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D6.1: Review of existing international governance structures regarding the conservation, restoration and recovery of marine ecosystems

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Review of existing international governance structures regarding the conservation, restoration and recovery of marine ecosystems

The Deliverable 6.1 manuscript is an output of MERCES Task 6.1 investigating the enabling and constraining conditions of the marine governance structures and legal frameworks. The legal framework is investigated in a separate deliverable D6.2. Review of current EU and international legal frameworks. The work in the D6.1 deliverable involved a review of existing governance structures which are relevant for (the implementation of) nature restoration. The report gives a broad overview of different governance structures and governance arrangements related to restoration. To prepare for the ex-post and ex-ante evaluations (Task 6.2 and later deliverables) the focus in this review aims to give a first overview of the different narratives and framing of restoration and related uncertainties, which affect how restoration is governed in specific restoration projects. The ex-post policy evaluation concerns an evaluation of the policy impacts of existing policies (such as MSFD; HD; BD; MSP; Blue Growth; UNCLOS) regulating a sustainable use of marine ecosystems (and regions) on nature restoration. The ex-ante evaluation will give insights in which (additional) nature restoration policy initiatives under specific EU and international instruments should be developed in the near future.

The manuscript has the following objectives:

- To present a spectrum of narratives of marine restoration;
- To identify the different uncertainties related to marine restoration;
- To develop a typology of governance arrangements;
- To combine narratives, uncertainties and governance arrangements in a conceptual framework to understand the enabling and constraining conditions to effectively govern marine restoration practices in specific areas.

The WP 6 participants met periodically during the project to set out the ideas for the manuscript starting with the objectives/questions and outline of the manuscript, followed by literature/subject reviews, with major developmental work completed during a dedicated workshop (directly following the MERCES First Annual Meeting). Participants then completed individual text sections, which were edited into the complete manuscript. The manuscript in the following section will be submitted shortly to the international peer-reviewed journal *Marine Policy*.

Abstract

Effective implementation of marine habitat restoration requires the inclusion of a governance perspective in addition to the ecological considerations of recoverability, resilience and adaptation. The governance perspective includes understanding of the interactions and interdependencies of multiple authorities and competing maritime activities (with different economic, political, social, and cultural interests), all of which operate at different governance levels, ranging from sub-national (coastal governments) to the international arena. This also necessitates acknowledging, mobilizing and using different narratives of marine restoration, and being confronted with different forms of uncertainties. The paper's overall contribution is the synthesis of these seemingly disparate components (narratives of restoration, uncertainty in decision making, and governance arrangements) to evaluate the impact of existing (maritime and environmental) policies, the governance setting, definitions of restoration and uncertainties on the effectiveness of marine restoration projects. Such a synthesis is a necessary move toward a systematic evaluation of ways to govern and formally institutionalize marine restoration in different (multi-level) governance settings and to understand the enabling and constraining factors to implement marine restoration initiatives.

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1. Introduction

The theory and practice of ecosystem restoration in terrestrial and freshwater environments have been widely discussed in the literature (Aronson et al. 2017; Brudvig 2017; McDonald et al. 2016a&b, Clewell and Aronson 2013; Bark et al. 2013; Benayas et al. 2009; Wheaton et al. 2008; Darby and Sear 2008; Dobson et al. 1997). Compared to these environments, ecological restoration in marine ecosystems is a more recent phenomenon, which presents new challenges related to both its technical implementation and its governance (France 2016; Abelson et al. 2015; Van Dover et al. 204; Elliot et al. 2007). Whereas the science of coastal and marine ecological restoration is rapidly advancing (Maxwell et al. 2017; Montero-Serra et al. 2017; van Oppen et al. 2015), the governance literature related to marine ecological restoration lags behind its land-based counterparts (France 2016; Van Dover et al. 2014). This report (deliverable D6.1) contributes to filling this gap by presenting a conceptual framework for the analysis of marine restoration from a governance perspective. Such an analysis is useful as it will allow us to identify the enabling and constraining conditions for effective marine restoration practices in specific sites, as well as to distil more general insights regarding effective governance of marine restoration across sites.

Addressing marine restoration from a governance perspective involves an understanding of the interactions and interdependencies of multiple authorities (governments) and maritime activities (and their different economic, political, social, and cultural interests at sea), operating at different governance levels, ranging from sub-national (coastal governments) to the international arena (van Tatenhove 2016; Raakjaer et al. 2014.), while mobilizing and using different narratives of marine restoration, and being confronted with different forms of uncertainties (Gross 2010; Buijs 2009; Darby and Sear 2008). The governance arrangements, narratives of restoration and uncertainties related to restoration activities will affect a successful implementation of marine restoration projects. This report provides insights into the governing of marine restoration.

The report's objectives are as follows:

- To present a spectrum of narratives of marine restoration;
- To identify the different uncertainties related to marine restoration;
- To develop a typology of governance arrangements;
- To combine narratives, uncertainties and governance arrangements in a conceptual framework to understand the enabling and constraining conditions to effectively govern marine restoration practices in specific areas.

The conceptual framework therefore consists of three building blocks, which will be presented in subsequent sections: (1) the various narratives of marine ecosystem restoration, (2) different types of uncertainties related to marine ecosystem restoration and (3) types of governance arrangements.

In section 2, we present a spectrum of narratives, in terms of the degree of human intervention in nature and the motivations to restore marine ecosystems. Definitions of ecosystem restoration coalesce around the central idea of "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed," (SER 2004). Nonetheless, there are gradations in the level of intervention by humans and their omnipotence to understand and influence the environment (Hall 2005) and the reasoning behind restoring ecosystems—ranging from altruistic concerns for ecosystems and all its constituent parts to concerns for resource provisioning and regulating mechanisms that primarily benefit people (Baker and Eckerberg 2016).

