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# Identification of important marine areas around the Japanese Archipelago: Establishment of a protocol for evaluating a broad area using ecologically and biologically significant areas selection criteria

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ABSTRACT

After the adoption of the Aichi Target, data accumulation and evaluation regarding biodiversity have progressed rapidly. The use of ecologically and biologically significant areas (EBSAs) criteria to evaluate important areas enables the identification of effective and prioritized areas for ecosystem management. This includes strategic environmental assessment and discussions aimed at establishing protected marine areas based on scientific data. This paper reviews previous and current ideas as well as the methods used, for the identification of EBSAs. In particular, the following issues are addressed: problems associated with different types of marine ecosystems in the Japanese Archipelago, such as seagrass and seaweed beds, coral reefs, offshore pelagic plankton, and deep-sea benthic ecosystems; and problems associated with the integration of multiple criteria that are not totally exclusive. Several candidate variables accounting for each of the 7 criteria used to identify ecologically important areas are presented. Data availability is the most important criterion that allowed for the comprehensive evaluation of different types of ecosystems in the same localities. In particular, for coastal ecosystems such as seagrass, seaweed beds, and coral reefs, it is possible to carry out broad spatial comparisons using variables representing most of these 7 criteria. Regarding methods for the quantitative evaluation of each criterion and their integration, application of these methods to kelp forest ecosystems in Hokkaido, Northern Japan is presented as a case study.


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## 1. Introduction: progress of marine conservation by international policy makers

Biodiversity conservation is a crucial issue for the sustainable use of natural resources and security of human societies. Taking action to effectively halt the loss of biodiversity is the responsibility of the contracting party to the Convention on Biological Diversity (CBD)(CBD-COP 6 Decision VI/26 [1,2]). The Global Biodiversity Outlook 3 (GBO3 [3]) reports that the target agreed upon by the world's governments in 2002—"…to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level"—was not achieved. Habitats in coastal areas, such as mangroves, seagrass beds, salt marshes, and shellfish reefs, are declining continuously. The biodiversity of coral reefs is also declining significantly [3,4]. It is reported that including offshore marine areas, "…about 80 percent of the world marine fish stocks for which assessment information is available are fully exploited or overexploited," [3]. In response to this situation, the Aichi Target, which is to be achieved in the next decade, was adopted in the Tenth Meeting of the Conference of the Parties to the CBD (COP10/CBD; CBD decision X/29 in CBD Secretariat [5]; Yamakita [6]). The Target 11 Strategic Goal C was proposed to extend conservation areas, which are particularly important for biodiversity and ecosystem services, and encourages the nations of the COP to specifically conserve at least 17% of terrestrial and 10% of coastal and marine areas by 2020 [5]. Thus, consideration of the spatial aspect of coastal and marine ecological conservation is increasingly recognized.

Although the establishment of marine protected areas (MPAs) is the primary conservation strategy in many regions, merely setting up MPAs by broad sense definition[1] is insufficient to effectively improve the current state of marine biodiversity [9]. This is related to two important criteria required for MPAs. First is the ecological importance of each location, and the second is management effectiveness. The effort to improve management efficiency has already started. For example, IUCN proposed the classification of Protected Areas [8]. In the case of fisheries science, there is an effort to manage fisheries at the maximum sustainable yield considering the ecosystem [10]. Discussion of the ecological importance of the location is also underway, not only to discuss the biological potential of areas for establishing MPAs, but also regarding basic information to be used for ecological impact assessment (EIA) or strategic environmental assessment (SEA). In both cases, much information regarding habitats, ecological status, and biodiversity should be integrated, and the significance of the area should be assessed on the basis of scientific data and expert opinions. This is discussed further in Target 11.

Before the adoption of the Aichi Target, a protocol for identifying ecologically and biologically significant areas (EBSAs) was established by Canada's Department of Fisheries and Oceans (DFO) in 2004 to be used as a tool to promote the selection of marine areas where protection should be enhanced (reviewed in Dunn et al. [11]. In a workshop held in 2004, the DFO developed *a priori* criteria to select EBSAs and defined the following 5 criteria for understanding ecosystem structural and functional significance: (1) uniqueness, (2) aggregation, (3) fitness consequences, (4) resilience, and (5) naturalness [12]. In 2008, the 9th meeting of the Conference of the Parties (COP9/CBD; DEC/IX/20) adopted the following 7 scientific criteria for identifying EBSAs, which were modified from the DFO's criteria to enforce initiation of protection area in open waters and deep-sea habitats: (1) uniqueness or rarity; (2) special importance for life-history stages of species; (3) importance for threatened, endangered, or declining species and/or habitats; (4) vulnerability, fragility, sensitivity, and slow recovery; (5) biological productivity; (6) biological diversity; and (7) naturalness. In 2010, the COP10 noted that application of the EBSA criteria is a scientific and technical exercise, and that it has no obligation to consider MPAs directly. However, areas found to meet the criteria may require enhanced conservation and management measures, which can be achieved through a variety of means, including MPAs and EIA [13]. Six regional workshops on EBSAs convened by the Executive Secretary of the CBD have been held since 2011 and have covered the Western South Pacific, Wider Caribbean and Western Mid-Atlantic, Southern Indian Ocean, Eastern Tropical and Temperate Pacific, North Pacific, and South-Eastern Atlantic [14].

## 2. Correspondence on international policy by scientific communities

Following the progress for marine conservation by international policy makers, various scientific communities have also been developing ways to evaluate marine ecosystems on broad spatial scales. For the ecological categorization of marine areas, the Biogeographic Classification of the World's Coasts and Shelves, and Marine Ecoregions of the World (MEOW) are used in coastal and marine research [15]. The Global Open Ocean and Deep Seabed (GOODS) biogeographic classification has been established under the ultimate umbrella of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and its Intergovernmental Oceanographic Commission (IOC) [16]. Data regarding the presence of species registered in the Ocean Biogeographic Information System (OBIS) and Global Biodiversity Information Facility (GBIF) has greatly increased [17]. Satellite images, data from geographical information systems (GIS), and oceanographic ensemble data are updated frequently, and are becoming more organized. These data regarding species distribution models have become popular methods for studying marine biodiversity [18]. Attempts to improve these models are principal challenges, such as consideration of the effect of evolutionally aspects using geographical variables [19,20]. Along with the increase in spatial data and broad-scale studies on marine biodiversity, quantitative methods are used to fill gaps in spatial distribution and production. These use surrogates of a certain biodiversity index, and are currently in progress [21,22].

Using these data, the number of empirical case studies on the application of the EBSA protocol have been increasing recently [23,24]. For example, Taranto et al. [25] proposed a framework for applying the EBSA criteria to locate ecologically and biologically significant seamounts and assessed the relevance of individual seamounts using 10 indicators. Meanwhile, McKinnon et al. [26] examined the application of the EBSA identification process for tropical marginal seas and concluded the process is an important and tractable step for sustainable management. Bundy et al. [27] demonstrated local ecosystem knowledge provided advice for ecosystem approaches for inshore coastal management using the EBSA concept. These studies have used several criteria of EBSA and have successfully detected specific areas with highly important characteristics.

In the case of the management discipline and establishment of MPAs, including the sociological and/or political aspects, methods for supporting spatial planning are also in development using spatial planning tools and GIS. In particular, prioritization using complementary analysis is a popular optimization tool for maximizing the number of species protected in the smallest protected area [28,29]. One of the most commonly used software programs

[1] MPA described here is based on the broad definition in Dudley 2008 which include "management area to protect particular species" and "traditional management practices" as examples. Narrow definition of MPA (i.e. no take marine reserve) is one out of six categories [7,8].