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Cold water coral reef management from an ecosystem service perspective

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ABSTRACT

Many countries have put in place protection of cold water coral (CWC) reef areas in relation to fishing, especially bottom trawling. As little has been known about the ecosystem function of CWC, protection has largely been driven by existence values such as uniqueness/rareness, charisma and low resistance from fishermen due to limited effects upon fisheries. This paper identifies the services from CWC, underlining the supporting services that may determine the flow of the more direct provisioning, regulating and cultural services. Current research points to the value of CWC as a habitat for commercially interesting species, which motivates management of these resources to include a more comprehensive set of mechanisms, such as placing incentives to encourage a change of gear from bottom trawling to less destructive methods in less densely covered CWC areas, and possibly a stronger focus on other benthic habitats that are equally or more valuable, such as sponges.

1. Introduction

The conservation of cold water corals (CWCs), and specifically CWC reefs, emerged as a significant environmental issue in the late 1990s, and many countries have put in place protection of CWC reef areas in relation to fishing, especially bottom trawling (see Appendix A for a non-exhaustive overview of closures related to CWC in Europe). As little has been known about the ecosystem function of CWC, protection has largely been based on CWC reefs being perceived as charismatic and unique hotspot areas, with closures involving low resistance from fishermen due to limited effects upon fisheries. Though there are few direct services to humans from CWC [1], research is increasing our knowledge of the indirect (supporting) services from the deep [2], pointing to ecosystem functions related to commercially interesting species [3]. This paper identifies the services from CWC, underlining the supporting services that may determine the flow of provisioning, regulating and cultural services, and argue for increased focus on management and marine spatial planning in relation to these services for CWC reefs and less densely covered CWC areas, as well as for benthic habitats in general.

CWC, consisting of colonies of small anemone-like individuals that build their own skeletons of white calcium carbonate, can be found in almost all the world's oceans. Unlike well studied tropical corals, these corals inhabit deeper waters on continental slopes, canyons and seamounts at depths ranging from 39 m to over 3000 m [4,5] and grow at a very slow rate of 4.1–25 mm per year [4,6]. Due to the inaccessibility of these resources, the degree of knowledge related to CWC services, be they supporting, provisioning, regulating or cultural [7], has been, and still is, limited. As of today, CWC have little direct human use, such as in the production of jewellery [8], but potential future provisioning services such as medical/biochemical resources have been suggested [1]. It has further been suggested that CWC may deliver regulating services such as a carbon sequestration [1,2], though this is increasingly being questioned.[1] CWC may hold existence values regardless of their direct or indirect uses to society, but valuation exercises to date have not succeeded in eliciting a willingness to pay for CWC protection amongst the public [9], whether due to actual

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[1] Another calcifying organism, the mussel *Mytilus edulis* builds its carbon skeleton using bicarbonate rather than CO_2. This, which is similar for CWC, pushes the carbon equilibrium in the ocean such that there is less CO_2 absorption, not more. In addition, when feeding, cold water coral emit CO_2, like most living organisms. Dead coral is nonetheless clearly a carbon sequester.

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unwillingness to pay, or methodological problems. What is known regarding CWC services is that these deep sea structures have been shown to harbour high biodiversity, and seem to attract large concentrations of some fish species [4,10]. Furthermore, analysis of co-occurrences give indications of possible links between cold water coral and fish, but as of yet no direct ecosystem functions have been identified [11–13]. Though not conclusive, recent research indicates that CWC may play an important role in the early life history of some fish and shark species [14,15]. It has long been thought that CWC provide supporting services through nursery grounds and habitat for protection, reproduction and feeding [4,16], but only recently has there been stronger grounds to claim this [14,15].

Despite these unknowns, an impressive number of spatial designations and management measures have been put in place globally with a view to protecting these reef ecosystems; see the Appendix for a non-exhaustive list of European MPAs related to CWC. In Europe, Norway was the first country to protect a CWC reef area [16]. This was later followed by closures in EU and Icelandic waters [17]. In the EU, application of the EU Habitats Directive [18] and the more recent Marine Strategy Framework Directive [19] have driven conservation of CWC reef areas with a number of countries establishing Special Areas of Conservation (SACs). In the US there has been increased focus on the identification of Essential Fish Habitat (EFH), and both there and in Canadian waters there have been area closures related to CWC. Likewise there have been closures in Australia and New Zealand, with the latter especially in relation to seamounts and benthic protection areas. Also in international waters Regional Fishery Management Organisations (RFMOs) responding to the FAO guidelines for the implementation of the UNGA 61/105 and 72/74 resolutions managing deep-sea fishing, have put in place closures, as well as so called "move-on" rules for fishing vessels that exceed threshold catches of specific species [20]. The introduction of these conservation measures indicates increasing awareness of the potential values found in ecosystems on the ocean floor.