In section 3, we present the second building block: uncertainty. Uncertainty—resulting from incomplete knowledge, unpredictability, and ambiguity—is central in policy making, particularly in how society deliberates and decides among various alternatives (Brugnach et al. 2008). Those designing and implementing ecosystem restoration and setting priorities on why and how to restore must grapple with three distinct kinds of uncertainties stemming from interlinked natural-technical-social systems (Van den Hoek 2014). The way actors define marine restoration and address the uncertainties related to these discourses affect the possibilities to implement marine restoration activities in an effective way.

At the same time the governance settings (institutional rules and division of resources) in which restoration projects are developed and implemented enable or constrain (marine) conservation and restoration (Chaves et al. 2015; Martín-López et al. 2009). Therefore, in section 4, we outline a typology of governance arrangements. A governance arrangement is a temporary stabilization of the substance and organization of a policy domain. In a governance arrangement different, more or less stable, coalitions of governmental and non-governmental actors try to influence the activities and developments, and to design legitimate initiatives, based on shared discourses, for managing resources and defining the rules of the game (on different levels) (Van Tatenhove 2013; 2016) with relevance to the implementation of marine restoration.

The paper's overall contribution is the synthesis of seemingly disparate components: (a) narratives of restoration, (b) uncertainty in decision making, and (c) governance arrangements, to evaluate the impact of existing (maritime and environmental) policies, the governance setting, definitions of restoration and uncertainties on the effectiveness of marine restoration projects. In section 5 we argue that such a synthesis is a necessary move toward a systematic evaluation of ways to govern and formally institutionalize marine restoration in different (multi-level) governance settings and to understand the enabling and constraining factors to implement marine restoration initiatives. The resultant conceptual framework may be employed in the analysis of cases of on-going marine restoration and their project evaluations. Finally, section 5 will illustrate the relevance of the conceptual framework to evaluate (ex-post and ex-ante) marine restoration projects.

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

An abundance of articles debate definitions of ecological restoration (e.g., McDonald, Jonson, and Dixon 2016; Jackson, Lopoukhine and Hillyard 1995). The proliferation of terms tangential to restoration—recovery, reconstruction, regeneration, rehabilitation, environmental repair, etc.—captures the diversity of approaches in ecological restoration, but the terms can also be confused and some are used interchangeably (Elliot et al. 2007). We argue for going deeper than definitions and looking at the ontological roots of restoration through two key dimensions: (1) the degree of intervention by humans (section 2.1) and (2) whom is served by restoration (motivations of marine restoration) (section 2.2.). Stated more simply, there is a need to examine *how* recovery is to be achieved through a delineation of the various ways human intervene and aim to restore ecosystems. Additionally, the *why* of ecosystem restoration ought to be examined as there are differing motivations captured within the term. The dimensions 'human intervention in marine restoration' and 'motivation of marine restoration' will result in a model, presenting different narratives of marine restoration (section 2.3), each of them emphasizing different problem definitions and solutions of marine (ecological) restoration.

2.1 Restoration concepts and terminology: a spectrum of human intervention

An influential definition of ecological restoration is presented by the Society of Ecological Restoration (SER), who defines ecological restoration as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER 2004; Clewell and Aronson 2013). This definition is carefully framed to draw attention to several aspects. First, the wording puts recovery, across a range of degraded-to-destroyed ecosystems, in centre stage. Second, the definition introduces the concept of restoration as a process in which time is important both at the socio-ecological level (e.g. designing, planning and monitoring a restoration project (Bayraktarov et al. 2016; Kirsch et al. 2005), and involving stakeholders to initiate a project (SER 2004; Gleason et al. 2010)), and 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., Gianni et al. 2013)). Third, the 'process of assisting' implies different types of human intervention restoration, ranging from passive restoration (unassisted (spontaneous) recovery)—(van Dover et al. 2014) to active restoration—carried out via myriad human interventions to assist recovery (see Figure 1).

Passive restoration includes two basic marine management approaches, i.e. regulate (certain aspects to reduce pressures and lessen impacts) and/or stop human activities as seen in many marine protection and conservation policies. For example, the designation of a no-take Marine Protected Area (according to the EU Habitats and Birds Directive) with the intention of halting the loss of biological diversity also prevents human-induced decline of biodiversity, ensures the conservation and sustainable use of marine biodiversity and secures the capacity of the marine ecosystems to support the provision of goods and services.

