NATURAL ENVIRONMENT RESEARCH COUNCIL

Wave & Tidal Consenting

Position Paper Series

Ornithological Impacts

AUTHORS

Paper One: Birds: Kirby, A. D., Hawkins, K. R., Freeman, S. M., McCall, R. A., Furness, R. W. & Edhouse, E. S. (2013)

PROJECT MANAGER

David Krohn, RenewableUK

RenewableUK, Scottish Renewables and Natural Environment Research Council

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"Highlighting key ornithological issues that have arisen during the development of wave and tidal devices and arrays..."

1 Background

The potential ornithological impacts associated with the construction, operation and maintenance and decommissioning (together referred to as the 'project lifecycle') of wave and tidal energy devices ('wave and tidal devices') have been identified and described in the Scottish Marine Renewables Strategic Environmental Assessment ('the SEA') (Faber Maunsell & Metoc, 2007), the Scottish Natural Heritage ('SNH') document "Guidance on survey and monitoring in relation to marine renewables deployments in Scotland – Volume 4: Birds" (Jackson & Whitfield, 2011) and by the Royal Society for the Protection of Birds ('RSPB') (McCluskie et al., 2013). These documents highlight the general impacts that may arise during the project lifecycle of wave and tidal devices and have informed the Environmental Impact Assessment ('EIA') of projects that have been consented or await consent.

This paper builds upon current knowledge and available literature, drawing upon the experiences of those involved in the wave and tidal energy industry (gathered by telephone interviews with 11 stakeholders in industry, regulators and academia) in order to highlight key ornithological issues that have arisen during the development of wave and tidal devices and arrays. The aim of this paper is to provide a consolidated understanding of the current status of the ornithological issues facing the wave and tidal industry, highlight knowledge gaps and detail key experiences. Recommendations are also made for future research priorities and to aid the successful future deployment of wave and tidal devices.

Table 1 summarises the number of full-scale devices installed or are currently operating in the UK where 3.4 MW are installed for wave and 5.2 MW for tidal projects

TABLE 1. FULL SCALE DEVICES INSTALLED OR CURRENTLY OPERATING IN UK WATERS

DEVICE TYPE	OPERATOR	DEVICE	RATING (MW)	COMMISSIONED	LOCATION
TIDAL	Andritz Hydro Hammerfest	HS1000	1	2011	Fall of Warness, European Marine Energy Centre ('EMEC')
	Alstom	DeepGen 1MW	1	2013	Fall of Warness, EMEC
	Marine Current Turbines	SeaGen	1.2	2009	Strangford Lough, Northern Ireland ('NI')
	Minesto	Deep Green	0.5	2013	Strangford Lough, NI
	OpenHydro	Open Centre turbine	0.25	2008	Fall of Warness, EMEC
	Scotrenewables Tidal Power	SR250	0.25	2011	Fall of Warness, EMEC
	Voith Hydro Ocean Current Technologies	Hy Tide 1000-13	1	2013	Fall of Warness, EMEC
WAVE	Aquamarine Power	Oyster 800	0.8	2012	Billia Croo, EMEC
	Fred.Olsen	Bolt "Lifesaver"	0.25	2012	FaBTest, Cornwall
	Pelamis	Pelamis P2	0.75	2010	Billia Croo, EMEC
	Seatricity	Oceanus	1	2013	Billia Croo, EMEC
	Wello	Penguin	0.6	2013	Billia Croo, EMEC

2 Key Issues

"To provide a consolidated understanding of the current status of the ornithological issues facing the wave and tidal industry, highlight knowledge gaps and detail key experiences..."

In the last 5 years the wave and tidal industry has seen a period of rapid expansion. Much of this activity has been developer led and has focused on the provision of environmental information and EIA in order to gain development consents, and the subsequent and related monitoring of environmental receptors in areas where devices (mostly test devices) have been installed. In addition, considerable research effort continues to be undertaken by the academic community (e.g. the Natural Environmental Research Council's ('NERC') Marine Renewable Energy Knowledge Exchange ('MREKE') programme) with a particular focus on quantifying the potential effects of wave and tidal devices or arrays. During this time, regulators have been primarily focused on the development of policy, guidance and approaches to the consenting process, and steering the focus of academic research.

