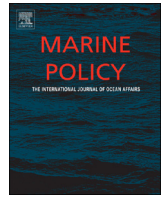




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Seeing the ocean through the eyes of seabirds: A new path for marine conservation?



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ABSTRACT

Seeing the ocean through the eyes of seabirds could help meet the challenges of managing common-pool marine resources both in protected and unprotected areas. First, seabirds are top-predators, exposed to all threats affecting the oceans, and this makes them ideal sentinel organisms for monitoring changes within marine ecosystems. Second, seabirds cross both ecological and political boundaries, and following their movements should help making interdependencies within and between marine ecosystems more visible. Third, seabirds are conspicuous and often charismatic animals, which interact differently with different groups of stakeholders and provide the opportunity to acknowledge and discuss each other's values and interests. In this paper, we present these research avenues using a seabirds' view, for tackling marine conservation and management issues, and we give operational examples of implementation based on our work in the English Channel.

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1. Introduction

Humans only very recently admitted to their historical, major impact upon marine ecosystems [35], probably because of their generally remote perception of underwater ecological processes. In parallel to the growing awareness for marine environmental issues, conservation efforts followed the path of terrestrial conservation initiatives, yet with a 100-year time lag [42]. From the industrialization of fisheries in the early 19th century to the late 20th century, marine conservation and marine resource management evolved separately. As in terrestrial systems, the establishment of protected areas has been the main response to environmental degradation. However, in 2010, only 1% of the world's oceans were protected [78], with only a tenth of this surface devoid of exploitation [85], compared to 13% for terrestrial areas [79]. Concomitantly, fisheries management slowly evolved from a state of no restriction supported by government subsidies following World War II to single-species, steady-state management with continued subsidies from the 1960s to the 1990s [33], before

finally recognizing the need for an ecosystem-based approach [31,63] in the early 21st century. Today, it is widely acknowledged that ecosystems are complex, dynamic, adaptive systems with nonlinear feedbacks and thresholds [43], and are tightly linked with similarly complex human systems [50]. Protected areas are no longer seen as an exclusionary conservation tool, and conservation policies now emphasize public participation in decision-making [56].

In terms of conservation efficiency and resolution of user conflicts, however, this progressive shift from separated ecological and human systems governed by top-down policies, to more horizontally-governed social-ecological systems [8] has not yet lead to the expected results. We see three main reasons for this: (1) the extreme complexity of social-ecological systems and inherent uncertainties concerning their functioning and dynamics, (2) the incapacity of marine protected areas (MPAs) alone to counter environmental degradation, and (3) the lack of consideration for power and information asymmetries between participants in public participation processes [65]. First, while it is crucial to analyze the social dimension of resource management together with resource and ecosystem dynamics [27], dealing with complex adaptive systems such as social-ecological systems implies addressing complex interactions, feedbacks, and uncertainty

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at multiple scales, a process which requires a huge amount of data [18] which are simply not available for many marine systems. For the ecological system alone, integrating changes in the physical environment and biological responses into operational ecosystem models while dealing with the increased uncertainty induced by climate change and human overuse is an immense challenge. In any marine system, meeting this challenge will take place at a much longer timescale than the one at which resource management commonly operates. Second, while the pace for MPAs designation has increased sharply in recent years to comply with international agreements, they are mostly restricted to the exclusive economic zones of coastal nations and our capacity to manage them efficiently is still lagging [14,59,74]. MPAs are not always ecologically efficient because they are too small or too static compared to the system they are supposed to protect, and/or because of insufficient or insufficiently applied regulations [2,85]. Often, and despite the institutionalization of public participation in decision making, MPAs are socially not well accepted (e.g. [84]). This can lead to user failure to comply with regulations, and ultimately undermine the conservation efficiency of MPAs [14,37,39]. The establishment of MPAs in specific geographical areas may also lead to ecological and social vulnerability transfers to other areas [1,10]. Third, while public participation in decision making is now a regulatory imperative in many countries, its implementation by administrative institutions is often creating more frustrations than shared decisions. Beyond the manipulation of public participatory processes by governance bodies [65,88], asymmetries in perceptions, power, or speaking skills between stakeholders as well as conflicting interests may seriously undermine conservation and conflict resolution [3,14,15,33,49,56], especially when such differences are not made explicit by the participatory process [6].

