Langton, R. et al. 2013. *BOU Proceedings – Marine Renewables and Birds*
http://www.bou.org.uk/bouproc-net/marine-renewables/poster/langton-et-al.pdf

This paper forms part of the proceedings from the BOU conference ***Marine Renwables and Birds***
Other papers from these proceedings can be viewed at www.BOUPROC.net.

POSTER ABSTRACT

Predicting the impact of wet renewables on seabirds using simulation modelling

REBECCA LANGTON[1]*, BETH E. SCOTT[1] & I. M. DAVIES[2]
[1] Ecology, Zoology Building, University of Aberdeen, Tillydrone Ave., Aberdeen AB24 2TZ, Scotland, UK
[2] Marine Scotland Science, Marine Laboratory, PO Box 101, 375 Victoria Road, Aberdeen AB11 9DB, Scotland, UK
* Email: r.langton@abdn.ac.uk

See PDF of poster including for reference to figures below.

In 2008, the UK Crown Estate announced a leasing round for wet renewables developments in the Pentland Firth and Orkney Waters (PFOW) Strategic Area of Scotland. As of 1 October 2012, approximately 265.5 km^2 of seabed in the region is subject to Agreements for Lease for tidal stream and wave energy projects (Fig. 1 – see PDF of poster). The area is also of international importance for many species of seabirds. The 11 Special Protection Areas in the region are mainly breeding colonies, although Orkney also supports significant numbers of over-wintering individuals. The wet renewable industry is still relatively new and there is little empirical evidence regarding how devices may affect seabirds. Experience from similar industries suggest that possible effects include collisions (primarily between diving birds and tidal turbines), alterations to behaviour (e.g. through displacement) and changes to habitat and/or prey availability (Langton *et al.*, 2011). Multiple reviews have highlighted a need for standardized before-after-control-impact (BACI) surveys, to identify the effects of devices on birds or their habitat (e.g. Grecian *et al.*, 2010).

Conservation legislation generally refers to population-level impacts and therefore it is necessary to be able to determine if observed effects on individuals will lead to significant changes to breeding success or survival, and hence have the potential to impact populations. Effects of developments, such as avoidance of devices or increases in prey abundance, can lead to impacts on breeding success or survival by changing the time and energy budgets of provisioning parent birds, and therefore those of their chicks. For example, increased commuting distances between the colony and feeding sites, due to avoidance of a renewable energy development, may extend the duration of foraging trips enough that the number of times a chick is fed by its parents decreases. Simulation models which link prey conditions and behaviour of breeding birds to their energy budget have previously been used to predict the impact of environmental change on seabird energetics (Enstipp *et al.*, 2006; Masden *et al.*, 2010). This concept was extended to develop a model which uses the changes to energetics to predict impacts on survival and reproduction by linking energy budgets to body mass and explicitly including a chick.

The model is based on the Guillemot *Uria aalge*. Individuals within the model are organized into pairs of adults with each pair having a single chick. These three individuals interact with each other. The model is designed to simulate behaviour of breeding Guillemots. Adults in the model spend time at the colony and periodically go off to feed. While on a foraging trip, individuals fly to a site and alternate rests on the sea surface with active foraging, before flying back. The number of times a bird forages during a trip and the number of trips (and therefore the number of times the chick is fed) all emerge from the model. Adults will only leave their chick alone if either they or the chick is in a *critical* condition. The model runs in discrete time steps, each representing 1 min, and simulates the whole chick-rearing period. Each day in the model the behaviour budget of the adults, how much they ate and how much the chick was fed are used to calculate the body mass of the individuals for the next day. This means that the model can be used to predict the fledging mass of the chick and the change in mass of adults over the season, as well as behavioural data such as how long the chick was left unattended.

Many of the model's input variables relate to characteristics of prey (e.g. calorific content or abundance) or bird behaviour (e.g. foraging range), which may exhibit natural fluctuations as well as possibly being directly affected by renewables. The model can therefore be used to compare the breeding success or survival under different scenarios, designed to represent changes due to specific effects of development and how those impacts might be expected to vary within environmental extremes. Figure 2 shows an example of a model output. In this set of scenarios, the ability of parent birds to provision their chicks enough to reach an appropriate fledging mass was compared between simulations with different foraging ranges, calorific density of prey and prey abundance. These results suggest that if developments cause birds to extend their foraging range, whether or not there is an impact on fledging success depends on the prey conditions and the commuting distance pre- and post-development (Fig. 2 – see PDF of poster).

The model output can be applied to real locations to predict which developments may lead to impacts to which colonies. There are a number of Guillemot colonies in the PFOW Region (Fig. 1 – see PDF of poster). The model results can be used to estimate where birds from those colonies can forage and successfully breed. The overlap between developments and the potential foraging area of successful birds can then be calculated and used to predict the proportion of individuals displaced if foraging birds avoid the development site. Figure 3 shows an example of this analysis for the PFOW Region, assuming colonies were successful if over 80% of chicks reached a suitable fledging mass and were not left unattended by their parents more than 10% of the time. The impact is higher if prey abundance is poor because the model predicts that successful adults cannot travel as far due to time and energy constraints (Fig. 3 – see PDF of poster), which means any overlap is likely to be a large proportion of the foraging area and displaced birds have a smaller area that they can use instead and still successfully provision chicks. The model predicts that the wave site at Brough Head may have the largest impact, because it borders several Guillemot colonies along the west coast of The Mainland, Orkney (Fig. 1 – see PDF of poster), and so occupies much of the potential foraging area of birds from those colonies when prey abundance is poor. This conclusion is, however, dependent on foraging birds avoiding the whole of the proposed site, although in reality only a fraction of this will actually contain devices. Therefore, the actual impact of a site depends on the extent of development and displacement distances of the seabirds from devices.

The simulation model provides a tool to link potential effects of wet renewables developments on seabirds at sea to impacts on breeding success and survival. It therefore may be helpful in comparing the possible impact of different development scenarios on populations.

References

Enstipp, M.R., Daunt, F., Wanless, S., Humphreys, E.M., Hamer, K.C., Benvenuti, S. & Gre millet, D. 2006. Foraging energetics of north sea birds confronted with fluctuating prey availability. In *Top Predators in Marine Ecosystems: Their Role in Monitoring and Management* (eds I. Boyd, S. Wanless & C.J. Camphuysen), pp. 191–210. Cambridge University Press, New York.

Grecian, W.J., Inger, R., Attrill, M.J., Bearhop, S., Godley, B.J., Witt, M.J. & Votier, S.C. 2010. Potential impacts of wave-powered marine renewable energy installations on marine birds. *Ibis* 152: 683–697. http://onlinelibrary.wiley.com/doi/10.1111/j.1474-919X.2010.01048.x/abstract

Langton, R., Davies, I.M. & Scott, B.E. 2011. Seabird conservation and tidal stream and wave power generation: information needs for predicting and managing potential impacts. *Marine Policy* 35: 623–630.

Masden, E.A., Haydon, D.T., Fox, A.D. & Furness, R.W. 2010. Barriers to movement: modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin* 60: 1085–1091.