

MACARTHUR GREEN OFFSHORE COMMISSIONS 2012-2016

- 1. SPR East Anglia ONE North and East Anglia TWO - Ornithology Assessment (2016 - ongoing)**
 - Production of onshore and offshore ornithology assessments for ES and HRA.
 - Regular engagement with Natural England and RSPB through Evidence Plan process.
 - Representation at Public Examinations.
- 2. Vattenfall Norfolk Vanguard - Ornithology Assessment (2016 - ongoing)**
 - Production of offshore ornithology assessments for ES and HRA.
 - Regular engagement with Natural England through Evidence Plan process.
- 3. Marine Scotland – Predicting the Fate of Displaced seabirds (2016) collaboration with CEH**
 - Project to simulate displacement of breeding seabirds from offshore renewable sites and generate population predictions.
- 4. Marine Scotland – Developing Seabird Survey Data Protocols (2016)**
 - Project to develop standardised recording formats for offshore surveys of renewable developments to ensure robust data collection.
- 5. Fehmarnbelt Environmental Monitoring and Consultancy (2016)**
 - Review of reports prepared for submission to Planning Application for a Fixed Link (motorway and rail tunnel) under the Baltic between Germany and Denmark, and assessment of the suitability of aerial survey data sets as baseline data on marine bird and mammal numbers in the development area.
- 6. Vattenfall / Statkraft / SPR - Identifying knowledge gaps for seabird populations and impact assessments (2015)**
 - Project to review state of knowledge for seabird populations present in North Sea in relation to offshore wind farms leading to identification of research priorities and opportunities to address gaps.
- 7. Triton Knoll Offshore Wind Farm – Development of Ornithology Monitoring Proposals (2016 - ongoing)**
 - Review of ornithology sensitivities and development of offshore monitoring proposals.
 - Regular engagement with Natural England.
- 8. SPR East Anglia THREE - Ornithology Assessment (2015 - 2016)**
 - Production of onshore and offshore ornithology assessments for ES and HRA.
 - Regular engagement with Natural England through Evidence Plan process.
 - Representation at Public Examinations.
- 9. SPR East Anglia ONE - Ornithology Monitoring support (2015 - ongoing)**
 - Review of ornithology sensitivities and development of onshore and offshore monitoring proposals.
 - Regular engagement with Natural England.
- 10. SMart Wind - Hornsea Project Two Offshore Wind Farm (2015)**
 - Updated population modelling of key seabird species.

- 11. UK Government / Marine Management Organisation - Ornithological Data Inventory for Offshore Wind Farm Consenting (2015)**
 - Collation of a dataset of collision risk figures and raw data for offshore wind farms in the UK.
- 12. SSE - Beatrice offshore wind farm EIA, HRA and post-consent monitoring (2012 - ongoing)**
 - Production of ES Addendum and HRA.
 - Provision of technical support during 18 months of engagement with SNH and MSS.
 - Provision of multiple supporting reports, input to conditions, and resolution of key impact issues (gull collisions and puffin displacement).
 - Ongoing support to develop ornithology monitoring proposals and analysis of monitoring data, including regular engagement with the Moray Firth Renewables Advisory Group – Ornithology subgroup.
- 13. JNCC - Ornithology Displacement Assessment Methods Workshop (2015)**
 - Contributed to two day industry workshop on displacement assessment methods.
 - Presented updated seabird sensitivity review.
- 14. Natural England - provision of training in Ornithology survey, monitoring and assessment methods (2015)**
 - Development and delivery of 4 days of training in coastal and marine bird ecology, survey, monitoring, analysis and assessment methods for Natural England case work and support staff.
- 15. RiCORE - Marine Renewables and Environmental Risks Current practices in pre and post consent monitoring (2015)**
 - Attended as facilitator at European wide industry workshop to share experiences for ornithology survey and monitoring methods.
- 16. Natural England Post - Consent Monitoring Workshop (2015)**
 - Presented session on role of power analysis in ornithological monitoring.
 - Contributed to discussions on strategic approaches for monitoring ornithological impacts.
- 17. Strategic Ornithological Support for Southern North Sea Offshore Windfarm Development Group (2014)**
 - Apportioning of sea birds amongst SPAs and wind farm sites.
- 18. UK Government (DEFRA) Offshore Wind Coping Strategy Workshop (2014)**
 - Involved in delivery of key aspects of DEFRA led workshop.
 - Bob Furness gave a talk on avoidance rates and sat on post-talk discussion panel.
 - Mark contributed slides illustrating multiplication of precautionary steps.
- 19. Statoil Dudgeon offshore wind farm ornithological monitoring programme (2014)**
 - Developing survey programme for offshore site (off north Norfolk).
 - Plan submitted to NE for discussion.
- 20. Forewind Dogger Bank offshore wind farm (Creyke Beck A & B, Teesside A & B) specialist advice (2013/2014)**
 - Provision of additional technical support.
 - Production of supporting information (e.g. displacement, foraging ranges, avoidance rates, PBR, apportioning among SPAs).
 - Technical support at stakeholder meetings and Examining Authority Hearings.