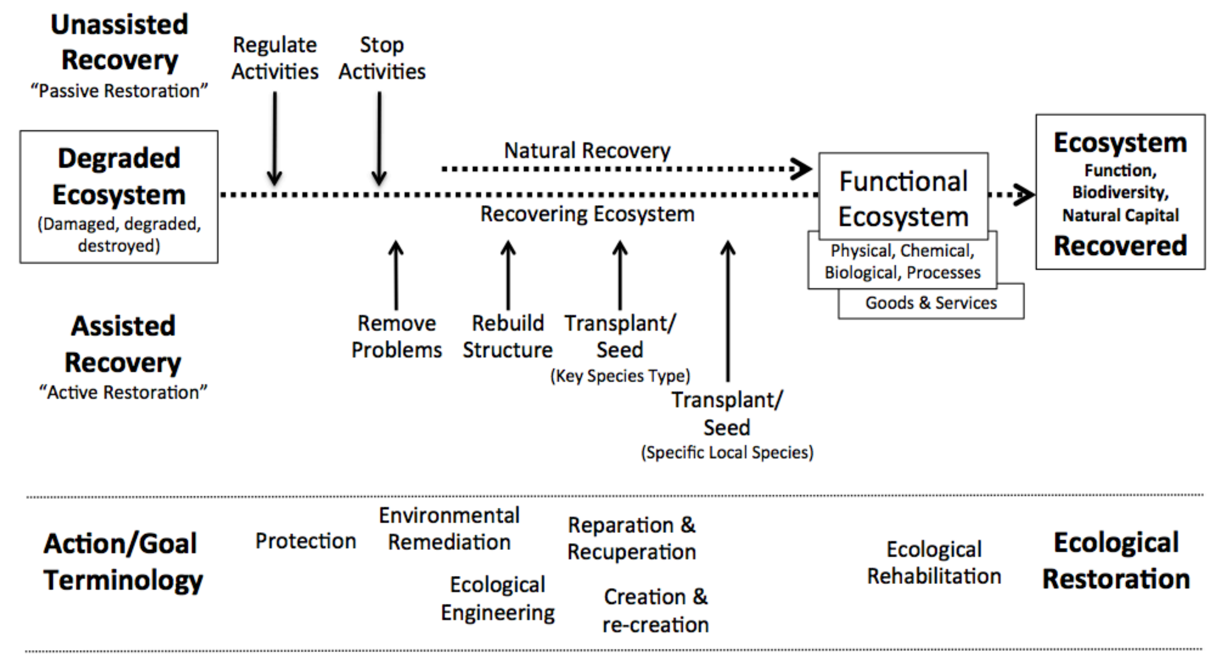

Figure 1. Schematic of Restoration Concepts and Processes

Active restoration can be presented along a 'restorative continuum' (McDonald et al. 2016a) (see assisted recovery level in Figure 1). Restorative actions include reducing causes of decline or removing problems, for example, sea urchins, which cause barrens from overgrazing on seagrass, have been removed from areas prior to the transplant of seagrass/bivalves (Terawaki et al. 2003). A more recent approach, promoting the ecosystem services framework and the restoration of natural capital (Blignaut et al. 2014), calls for a family of restorative activities that can be carried out simultaneously or sequentially, to scale up restoration (Aronson et al. 2017). This family of restorative practices, shown in the goal/terminology level of Figure 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 services. The goal of recuperation is to bring a degraded site, land, or ecosystem back to a state where sustainable use is once again possible (Aronson et al. 2017). *Rehabilitation* is direct or indirect actions with the aim of reinstating a level of ecosystem functionality (McDonald et al. 2016). Rehabilitation, according to Elliot et al. (2007), 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, following degradation by human activities, a sustainable habitat or ecosystem with a natural (healthy) structure and functioning. Both terms, recuperation and rehabilitation, share a focus on historical or pre-existing ecosystems as references or models, but restoration additionally includes the re-establishment of the pre-existing biotic integrity on terms of species composition and community structure (SER 2004). Elliot et al. (2007) note, however, that the terms remediation, rehabilitation, restoration and even re-creation have been used interchangeably as synonyms, leading to a lack of clarity or conflation in the terminology.

Habitat re-creation is about re-constructing a habitat that was present within historical records, while creation is an anthropogenic intervention which produces a habitat not previously there; for example, artificial reefs placed on an otherwise sandy sea bottom should be regarded as creating new habitat aiming to increase the biodiversity of an area rather than replacing lost habitat (Elliot et al. 2007). 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 (SER, 2016). Both reconstruction and ecological engineering contain subfield activities which include creation. In a restoration approach appropriate biota are reintroduced (Bekkby et al. 2017, deep sea coral garden example from the Azores). In contrast, the intentional creation of biotic assemblages whose species have been selected in the design process to serve a specific purpose, are called designer ecosystems (Clewell and Aronson, 2013). These terms highlight the extent of human interventions from do-nothing, hands-off, (i.e. let human induced degradation and nature fight it out or find a new state) to hands-on and skills-on-board to creating purpose-built ecosystems.

The focus here has been on how, or to what degree, humans intervene in order to restore degraded ecosystems. Some interventions are characterized as *passive* in the way that pressures are removed, but the intention is to have nature “fight back.” *Active* restoration techniques adopt an ethos of “nature needs us,” in order to fully recover. However, there is another distinguishing criteria, the *why* or the purpose of the restoration. To illustrate, think of a situation of transplanting historically abundant species that are challenged to survive in changing environmental conditions versus the introduction of new species that thrive in present environmental conditions and serve essential functions of historical species. Here, arises a debate among ecologists as to the purpose of restoration, which in many ways rests on the view of the relationship of humans within or outside of nature and questions of for whom are restoration activities intended. The question of what is “natural” divides between historical levels of biodiversity and the idea that nature has always been evolving and function is the primary concern (Callicott et al. 1999).

2.2 Motivations of marine restoration: why, and for whom, should humans restore?

Studies on the effectiveness of ecosystem restoration tend to measure biodiversity (Stevens et al. 2014), ecosystem goods and services (Bullock et al. 2011), or the combination (Benayas et al. 2009, Bullock et al. 2011; Worm et al. 2006). These two measurement categories reflect underlying divisions in the motivation of restoration: to serve primarily the interests and needs of humans or to adopt the responsibility of restoration on behalf of the ecosystem and its constituent species. Similar to ecosystem restoration, in ecosystem management three distinct "ethical precepts" exist: anthropocentrism, biocentrism, and ecocentrism (Yaffee 1999). In anthropocentrism, "nature deserves moral consideration because how nature is treated affects humans." (Kortenkamp and Moore 2001, 1). Thus, anthropocentrism takes the view that humans and their needs hold the primary importance and holds an interpretation of the world exclusively through human values and experiences (Boylan 2014). Moreover, "the anthropocentric view is related to consequential-ism in which human action is considered to be good if positive consequences outnumber negative consequences," (Swart et al. 2001, 232). In contrast, biocentrism recognizes the survival rights of other organisms (Yaffee 1999). Ecocentrism evolves further from biocentrism, where "management needs to proceed not just with a sense of the rights assigned to specific elements of the biota but with a sense of the interconnections among all components of the ecosphere," (Yaffee 1999, 719). In anthropocentrism, humans are outside or acting upon nature primarily; in ecocentrism, humans are a part and reliant on nature.

