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

EIMR2014-8111

What's Next and Why? A look ahead at strategic ecological research direction.

Beth Scott[1]
School of Biological Sciences,
University of Aberdeen,
Tillydrone Ave, Aberdeen,AB24
2TZ, UK

INTRODUCTION

In the marine environment we are about to move from an era of testing and single devices or relatively small areas of wind farms to very large arrays of offshore energy development for wind, wave and tidal energy extraction. As we are moving to the use of substantial amounts of our most productive oceanic areas to be harnessed for the 'greater good' of supplying the urgent need for low-carbon energy we must understand, at a fundamental level, the ecological impact of this activity at the ecosystem level. In our world, with an increasing population, we need to be smarter in encouraging anthropological activity at sea than we were on land over the last few centuries – where globally our biggest cites are also generally over running on top of very fertile soils, situated in large deltas of the major maritime trading ports of the past.

So far the understanding of possible environmental interactions has been somewhat limited by the lack of even the most basic of baseline data. Therefore some years and a lot of money has now been spent just in starting to determine the answers to question such as: what species are present, how many and where are they? A resounding answer to all questions has been - YES, there are a lot of species which use these high energy areas for foraging and migration routes between feeding grounds and sites used for reproduction. There are also some specialist species which may use these high energy sites almost exclusively for foraging.

Therefore we need to do much more than just document what organisms are present and if their distributions are changing. We need to understand what happens across trophic levels at these high energy sites and what the effects of extracting a proportion of wind, wave & tidal energy, or just the deployment of man-made structures, will have on the behaviour of foraging and migrating animals.

An understanding of cumulative effects, in their widest sense, ranging from the production levels of primary produces to the reproductive output of marine mammals, needs to be progressed such that a more accurate prediction of the scale and intensity of effects in 'downstream' regions can be considered. We do have a good enough understanding at both small and large scale spatial and temporal levels to be able to make predictions of at least what will change physically within our marine environment when many hundreds to thousands of marine renewable devices are operating. We need to match that knowledge with a rapid increase in our understanding of how a range of animals from the benthos, through to fish, seabirds and mammals will react to those changes in order to make well informed, lower risk and ecologically sustainable choices in the approved locations, density and detailed array design of renewable developments.

[1] Corresponding author: b.e.scott@abdn.ac.uk

METHODOLOGY

Using a review of results from ongoing marine renewables projects (in particular the NERC /DEFRA funded projects FLOWBEC & RESPONSE) aimed at increasing our understanding of marine animal usage of high energy sites - the scope of this paper will be to outline what needs to be measured and studied at a strategic level to provide much more certainty in the ability to incorporate ecological sustainability into the planning and regulating of large scale marine energy extraction.

OBSERVATIONS

This paper reviews what types of studies are rapidly and insightfully increasing our knowledge of ecological interactions in high energy environments. The short answer is those studies that can follow individuals and generate very detailed knowledge about plausible reasons for animals' temporal and spatial usage of specific locations (horizontal and vertical) are proving the most useful in increasing basic understanding.

Species specific behaviour in high energy sites

The main benefit in intensively studying a few sites is being able to detect general facts about species specific behaviour that are related to physical characteristics that are going to change, such as the speed of tidal flow, with the introduction of multiple renewable devices. The information collected on species in high definition at one site can then be transferred and tested to be seen if it applies equally to other sites and rapidly build-up an understanding

if there are general behavioural patterns, or not, within high energy sites.

The detailed information that studies of individual animal behaviour is providing is also exactly the type of information that is needed to parameterise simulation models of individual based behaviour which can be used to test the range of costs/benefits to individual of changes in their behaviour due to the effects of man-made structures and increases in the level of disturbance. These costs/benefits can then be modelled at a population level providing levels of certainty and risk to key decision makers such as regulators.

Tagging of individual animals

A rapidly increasing used method to provide detailed information on individual animals is to tag them with a range of devices that can collect information on their movements and be used to interpret their behaviour. From the low tech colour ring/band through to data storing tags that need to be retrieved to get information (i.e. GPS tags), to data transferring tags (i.e. transmitting to satellites) and to active acoustic tags (i.e. 'pingers' that need to be picked up by hydrophone receivers).

A review of what can be learned by the tagging of individual animals in high energy environments will be provided. In particular state-of-the-art tags which provide high temporal definition (information at the level of seconds) of changes to behavioural states can be used in powerfully predictive state-space models which allow the small differences in hourly, daily movements to be assessed at seasonal and population levels. However we argue that to understand the connection between animal behaviour and the physical environment, in order to predict what may change with the large scale extraction of marine energy, there is a need for the simultaneous collection of behavioural and biological & physical oceanographic data.

Active and Passive Sonar

In high energy sites multiple aspects of the environment can change extremely rapidly. In fact it may be the range of extreme environments that attracts so many animals to these sites to forage. An approach to getting data on the behaviour of multiple animals and their bio-physical habitats at the same time is the use of acoustics, both passive and active, collected in either an upward facing position from the seafloor or downward facing from the sea-surface, covering the entire water column. Passive acoustics can detect the presence and location of animals within the water column that make sounds as well the animals with active acoustic tags. Active acoustics can be used to track the very fine scale movements of all moving animals in the vertical water column from larger plankton species through fish species, seabirds, basking sharks and marine mammals. The use of both passive and active acoustics on a movable moored system could provide the most comprehensive method that is capable of identifying and tracking the movements of the full range of trophic levels and capturing their interactions. With the additions of instruments that measure current speeds, directions, temperatures and turbidity, these self-contained moorings can simultaneous measure both biological activity and the physical conditions in which distinct behaviours occur. The use of such systems, possibly with the addition of cameras triggered by the detection of animals, will reveal the current hidden world of predator-prey interactions in high energy environments.

Globally Shared Databases

We strongly suggest that, to move our understanding and ability to accurately predict ecological interactions and ecosystem effects forward rapidly, infra-structure needs to be created for the production and servicing of globally shared databases. We suggest that the task of setting up and sustaining such databases should be given to those national organisations (for example the Joint Nature Conservation Committee (JNCC) jncc.defra.gov.uk in the UK) that already have the proven track record of providing such a service nationally and internationally.

Communities and Stakeholders Discussions

And last, but certainly not least, an argument is presented for the encouragement of active interaction with communities and stakeholders concerning facilitated discussions about the use of ecological data and educating society's choices about trade-offs and the ecosystem effects of large scale marine energy extraction. There will be neither a rapid nor sustained movement towards the acceptance of large scale developments of renewable energies without public backing. And public acceptance will only come where there is a sense of transparency, fairness and acceptance of the risk and trade-offs to the changes to our ocean habitats.

ACKNOWLEDGEMENTS

The insights that this work covers come from the privilege of interactions with the researchers in the groups that make up FLOWBEC (Paul Bell, Philippe Blondel, Benjamin Williamson, Eric Armstrong, Chris Hall, Ian Davies, Ian Ashton, Lars Johanning Angus Creech, David Ingram, Ricardo Torres, Pierre Cazenave, Daniel Conley, Deborah Greaves) and RESPONSE (Dave Thompson, Ben Wilson, Gordon Hastie, Paul Lepper, Simon Jude) as well as an array of my current and past PhD and post-docs: Jacqui Tweddle, Marianna Chimienti, Shaun Fraser, Andronikos Kafas, Beckie Langton, Evelyn Philpott, James Waggitt.