Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles

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The UK has globally significant populations of grey and harbour seals, which are protected under national and international legislation. In recent years, aerial surveys have revealed region-specific changes in population trends for both species, ranging from exponential increases (e.g. grey seals in the Southern North Sea) to catastrophic declines (e.g. harbour seals in East Scotland and Orkney) (SCOS 2019). Moreover, the marine landscape in the UK is facing a period of unprecedented change, with large-scale decommissioning of oil and gas infrastructure and rapid expansion of the marine renewable sector. Whilst the impact of man-made structures on the marine environment is largely unknown, there is evidence that existing infrastructure may act as artificial reefs, influencing the foraging movements of some seals (Russell et al. 2014). Moreover, disturbance during the installation of new structures may also affect behaviour (Whyte et al. 2020). In addition to information on the mechanism of these effects, up-to-date information on the at-sea distribution of seals is required to fully understand their magnitude, and thus inform environmentally sensitive marine spatial planning.

In the current study, we modelled seal presence (telemetry locations) against a sample of available habitat (control points) as a function of static (e.g. water depth, substrate type) and seasonally dynamic (e.g. sea surface temperature, vertical stratification) environmental covariates. Importantly, this analysis was performed regionally, allowing for the possibility of different species-environment relationships in different regional sub-populations. These regional habitat preference models were combined with recent haulout counts to produce predicted distribution estimates for the entire populations of grey and harbour seals hauling-out in the British Isles. The resulting maps provide ecologically relevant density estimates for both species to be used in marine spatial planning and conservation management. Although habitat preference models have previously been used to investigate the environmental drivers of distribution for seals in the UK, these efforts have largely been focussed on specific areas of the North Sea, or treat the North Sea as one region. Our study found marked differences in environmental drivers of distribution among regions for both species. Given the regional differences in population trends, diet, and available habitat, within the North Sea and elsewhere around the British Isles, not accounting for geographical variation in habitat preference may lead to inaccurate species-environment relationships.

Acknowledgements

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Interspecific Interactions: Investigating the role of grey seals in the harbour seal decline

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Ecological space can be occupied by multiple species. Thus, individuals across species have the potential to interact, either directly or indirectly, and these interactions can drive the structure of ecological communities. Harbour seal (*Phoca vitulina*) populations on the north and east coast of Scotland have suffered catastrophic declines of up to 95% since the early 2000s (Thompson et al. 2019); the cause of which remains unclear. In the same areas, grey seal (*Halichoerus grypus*) populations are either increasing or have stabilized at an apparent carrying capacity (Thomas et al. 2019). The two species overlap in their distributions (Russell et al. 2017) and diet (Wilson & Hammond 2019), and there is growing evidence that adult male grey seals can kill and partially eat marine mammals, including adult harbour seals (Brownlow et al. 2016). It is therefore possible that there could be some causal relationship between the contrasting population trends observed.

This study aims to investigate the population level effects of competitive and predatory interactions between harbour and grey seals. Archival diet and animal-borne tracking data will be used to define the multidimensional ecological niche space of both species; along dietary, geographic and environmental axes. These will be defined at the regional scale, and the breadth and overlap between the species will be investigated along various points of their population trajectories. These datasets will then be used in conjunction with population trends to investigate how the habitat preferences of harbour and grey seals may have changed through time in relation to population densities. In addition, grey seal inflicted mortality data from the Scottish Marine Animal Strandings Scheme (SMASS) and the UK Cetacean Strandings Investigation Program (CSIP) will be supplemented with data collected through a new citizen-science website to quantify the extent of grey seal predation of marine mammals. From this work, we will define competition and predation parameters, which will be used in a Leslie matrix alongside UK seal population estimates through the years, to better understand the role of that grey seals have played in the regional harbour seal decline.

Acknowledgements

This study is part of a PhD which is funded through the Scottish Universities Partnership for Environmental Research (SUPER) Doctoral Training Partnership, part of the Marine Alliance for Science and Technology for Scotland (MASTS). The project uses archival datasets (scats, telemetry tags, aerial surveys and strandings) so we would like to thank everyone who has been involved in both funding and collecting these data through the years. We would also like to thank the numerous volunteers and naturalist groups who have submitted reports, images and video files of potential grey seal predation events to the Sea Mammal Research Unit.

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Assessing the feasibility of citizen science to access changes and monitor cetacean distribution in Iceland

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Cetaceans have been a prevalent part of Icelandic culture dating back to the 10th century. As both a whaling nation, and home to a thriving whale watching industry, Iceland is well known for its complex relationship with cetaceans. The cetaceans of Iceland have been routinely studied for the past 30 years, however, there are still major gaps in understanding their current and changing distributions. Furthermore, widespread surveillance of cetaceans is both an expensive and laborious process, and often conducted seasonally. This study examines the feasibility of using citizen science in Iceland to assess changes and monitor cetacean distribution. Citizen science is a cheap and effective tool for collecting data, educating participants and sparking community-ownership of research, but its success depends on willingness of participants to contribute data. We surveyed individuals' interest to contribute and knowledge of cetaceans through an online questionnaire survey. We targeted fishermen and whale-watching employees as two groups who spend considerable time at sea, covering larger areas. Our prior expectation was that whale watching employees would be more willing to contribute to cetacean citizen science. In total, 81 fishermen and 30 residents and workers took the questionnaire. Although just under 50% of participants were interested in submitting sightings of location and species in the future, the projected survey coverage was still widespread across Iceland with 52 individuals. Participants were also tested in their ability to identify species – fishermen often were unable to recognize cetacean species by image, while watching employees could differentiate between species. However, fishermen, as well as residents and workers were able to identify species specific changes they had seen over time, including, an increase in humpback whales, decrease in minke whales and shift of blue whales northward. Fishermen, in particular, also made specific comments on cetacean prey associations, such as, humpback predation on capelin. These changes correspond well with current scientific understanding and therefore add to the credibility of participants. Based on the results of this study, a citizen science project in Iceland is possible and likely will support a better understanding of Icelandic cetaceans.