Unsurprisingly, the motivations or the arguments for why to restore ecosystems can range in a spectrum from anthropocentrism to ecocentrism. For instance, some make arguments for ecosystem restoration as a means of sustaining resources, such as fisheries. Thus, marine restoration of critical habitats and nursery areas is substantiated by its connection to the provision of goods, such as fish for human and non-human consumption in value chains. A focus on the return on investment or the question of costs and ecological payoffs, or the prioritization of "low hanging fruit" (Menz et al. 2015) also underscore anthropocentric motivations. In contrast, ecocentric motivations of restoration center on the integrity of systems as they were found "in nature" or prior to human disturbance, either to serve the needs of diverse flora and fauna (biocentrism) or to re-establish the integrity of systems and their functions. Here, the notion that people act as stewards caring for a shared space that is greater than they, motivates restoration.

In many respects, ecosystem restoration and its permutations have a lot to do with the underlying assumptions of the role or place of humans within or outside of nature. Multiple dichotomies or spectrums capture on one end, a view of humans outside of nature and on the other side, some philosophies understand humans operating within ecosystems. Hall (2005) contrasts the differing views of degeneration and degradation of nature and their prescribed interventions as "gardener" or "naturalizer" depending on the perspective of humans' impact and role within the environment. Conservation is often understood as a difference between preservation guided by aesthetics and resource-ism or resource utilitarianism (Hall 2005; Callicott et al. 1999). Nonetheless, new thinking on conservation has given rise to a spectrum of compositionalism and functionalism, rooted in evolutionary and ecosystem ecology respectively (Callicott et al. 1999). In compositionalism, humans are viewed outside of the system and thus their influence is primarily viewed as pernicious (Callicott et al. 1999). This frame prioritizes biotic communities in ecosystems and seeks to have all the parts compiled or composed in the system, whereas functionalism emphasizes the maintenance of ecosystem functioning and sees people within these systems (Callicott et al. 1999).

Overall, resource-ism and functionalism reflect an anthropocentric orientation because the provision of goods or services represents the primary concern of ecosystem health. Furthermore, there is less concern for the needs of other species or even changes in biotic composition as long as ecosystems function in the same fashion. Compositionalism and preservationism prioritize biodiversity and see the importance of ecosystems as independent of human needs. Rolston (1991, 148) writes on the essentials of ecocentrism underscoring that the conservation criteria of ecosystem "stability, integrity, and beauty of all biotic communities" are paramount. He highlights, "Humans count enough to have the right to flourish in ecosystems, but not so much that they have the right to degrade or shut down ecosystems," (Rolston 1991, 148). In terms of restoration, ecological engineering or novel ecosystems are rooted in anthropocentrism, whereas those holding an ecocentric view would likely be uninterested in restoration efforts that only meet function criteria and do not re-establish species and communities that were historically present.

The primary question addressed here is why motivations or narratives matter in ecosystem restoration. Keulartz and Weele (2009) demonstrate how discourses and frames within environmental policy have political power. Moreover, there is evidence that these scientific discourses are taken up in the media, affecting public perceptions of the problem and thus constraining the policy prescriptions (Carballo-Cárdenas 2015). Similarly, the motivations and frames for why to restore marine ecosystems, or more concretely how the problem of marine degradation is framed and thus interventions prescribed, ought to be considered when determining suitable governance arrangements.

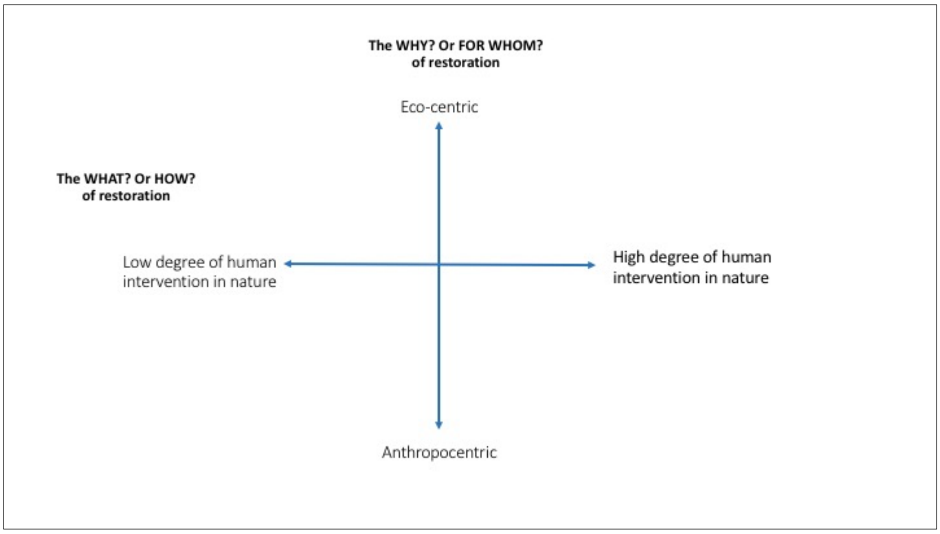

Figure 2. Ethical motivations of ecological restoration

2.3 Model of philosophical understanding of marine restoration

By combining the two different spectrums important to the understanding of marine ecosystem restoration as presented in sections 2.1 and 2.2: "human intervention in restoration" and "motivation of marine restoration" we are now able to present a conceptual model, showing different narratives of marine restoration, each of them emphasizing different problems and solutions (Figure 2).

The x-axis represents the degree of human intervention, or the "how" of marine ecosystem restoration. Along the y-axis, there are gradations of anthropocentric and ecocentric motivations, or essentially the "why" of restoration.

To summarize, this section showed that ecological restoration encompasses a wide range of activities that are characterized by varying degrees of human intervention in nature, underpinned by different values and driven by multiple rationales. The following section will elaborate on the notion of uncertainty in the science and practice of ecological restoration.