- 21. Natural England Identification of seabird movements and seasonal populations (BDMPS) to provide guidance on assessment of impacts in non-breeding season (2014)**
 - Comprehensive review of GB seabirds in relation to SPA populations and overseas migrants
 - Determination of Biologically Defined Minimum Population Sizes for use in impact assessments across annual cycle.

- 22. RES Mull of Kintyre tidal stream (2012 - 2014)**
 - Provision of seabird, marine mammal and ecology assessments for marine licence application.
 - Undertook land based surveys for seabirds, mammals and habitats (cable route).
 - Production of chapters for assessment and providing post-submission support.

- 23. SPR Sound of Islay and Marwick Head (2009/2014)**
 - Technical support for ecology and ornithology assessments.
 - Substation and grid-connection survey.

- 24. SMart Wind Hornsea Project 1 Offshore Wind Farm (with Niras and RPS) (2013/2014)**
 - Input to EIA and HRA in latter stages.
 - Additional technical support on specific issues and witness at Examining Authority Hearings.
 - Population modelling of key seabird species.

- 25. UK Government (DEFRA) Guidance on seabird compensation options for offshore Wind (2013) (Conducted via CEFAS)**
 - Review of GB SPA seabird population.
 - Consideration of options to increase numbers to offset potential reductions due to offshore wind and marine renewables.
 - Conducted as part of DEFRA strategic work.
 - Report to be published on DEFRA web site (undergoing legal review).

- 26. The Crown Estate PFOW CIA Methods for Wave and Tidal Projects. Including the preparation of a Worked Example (2012/2013)**
 - Review of CIA and in-combination HRA methods.
 - Development of proposals for conducting CIA for marine renewables in PFOW.
 - Preparation of worked examples, and conducting a Workshop to develop ideas.
 - Reports available on TCE website: <http://www.thecrownestate.co.uk/media/152012/PFOW-ornithological-cumulative-impact-assessment-framework.pdf>.

- 27. Marine Scotland Strategic collision assessment for migratory birds at offshore wind farms (with WWT) (2012/2013)**
 - Review of migratory routes used by terrestrial birds and seabirds through Scottish waters.
 - Assessment of cumulative collision risk at planned Scottish offshore wind farms.
 - Draft Report: <http://www.scotland.gov.uk/Resource/0044/00443170.pdf>

- 28. Natural England Seabird sensitivity mapping in English waters (with WWT) (2013)**
 - Analysis of existing seabird survey data; European Seabirds at Sea (ESAS), WWT strategic aerial data and wind farm survey data.
 - Generation of seabird density maps for English waters (GIS tool).
 - Inclusion of seabird vulnerability scoring to identify key areas of highest potential sensitivity to development.
 - Report: <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0106366>

29. Lesser Black-Backed Gull PVA (ScottishPower Renewables) (2013)

- Assessment of additional mortality on the Alde-Ore Estuary SPA population of lesser black-backed gulls.