There is still uncertainty regarding the level of impacts on birds (at the population scale) that may arise from the construction and operational phases of wave and tidal devices and arrays. Although the application of the source-pathway-receptor model within the EIA process identifies the potential impacts, it is the quantification of the impacts that remains challenging. A degree of uncertainty will remain, regardless of ongoing research or monitoring of test devices, until monitoring results from larger installations become available. Ensuring that this uncertainty is addressed in a constructive and co-ordinated fashion early in the development of the industry may avoid the issues that continue to hamper the development of offshore wind. It is also likely to prove to be a more cost effective solution in the medium to longer term by reducing regulatory burdens and reducing monitoring requirements in the future. This general position is common for both wave and tidal projects; however it is acknowledged that there are fundamental differences between these two types of generation at the level of individual impacts.

This paper recommends that the consenting and development of arrays of around 10 megawatts ('MW') in size, or phased deployment of larger arrays, should be prioritised. These projects would then need to be monitored (using statistically robust methodologies) to advance the position of the industry as a whole. This recommendation supports the pragmatic policy of survey-deploy-monitor that has been developed by Marine Scotland. In the interim, the vulnerability index developed by Furness et al. (2012), when allied with the outputs of current research, provides a basis for the assessment and consenting of ~10MW arrays (with regard to ornithology). Once these arrays are installed the industry will be able to reduce consenting risk to future projects by ensuring that uncertainty can be reduced. This will avoid the prolonged precautionary approach that has been adopted by regulators during the deployment of both onshore and offshore wind (an approach most associated with Habitats Regulations Assessment ('HRA') under The Conservation of Habitats and Species Regulations 2010 (as amended) in England and Wales and The Conservation (Natural Habitats, etc.) Regulations 1994 (as amended) in Scotland). The key to the success of this pathway will be to ensure that the design of the monitoring strategies are focused on answering specific questions and do not simply repeat the surveys undertaken to inform the consenting process.

In addition to the monitoring programmes, further strategic funding initiatives for applied research focused on the quantification of environmental impacts are critical during the coming three to five year period. These programmes could provide both important evidence for use within the consenting process and aid in the development of monitoring strategies that will reduce uncertainty (e.g. through the development of suitable sensor arrays for detecting bird collisions). It is important that both regulators and industry play a role in shaping the direction of research to ensure that maximum value is achieved; however, the funding of such work may need to be allocated centrally (e.g. through research grants) as it is not considered feasible for individual developers to support this work.

Other key consenting issues that have been identified through the current review of industry experience and that are considered important in ensuring the future success of the wave and tidal industry are:

» *Ensuring that the level of ornithological survey effort required to inform EIA and post-consent monitoring is determined on the basis of the risk of project specific impacts occurring and that survey design is tailored to answer specific questions for a given project;*

» *Ensuring that standardisation of survey protocols enables comparative approaches but does not result in a 'one size fits all' approach;*

» *Ensuring the surveys undertaken are designed to minimise the effects of natural variation and maximise statistical power to detect real change;*

» *Ensuring that uncertainty is highlighted and that consideration is given to how it should be dealt with in the impact assessment process;*

» *Undertaking further research to reduce uncertainties and provide tools for developers to use within the assessment process; and*

» *Understanding how the potential assessment of cumulative impacts can be undertaken as the number and size of projects increases.*

Guidance developed for ornithological surveys for offshore wind farm projects (e.g. Camphuysen et al., 2004) has provided a useful basis for the advice provided to wave and tidal developers by regulators. However, the high levels of survey effort required to inform an EIA for a large offshore wind farm or wind farm zone, and the types of techniques used, may not be appropriate to many of the wave and tidal projects being proposed. This is because wave and tidal devices are generally considered to pose less risk to birds (i.e. through displacement and/or collision) than wind turbines, while the projects developed to date and those planned in the near future, are considerably smaller in scale than current offshore wind projects (a typical Round 3 project may be approximately 550km^2 and 1.2GW capacity). The consensus from all parties interviewed is that the survey programme to inform EIA should be proportional to the risk of impact posed by each individual project. In addition, the surveys undertaken should be focused on the particular technology type and be purposefully designed

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to answer specific questions related to impacts thereby reducing levels of uncertainty. It may also be of benefit to consider survey protocols used for other development types (e.g. aquaculture), rather than rely solely on the foundations built for the offshore wind industry. The benefits of engendering a strongly project-focused approach would be the delivery of robust EIA with lower levels of uncertainty regarding impact prediction and the potential for the provision of specific data that may be useful in the assessment of other schemes or to aid future research.