3. Uncertainties and (marine) ecological restoration

Nature often responds to human intervention in surprising ways. Ecologically engineered ecosystems designed to provide certain ecosystem services are more predictable than restored ecosystems that are more complex and dynamic - engineers aim to remove uncertainty while ecologists hope for complexity over time (Aronson et al. 2016). Within natural resource management, the desire to "get rid of" or minimize uncertainty and surprise has gradually been replaced by acceptance of uncertainty as inherent to complex socio-ecological systems, and therefore, as unavoidable (Brugnach et al. 2008; Berkes 2007; Folke 2006). Although the topic of uncertainty has attracted extensive scholarly attention, uncertainty is mostly understood in the literature as a mathematical concept or scientific uncertainty, as exemplified in conversations about adaptive management (Walker et al. 2003; Walters and Holling 1990). Decisions about and implementation of ecological restoration programs, however, involve non-quantifiable forms of uncertainty which emerge from the plurality of values, assumptions, interpretations and behaviours of the various actors involved in governing restoration (van der Hoek 2014; Failing et al. 2012; Wheaton et al. 2008; Brugnach et al. 2008). Therefore, uncertainty analyses should explicitly incorporate uncertainties related to both scientific knowledge and to plural actor perspectives in order to facilitate communication about uncertainties and devise strategies to deal with them in restoration governance settings.

3.1 Three kinds of uncertainty

Brugnach et al. (2008) define uncertainty as "the situation in which there is not a unique and complete understanding of the system to be managed" (2008, 4) and distinguish three kinds of uncertainty: *unpredictability, incomplete knowledge*, and *ambiguity* (Figure 3).

Unpredictability refers to the uncertainty that arises due to the complex, dynamic and non-linear behaviour of the system to be managed, be it a natural, technical, or social system. For instance, the impact of combined environmental stressors on coral reef ecosystems is unpredictable due to the interaction of multiple factors affecting various organisms in complex ways (Pendleton et al. 2016). This complexity is compounded when humans are added to the equation, for example when fisheries, recreational and other activities, as well as restoration efforts take place around the same reef ecosystem. As Brugnach et al. (2008: 8) put it, "unpredictability implies accepting that it is not possible to make deterministic predictions about a phenomenon and that doing more research will not change this situation in the near future."

Uncertainty is characterized as *incomplete knowledge* when there is not enough data available, accessible, or of sufficient quality to provide reliable knowledge of the system to be managed. High research costs at sea mean that, for most marine ecosystems, large knowledge gaps exist about their structure, functions, biodiversity, and interactions. In order to restore, for instance deep-water ecosystems, knowledge of the target species abundance, distribution, and life history is necessary, but the remoteness of the deep-sea, sampling/mapping challenges and lack of taxonomic expertise severely hamper understanding of deep-sea benthic biodiversity (Sinniger et al. 2016; Danovaro et al. 2010). Incomplete knowledge implies that collecting more or better data could in principle reduce uncertainty and in turn improve understanding of the system to be managed (Walker 2003). Nonetheless, attempts to complete knowledge do not always decrease uncertainty; new discoveries usually reveal new knowledge gaps, which lead to new uncertainties (Gross 2010; Wheaton et al. 2008; Berkes 2007).

The discussion so far has described knowledge situations where the nature of uncertainty lies in "not knowing enough." Now we turn our attention to a situation where uncertainty arises from ambiguity, or "knowing differently" (Floor et al. 2016; van den Hoek et al 2014). *Ambiguity* is defined as "uncertainty due to the presence of multiple knowledge frames or different but (equally) sensible interpretations of the same phenomenon, problem or situation" (van der Hoek et al. 2014: 31). Frames are sense-making devices that actors use to define issues, prioritize actions, and mobilize other actors and/or resources (Buijs 2009; Dewulf et al. 2005). In multi-actor environmental governance settings, multiple knowledge frames shape interpretations of the problem at stake and its solution, which may lead to conflict and impede collective action (Brugnach et al. 2008). Rigs-to-reefs debates illustrate the different—and often conflicting—knowledge frames through which the problem of decommissioning obsolete oil and gas platforms is interpreted, as well as the solutions offered by different actors (McCann et al. 2017; Fowler et al. 2015).

In the remainder of this section we briefly describe the system to be managed, which in this case refers to the marine ecosystem to be restored and includes not only the natural system, but also the technological and social systems involved in or affected by restoration. Although arguably the system components are closely interlinked and form complex natural-technical-social systems, it is useful to make an analytical distinction of the component where the identified uncertainty is present. The system components are therefore the objects of knowledge (Van Asselt and Rotmans 2002) that the different actors, or knowing subjects, strive to understand.

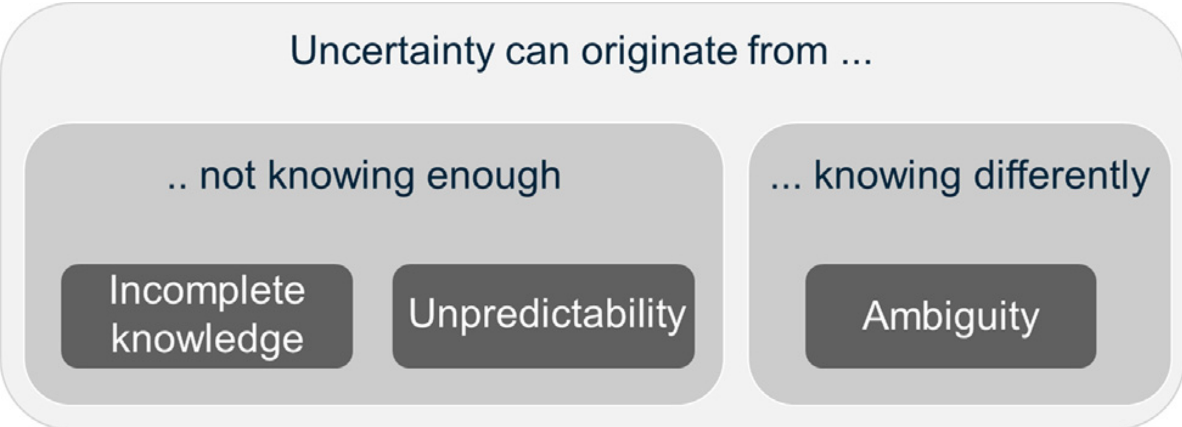

Figure 3. Types of uncertainty (from van den Hoek 2014, 73; Brugnach et al. 2008; figure adapted from Floor et al. (2016))

