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Opinion

Shortcomings in Marine Biodiversity Conservation

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Abstract

To address biodiversity loss, conservation measures in the marine environment are focused on marine protected areas and threatened species. Nevertheless, these are reductionist approaches in a vast ocean where everything is interconnected. Further, in both cases, protected areas and threatened species, conservation measures apply only to the adult phases of benthic species. However, most marine species are broadcast spawners with a bi-phasic life cycle including a pelagic phase. Linking both planktonic and benthic phases is critical for the persistence of marine populations. Therefore, conservation of marine biodiversity should be based on and holistic approach broadening beyond protected areas and from traditional coastal approaches to the pelagic realm.

Keywords: Marine protected areas; Threatened species; Pelagic larval phase

Introduction

There is overwhelming evidence of widespread biodiversity loss in the marine realm. Even though there are few well-documented examples of global marine extinctions in recent centuries, many marine species are regionally, locally and/or functionally extinct [1]. Habitat modification, fragmentation, degradation and loss reduce local-scale species richness and abundance in coastal and other marine ecosystems [2-4]. These primary impacts along with overexploitation, pollution, introduction of exotic species, diseases and global change, among others, are the cause of the so calling "marine defaunation" [5]. As a result, marine populations declines are ubiquitous and often severe, and there is a progressive shift from "especialist" or endemic species to "generalist" or common species [6]. Those of us who have been sampling the marine environment for many years observe local disappearance of many species or significant lowering of their populations [4]. Furthermore, size/density populations decline involve genetic diversity loss that will likely affect all levels of biodiversity.

Discussion

Faced with this biodiversity crisis, the primary conservation tools implemented in the marine environment are mainly focused on Marine Protected Areas (MPAs) and threatened species. The positive effects of MPAs have been widely documented within their boundaries and in their vicinity and they have proven effective local conservation tool for enhancing the structural complexity of benthic communities [7,8]. Nevertheless, MPAs have also been the subject of some criticism [9-11]. MPAs reduce but not eliminate the threats to marine biodiversity. Human impacts are diminished within the MPAs, but they do not decrease as a whole, but rather move outside of these protected areas, often to their surroundings. Even when properly designed and managed, MPAs might fail if the nearby unprotected areas are degraded [12]. Further, MPAs are not safe from the diverse nature of global threats for the ocean, including climate change, acidification, sedimentation, plastic pollution, eutrophication, pests or diseases, which are only rarely addressed in the context of MPAs [13]. On the other hand, policies promoting biodiversity conservation are also aimed at adopting measures to protect those species considered threatened or endangered. Threatened species lists (the so called "red lists") fulfil important social, legislative and scientific requirement, and are useful for awareness people the importance of recovery species [14]. Likewise, threatened species classification systems provide a way for highlighting those species under extinction risk, as to focus attention on conservation measures designed to protect them and they also serve to guide reserve planning. Therefore, international conventions, governments and conservation organizations apply these red lists to apply locally, regionally or under international status. The International Union for Conservation of Nature (IUCN) Red List is the most comprehensive compilation of the global conservation status of species and is a usual tool for management, monitoring, conservation planning and decision-making [15].

However, this and other red lists have inevitably become linked to several decision-making constrains and they are heavily biased to charismatic species (mainly vertebrates or large and conspicuous invertebrates) and disregard what represents the bulk of biodiversity: the immense number of small, rare and mostly poorly known species [15]. Moreover, the bias towards the protection of certain species adds subjectivity in the choice of research topics and also influences how resources are allocated in scientific projects concentrating in a few species [16]. However, place just the focus and spending most of resources on very few threatened or endangered species is not the most efficient way to cope with the impoverishment of biodiversity [14]. To minimize the overall loss of species would be necessary to allocate resources to measures that cover as many species as possible. Here arises the first of the questions that are put on the table. What is better, to focus the efforts to conserving the endangered species or to devote them so that the rest of the species do not reach such status? In short, MPAs and red lists create a pipe dream about biodiversity conservation for people and policymakers. Nevertheless, MPAs and protected species represent reductionist approaches focused on few isolated pieces of the huge puzzle that make up marine biodiversity in an immense ocean where everything is interconnected. Although the Aichi Biodiversity Target 11 of the Convention on Biological Diversity called for 10% of the coastal and marine areas to be conserved by the end of 2020, less than 3% of the ocean is fully or highly protected at that date [13,17] and only a very low percentage of marine species are included in red lists [15]. MPAs are often isolate spaces with healthy habitats surrounded by an environment where habitats are in worse conditions. Furthermore, species are not isolated pieces, but rather each one depends on many others and in turn many others depend on them.

Likewise, it must be taken into account that most benthic marine species are broadcast spawners with a bi-phasic life cycle, including a planktonic larval phase that spend between minutes to months (depending on the species) in the water column before settlement. However, conservation measures for both endangered species and MPAs focus almost exclusively on safeguard the adult benthic phases of the species but not their planktonic larval phases. Moreover, larvae are likely more sensitive to stressors than adults making them more vulnerable [18]. Linking both planktonic and benthic phases of the life cycles of species is decisive for the persistence of marine populations and requires a series of processes to be overcome, each of them being subject to different limiting factors. This pathway includes adult density (stock size) and fecundity, mass spawning events, fertilization success and larval production, planktonic larval phase (dispersion, survival/mortality), larval supply, pre-settlement behavior, settlement, post-settlement events and recruitment [19]. The success of each of these steps (some of which occur in the water column) act on the replenishment and persistence of local populations, which are largely or exclusively dependent on the supply of larvae from the plankton. Furthermore, all these processes have far-reaching consequences for demographic connectivity and gene flow. At this point the following questions are posed: MPAs export larvae (acting like source population), but do they import enough larvae from other sources? Are the larvae produced in MPAs sufficient to maintain the entire metapopulation of the species? What are the biological factors and physical processes affecting the larval dispersal and successful settlement?

The answer to these questions is still limited despite considerable research effort because marine larval dispersal is biophysically complex subjected to stochastic events. Thus, optimal conservation of marine species involves not only ensuring the survival of benthic phases of the life cycle, but also maintaining the larval input and recruitment dynamics [19]. Therefore, conservation measures should also expanded to protect the dynamic pelagic environment to maintain the larval supply and settlement in favourable habitats and, ultimately, gene flow. Such measures should also ensure that well-preserved benthic population (both within and outside MPAs) not only maintain larval production that can supply other populations, but also receive larvae from outside. In the marine realm everything is interconnected and the water masses surrounding MPAs must also have favourable conditions. Likewise, suitable habitats must be preserved also outside these protected areas, otherwise a considerable part of the larvae produced within the MPAs will be wasted. Definitely, conservation of marine biodiversity should be based on and holistic approach linking marine protected areas to a whole coastal and ocean management and extending the protection measures from the benthic to pelagic environments. As highlighted by some authors [20,21], it is necessary to move marine conservation beyond traditional coastal approaches to the pelagic realm taking into account the dynamic and complex oceanographic features.

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