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Governing marine ecosystem restoration: the role of discourses and uncertainties

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ABSTRACT

Governing marine environments has evolved from dominant interests in exploitation, allocation, conservation, and protection to restoration. Compared to terrestrial and freshwater environments, restoration of and in marine ecosystems presents a new mode of intervention with both technical and governance challenges. This paper aims to enhance understanding of the important factors at play in governing marine ecosystem restoration. *Discourses* of marine ecosystem restoration are an important factor which shape how the restoration activity is governed, as discourses structure how actors and coalitions define problems and their approaches to solutions. The article produces a conceptual model of the discourses of marine ecosystem restoration, built on two dimensions: (1) the degree of human intervention and (2) motivations for restoration. Together, these dimensions create four broad restoration discourses: "Putting Nature First," "Bringing Nature Back," "Helping Nature support Humans," and "Building with Nature." Moreover, marine ecosystem restoration is confronted with different forms of *uncertainty*, such as incomplete knowledge, unpredictability, and ambiguity, which must be managed by actors participating in restoration initiatives. The article's overall contribution is the synthesis of these components, which illuminates the specific governance challenges under various circumstances.

1. Introduction

Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed [1,2]. While the practice of ecosystem restoration in terrestrial and freshwater environments has been widely discussed in the literature [3–13] restoration of marine ecosystems is relatively new and presents different scientific, technical, and governance challenges [14–19]. Whereas the science of coastal and marine ecological restoration is rapidly advancing [20–22] numerous questions on the governance of marine ecosystem restoration remain [12,14,16,19].

Governance encompasses, "The rules of collective decision-making in settings where there is a plurality of actors or organizations and where no formal control system can dictate the terms of the relationship between these actors and organizations," [23]. The objective of this paper is to enhance understanding of two key factors in collective decision-making about marine ecosystem restoration: the ways actors define and operationalize restoration (the how and why of restoration), and the ways they perceive and address uncertainty. For this purpose, a conceptual framework is developed, consisting of two building blocks: a typology of discourses of marine ecosystem restoration and a typology of uncertainties relevant in marine governance.

Discourse entails the views and narratives of the actors involved: their norms, values, definitions of problems, and approaches to solutions [24]. Discourse coalitions draw on knowledge to make themselves legitimate and persuasive and deal with uncertainty in different ways, which ultimately affects decision-making [25–27]. Section 2 distinguishes different discourses of marine ecosystem restoration, constructed on two axes: (1) the degree of human intervention and (2) the motivations for restoration. Together, these axes generate four distinct discourses of restoration: "Putting Nature first," "Bringing Nature back," "Helping Nature support Humans," and "Building with Nature." In marine ecosystem restoration governance, different coalitions of actors (governmental and non-governmental) try to initiate, develop, and implement restoration activities centered in one of these dominant discourses. The dominant discourses and related coalitions determine

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the rules of the game and the availability of resources [28,29].

The second building block is uncertainty, elaborated in Section 3. Uncertainty is crucial in policymaking and governance processes, particularly in regard to how society deliberates and decides among various alternatives [30]. Uncertainties stem from interlinked natural-technical-social systems [31]. Actors, who set priorities on why and how to restore and implement (marine) ecosystem restoration, grapple with distinct kinds of uncertainty [10,31–33]. Three types of uncertainty are distinguished in this paper—incomplete knowledge, unpredictability, and ambiguity. This section clarifies that uncertainty relates not only to scientific knowledge and the natural system being restored, but also to societal perspectives of those involved in or affected by restoration.

The way coalitions define marine restoration through restoration discourses and how they address the uncertainties related to these discourses affect the possibilities for governing marine ecosystem restoration. Section 4 elaborates on the four discourses of marine ecosystem restoration and, using examples of marine restoration from literature, relates the different types of uncertainties and their manifestations. For each discourse, governance challenges are identified. Finally, Section 5 presents conclusions.

2. Restoration: the interplay of human intervention and philosophical underpinnings

Numerous authors have debated definitions of ecological restoration e.g. [1,5,34]. The proliferation of terms tangential to restoration—recovery, reconstruction, regeneration, rehabilitation, rewilding, environmental repair—indicates the diversity of approaches in ecological restoration. Although detailed terms are favored by some arguing against conflation [3,35], others use the term restoration in a broad sense without being bothered about semantics [18]. Many authors acknowledge that terms are often used interchangeably because precisely distinguishing among terms is not easy and terms can be conflicting or overlapping [15,17,18]. Interpretation and fitness of certain terms can differ between marine and terrestrial applications; for example, Elliott et al. [17] disagree with Bradshaw [36] and propose restoration, rehabilitation, remediation and re-creation to be considered as synonyms for coastal and estuarine applications. Such ambiguity necessitates a systematic evaluation of terms and their definitions and the ontological roots of restoration along two key dimensions: (1) the degree of intervention by humans and (2) the motivations for marine restoration. Simply stated, there is a need to examine *how* recovery is to be achieved by delineating the various ways people intervene and practice marine ecosystem restoration. Additionally, questioning the *why* of ecosystem restoration probes the philosophical underpinnings of restoration motivations.