3.2 Uncertainties related to the natural, technical and social system

The three forms of uncertainty refer to knowledge processes in the system components to be managed. In this section we will illustrate the different uncertainties in the natural, technical and social systems related to coral reef ecosystems and reef restoration (Table 1).

The natural system comprises the ecosystem to be restored, including target species and abiotic factors such as water quality, as well as natural phenomena that could either drive or affect restoration initiatives, such as climate change or invasive species. In Caribbean reefs, both incomplete knowledge and ambiguity regarding the impact of invasive lionfish on native fish species influence stakeholders' views regarding the need to remove lionfish (Hackerott et al. 2017; Carballo-Cárdenas 2015).

The technical system consists of infrastructures, technologies, and innovations through which humans (potentially) intervene in nature. Several coral restoration methods and technologies have been applied worldwide in the last couple of decades (Lirman and Schopmeyer 2016; Rinkevich 2014; Spieler 2001), with different outcomes and perceptions of feasibility and cost-benefit assessments (Bayraktarov et al. 2016; Bayraktarov et al. 2017; Rinkevich 2017). Potentially controversial innovations have been recently proposed, including restocking reefs with grazers reared in aquaculture facilities (Obolski et al. 2016) and reef restoration initiatives that involve (human) assisted evolution of corals (van Oppen et al. 2017; 2015). High levels of the three forms of uncertainty surround such initiatives given their state of development (incomplete knowledge), unpredictability of ecological consequences, and possible resistance from society.

The social system includes economic, legal, political, cultural, administrative and organizational aspects related to both ecological degradation and restoration. Examples of uncertainties pertaining to the social system are unpredictability of how societies dependent on coral reef resources will adapt to degradation of these ecosystems, and ambiguity about what constitutes restoration "success" (Wortley et al. 2013; Gross 2010; Zedler 2007; Rinkevich 2014).

The framework provided in this section is useful to classify the various kinds of uncertainty that will inevitably arise in marine restoration practices.

Table 1. Uncertainty classification matrix (adapted from Brugnach et al., 2008)**, illustrated by questions around coral reef ecosystems and reef restoration**

	Unpredictability Unpredictable behaviour of nature, technology developments, and humans	**Incomplete knowledge** Imperfect knowledge; lack of data, unreliable data; inaccessible data	**Ambiguity** Multiple (conflicting) knowledge frames
Natural system Target species, ecosystem function and structure, climate change, water quality, invasive species, etc.	Unpredictability of the natural system e.g., how will the combined impacts of climate change, ocean acidification, storms, and local stressors affect coral reef ecosystems? (Pendleton et al. 2016)	Incomplete knowledge of the natural system e.g., what is the structure and function of deep-water coral reef ecosystems? (George et al. 2007)	Multiple knowledge frames about the natural system e.g., to what extent is invasive lionfish a threat for native fish species in Caribbean coral reefs? (Carballo-Cárdenas 2015)
Technical system Infrastructures, technologies, innovations	Unpredictability of the technical system e.g., what will be the ecological consequences of restocking of grazers to assist reef recovery? (Obolski et al. 2016)	Incomplete knowledge of the technical system e.g., what are the expected interactions of the artificial [coral] substrate's composition, texture, orientation, and design with the damaged environment and the biota of interest? (Spieler et al. 2001)	Multiple knowledge frames about the technical system e.g., in the face of rapid changes, should the original stock be used for restoration, or translocation of a species outside its historic range be attempted? (Spieler et al. 2001) Should oil and gas platforms be removed or converted into artificial reefs? (McCann et al. 2017; Fowler et al. 2015)
Social system Economic, legal, political, cultural, administrative and organizational aspects	Unpredictability of the social system e.g., how will societies adapt to coral reef loss in small island development states highly dependent on reef resources? (McField 2017)	Incomplete knowledge of the social system e.g., how will the public react to coral reef restoration initiatives that involve (human) assisted evolution? (van Oppen et al. 2017; 2015)	Multiple knowledge frames about the social system e.g., how should restoration outcomes be assessed? (Wortley et al. 2013; Zedler 2007; Rinkevich 2014)

4. A typology of governance arrangements

This section introduces the third building block of our conceptual framework: a typology of governance arrangements. The main research question guiding this section is, what forms of governance structures and governance arrangements at sea can be distinguished?

Governance is about 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 (Chhotray and Stoker 2009). A governance arrangement is a temporary stabilization of the substance and organization of a policy domain. In a governance arrangement different, more or less stable, coalitions of governmental and non-governmental actors try to influence the activities and developments, and to design legitimate initiatives, based on shared discourses, for managing resources and defining the rules of the game (on different levels) (Van Tatenhove 2013; 2016). The structure of a governance arrangement can be analysed along four dimensions (Arts and Van Tatenhove 2006; Liefferink 2006; Van Tatenhove 2015):

- ***The actors and their coalitions.*** Which actors are involved in the development of marine restoration projects and related policy making and decision-making processes, and how are these actors selected?
- ***The (unequal) division of resources between these actors, leading to differences in power and influence.*** Power refers to the mobilization and deployment of the available resources, while influence refers to who is able to change policy outcomes (and how). What are the power relations and balances between the actors in, for example, marine (ecological) restoration policies?
- ***The rules of the game currently in operation.*** In marine (ecological) restoration policies and politics these rules refer both to the formal procedures of decision-making and the implementation of ecological restoration projects as well as the informal rules and 'routines' of interaction within these restoration projects and the institutions (in which these projects are embedded).
- ***The policy discourses, entailing the norms and values, the definitions of problems and approaches to solutions of the actors involved.*** Discourses are relevant at two different levels: (1) general ideas about the organisation of society and the relation between state, market and civil society (preferred mode of governance), and (2) ideas about the concrete problem at stake, e.g. about the character and definitions of marine restorations problems, its causes and possible legitimate solutions. To develop the typology of governance arrangements we will make use of the first level.

