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TOPICAL COLLECTION

The importance of the ecosystem approach in the management of the marine environment

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Abstract
The present paper focuses on the importance of the ecosystem approach (EA) for the preservation and conservation of the marine environment. Marine ecosystems are complex entities that contribute significantly to the sustainable well being of people by providing a wide range of goods and services. The economic benefits of these goods and services are enormous and to a large extent impossible to estimate. Thus, due to the extensive and irrational use and overexploitation of marine resources, there is a need for an integrated, holistic, sustainable approach to marine environmental management. The EA requires a deep understanding of ecological, economic, societal, and cultural interactions and is the ultimate tool for implementing and achieving sustainable development. It is the key to balancing the number of users of marine resources and stakeholders in order to promote the roles of the green economy and (sustainable) blue growth (e.g., maritime activities, fisheries, renewable energy, and blue biotechnology). The aim is to use the EA to optimize the benefits provided by the oceans while simultaneously minimizing the pressures exerted by human activities on marine ecosystems.

Keywords Ecosystem approach · Ecosystem-based management · Sustainable shipping · Marine spatial planning · Collisions with whales

Introduction

In his book *Salvatores Dei/The Saviors of God: Spiritual Excercises*, Nikos Kazantzakis notes that the ultimate, most sacred form of theory is action. Ecosystem-based management (EBM) is a fundamentally different approach not only in theory but also in practice. This approach requires not only expertise in the ecological, social, and economic sciences but also an enhanced understanding of social and economic systems and their links to biophysical systems.

In addition, EBM differs from conventional management that focuses on a single sector because EBM considers the cumulative impacts of various sectors (UNEP 2011). Given its complexity, the marine ecosystem needs to be addressed nonlinearly and with a great deal of cooperation and willingness to implement change holistically. Incorporating the results of previous actions and the scientific knowledge earned from them allows managers to remain flexible. There is no single way to implement the EA, as it depends on the conditions of the system considered, which are taken into consideration ad hoc (Shepherd 2008).

Ecosystem-based management is a response to today's deepening biodiversity crisis (Grumbine 1994). It is also inseparable from the concept of ecosystem health and human wellness (European Commission 2011). In EBM, management measures are based on the precautionary principle (which is part of the EA), as this can reduce the impacts of disasters and improve both livelihoods and biodiversity outcomes. Setting clear goals that aim to reduce crises is crucial to the success of adaptive management.

The Conference of the Parties for the Convention on Biological Diversity (CBD) has elaborated 5 points of operational guidance and 12 principles for the ecosystem approach (EA), and refers to EA as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" (UNEP/MAP 2009; Smith and Maltby 2003).

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The challenges

Shipping industry

The global nature of the shipping industry is unlike any other. Shipping is the prime facilitator of global trade and economic growth. At the same time, shipping presents risks from accidental spills, tank cleaning practices, and pollution (not only air pollution that contributes to anthropogenic climate change, but also pollution from ship recycling, shipping-facilitated species invasions, etc.). Though shipping is a comparatively minor contributor to marine pollution, especially considering that it transports 90% of global trade, it does still contribute significantly to pollution (UNCTAD 2019; GMTT2030 Team 2015). Despite improvements in marine pollution prevention, accidents do still occur.

In order to protect the marine environment and comply with Annex VI of the MARPOL convention (developed by the International Maritime Organization, IMO), the shipping industry is in the process of switching over to a compliant fuel: low-sulfur (0.5%) fuel oil. There is currently a great deal of controversy regarding how companies will implement the regulation.

Marine spatial planning

The European Union (EU) has adopted an integrated maritime policy by establishing several directives, recommendations, and strategies that encourage member states to apply an ecosystem-based approach to the management of human activities, thus ensuring that the collective pressure of such activities on marine ecosystems is kept within levels compatible with the achievement of Good Environmental Status (GES—Marine Strategy Framework Directive) (Farmer et al. 2012). In 2014, the EU adopted Directive 2014/89/EU that establishes a framework for marine spatial planning.