30. Scottish Government (Marine Scotland) Seabird sensitivity to offshore wind farms (2012)

- Review of evidence on likely sensitivity of Scottish seabirds to offshore wind development.
- Published: Furness, R.W., Wade, H. & Masden, E.A. 2013. Assessing vulnerability of seabird populations to offshore wind farms. *Journal of Environmental Management* 119, 56-66.

31. SNH Seabird sensitivity to marine renewables (2012)

- Review of evidence on likely sensitivity of Scottish seabirds to marine wet renewable (wave and tidal) development.
- Report available on Marine Scotland website.
- Published paper available: Furness, R.W., Wade, H.M., Robbins, A.M.C. and Masden, E.A. 2012. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices. *ICES Journal of Marine Science*, 69, 1466-1479.

32. Strategic Offshore Support Services (The Crown Estate) Gannet PVA (with RPS & WWT) (2012)

- Analysis of gannet population data.
- Development of density dependent and density independent stochastic population model.
- Calculation of cumulative collision risk in existing and planned offshore wind farms.
- Prediction of potential impacts on GB population as a whole and main SPA populations separately.
- The report is available on the SOSS website: <http://www.bto.org/science/wetland-and-marine/soss/projects> and was presented at BOU annual conference (Nov. 2012). The report has been used widely by industry (SNCBs and developers), and been updated on request from Marine Scotland.

Other Related Experience:

- **Supervising PhD students** - Mark Trinder and Bob Furness are supervising PhD students researching interactions between seabirds and marine renewables including: Julie Miller (NERC CASE PhD student modelling impacts on seabird populations, at University of Glasgow 2015-2018), Daniel Johnston (SNH/MASTS PhD student at University of the Highlands and Islands studying black guillemot ecology and use of high tidal flow habitat 2015-2018), and Alex Robbins (University of Glasgow Scholarship (part time) 2010-2016 studying seabird ecology in relation to tidal stream habitat in Shetland and Orkney).
- **Sandeel stock assessment** - Bob Furness chaired 5-day Benchmark Working Group of ICES to evaluate assessments of European sandeel stocks – Bergen, October 2016.
- **Natural England Scientific Advisory Committee** Bob Furness gave an invited presentation on uncertainty in offshore wind farm assessments to Natural England Scientific Advisory Committee workshop on Science and Law, London, September 2016.
- **JNCC** - Bob Furness served on JNCC Marine sub-Group assessing science underpinning designation of Marine Protected Areas in UK waters (2014-2016).
- **SNH** - Bob Furness chaired SNH SAC Marine sub-Group assessing science underpinning designation of SPAs, SACs and MPAs for marine habitats and wildlife in Scottish waters (2014-2016).
- **International Union for the Conservation of Nature (IUCN)** commissioned Bob Furness to write a review chapter on the impacts and effects of global warming on seabird populations (2016).
- **Bob Furness has been a member of ORJIP Expert Panel (2014-2016)** providing an overview of the ORJIP Collision Avoidance Study.
- **Bob Furness** gave an invited presentation in a workshop on assessing the vulnerability of Alaskan seabirds to human impacts, held in Washington, USA in April 2016, an invited presentation in a workshop on seabird-fishery interactions held in Cape Town in October 2015, an invited presentation at the 2nd Intergovernmental Conference on marine renewables in London 2015 and chaired a session on seabird and offshore wind trans-boundary issues at an ICES/OSPAR workshop in Copenhagen in 2015.
- **Bob Furness – Review of SOTEAG Monitoring Programme (2015)** – Review of the monitoring of seabirds at Shetland funded by Sullom Oil Terminal Environmental Advisory Group since the 1970s, and recommendations on the evolution of the monitoring programme for future years.
- **Mark Trinder - BSI Steering Group (2014)** –Offshore EIA Guide.
- **Mark Trinder - Marine Scotland Steering Group (2013/14)** – Development of Analytical Methods Spatial Modelling of Bird and Marine Mammals.
- **Mark Trinder - Marine Scotland Steering Group (2016)** – Development of Analytical Methods for Detecting Change in Bird and Marine Mammal abundance at Offshore Renewable Developments.
- **Bob Furness - Chaired Benchmark Working Group of ICES** to evaluate assessments of sprat stocks in European waters and ecological impacts of sprat fisheries – 2013.
- **Bob Furness - Peer reviewed for TCE** report on impacts of climate change on seabirds in waters off east coast of Scotland – 2013.