The four dimensions of a governance arrangement are inextricably interwoven. Change in one of the dimensions may induce change in the other dimensions, which in turn might change the overall governance arrangement (Liefferink, 2006; van Tatenhove, 2013 and 2015). However, the interconnectedness of the dimensions not only makes it possible to analyse the dynamics (change and stability) within a governance arrangement, but also provides the tools to develop a typology of governance arrangements.

Marine restoration projects are (or could be) implemented in different institutional settings, such as coastal areas, the territorial sea of nation states, the regional seas, or at the high seas. In this section we present a typology of governance arrangements which gives insight into the different governance arrangements and related institutional settings in which marine restoration projects are implemented. The typology is based on the variation of institutional settings in which these arrangements institutionalize. A well-known distinction is national; intergovernmental; supranational and transnational. Within the institutional setting of national states a further distinction can be made between etatism; liberal-pluralism, neo-corporatism, and communitarianism (see Table 2).

The typology is based on variation on the following dimensions: (a) coalitions (which actors form a collation and who decides about access to this coalition?); (b) control over the major resources, (c) the rules of authority, and (d) the discourses of cooperation. For the discourses of cooperation we used a continuum ranging from "confrontational bargaining" to "deliberative problem-solving" (Elgström and Jönsson 2000; Soma et al. 2015). Confrontational bargaining is a non-cooperative strategy which involves manipulative tactics and power games between public and private actors. Deliberative problem solving refers to a conscious strategy of public and private actors, working together to find joint solutions for defined problems.

Dimensions **Types**	**Coalitions** Access (number of actors in coalition)	**Control over resources**	**Rules**	**Discourses (of cooperation)**
National				
• *Etatism*	State based coalition (access low)	Dominance of state	State locus of formal authority	Confrontational and cooperative (imposed)
• *Liberal-pluralism*	State – market –civil society coalitions (access high)	Diffusion of power between state – market – civil society actors	Shared authority, basic democratic rules, open competition	Confrontational and integrative
• *Communitarianism*	Civil society/community based coalition (access limited)	Diffusion of power between community members	Shared authority between community members, negotiation	Cooperative and consensual
• *Neo-corporatism*	Monopolistic representation of state – market – civil society actors (access limited)	Diffusion of power between state – market – civil society actors	Negotiation based on rules of exchange, shared authority	Cooperative and consensual
Intergovernmental	Regional blocks of states, also coalitions of non –state actors (access low)	Dominance of national states	Sovereign states are the locus of formal authority and legitimacy; also informal authority and legitimacy for non-state actors	Mainly Confrontational, integrative and consensual.
Supranational	Supranational institutions, member states and non-state actors (access limited)	Diffusion of power between states and supranational institutions	Supranational institutions are the locus of authority and legitimacy	Integrative, confrontational, and consensual
Transnational or transboundary	Flexible coalitions of state and non-state actors in formal and informal institutions (access limited)	Diffusion of power among public and private actors	Coalitions of states and non-state actors are the locus of authority and legitimacy	Mainly Integrative, consensual

Table 2 Typology of governance arrangements (based on Arts, 2000; Liefferink, 2006; Van Tatenhove, 2015).

In *etatist arrangements* state actors are dominant. Resources are controlled by the state. Market parties and civil society actors are placed in a dependent position and have limited access to decision-making. Etatist arrangements are buttressed by strict rules, conferring on the state the necessary authoritative instruments. Additionally, the prevailing substantive discourse and discourses of cooperation are determined by the state and are of confrontational and cooperative nature. *Liberal pluralist arrangements* denote a market-oriented model. In this arrangement no single actor dominates. Resources are spread over a wide array of public and private parties. Examples in the marine domain are "building with nature" (ecological engineering) projects (Korbee, Mol, and van Tatenhove 2015) and entrepreneurial Marine Protected Areas (Bottema and Bush 2012). These governance arrangements show a diffuse authority between non-state (market parties and NGOs) and state actors. Liberal pluralist arrangements accommodate open competition between the actors involved, this also extends to discourses of cooperation: competition and promoting conflicting views of policy problems. *Communitarian arrangements* denote a community-based model, emphasizing the self-governance of communities, such as in co-management systems. Communitarianism emphasizes a community of people to sustain shared values or substantial discourses (morality) (Koikkalainen 2013, 461). In fisheries co-management arrangements coalitions of local community representatives and fisherman define the rules and resources to manage the commons, for example, by deciding about days at sea or rules about quota distribution between members of the local community. In *neo-corporatist arrangements* political authority is shared by the state and some acknowledged intermediate organisations (such as trade unions and employers' organisations).

