Proceedings of the 2nd International Conference on Environmental Interactions of Marine Renewable Energy Technologies (EIMR2014), 28 April – 02 May 2014, Stornoway, Isle of Lewis, Outer Hebrides, Scotland. *www.eimr.org*

EIMR2014-972

DIVING AND FORAGING BEHAVIOUR OF SEABIRDS IN A HIGH-ENERGY TIDAL STREAM: IMPLICATIONS FOR ENCOUNTERING TIDAL-STREAM DEVICES

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ABSTRACT

Diving seabirds may encounter and collide with tidal turbine installations while foraging underwater. The consequences of collisions with these devices have the potential to impact on seabird populations. For birds with foraging and diving preferences within high energy tidal streams the devices may have important behavioural and ecological implications. However, our knowledge base on this is currently very limited. Our study seeks to develop our understanding of seabird foraging and diving behaviour under different tidal conditions within a high-energy tidal stream.

Focal observations were undertaken from vantage points along the length of Bluemull Sound, Shetland. We present results on diving frequency under these different tidal conditions, and also determine if any relationships exist between diving direction and bird movement and the current flow within the sound. This study is identifying under which tidal conditions species may be more likely to encounter tidal turbines. This should lead to a more accurate assessment of the impacts of marine renewable energy developments.

INTRODUCTION

High-energy tidal stream devices are being developed, and this is challenging our understanding of impacts on seabirds. Diving seabirds may encounter and collide with tidal turbine installations while foraging underwater. Some may be killed or injured. Others may avoid the devices, or even harness prey associated with them, with implications for their foraging efficiency. These consequences have the potential to impact on seabird populations. There is a legal requirement to assess any impacts of marine renewable energy developments through an Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA).

For birds with foraging and diving preferences within high energy tidal streams the devices may have important behavioural and ecological implications. Diving birds face a trade-off between energy gain due to prey consumption against energy lost due to the energetics of diving [1]. Studies have found different species exploited different states of the tidal cycle [2]. However, our knowledge base on how they utilise high-energy tidal environments in a UK context is still very limited [3, 4, 5]. Our study seeks to develop our understanding of seabird foraging and diving behaviour under different tidal conditions within a high-energy tidal stream.

METHODOLOGY

Focal observations were undertaken from six vantage points along the length of Bluemull Sound, Shetland, prior to the deployment of a tidal stream device. Over 1,000 focal observations were collected during the 2011 and 2012 breeding seasons, and January 2012. During each observation the location and duration of behaviours were recorded, including foraging behaviours and the direction the bird was facing and moving within the tidal stream. Observations were undertaken across a range of tidal conditions. These have been analysed with tidal current speed and direction data, collected through an Acoustic Doppler Current Profiler (ADCP) deployed in Bluemull Sound in 2004. We have used binomial generalized additive models (GAMs) to determine relationships between diving observations and tidal parameters, including mean speed (averaged across depths), speed at different depths within the water column and current direction. Finally we have used the focal observations to investigate relationships bird movement within the sound in relation to current direction.

OBSERVATIONS

We briefly summarise some of our key observations. The most frequently observed diving species included European shag (*Phalacrocorax aristotelis*), black guillemot (*Cepphus grylle*), common guillemot (*Uria aalge*) and Atlantic puffin (*Fratercula arctica*), with European shag and black guillemot being the most frequently observed species in both breeding and non-breeding seasons.

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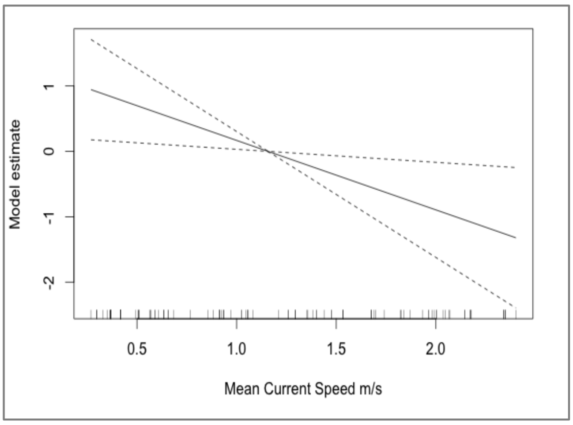
Initial analyses suggest that diving frequency in some species, such as puffin show significant correlation with the mean current speed (mean current speed, p=0.014*. N=114, dev. explained =51.8%; refer to figure 1). However, other species show more complicated relationships, e.g. common guillemot diving frequency is better explained by models that use current speed at different depths within the water column.

Figure 1: Atlantic puffin diving frequency by mean current speed (m/s). Binomial GAM: Dive frequency ~ Focal duration + mean current speed



We found that focal observations have enabled identification of behavioural adaptations by birds utilising high-energy tidal streams. For example, we frequently observed black guillemot undertaking short flights upstream, against the current, before landing, diving and drifting downstream with the current. A similar behavioural pattern of using the currents as a “feeding conveyor-belt” has been described for the closely related species, pigeon guillemot (*Cepphus columba*) [2]. We suggest this behavioural adaptation to a high-energy tidal environment, maximises black guillemot foraging within a smaller area. However, this has potential implications for turnover rates and estimated abundances of birds within development sites.

CONCLUSIONS

Our findings show that diving frequency varies under different tidal conditions. A better understanding of these preferences can help inform a species’ sensitivity to tidal developments and any impact assessments.

For example, species that are observed diving more frequently in faster flows have an increased potential for encountering a tidal device at maximum velocity. Similarly, preferences for currents at certain depths may help determine a species’ sensitivity to the location of turbines within the water column. While orientation of dives in relation to current flow may affect how a species approaches, and consequently detects, an underwater device.

Finally, our study highlights the importance of focal observations in understanding behavioural usage of tidal environments. We suggest these observations can provide context to site abundance and density estimates, and give an indication of turnover within development sites. This can lead to a more accurate assessment of the impacts of marine renewable energy developments.

ACKNOWLEDGEMENTS

This work has been funded by a University of Glasgow PhD scholarship and Scottish Natural Heritage. We would like to thank Maurice Henderson, Shetland Islands Council and Alan Harpin, Shetland Seafood Quality Control for providing access to ADCP data for Bluemull Sound. Karen Hall, Glen Tyler and George Lees, Scottish Natural Heritage, Andrew Nisbet, North Yell Development Group, Ross McGregor, Natural Power for their guidance in developing this field study. Finally thanks to Melissa Bruns, Kate Tyler, Lynn Thompson, Jim Nangle, Helen Wade, James Waggitt and Liz Masden for fieldwork assistance and methodological discussions.

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