The production of survey guidance by regulators is generally well received across the industry, as long as the different survey protocols can be applied on a case-by-case basis and amended, depending on the location and scale of the project and the type of technology being proposed. This approach allows for individual projects to match survey effort to perceived impact, whilst ensuring that the methodology employed is comparable with that used elsewhere (aiding any cumulative impact assessment (CIA)).

Feedback from the interview process suggests that the development of survey guidance should be undertaken by regulators in conjunction with the academic community and developers. This is because many of the data sets collected through the EIA or post-construction process have little or no value for the research community as (1) subtle differences in the interpretation of survey methodologies can result in different data sets being incompatible and (2) the statistical power of the survey methods are not always sufficient to allow adequate confidence to be placed in the data. Remedying these drawbacks in the short-term is in the best interests of developers, regulators and the academic community, as it will reduce uncertainty in the results (by dealing more effectively with natural variability), allow more robust EIA and provide data which may be of use in the future de-risking of the consenting process.

3 Key Impacts

This section provides a summary of the current state of knowledge on key impacts on birds, and where uncertainty exists. Key impacts were determined from a combination of reviewing available research and monitoring studies (see the References section below), review of project specific scoping and EIA documents and information gathered during telephone interviews. Other impacts, often highlighted in the assessment process, such as entrapment of birds within devices and pollution of the marine environment through chemical loss are not described below as they are not considered to be key impacts.

3.1. Collision
Tidal devices

Collision risks to birds due to wave and tidal energy projects may occur during construction (e.g. with construction vessels) or operation (e.g. with fixed structures, anchor chains etc.). However, the risk of collision is generally considered to be greatest for birds that may forage by diving at depths in which tidal devices may be deployed; the risk of collision with construction vessels and wave devices is considered to be negligible. Quantifying the collision risk for individual projects is generally based on a two stage approach – the first stage is to identify the species present within the site which have the ability to dive to depths where they may be at risk of colliding with devices, while the second stage is to then understand the potential encounter rate for each 'at risk' species using a suitable model. The difficulties with this approach are that little is known with regard to the behaviour of diving birds when close to underwater obstructions. Without this information, the outputs from modelling cannot be relied upon when undertaking assessments and therefore a precautionary interpretation of results may be required.

Sensor arrays are currently being developed that will be able to provide further insight into the behaviour of birds when in proximity to tidal devices. This information should help to both understand the risk of impacts associated with different types of device and to develop tools for use in the quantification of impacts for projects within the planning system. Information gathered at operational sites should also provide some information on which species may be attracted to the sites for foraging (i.e. increasing encounter rates) or are likely to be displaced from the area (i.e. reducing encounter rates).

To date, no anecdotal reports of collisions with tidal devices have been reported. However, as no specific monitoring of collision rates at operational devices has been undertaken the lack of a reported effect does not result in the conclusion of no effect.

3.2. Disturbance / displacement
Wave devices and Tidal devices

The concept of disturbance and displacement of birds from wave and tidal generation schemes during both the construction and maintenance phases of a development by aural and visual stimuli is well understood. However, relating the concept of disturbance to the quantification of an impact at the level of the local, regional or national population is problematic. The displacement of birds from preferred foraging areas may result in reductions in body condition and survival (e.g. Burton et al., 2006), however the area of displacement, foraging range, the level of competition for resources and the temporal and spatial changes in resource distribution that may occur within the environment will all play a role in determining the size of the impact for each project and each species.

Until evidence is available that enables the potential population level effects to be estimated based on data gathered at operational sites, quantified assessments will remain challenging. However, in order to standardise the approach, Marine Scotland is developing guidance to aid developers in undertaking quantitative assessments of the effects of displacement, due for publication in late summer/autumn 2013. This guidance will be based on best current knowledge and will provide a tool that can be used by all developers to give a consistent approach to assessment.