However, these nation state-based governance arrangements are not applicable at the international level. Based on the international relations, European studies, and marine governance literature we present the following additional types of governance arrangements: intergovernmental, supranational, and transnational. In *intergovernmental arrangements* (regional blocks of) states are dominant, but Intergovernmental Organisations (IGOs), transnational corporations (TNCs), and epistemic communities play an important role. The *supranational arrangement* refers to the EU multilevel governance arrangements, consisting of the supranational institutions (European Council, Council of Ministers, European Commission, European Parliament and the European Court of Justice), the Member state institutions and a diversity of agencies and committees. The transnational arrangements bring together state and non-state actors (of different levels) beyond the national borders of states, for example at the level of the regional sea. An example is what Raakjear et al. (2014) called a nested governance system at the level of the regional sea. Their analysis of the governance situation in the four regional seas (The Baltic Sea; The Black Sea; the Mediterranean Sea and the Northeast Atlantic Ocean) showed a lack of synergetic institutional interaction between the EU policies and institutions on the one hand and the relevant sectoral governance arrangements on the other. These transnational governance arrangements consist of coalitions between member states, EU institutions, Regional Sea Commissions and the UN.

It should be noted that this typology of governance arrangements is an analytical typology. In the empirical reality of policy making and politics, in this case marine (ecological) restoration, governance arrangements may exhibit more or less national, intergovernmental, supranational and transnational characteristics. For example, marine restoration governance arrangements at the high seas consists of characteristics of intergovernmental and market based governance arrangements. Key players in this deep-sea governance arrangement are the UN International Seabed Authority (ISA), nation states (as members of ISA) and market parties, buts also RFMOs and the High Seas Alliance, a non-governmental organization. Marine restoration projects at the coast or within the territorial waters could have characteristics of etatist, communitarianist, liberal-pluralist, and supranational governance arrangements. In general, different governance arrangements co-exist within a specific institutional setting (polity).

5. A conceptual framework to evaluate marine restoration projects

Governing ecological restoration activities and the effective implementation of restoration projects depends on where these activities are developed, who is involved, who is the responsible authority, the way marine (ecological) restoration is defined and with what kind of uncertainties scientists, governments and actors carrying out maritime activities are confronted with and how they have to deal with these uncertainties.

There is a clear difference between terrestrial and marine ecosystem restoration; terrestrial ecosystem restoration struggles with or contends with property regimes, rights, and responsibilities between private landowners and nested governance of local, regional, national, and supranational jurisdiction. For maritime space (from deep seas, high seas, EEZs, and territorial seas), sovereignty and sovereign rights are predicated through UNCLOS (United Nations Convention on the Law of the Seas) and thus private (individual or commercial) access privileges and extraction rights/leases are decided through policies and leasing mechanisms. The governance challenge at sea is not so much the delicate balance between private ownership rights and freedoms and the individual actions affecting the common good or the issues of collective suffering from individual actions, but rather how to coordinate overlapping jurisdictions because of the legacy of sectoral or single-use management and the greater uncertainty associated with marine ecosystems.

In general, the institutional governance setting at seas consists of regime complexes and emerging network states (Van Tatenhove 2016). Regime complexes are arrays of partially overlapping and non-hierarchical institutions governing a particular issue area (Raustiala and Victor 2004). Examples of regime complexes in the maritime domain are shipping, fisheries and aquaculture, non-renewable and renewable energy production, etc. The network state (Castells 2009) refers to the shared sovereignty and responsibility at sea between different states and other levels of governance, such as the United Nations (International Maritime Organisation; the International Seabed Authority, Commission on the Limits of the Continental Shelf), the European Union, and the regional Sea Conventions. These institutions set the main principles, such as the different sovereignty zones employed by UNCLOS, from the coastal waters to the high seas. Each European sea shows a specific constellation of institutions and forms of sovereignty. However, a general description and analysis of the interplay between regime complexes and governmental actors regarding marine restoration activities for the European seas would be too general to construct governance arrangements and to evaluate specific marine restoration activities.

To understand the enabling and constraining conditions to implement restoration activities we developed a conceptual framework consisting of three building blocks (narratives; uncertainties and governance arrangements), this will provide a more sophisticated tool to analyse and to evaluate marine restoration projects within their specific institutional settings in more detail.

The starting point of the analysis is a restoration activity/practice. The leading question for any application will be what kind of governance arrangement can be constructed around the restoration activity, taking into account the way the activity is framed (narratives) and the uncertainties related to the restoration activity. More in detail, the analysis consists of the following steps, in which the 3 building blocks are brought together:

1. Identify the way the restoration activity is framed. Is there a dominant narrative/discourse? Are there conflicting discourses?
2. Which actors formulate or oppose these discourses? What discourse coalitions have developed? Which (public and private) actors form a discourse coalition?
3. What kind of uncertainties can be distinguished? How do these uncertainties relate to the discourse coalitions?
4. Where is the restoration activity situated? (coastal zone, territorial sea, EEZ, high sea) and what rules and what forms of authority are related to this maritime zone where the activity takes place?

5. What kind of policies (rules) regulate the restoration activity? And which resources are related to these policies and forms of authority?

6. Conclusion

In addition to the ecological considerations (e.g., recoverability, resilience and adaptation) requisite for habitat restoration, effective implementation of marine habitat restoration, as with any environmental management initiative, requires the inclusion of a governance perspective. The governance perspective includes understanding of the interactions and interdependencies of multiple authorities and competing maritime activities (with different economic, political, social, and cultural interests), all of which operate at different governance levels, ranging from sub-national (coastal governments) to the international arena. This also necessitates acknowledging, mobilizing and using different narratives of marine restoration, and being confronted with different forms of uncertainties.

Marine restoration will be bounded by multiple and various enabling and constraining conditions. One would expect individual coastal restoration cases would have different constraints in terms of governance structures, restoration narratives (discourses), and uncertainties than will be found in the open/deep sea. The conceptual model developed in this work provides the tools to evaluate the enabling and constraining conditions. The next step will be to apply this framework to evaluate in what way an effective and legitimate implementation of marine restoration projects is affected by different institutional settings, different policies (such as the implementation of the Marine Strategy Framework Directive and the Birds and Habitat Directives), different (conflicting) marine restoration discourses (narratives) and related uncertainties.

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