2.1. Restoration concepts and terminology: a spectrum of human intervention

Restoration is predominantly defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed [1,2]. This definition is carefully framed to draw attention to several aspects. First, recovery, across a range of degraded-to-destroyed ecosystems, is set at center stage. Second, it understands restoration as a process in which time is important at (a) the project level (e.g. the designing, planning, and monitoring of a restoration project [37–39], including the involvement of stakeholders to initiate a project [1,40]), and (b) the biological level (in terms of life cycles, return/rebuild of abiotic and biotic functions, replacement/introduction of structure (e.g. replanting key structural species or providing alternative structures), e.g., [41]). Third, "assisting" implies different strategies and degrees of human intervention, ranging from passive restoration—unassisted (spontaneous) recovery [16]—to active restoration, carried out via various human interventions to assist recovery (see Fig. 1).

A number of fundamental conceptual restoration ecology models have been developed, e.g. [3,15,36,42]. Fig. 1 illustrates a simple understanding for the application of the marine restoration process that differentiates types of restoration and some of the actions involved, ranging from hands-off, unassisted recovery to hands-on, assisted recovery involving direct ecosystem interventions. It is accepted that different types of restoration may end in variations of altered states [42], but that the aim should place an ecosystem on the trajectory to recovery relative to an appropriate reference ecosystem [5], re-establishing an interrupted ecological trajectory [43]. This is not aimed at a pre-disturbance ecosystem "turning back the clock" ignoring change [5], but at reinstating self-organization of the system along with structure, function, biodiversity and natural capital.

Unassisted restoration ("hands-off") includes two basic marine management approaches, i.e. regulate certain aspects to reduce pressures and lessen impacts and/or prohibit certain human activities as seen in many marine protection and conservation policies. For example, the designation of a no-take zone (NTZ) within a Marine Protected Area (MPA) intends to halt the loss and further anthropogenic decline of biodiversity through the no-take policy and secures the capacity of the marine ecosystem to recover or remain healthy by setting aside particular space in the ocean.

Assisted recovery ("hands-on") can be achieved by various actions (see assisted recovery level in Fig. 1). Restoration methods and actions include reducing causes of decline or removing problems. For example, removal of sea urchins, which cause barrens by overgrazing seagrass, occurs prior to the transplant of seagrass and bivalves [44]. More complex approaches include seeding, transplant of fragments and nursery grown corals, the introduction of artificial structures to support transplants of key ecosystem engineers (e.g. corals) and/or facilitating transplant success by other species (e.g. mussels with seagrass) [37,45,46]. A recent approach is directly linking the ecosystem services framework and the restoration of natural capital [47] to a family of restorative activities that can be carried out simultaneously or sequentially, at any site or ecosystem and regional levels to achieve long lasting positive impacts [3]. This family, shown in the approaches level of Fig. 1, includes environmental *remediation* (clean-up) of polluted areas, *reparation* and *recuperation* of degraded lands and water bodies to the more challenging tasks of *ecological rehabilitation* of natural or semi-natural ecosystems and *ecological restoration* of degraded ecosystems.

Recuperation is the partial recovery of ecosystem-based productivity and goods and services. Its goal is to bring a degraded site or ecosystem back to a state where sustainable use is once again possible [3]. The aim of *rehabilitation* is to reinstate a level of ecosystem functionality [5]. Rehabilitation, according to [17], is the activity of partially or fully replacing structural or functional characteristics of an ecosystem that have been lost, while *restoration* is the process of re-establishing a sustainable habitat or ecosystem with a healthy structure and functioning following degradation by human activities. Both recuperation and rehabilitation share a focus on historical or pre-existing ecosystems as references or models, but restoration incorporates the re-establishment of pre-existing biotic integrity in terms of species composition and community structure [1].

Encompassing different motivations and goals, habitat *re-creation* is about re-constructing a habitat that was present within historical records, while *creation* is an anthropogenic intervention that produces a habitat not previously on site. For example, artificial reefs placed on an otherwise sandy sea bottom should be regarded as creating a new habitat with the aim to increase the biodiversity, rather than replacing lost habitat [17]. *Creation*, in other words, is the intentional fabrication of an ecosystem (different from the one previously occurring on a site) for a useful purpose without a focus on achieving a reference ecosystem [5]. The reconstruction approach can be employed when damage is very high and where in addition to removing or reversing degradation by correcting all biotic and abiotic damage, to match the target local reference ecosystem, a major proportion of its biota need to be re-