- **Review for Vattenfall** of planned research and research outputs on cumulative impacts on red-throated divers and sea ducks – 2011. We also carried out a review for Vattenfall of seabird post-construction studies at Horns Rev and Nysted OWFs and preparation of text for book reviewing those studies – 2012.
- **Review for Bureau of Offshore Management (USA)** of methodology being developed to assess impacts on birds of OWFs in Atlantic US waters – 2012.

RECENT PUBLICATIONS ON MARINE TOPICS BY MEMBERS OF THE MACARTHUR GREEN TEAM:

Dierschke, V., Furness, R.W. and Garthe, S. 2016. Seabirds and offshore wind farms in European waters: Avoidance and attraction. *Biological Conservation* 202, 59-68.

Grecian, W.J., Witt, M.J., Attrill, M.J., Bearhop, S., Becker, P.H., Egevang, C., Furness, R.W., Godley, B.J., Gonzalez-Solis, J., Gremillet, D., Kopp, M., Lescroel, A., Matthiopoulos, J., Patrick, S., Peter, H.-U., Phillips, R.A., Stenhouse, I.J. and Votier, S.C. 2016. Seabird diversity hotspot linked to ocean productivity in the Canary Current Large Marine Ecosystem. *Biology Letters* 12, 20160024.

Wade, H.M., Masden, E.A., Jackson, A.C. and Furness, R.W. 2016. Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy* 70, 108-113.

Furness, R.W., Trinder, M., MacArthur, D. and Douse, A. 2016. A theoretical approach to estimating bird risk of collision with wind turbines when empirical flight activity data are lacking. *Energy and Power Engineering* 8, 183-194.

Furness, R.W. 2016. Qualifying impact assessments for selected seabird populations: A review of recent literature and understanding. MacArthur Green report to Vattenfall, Statkraft and ScottishPower Renewables.

Garthe, S., Hallgrimson, G.T., Montevecchi, W.A., Fifield, D. and Furness, R.W. 2016. East or west? Migration routes and wintering sites of northern gannets *Morus bassanus* from south-eastern Iceland. *Marine Biology* 163: 151.

Hammer, S., Nager, R.G., Johnson, P.C.D., Furness, R.W. and Provencher, J.F. 2016. Plastic debris in great skua (*Stercorarius skua*) pellets corresponds to seabird prey species. *Marine Pollution Bulletin* 103, 206-210.

Grecian, W.J., Taylor, G.A., Loh, G., McGill, R.A.R., Miskelly, C.M., Phillips, R.A., Thompson, D.R. and Furness, R.W. 2016. Contrasting migratory responses of two closely-related seabirds to long-term climate change. *Marine Ecology Progress Series* M11875

Hammer, S., Nager, R.G., Alonso, S., McGill, R.A.R., Furness, R.W. and Dam, M. 2016. Legacy pollutants are declining in great skuas (*Stercorarius skua*) but remain higher in Faroe Islands than in Scotland. *Bulletin of Environmental Contamination and Toxicology* 97, 184-190.

MacArthur, D.H., Furness, R.W., Quinn, B., Borodzicz, E.P. and MacArthur, K.I. 2016. Future scenario analysis of aquaculture, tourism & recreation and marine traffic within the Clyde and Argyll marine regions. MacArthur Green and University of the West of Scotland report to Caledonian MacBrayne.

Furness, R.W. 2016. Impacts and effects of ocean warming on seabirds. In: Laffoley, D., & Baxter, J.M. (editors). *Explaining ocean warming: Causes, scale, effects and consequences*. Full report. Gland, Switzerland: IUCN. pp. 271-288.