The potential impacts of disturbance and displacement during the operational phases of a project are most likely to be associated with wave devices. This is because the amount of surface breaking infrastructure is likely to be considerably greater than for tidal turbines (many designs of which require no surface infrastructure). The level of potential impact is highly likely to be directly related to the scale of the project.

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3.3. Alteration of hydrodynamic regime
Wave and Tidal devices

The placement of any structure within the marine environment will result in changes to the hydrodynamic regime. These changes may include the creation of areas of turbulent water, increases in the level of suspended sediment present in the water column or reduction in wave height. These changes in the physical environment have the potential to influence the behaviour of birds in the area by altering the value of an area as a foraging locus (i.e. by altering prey density or by increasing/reducing foraging efficiency) or by acting as a resting location (i.e. using the waters on the leeside of a device for shelter).

By linking the likely changes in hydrodynamic regime to potential changes in both prey populations and bird behaviour (e.g. how birds react to state of tide, water depth, position of fronts etc.), a greater understanding of the potential scale of impact may be realised.

3.4. Attraction of birds
Wave devices

The attraction of birds to a range of devices currently deployed across the UK has been noted – including at WaveHub, Cornwall and EMEC, Orkney. The attraction may be due to the provision of a suitable roosting or resting platform or because the device attracts fish or provides hydrological conditions suitable for foraging. Cameras installed to monitor the operation of wave energy generators have recorded birds roosting on, fishing off and sitting in the lea of devices. The attraction of birds may be both positive and negative; for example

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the provision of a foraging platform due to the aggregation of fish around the device could improve foraging efficiency and subsequent fecundity and survival. It is also possible that the range of predators or klepto-parasites could be extended placing more pressure on certain species of seabird when travelling back to breeding colonies after foraging.

At present the observations of attraction come from test devices which limit the number of birds that may take advantage of the change in conditions. It is therefore, not possible to understand what the population/ community level effects of this attraction could be when larger scale arrays are deployed, and whether this is a beneficial impact that can or should be encouraged. However, given issues with the fouling of devices by birds and the potential problems with safety and / or corrosion this may bring, there is the potential that future developments in device design may be made to prevent birds landing.

3.5. Cumulative impacts

As the number of projects entering the planning system increases, the potential for an increase in uncertainty within the assessment process and a greater focus on CIA has been recognised by RenewableUK (2013) and The Crown Estate (MacArthur Green, 2013). The development of the offshore wind industry has been hampered by a lack of clarity and agreement regarding how to undertake a robust CIA; with uncertainty resulting in the provision of qualitative and overly precautionary assessments. This means that the quantification of impacts at the individual project level is often highly conservative and based on worst-case scenarios, making the addition of effects across projects unrealistic.

Recognising these issues, The Crown Estate has published a methodological framework for the wave and tidal industry in the Pentland Firth and Orkney Waters (MacArthur Green, 2013) to provide a consistency of approach in this location; however in order to ensure realistic quantitative assessment the uncertainty regarding the level of impacts at the individual project level still requires further investigation (see above). The potential of using this approach, for sites other that the Pentland Firth, is also still to be tested.

4 Impact Mitigation

Measures that may reduce potential impacts on birds are currently being developed; much of this work being driven by advances in design aimed at maximising the commercial potential of a device. For example, both disturbance and displacement of birds and project costs during the construction period are being reduced as engineers minimise the time it takes to deploy a device and the amount of maintenance it will require. Similarly alterations in device design may reduce other potential impacts such as collision risk.

It may also be possible in the future, following further development of sensor technology, to fabricate devices with sensors in-built to ensure that long term monitoring efforts (e.g. recording collisions) are wholly integrated within the project. This may increase the amount of data collected at the same time as reducing cost.

Many interviewees did note that the development of renewable energy devices is itself mitigation for predicted climate change. It is recognised that the threat to the size and characteristics of the ornithological community using UK waters is much more likely to be impacted by gross changes in the environment than by individual marine renewable developments.