In 2018, Greece transposed this directive with Law 4546/2018. This new law states that the goal is sustainable development through synergies between ecological, environmental, economic, social, and cultural parameters. Its implementation involves (among other things) establishing areas in which biodiversity is protected but that can also be used as shipping routes. However, implementing a system for marine spatial planning by 21 March 2021 could be a real challenge (see the "Consensus choice" section).

Marine spatial planning, a tool for implementing the EA, is also a sine qua non for achieving sustainable blue growth. The results of marine spatial planning will depend on both the quality of the strategy adopted and the intentions of the stakeholders (Ehler and Douvere 2009).

Consensus choice

One major challenge is ensuring the effectiveness of the measures taken. We need feasible measures in order to maximize the effectiveness of the consensus choice. The EA—the fundamental delivery mechanism—requires all sectors to be engaged (Laffoley et al. 2004). Regarding the challenges of sharing ocean resources with various industries (shipping, fisheries, deep sea mining, etc.), the EA is the key to balancing the number of users of marine resources and stakeholders (Kraan et al. 2014).

Furthermore, EBM provides the mechanism to bring all the stakeholders together. This process is dynamic due to the diversity of stakeholders and governmental organizations involved. Interagency and interministerial coordination is a major obstacle that requires strong political will and appropriate incentives to encourage agencies, ministries, and scientific communities to come together to promote better marine and coastal management (UNESCO 2006).

In addition, stakeholder engagement—particularly with local people—can have substantial positive implications for the success of conservation projects. A more integrative approach to ecosystem management alongside increasing public engagement could be key to the development of effective marine conservation initiatives (Easman et al. 2018).

Good decisions require good data

There is a knowledge gap that needs to be addressed. Ocean and coastal ecosystems cover three-quarters of the planet and provide almost two-thirds of all ecosystem services, meaning that the potential economic challenges are extremely large (UNEP/TEEB 2012). Healthy marine ecosystems have a greater capacity to provide the full range of ecosystem services. Unfortunately, despite the huge contribution of marine ecosystems to ecosystem services, our knowledge of these ecosystems is lacking.

Research into preparing the best practice guidance on how to undertake integrated assessments is needed. High-quality scientific information should be powered by data specific to the problem and location. Scientific information should also be analyzed in conjunction with stakeholders, because *research that is inclusive and balanced by a diversity of interests provides results that stakeholders view as more credible and acceptable* (Wiley et al. 2013). One way to speed up the implementation of conservation measures is to develop a social process as early as possible (Constantine et al. 2015). Success stories associated with this approach include the Transit Protocol for Commercial Shipping, which protects whales from ship strikes in the Hauraki Gulf, New Zealand, and the shifting of the Boston Traffic Separation

Scheme (BTSS) to protect whales from ship strikes in the Stellwagen Bank National Marine Sanctuary in the US (see "Best practices").

Implementation of the EA is also hindered by a lack of monitoring data for key indicators (ecological, economic, and social). In addition, there are no standard criteria for evaluating the effectiveness of the measures taken and the managers' performance in achieving sustainable development goals (Rice et al. 2010). Adopted measures must be followed up to monitor their efficiency.

Responsibility

Responsibility as a core principle

It is crucial to understand that for environmental, economic, and social sustainability to occur simultaneously, the stakeholders involved must be innately responsible for the actions taken (McGuire 2011). To be effective, actions must be holistic and coherently integrated spatially and temporally. Factors to be considered include environmental sustainability, technological and administrative feasibility, economic viability, social desirability/tolerance, political expedience, and the legal structure (Gray and Elliott 2009).

Changes in behavior often do not occur spontaneously; they must be performed consciously, because different outcomes require different actions to be taken. To achieve efficiency and effectiveness in the management of the marine environment requires an understanding that those involved (scientists, policymakers, managers, and citizens) and each of those with interests that affect the marine environment should consider their own objectives from the perspective of a larger set of objectives (Burgess et al. 2018).

It would certainly make a significant impact if the medical axiom *primum non nocere* (first, do no harm) and corporate social responsibility became the foundations for policymaking regarding the management of the marine environment. In other words, "first, do no harm" should be the ultimate principle of sustainability to achieve prosperity.