Furness, R.W. 2015. Density dependence in seabirds: great skuas *Stercorarius skua* start to breed at a younger age when conditions are better. *Ringing & Migration*, 30, 43-50.

Bustnes, J.O., Bourgeon, S., Leat, E.H.K., Magnúsdóttir, E., Strøm, H., Hanssen, S.A., Petersen, A., Olafsdóttir, K., Borgå, K., Gabrielsen, G.W. and Furness, R.W. 2015. Multiple stressors in a top predator seabird: potential consequences of environmental contaminants, population health and breeding conditions. *PLoS ONE*, 10(7): e0131769.

Furness, R.W. 2015. A review of red-throated diver and great skua avoidance rates at onshore wind farms in Scotland. Scottish Natural Heritage Commissioned Report No 885. Scottish Natural Heritage, Inverness.

Quillfeldt, P., Cherel, Y., Masello, J.F., Delord, K., McGill, R.A.R., Furness, R.W., Moodley, Y. and Weimerskirch, H. 2015. Half a world apart? Overlap in nonbreeding distributions of Atlantic and Indian Ocean thin-billed prions. *PLoS ONE* 10(5):e0125007.

Grecian, W.J., McGill, R., Phillips, R.A., Ryan, P.G. and Furness, R.W. 2015. Quantifying variation in the isotopic signal from feathers. *Marine Biology*, 162, 733-741.

Macdonald, A., Heath, M.R., Edwards, M., Furness, R.W., Pinnegar, J.K., Wanless, S., Speirs, D.C. and Greenstreet, S.P.R. 2015. Climate driven trophic cascades affecting seabirds around the British Isles. *Oceanography and Marine Biology*, 53, 55-80.

Furness, R.W. 2015. Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report Number 164. 389 pp.

Bugoni, L., Naves, L.C. and Furness, R.W. 2015. Moulting of three Tristan da Cunha seabird species sampled at sea. *Antarctic Science*, 27, 240-251.

Furness, R.W. and Wanless, S. 2014. Quantifying the impact of offshore wind farms on gannet populations: a strategic ringing project. *Ringing & Migration* 29, 81-85.

Wade, H.M., Masden, E.A., Jackson, A.C., Thaxter, C.B., Burton, N.H.K., Bouten, W. and Furness, R.W. 2014. Great skua (*Stercorarius skua*) movements at sea in relation to marine renewable energy developments. *Marine Environmental Research*, 101, 69-80.

Bourgeon, S., Leat, E.H.K., Magnúsdóttir, E., Furness, R.W., Strøm, H., Petersen, A., Gabrielsen, G.W., Hanssen, S.A. and Bustnes, J.O. 2014. Feather corticosterone levels on wintering grounds have no carry-over effects on breeding among three populations of great skuas *Stercorarius skua*. *PLoS ONE*, 9(6): e100439.

Bradbury, G., Trinder, M., Furness, R.W., Banks, A.N., Caldow, R.W.G. and Hume, D. 2014. Mapping seabird sensitivity to offshore wind farms. *PLoS ONE*, 9(9): e106366.

Magnúsdóttir, E., Leat, E.H.K., Bourgeon, S., Jonsson, J.E., Phillips, R.A., Strøm, H., Petersen, A., Hanssen, S.A., Bustnes, J.O. and Furness, R.W. 2014. Activity patterns of wintering great skuas *Stercorarius skua*. *Bird Study*, 61, 301-308.

Cross, A.D.P., Hentati-Sundberg, J., Österblom, H., McGill, R.A.R. and Furness, R.W. 2014. Isotopic analysis of island house martins *Delichon urbica* indicates marine provenance of nutrients. *Ibis*, 156, 676-681.

Robbins, A.M.C., Thaxter, C.B., Cook, A.S.C.P., Furness, R.W., Daunt, F.H. and Masden, E.A. 2014. *A review of marine bird diving behaviour: assessing underwater collision risk with tidal turbines*. Proceedings of the 2nd International Conference on Environmental Interactions of Marine renewable Energy Technologies (EIMR 2014).

