAs are created, lessons are being learned that can be applied to current and future protected areas [5,10]. Furthermore, large open ocean MPAs are essential to reach Aichi target 11 for protection of 10% of the world's ocean. However, these areas must be both ecologically representative and effectively managed [5]. Still, large geographic gaps in protection remain in the open ocean, particularly in ABNJ, leaving many ecosystems vulnerable to current or future over-exploitation. While designation of MPAs is actively being pursued, no overarching systematic approach for identifying and designating MPAs or managing the multiple and expanding human activities and impacts exists to date [7]. Indeed, management institutions in ABNJ are single-sector focused (e.g., fisheries, shipping, or mining) and have neither an adequate mandate for integrated planning, nor the capacity to effectively coordinate across multiple management regimes [11].

The purpose of this paper is to examine current knowledge about ecological considerations and linkages in open oceans, how they might be affected by human activities, and recommend management approaches that would better take the interlinked ecology of open oceans into account. In particular, three themes that differentiate open oceans from other realms when contemplating planning and management options are considered: ecosystem interactions, especially between benthic and pelagic systems; the potential effects of human activities in open oceans on ecological linkages; and the management and governance context. Particular attention is paid to ABNJ, where comprehensive governance and management are lacking but also within EEZs, where management in many countries could be improved. The implications of these characteristics of the open ocean for planning for conservation and sustainable use are discussed.

2. Open ocean ecosystem characteristics key to management

A number of key ecological factors differentiate open oceans from coastal systems for planners and managers: (1) many species are widely distributed and, especially for those at higher trophic levels, wide ranging; (2) the sizes and boundaries of biogeographical domains vary significantly by depth; (3) habitat types exhibit a wide range of stabilities, from ephemeral (e.g., surface frontal systems) to hyper-stable (e.g., deep sea); and (4) vertical and horizontal linkages are prevalent. Below each of these points are expanded upon as a basis for discussing requirements for integrated planning and management.

2.1. Wide distributions and ranges of species

Many species in the open ocean are widely distributed (e.g., plankton, [12], tuna, [13]), and for the high trophic levels in particular, wide ranging (e.g., seabirds, [14], turtles, [15], tuna, [16], many species, [17], [18]). Such wide-ranging species serve as ecological linkages between otherwise distant geographic regions. While planning should thus consider similar broad spatial extents, this does not necessarily translate into extremely large portions of species' ranges needing to be protected [19]. For example, many wide-ranging marine animals show site fidelity at particular times during their lives or have relatively small and well-defined areas of critical habitat (Fig. 1). In addition, most wide-ranging species spend portions of their migrations in both national EEZ waters as well as ABNJ [20]. Parts of distributions important to marine animals are related to the temporal and spatial predictability of the physical habitats with which they are associated, as evidenced by predictable seasonal aggregations of fishes, birds, turtles and mammals (e.g., [21,22,23] that can assist in the design of MPAs [24–27]).

2.2. Depth-related differences between biogeographical domains

Biogeography underpins an approach in which scientists use biological and physical data to partition ecosystems into ecological units at particular scales, from broad-scale ecological provinces to finer-scale "seascapes" [28]. In the open ocean, biogeographic units occur in three dimensions, where an array of ecosystems are shaped by an equally diverse set of oceanographic processes [29]. Open oceans thus require multiple biogeographic classifications and dimensions to even crudely describe general provinces. Surface pelagic classifications, largely based on productivity regimes, were developed almost 20 years ago [30], while other pelagic and benthic classifications emerged more recently [29,31–33]. Much less is known about the rest of the water column, although linkages are known to occur both vertically and horizontally. Determining biogeographic boundaries in open oceans is inherently difficult, and made more so by limited sampling of physical and biological attributes. Yet to effectively represent the diversity of open ocean systems within MPAs or in areas of enhanced management, biogeographic regions should be included in planning efforts [28]. Furthermore, much remains to be understood about the differences between pelagic and benthic realms, and there seems to be little correlation between boundaries of provinces at different depths [34,35]. A planning and management challenge is thus to fully represent biogeographic regions when these are not yet well known.

2.3. Habitats of varying stability

In contrast to coastal and terrestrial regions, pelagic habitats are largely based on properties of water masses, whereas physical structures, such as seafloor geomorphic features (e.g., seamounts) and habitat-forming species (e.g., deep sea corals and sponges aggregations) play a major role in benthic ecosystems. At broad scales, seafloor biogeographies have boundaries generally coincident with changes in physical oceanographic properties [33,34,36]. Surface waters (approximately the top 100 m) of the open ocean are highly