If the importance of the social dimension of change is underestimated, the strategy is likely to result in a simple technology-oriented approach. Social innovation can be viewed as changes in the behavior of a networked group of actors that lead to new and improved ways of acting collaboratively within the group and beyond it. Such innovation can drive changes in behavior across institutional settings, markets, and public sectors, and enhances bottom-up inventiveness in the integration of social, economic, and environmental objectives (Soma et al. 2018).

Best practices

Collisions between vessels and whales are a significant source of whale mortality and therefore an issue of growing concern (Frantzis et al. 2019). The Hauraki Gulf Transit Protocol for Commercial Shipping is an agreement between the Ports of Auckland (POAL) and the shipping industry. It is the outcome of collective efforts of the POAL, the commercial shipping industry, New Zealand's Department of Conservation (DOC), and Auckland University (Constantine et al. 2015), and contains reasonable and practical measures to reduce the number of whale deaths caused by vessels. Furthermore, though it is voluntary in nature (it consists of recommendations that have been agreed upon), the threat of ship strikes to the whale population has been shown to be vastly reduced due to the lowering of vessel speeds in the Hauraki Gulf (a recommendation of the protocol). Indeed, no ship-strike whale mortality events have been reported since September 2014. This demonstrates how a dynamic group is capable of making decisions that have a positive impact on conservation.

Apart from the Hauraki Gulf, another hotspot for lethal collisions between vessels and whales is the National Oceanic and Atmospheric Administration's (NOAA's) Stellwagen Bank National Marine Sanctuary (Wiley et al. 2013). This is an 852-square-mile marine protected area located off the coasts of Massachusetts and New Hampshire that hosts large aggregations of endangered whales; however, the Boston Traffic Separation Scheme (BTSS) also passes through this area. Due to the persistence of several researchers, scientists and stakeholders (e.g., the Boston Port Operators Group, which represents the local, national, and international shipping communities) began meeting in an attempt to find the consensus choice for a new BTSS route that would spatially separate whales and ships. Using geographic information system (GIS) data, a potential new alignment for the BTSS was identified and agreed upon. The team members then proposed the new BTSS route to the relevant governmental agencies (e.g., the US Coast Guard) and the IMO in December 2006. This turned out to be a success story. Commercial ships use the BTSS on a voluntary basis and thus the team was able to evaluate mariner adherence to the new alignment as an indicator of the effectiveness of this conservation measure. Data showed that nearly 100% of the shipping traffic shifted from the old pattern to the new alignment. This marine spatial planning scheme provides important lessons for those involved in the management of the marine environment.

Conclusions

The growing demands on ocean resources have led to a drastic increase in the number of human activities in the marine environment, which have had a cumulative impact

on marine ecosystems. Considering that unsustainable practices are carried out around the world, there is still much to be done on a global scale to ensure that the human dimension is properly considered when implementing the EA in order to effectively protect the marine environment (FAO 2008). Responsibility comes by raising current awareness. Stakeholders take greater responsibility for marine environmental management as their awareness of the impacts of human activities on marine ecosystems increases. The collective mindset regarding how oceans should be treated must change in accordance with the UN's SDG 14: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development."

Progress towards sustainable development can be achieved by adopting the EA. This is because, rather than targeting short-term economic gains, it instead aims to optimize the use of an ecosystem without damaging it. The EBM approach shifts current management practices from short-term sectoral perspectives to long-term, ecosystem-based perspectives that consider humans to be integral parts of ecosystems. The challenge in adaptive management is to make practitioners more responsive to change and to institutionalize new learning. Furthermore, achieving a consensus between stakeholders and all interested parties will allow policy decisions to be made while taking the fundamental principles of sustainability into account.

> Ecosystem management is more about people than anything else… the success or failure of ecosystem management in protecting environments, revitalizing economies, or restoring healthy communities starts and ends with people and their choices—not with nature preserves, databases, ecological classifications or any other technological tools that are merely useful means to desired ends… (Crober 1999).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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