Davies, I., Watret, R. and Furness, R.W. 2013. *Sensitivity maps for interactions between seabirds and marine renewable energy developments*. BOU Proceedings – Marine Renewables and Birds www.BOUPROC.net

Robbins, A.M.C., Bailey, D.M. and Furness, R.W. 2013. *Implications of marine bird behaviour in a fast tidal stream for interactions with wet renewable energy schemes: a Shetland case study*. BOU Proceedings – Marine Renewables and Birds www.BOUPROC.net

Trinder, M., Furness, R.W. and Bradbury, G. 2013. *Potential impact of offshore wind farm collisions on the gannet population of the British Isles explored using PVA*. BOU Proceedings – Marine Renewables and Birds www.BOUPROC.net

Wade, H.M., Masden, E.A., Jackson, A.J. and Furness, R.W. 2013. *Habitat use by seabird species in high-velocity current flows: investigating the potential effects of tidal-stream renewable energy developments*. BOU Proceedings – Marine Renewables and Birds www.BOUPROC.net

Furness, R.W., Wade, H., Robbins, A.M.C. and Masden, E.A. 2013. *Potential population-level consequences of marine renewables*. BOU Proceedings – Marine Renewables and Birds www.BOUPROC.net

Kirby, A.D., Hawkins, K.R., Freeman, S.M., McCall, R.A., Furness, R.W. and Edhouse, E.S. 2013. *Wave & Tidal Consenting Position Paper Series: Ornithological Impacts*. Renewable UK, Scottish Renewables, Natural Environment Research Council.

Furness, R.W., Wade, H. and Masden, E.A. 2013. Assessing vulnerability of seabird populations to offshore wind farms. *Journal of Environmental Management* 119, 56-66.

IAPEME Viewpoints on 'Wind Farms affect common scoter and red-throated diver behaviour' in *Danish Energy Authority 2013. Danish Offshore Wind: Key Environmental Issues*. DONG Energy, Vattenfall, Danish Energy Authority and Danish Forest and Nature Agency, Copenhagen, ISBN 87-7844-625-2.

Furness, R.W., Wade, H.M., Robbins, A.M.C. and Masden, E.A. 2012. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices. *ICES Journal of Marine Science*, 69, 1466-1479.

Masden E.A., Reeve, R., Desholm, M., Fox, A.D., Furness, R.W. and Haydon, D.T. 2012. Assessing the impact of marine wind farms on birds through movement modelling. *Journal of the Royal Society Interface* 9, 2120-2130.

Jennings, G., McGlashan, D.J. and Furness, R.W. 2012. Responses to changes in sprat abundance of common tern breeding numbers at twelve colonies in the Firth of Forth, east Scotland. *ICES Journal of Marine Science* 69, 572-577.

Garthe, S., Ludynia, K., Hüppop, O., Kubetzki, U., Meraz, J.F. and Furness, R.W. 2012. Energy budgets reveal equal benefits of varied migration strategies in northern gannets. *Marine Biology* 159, 1907-1915.

Magnusdottir, E., Leat, E.H.K., Bourgeon, S., Strøm, H., Petersen, A., Phillips, R.A., Hanssen, S.A., Bustnes, J.O., Hersteinsson, P. and Furness, R.W. 2012. Wintering areas of great skuas *Stercorarius skua* breeding in Scotland, Iceland and Norway. *Bird Study* 59, 1-9.

Fort, J., Pettex, E., Tremblay, Y., Lorentsen, S-H., Garthe, S., Votier, S., Pons, J.B., Siorat, F., Furness, R.W., Grecian, W.J., Bearhop, S., Montevecchi, W.A. and Gremillet, D. 2012. Meta-population evidence of oriented chain migration in northern gannets (*Morus bassanus*). *Frontiers in Ecology and the Environment* 10, 237-242.