Using a multi-disciplinary approach to quantify spatial overlap between deep diving seabirds and tidal stream turbines

James J. Waggitt (1), Benjamin J. Williamson (1,2), Philippe Blondel (2), Paul S. Bell(3), Beth E. Scott (1)

(1) Institute of Biological and Environmental Sciences, University of Aberdeen, Aberdeen, UK; (2) Department of Physics, University of Bath, Bath, UK: (3) National Oceanography Centre, Liverpool, UK. Presenter contact details: r01jjw11@abdn.ac.uk.

Summary

There is likely to be a rapid increase in the number of tidal stream turbines in the next decade. A major concern is that deep diving seabirds (auks *Alcidae sp* and cormorants *Phalacrocorax sp*) may collide with the moving components of devices during foraging dives. However, if individuals do not dive near tidal stream turbines within the tidal pass habitats favoured for installations, then they will not face collision risks. Identifying associations between physical conditions and deep diving seabirds would allow species fine scale foraging distributions within tidal passes to be predicted, leading to estimations of spatial overlap between species foraging distributions and tidal stream turbines. Here we outline a suite of biological and physical datasets from the Fall of Warness, Orkney, UK that have been collated to identify associations between physical conditions and vulnerable species. Preliminary results reveal associations between strong currents and several vulnerable species although seasonal variations were seen. However, the inclusion of more physical conditions in future statistical analysis will allow more precise predictions of species fine-scale distributions. This will lead towards confident estimations of spatial overlap between deep diving seabirds and devices in tidal pass habitats.

Introduction

Following the European Commission Renewable Energy Directive (2009/28/EC), there have been rapid developments in tidal stream turbines with many companies approaching large-scale installations within the UK (Willow & Valpy 2011). There is a legal responsibility to minimise the impacts of installations on seabird populations (The European Birds Directive 2009/147/EC) yet it remains unknown whether installations present real and substantial risks at the population-level (see Furness et al 2012). One possible impact that receives much attention is collisions between deep diving seabirds (auks *Alcidae sp.* and cormorants *Phalacrocorax sp.*) and moving components of devices. However, if individuals do not dive near devices within the tidal pass habitats favoured for installations, then they shall not face collision risks. Within these habitats, tidal stream turbines require specific physical conditions with consistently fast and unidirectional currents (+ $2ms^{-1}$) required to provide efficient energy returns (Fraenkel 2006). It is unknown whether deep diving seabirds also require specific physical conditions to enhance prey availability. However, identifying associations between physical conditions and vulnerable species would allow their fine scale foraging distributions within tidal passes to be predicted. This would allow estimations of spatial overlap between species foraging distributions and tidal stream turbines within these habitats: identifying those likely to dive near devices and face collision risks (Waggitt & Scott In press). Here we outline a suite of physical and biological datasets from the Fall of Warness, Orkney, UK that have been collated to identify associations between physical conditions and vulnerable species within tidal pass habitats.

Materials and Methods

Fieldwork was conducted in the Fall of Warness, Orkney, UK (57°7 to 59°11'N, 002°47 to 002°50) during May 2012, October 2012 and May 2013. Concurrent datasets detailing seabird distributions, prey characteristics hydrodynamics, bathymetry and substrate at fine spatial (<100m) and temporal scales (<15minutes) were collated. The location of foraging seabirds was recorded by JNCC trained observers on-board the *FRV Alba na Mara* vessel during a series of zigzag transects. During transects, a Simrad EK60 multifrequency echosounder operating at 38,120 and 200 kHz collected information on prey abundance and distribution (fish species) beneath the vessel. This also provided information on substrate and subsurface hydrodynamics. Vessel surveys were supplemented with outputs from 2D hydrodynamic (MIKE 21) models (Lawrence *et al*. 2009) showing current speeds and directions, and outputs from Marine X-band radar data (Bell *et al*. 2012) showing surface features such as shearlines, boils and standing waves. Bathymetry was sourced from a past multibeam sonar survey.

Results and Discussion

Here a diverse suite of physical and biological data sourced from a range of diverse disciplines (ecology, oceanography, fisheries sciences) and approaches (human observations, remote sensing, modelling, *in-situ* measurements) have been collated together to identify associations between physical conditions and deep diving seabird species within a tidal pass habitat. Preliminary analysis revealed associations between Atlantic puffins *Fratercula arctica,* common guillemots *Uria aalge,* Razorbills *Alca torda,* black guillemots *Cepphus grylle* and high currents although seasonal variations were seen. This hints that high levels of spatial overlap may be present during some seasons for these 4 species. However, statistical analysis has yet to be performed upon these datasets. Moreover, any statistical analysis shall also include more measures of physical conditions including current gradients, subsurface hydrodynamics, bathymetric features and substrate characteristics. By including more measures of physical conditions, very precise predictions of fine-scale distributions within tidal passes may be achieved. This would lead to confident estimations of spatial overlap and therefore the identification of species likely to dive near devices and face collision risks. By identifying vulnerable species in the sites earmarked for installations, estimations of spatial overlap can provide the information needed to develop appropriate mitigation schemes to reduce collision risks.

References

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