Interactions of commercial fisheries and marine renewable energy developments in Scottish waters

Andronikos Kafas (1), Gareth Jones (1), Ian Davies (1), Beth Scott (2)
(1) Marine Scotland Science Marine Laboratory, Aberdeen, Scotland, UK; (2) University of Aberdeen, Institute of Biological & Environmental Sciences, Aberdeen, Scotland, UK.
Presenter contact details: andronikos.kafas@scotland.gsi.gov.uk , Tel: +44 (0) 1224 2953 47

Summary
Marine Renewable Energy Developments (MREDs) need to be accommodated within the existing pattern of commercial and conservation uses, in the context of limited ocean space availability. The Scottish Government places high priority on renewable energy, aiming to cover the total electricity demand from renewable sources by 2020. Hence a large number of MREDs are expected. Optimum siting of these developments, while maintaining the sustainability of sectors (economic and ecological), such as commercial fisheries, involves multiple scientific challenges. Predicting and minimising environmental and socio-economic interactions between fisheries and the renewable industry is an important element of both marine planning and licensing. In this study, the spatial distribution of the Scottish commercial fishing fleet is studied to quantify the conflicts and synergies arising from MREDs. The number of vessels impacted, gear types used and fishing intensity in the draft sectoral plan option areas for MREDs in Scottish waters out to 200 nm have been identified. Socio-economic impacts of renewable energy developments on fishing effort/ landings/ revenues at the Scottish fleet and individual vessel scales have been assessed, and potential displacement opportunities have been identified. Outputs from this study may inform both large scale strategic planning and individual project siting in the future.

Introduction
Marine Spatial Planning (MSP) relies on robust data on human uses of the sea to minimise spatial conflicts and account for the cumulative effects of multiple activities in decision making. Commercial fisheries are major users of Scotland's seas and it is important to take account of their needs in marine plans. Current planning in Scotland prioritises renewable energy, aiming to cover the total electricity demand from renewable sources by 2020, and hence a large number of MREDs are expected. To this end, a constraint mapping exercise identified draft plan options for offshore wind, wave and tidal areas where future MREDs are likely to be located. In this study, we analyse spatial data of commercial fisheries to inform the MSP process for marine renewable energy in Scotland.

Materials and methods
Vessel Monitoring System (VMS) data for all UK registered commercial fishing vessels with an overall length of ≥15m in years 2007-2011 have been combined with landings information to develop GIS layers describing annual spatial patterns of landings for defined sections of the fleet. At first, VMS pings were filtered by speed (0 < speed < 5 knots; Lee *et al.*, 2010) to distinguish fishing from steaming. Then, fishing pings were merged with landings data (i.e. logbooks). To avoid landings misallocation, fishing pings were assigned to overlapping ICES rectangles. Reported landings data were broken down by reported day and the days landings in each ICES rectangle were equally distributed for those assigned pings in that day. All pings within a 2.5 km^2 radius from major fishing ports were removed since the speed threshold failed to account for fishing vessel's reduced speed when entering port areas. Total trip landings associated with removed pings were re-allocated to all remaining pings of each trip. Finally, VMS pings were grouped to nine target fisheries, based on the gear used and dominant species landings (by weight). The groups were selected as representative of Scotland's commercial fishing activity and included squid, lobster, pelagic, mackerel, herring, crab, nephrops (mobile and static), demersal (mobile and static), and scallop.

Target fishery groups were overlain with the draft plan option areas for MREDs. Total landing weight and value within each plan option area were determined. The number of vessels impacted, gear types used and fishing intensity in the draft plan option areas for MREDs in Scottish waters out to 200 nm have been identified. Socio-economic impacts of renewable energy developments on fishing effort/ landings/ revenues at the Scottish fleet and individual vessel scales have been assessed. Potential displacement opportunities have been identified using a previous study on the spatial distribution of commercial fisheries in Scotland (Kafas *et al.*, 2012). Sample results derived from overlaying offshore wind plan option (OWPO) areas with fishing layers are discussed below.

Results and Discussions

Grouping VMS pings resulted in pelagic and demersal groups having the most landings (average annual landings of 195k and 87k tonnes respectively). Mackerel comprise about 60% of the pelagic group's landings, highlighting the dominance of this species in this fleet. Two other significant contributions come from nephrops and scallop fisheries (26.4k and 21.7k tonnes respectively). Finally, crab, squid, and lobster targeted fisheries contribute to a total of approximately 6k tonnes.

Average annual landings of approximately 23k tonnes, equating to £28.4M, are derived from the OWPO areas. Northern areas around Shetland Islands had the greatest landings value (mainly pelagic and nephrops fisheries). In most areas, vessels targeting demersal species and nephrops were found to show the greatest overlaps with OWPO areas. Draft plan option areas in the south-west of Scotland (off Campbeltown and Ayr) were found to interfere with the greatest number of vessels. Vessels targeting for nephrops, scallop and demersal groups crossed through a draft plan option area for most of their trips (most vessels with >40% of their trips intersecting with a plan option area). The vast majority of the overlapping vessels sourced less than 10% of their landings within a draft plan option area. However, there were a number of vessels with >30% landings from OWPO areas suggesting that there may be scope for further spatial refinements. No vessel was found to source more than 50% of its annual landings from the draft plan option areas.

This analysis provides a baseline description of fishing activity within draft plan option areas. However, this should be seen as just the beginnings of analysis of potential spatial conflict as all economic calculation were done on landings which are neither a direct measure of profit (e.g. due to fuel costs etc.) nor a good estimate of fishing grounds' potential productivity (e.g. due to discards).. Moreover, the issues of fishing displacement and benefits of closed areas need to be considered within future management scenarios. Activity displacement might lead to increased competition and considering core fishing areas remain relatively the same across years, alternative or increased fishing on the core grounds might not be able to support a sustainable industry. Potential benefits for areas adjacent to closed fishing grounds through spill-over effect need to be considered. There is a great need for developing spatial planning models which incorporate economic and environmental effects of fisheries displacement while accounting for cumulative (positive and negative) effects of other ocean uses such as MREDs.

References

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