There are, however, questions to be asked as to the motivations for the CWC protection to date. FAO [21] gives clear guidelines for classification of vulnerable marine habitats (VMEs) based on (1) uniqueness or rarity, (2) functional significance of the habitat, (3) fragility, (4) life-history traits that make recovery difficult and (5) structural complexity. Most of these criteria, if not all, are satisfied regarding many closed CWC reef areas. However, the second criterion is not sufficiently scientifically known, and with an increasing number of identified and protected CWC reefs, one can clearly question the first criterion. It is important to note that although the criteria above describe VMEs, they are not all required to be present in order to define a VME. Furthermore, they need not describe the motivations for protection. It appears that to date the main criteria for protecting CWC have been due to CWC reefs being charismatic and unique hotspot areas, combined with the fact that the area closures have limited economic consequences for fisheries, or would carry greater cost for fisheries in the form of negative publicity if fishers were to go against closures. Indeed, CWC may be seen as the poster child of benthic habitat protection, or the whale or seal pup of the deep sea, in the imagination of the public. And yet, the fact that more and more CWC reefs are being identified may reduce the scarcity aspect, but nonetheless point to increased ecological importance.

Increased awareness of the many services emanating from the ocean floor raises the question of a broader focus on benthic habitats [22], including habitats that may be less charismatic and more sparsely distributed than CWC reefs. If benthic habitats are more generally shown to supply important supporting services that have not been taken into account when managing destructive human activities, such as bottom trawling, then this could lead to a "tragedy" of common habitats, requiring further management and marine spatial planning efforts.

The paper is laid out as follows: in the next section the ecosystem services of CWC are presented, focussing especially on supporting services. This is followed by the identification of the criteria in place for protecting CWC, and a non-exhaustive presentation of protection occurring globally to date. The paper concludes with a discussion of the protection of CWC and benthic habitats today, pointing to the need for a broader approach to protecting ecosystem services.

2. Ecosystem services

Assessing ecological processes and resources in terms of the services they provide translates the complexity of the environment into a series of entities which can be more readily understood, for example by policy makers and non-scientists [23]. Information on the services associated with CWC enables decision-makers to focus their attention on initiatives with the greatest potential to protect CWC while at the same time safeguarding marine commercial interests, livelihoods and societal values [1], i.e. there are often trade-offs between different services. The identification of services, their values and conflict areas are therefore important for policy making, in particular marine spatial planning. In Europe, Action 5 of the EU Biodiversity Strategy to 2020 calls for mapping and assessment of ecosystems and their services as part of the analytical framework for ecosystem assessments [24]. However, little information of an economic nature is available, and what is available leaves many unanswered questions [1,9,25].

As shown in Fig. 1, CWC may have function based values as well as an intrinsic right to exist, both of which drive the policy for protection of these species and ecosystems. The focus of this paper is on the functional values and ecosystem services of CWC which feed into the economic values.

Using the Millennium Ecosystem Assessment framework [7], CWC services can be classified under supporting, regulating, provisioning or cultural. The services related to CWC under the MEA framework are discussed in more details below. Note, this paper does not differentiate between CWC reef areas and more sparsely covered areas.

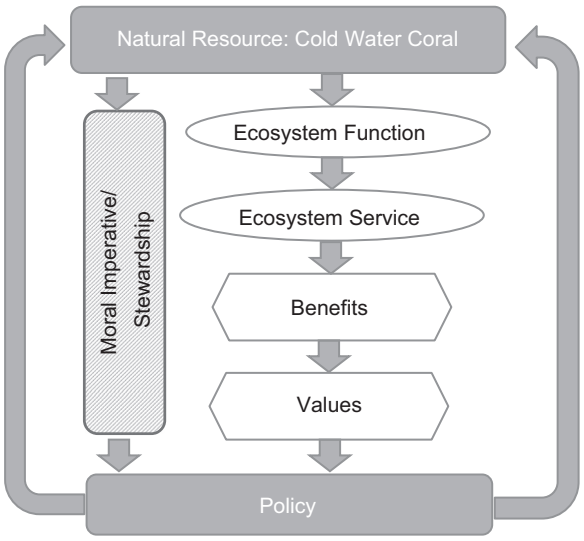

Fig. 1. Cold water coral policy drivers. Cold water corals have both intrinsic and function based values. The moral imperative (striped box) represents the intrinsic nature of the resource, its right to exist. The focus of this paper is the functional values of CWC ecosystems, which are driven by nature (oval boxes) and feed into the economic values and benefits (hexagonal boxes). Both elements drive policy decisions which feed back into the resulting availability of the CWC resource.