

Multi-industry Marine Spatial Planning: assessing trade-offs and co-location opportunities with fishing, conservation and offshore renewable energy

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Summary

Oceans are getting busier and integrated management of multiple uses is an increasing challenge. The offshore renewable energy industry is expanding rapidly and attempts to maintain and restore marine biodiversity are becoming more spatial, principally through the designation of marine protected areas (MPAs). MPAs and offshore energy generation compete for space with existing uses, primarily impacting the fishing industry. Decision makers require guidance on how to zone the ocean to conserve biodiversity, mitigate conflict and accommodate multiple uses. Here we demonstrate how multiple sectors can be transparently incorporated into marine spatial planning processes. We identified priority areas for multiple ocean zones, incorporating goals for biodiversity conservation, two types of renewable energy, and three types of fishing. We evaluated trade-offs between industries and we investigated the impacts of co-locating some fishing activities within renewable energy sites. We found that the trade-off curves of subsectors within a given industry varied greatly. Incorporating co-location resulted in significant reductions in cost to the fishing industry, including the subsectors that were not co-located. Co-location also altered the optimal location of zones with planning solutions. Our findings highlight the need to include industry subsectors and stress the importance of considering co-location opportunities from the outset.

Introduction

In our increasingly busy seascapes marine biodiversity is threatened by a suite of anthropogenic impacts (Halpern *et al.*, 2008). Efforts to conserve marine biodiversity are becoming more focused on spatial approaches and there has been a rapid increase in the designation of MPAs (Pita *et al.*, 2011). Fishing is the most common activity restricted or excluded from MPAs, creating conflict between the conservation and fishing communities. Consequently, most MPA planning processes seek to minimize this conflict (e.g. (Yates and Schoeman, 2014)). However, as oceans get busier and new industries emerge, both conservation and fisheries will face growing competition for space, and marine planners will have to deal with a wider range of spatial conflicts. Ocean zoning, a component of marine spatial planning, has been proposed to accommodate multiple conflicting and compatible uses of the ocean (Crowder *et al.*, 2006). Here we develop an ocean zoning approach to optimize space allocation for conservation, fishing, and offshore marine renewable energy generation, and apply it to Northern Ireland, a country that is both expanding its existing MPA network and developing its renewable marine energy generation infrastructure.

Materials and Methods

We developed a multi-industry zoning scenario, which optimized zone configuration when simultaneously planning for conservation, fisheries and renewable energy. It contained seven zone types: three MPA zones, two renewable energy zones, an open fishing zone and an aquaculture zone. We targeted a total of 60 biodiversity conservation features for inclusion into MPAs under all

scenarios. We used fisheries data derived from Spatial Access Priority Mapping (SAPM) interviews with 103 Northern Irish fishers (Yates and Schoeman, 2013). Data on the location of aquaculture sites and data on potential marine renewable energy development areas were obtained from Northern Ireland government departments. We used the decision support tool Marxan with Zones to identify cost-effective solutions to the zoning problem. We set initial conservation targets at 15% of each biodiversity feature to be contained within the three MPA zones (reserve, conservation zone and scallop management zone) and at least 5% of each biodiversity feature within reserves. Initial renewable energy targets were set at 30% of the potential area, based on government expectations, and initial fisheries targets were to maintain 80% of the original value (SAP) within fishable areas.

We explored the trade-offs between representing biodiversity features, reducing the impacts on fisheries, and providing space for renewable energy development, at a range of target levels. We incrementally increased the fisheries target from the original 80%, kept targets for conservation constant and observed the extent to which the renewable energy target could be met. We then incrementally increased the renewable energy target from 30%, kept targets for conservation constant, and observed the extent to which the fisheries target could be met. This was repeated with different conservation targets. We next investigated the impact of co-location (allowing concurrent activities in time or space) of marine renewable energy and fishing on the cost (displaced SAP) of planning solutions for the whole fleet and for each of the three main fisheries. We developed a set of scenarios in which some pot fishing occurred within renewable energy zones. We tested two levels of co-location, where either 25 or 50% of the original pot fishing value (SAP) was maintained in areas zoned for renewable energy.

Results and Discussion

We found that the trade-offs between fishing and renewable energy were non-linear and that they varied depending on the specific fishery or type of renewable energy. We also found that co-locating even low levels of fishing activity within renewable energy zones both significantly reduced the cost of planning solutions and changed the spatial distribution of zones within planning solutions. Our approach facilitates the development of ocean zoning solutions that optimizes the location of MPAs and emerging industries, whilst minimizing impacts on existing sectors. The approach allows the transparent exploration of trade-offs, uses a free planning tool, and is readily adaptable to different planning scenarios. The use of this approach should assist ocean zoning and marine spatial planning processes to identify efficient and defensible solutions to multi-industry spatial conflicts (Yates *et al.*, 2015).

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