5 Key Research

The ongoing development of wave and tidal devices has provided valuable information to support the consenting of future large scale projects. Currently, much of this information is included within individual project monitoring reports which focus on single technology types; however, there are other projects currently ongoing that aim to provide more generalised results for both wave and tidal devices, which may provide outputs within the next six to twenty-four months.

As the industry moves toward installing large commercial scale arrays, they will be provided with the opportunity to reduce consenting risks by ensuring that uncertainty can be reduced sufficiently to avoid the prolonged precautionary approach adopted by regulators during the deployment of offshore wind. The key to the success of this will be to ensure that the design of the monitoring strategies are focused on answering specific questions and do not simply repeat the surveys undertaken to inform the consenting process.

Table 2 provides information on recent and current work streams that have been identified through this study as key to reducing uncertainty in the marine renewables industry.

TABLE 2. KEY ORNITHOLOGICAL RESEARCH

PROJECT TITLE/PUBLICATION	BRIEF DESCRIPTION	REPORTING
FLOWBEC AND RESPONSE PROJECTS (NERC MREKE)	These projects aim to understand how birds respond to different marine environments and to marine renewable devices. These projects will provide valuable information on species behaviour that will inform the understanding of risks to birds (notably collision) enabling better assessments and array layout planning.	These projects are due to report in 2014.
IMPACT ASSESSMENT TOOL (AQUATERA)	This tool enables users to determine the potential effects associated with a project that could be significant and screen out those that will not be. The database is updatable and will be populated with further information as it becomes available.	The IMPACT Assessment tool is available at www.marine-impact.co.uk/index.asp
WILDLIFE OBSERVATION PROGRAMME (EMEC)	EMEC is embarking on an analysis of long-term datasets that have been collected across their wave and tidal energy sites over the previous eight years. The aim of the analyses is to provide insights in to a range of issues including displacement of seabirds.	The project is due to report in spring 2015.
FUTURE OF ATLANTIC MARINE ENVIRONMENT (FAME) PROJECT (RSPB AND OTHERS)	The FAME project is undertaking a wide-range of studies (including Geographical Positioning System ('GPS') tagging) to determine how seabirds use the waters around the UK and elsewhere. Some of the information collected will be directly relevant to marine renewables development.	Journal articles associated with the project have already been published and more will become available as the project progresses (funded until 2013).
MONITORING REPORT SYNTHESIS (EMEC)	A large number of monitoring reports of tidal energy devices have been produced by individual developers based at EMEC. However, these are not usually publically available and can lack authority being often based on a single device. EMEC is planning to undertake a review of these reports and provide a synthesis of these monitoring reports to highlight common themes.	This project aims to start in the second half of 2013 (reporting date to be confirmed).
MARINE RENEWABLE ENERGY AND THE ENVIRONMENT (MAREE) PROJECT (ENVIRONMENTAL RESEARCH INSTITUTE AND THE SCOTTISH ASSOCIATION FOR MARINE SCIENCE)	This project is multi-themed, with one of these being on the environmental impacts of marine renewables. As part of this project the potential interactions between marine energy developments and seabirds are being investigated.	This project aims to report in 2013.
HEBRIDEAN MARINE ENERGY FUTURES PROJECT (UNIVERSITY OF HIGHLANDS AND ISLANDS, ENVIRONMENTAL RESEARCH INSTITUTE AND THE SCOTTISH ASSOCIATION FOR MARINE SCIENCE)	This project is multi-themed, with one of these being the survey of sites to determine physical conditions and ecological receptors.	This project aims to report in 2014.
MACARTHUR GREEN (2013) ORNITHOLOGICAL CUMULATIVE IMPACT ASSESSMENT FRAMEWORK: PENTLAND FIRTH AND ORKNEY WATERS WAVE AND TIDAL PROJECTS. REPORT COMMISSIONED BY THE CROWN ESTATE.	This report provides a methodological framework for the assessment of ornithological cumulative impacts for the Pentland Firth and Orkney Waters.	This report is available on the internet at www.thecrownestate.co.uk/media/420424/PFOW-ornithological-cumulative-impact-assessment-framework.pdf
FURNESS ET AL. (2012) ASSESSING THE SENSITIVITY OF SEABIRD POPULATIONS TO ADVERSE EFFECTS FROM TIDAL STREAM TURBINES AND WAVE ENERGY DEVICES.	This paper provides a risk-based approach to the assessment of effects of wave and tidal devices for a range of seabirds.	This paper is available for order (see reference list).
ROBBINS (2012) ANALYSIS OF BIRD AND MARINE MAMMAL DATA FOR BILLIA CROO WAVE TEST SITE, ORKNEY. SCOTTISH NATURAL HERITAGE COMMISSIONED REPORT NO. 592.	This report explores the relationship between bird use of the Billia Croo Wave Test Site and environmental variables such as tidal state and wind direction.	This report is available on the internet www.snh.org.uk/pdfs/publications/commissioned_reports/592.pdf
JACKSON & WHITFIELD (2011) GUIDANCE ON SURVEY AND MONITORING IN RELATION TO MARINE RENEWABLES DEPLOYMENTS IN SCOTLAND. VOLUME 4. BIRDS. UNPUBLISHED DRAFT REPORT TO SCOTTISH NATURAL HERITAGE AND MARINE SCOTLAND.	This draft report provides guidance on ornithological survey methods for marine renewable projects.	This report is available on the internet at www.snh.gov.uk/docs/A585081.pdf