Tweetable abstract:

Citizen science is a fantastic, inexpensive method of collecting data, that can also educate and spark ownership in a community. This study assessed the feasibility of using citizen science to not only monitor cetacean distribution in Iceland, but also use local knowledge to understand changes over time.

Twitter handle: @whalewise

Acknowledgements:

Firstly, thank you to Aidan Keane, my supervisor, for all of your guidance this year, sharing your immense knowledge and experience in social science, and yet, still allowing me the freedom to create (and make mistakes).

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Thank you to Christian Schmidt and Eva Björk Káradóttir for translations and guidance along the way.

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(1) Making the writing more concise, direct and concrete, or
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Lastly, a huge thank you to the Húsavík Whale Museum and researchers from the University of Iceland's Húsavík Research Centre for your continuous assistance and collaboration.

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The occurrence of harbour porpoises around salmon farms in Scotland

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Do #porpoises interact with #fishfarms in #Scotland? A novel approach allows monitoring even if farms use Acoustic Deterrent Devices #ADDs. Long-term #PAM reveals high #echolocation rates at some farms and #foraging. But what drives these observations? **#MASTSasm2020 @tex_sim**

The harbour porpoise is the most abundant cetacean in UK waters. On the west coast of Scotland, the Inner Hebrides and Minches Special Area of Conservation (SAC) was designated in 2018 for the protection of porpoise habitat. Within the SAC there is significant overlap with Atlantic salmon aquaculture, yet the nature and extent of porpoise interactions with salmon farms are poorly understood. The aims of the present study were to determine if Passive Acoustic Monitoring (PAM) for porpoise echolocation could be conducted at salmon farms, and if so, gather long-term data to establish when and how often they approach farms on Scotland's west coast.

Acoustic recorders (C-PODs) were deployed at seven salmon farms and one control site in the Sound of Mull and wider Firth of Lorn between May 2018 and March 2020. Initial deployments indicated that the signals emitted by Acoustic Deterrent Devices (ADDs) to deter seals limited the ability of the C-PODs to effectively monitor porpoises. ADD signals caused C-PODs to reach a pre-programmed click limit setting and stop recording. C-POD experiments were conducted using established and new techniques to prevent the click detection threshold being reached under ADD exposure, thus allowing porpoise monitoring at farms whether or not the deterrent devices were used.

While some farms had low levels of porpoise vocalisation activity across the monitoring period, (n= 893 detection positive minutes at one farm), at others, far more detections were made (n= 34,165 detection positive minutes). Detection of foraging buzzes suggested that porpoises may be feeding around the fish farm infrastructure. Models were used to explore the factors that may have influenced porpoise detections. Environmental variables such as water temperature, salinity, wind/current speed and direction, and tidal elevation were extracted for each fish farm from the West Scotland Coastal Ocean Modelling System (WeStCOMS; Aleynik et al., 2016). Farm related variables such as the presence of fish farm staff and farm status (active/fallow) were also included. Porpoises may be temporarily displaced from salmon farms when workers are present (Haar et al., 2009), while current speed and time of day may drive detections in non-farm areas (Holdman et al., 2019). In the present study, results indicated significant inter-farm variability in terms of the factors that influenced detections, including hour of day, time of year, farm status, and tidal elevation. The study shows for the first time that interactions between aquaculture and porpoises occur regularly on the west coast of Scotland.

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Harbour seals avoid tidal turbine arrays during operations

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Abstract

The increasing global demand for energy coupled with the desire to reduce atmospheric carbon has fuelled the development of the renewable energy industry in recent years. Owing largely to their predictability, tidal currents provide one useful source of renewable energy which can be harnessed in a similar manner to wind. However, due to its relative infancy, the environmental impacts ranging from changes to physical oceanic properties to direct interactions with megafauna, are largely unknown. Here, we present an analysis which quantifies the behavioural effects of the presence and operations of the world's largest operational tidal turbine array on a population of harbour seals in the north of Scotland. Using adaptive smoothing algorithms in generalised additive models within a generalised estimating equation framework, we present results demonstrating that seals show overt avoidance responses to the operations of the turbine, with a significant decrease in predicted abundance within a range of ~2 km from the turbine array while they are generating power. We also show that, over the longer period of exposure to the presence of the turbines, no significant changes in distribution were observed indicating that during the study period, foraging sites were not obstructed by any apparent barrier effects or perceived threats. These results provide important information which can be used to update estimates of potential interactions and collision rates between harbour seals and tidal turbine arrays, and demonstrates a robust analytical framework which can be employed in future studies to assess how arrays of increasing size and operational status can affect distributions of marine animals.

Tweetable Abstract

@JojoOnoufriou shows that harbour seals avoid tidal turbines during operations but overall distributions remain consistent post-installation. Significant implications for collision risk models and population level effects.