In order to overcome these obstacles and improve the efficiency of marine conservation policies, we advocate using seabirds both as indicators of marine ecosystem health and as ambassadors of less visible, and often less charismatic, marine species, to improve participatory schemes leading to global ocean conservation. While this approach might seem reductive or purely ecology-oriented at first, it is supported by several features that make seabirds a highly pertinent meeting point (or ‘boundary object’ *sensu* [72]) for marine sciences and stakeholder groups. First, their position at or near the top of most marine food chains results in seabirds being ideal sentinel organisms for monitoring changes within marine ecosystems (e.g. [11,25,30]). Because seabirds are exposed to all threats affecting the marine environment (Fig. 1), conservation strategies

based on their ecological requirements deliver broad ecosystem-level benefits [21], as shown for other top predators [70,71]. Second, seabirds cross both ecological and political boundaries on a regular basis [38]. Therefore, following seabird movements throughout their annual cycle should allow overcoming the dichotomy between protected and non-protected areas, and make interdependencies within and between marine ecosystems more visible. Third, seabirds are conspicuous and often charismatic animals (e.g. penguins, albatrosses or gannets) that are part of the culture of coastal communities [51,53] but can be perceived differently by different groups of stakeholders (Fig. 2). Acknowledging and discussing these different perceptions would help build a better understanding of each other's values and interests, which is essential for cooperation. Importantly, seabirds are also big enough to be equipped with electronic devices (e.g. GPS recorders or miniaturized video cameras; [66]) that collect data about their movements and behavior. These data are highly accurate, cheap to acquire compared to vessel-based observations, and can be represented and conveyed to a variety of audiences in a highly visual and intuitively understandable way (e.g. maps of locations and movement, pictures, and video clips) that is likely to facilitate discussions and information transfer among stakeholders.

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Seeing the ocean through the eyes of seabirds therefore implies: (1) identifying, characterizing and quantifying interactions between seabirds and human activities, (2) identifying ecological solidarities and vulnerability transfers among the different habitats used by seabirds, and (3) studying and developing the use of seabirds as a boundary object to foster stakeholder cooperation. Below, we will develop these three research avenues and give operational examples of implementation based on our work in the English Channel.

2. Interactions between seabirds and human activities

2.1. Seabirds as ocean sentinels

Seabirds raise their young on land but feed, and often winter, at sea. Depending on the species considered and on the time of year, they rely on coastal or offshore waters, from the water surface to several hundreds of meters. Seabird behavior (e.g. foraging effort) is especially sensitive to environmental changes (e.g. fish availability)

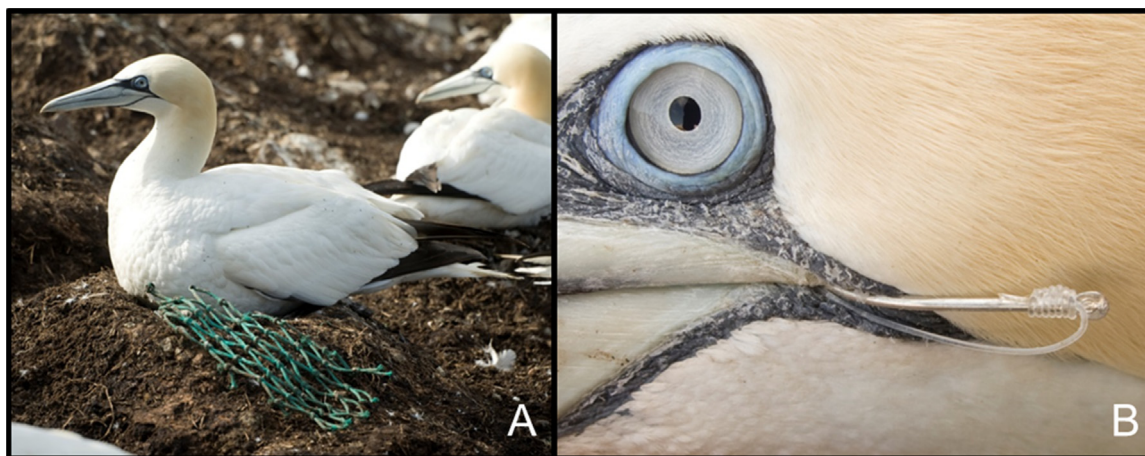


Fig. 1. Seabirds are exposed to all the threats affecting the marine environment: climate warming [34], habitat degradation (organochlorine contaminants and mercury, plastic debris, oil pollution, [80]), direct mortality through bycatch [20] and overexploitation of their prey [64]. On Northern gannet (*Morus bassanus*) colonies, it is common to see plastic debris in nests, often from fishing gear (A), as well as hooked individuals (B). In 2012, 28% of seabird species were classified as threatened (compared to 12% for all bird species; [20]). Pictures by David Grémillet.

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