PROJECT TITLE/PUBLICATION	BRIEF DESCRIPTION	REPORTING
ROBBINS (2011) ANALYSIS OF BIRD AND MARINE MAMMAL DATA FOR THE FALL OF WARNESS TIDAL TEST SITE, ORKNEY. A REPORT TO SCOTTISH NATURAL HERITAGE.	This report explores the relationship between bird use of the Fall of Warness Tidal Test Site and environmental variables such as tidal state and wind direction.	This report is available on the internet at www.scotland.gov.uk/Resource/0041/00410511.pdf
ROYAL HASKONING (2011) SEAGEN ENVIRONMENTAL MONITORING PROGRAMME: FINAL REPORT TO MARINE CURRENT TURBINES.	This report provides an analysis of ornithological observations made during the pre-installation, installation and operational phases of tidal turbines in Strangford Narrows.	This report is available on the internet at www.marineturbines.com/sites/default/files/SeaGen-Environmental-Monitoring-Programme-Final-Report.pdf

6 Recommendations

It is clear that our understanding of the potential impacts on birds of wave and tidal devices is developing, yet a large degree of uncertainty still surrounds the potential impacts of wave and tidal technology (particularly larger arrays). The focus of stakeholders should therefore be on the rapid development of small arrays (or larger arrays developed in phases). Research priorities identified, through interview, over the next three – five year period (2014 – 2019) include:

- *The further development of sensor arrays (such as sonar) to provide information on predator and prey behaviour;*
- *The use of data gathered from sensor arrays to develop robust tools for estimating collision risk;*
- *Sensitivity mapping of proposed development areas (and elsewhere) using ornithological data (e.g. populations, foraging ranges, etc.) and physical parameters;*
- *Establishing fine-scale relationships between foraging birds and habitats and predicting how these may change following the deployment of wave and tidal generators; and*
- *Establishing the likely effects of climate change on bird populations and how to account for this within both the assessment and monitoring processes.*

In addition, this review has identified a number of more general recommendations to aid the development of the wave and tidal industry (many of these are common across all taxa and are not specific to birds):

- *Encourage dialogue that makes a distinction between wave energy and tidal energy schemes and ensures the differences in impacts are understood;*
- *Strategic scientifically robust and timetabled monitoring of test devices and arrays (through pre-construction, construction and operation phases) should follow survey protocols designed to ensure a high degree of statistical power and outputs should be made publically available;*
- *A regularly updated synthesis of available monitoring reports should be co-ordinated centrally; and*
- *Focus survey programmes for projects in development, as far as possible, on answering specific and relevant questions or understanding the behaviour of key species in relation to key risks as opposed to a general recording of sightings.*

As resources are limited, there should be a drive to undertake research in a strategic and coordinated manner to maximise the benefit of outcomes and avoid unnecessary duplication.

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