Department for Business, Energy & Industrial Strategy

Recent Papers from BEIS Offshore Energy SEA funded projects

Since 1999, the UK's Department for Business, Energy & Industrial Strategy (BEIS) and its forerunner departments (most recently the Department of Energy and Climate Change) Offshore Energy SEA programme has funded a significant number of marine surveys and research projects to improve the information base for strategic assessment and activity specific consenting. The reports of, and data from, these studies are publicly available and deposited in the SEA data archive hosted by the British Geological Survey.

The authors and researchers involved in BEIS SEA studies have been encouraged to submit papers for peer reviewed publication. A list of recent publications is given below arranged chronologically under 3 headings: Birds, Marine mammals (and noise), and Seabed and water column. Where available, links to the paper or journal are included.

Birds

1. Green RMW, Burton NHK & Cook ASCP (in press). Migratory movements of British and Irish Common Shelduck *Tadorna tadorna*: a review of ringing data and a pilot tracking study to inform potential interactions with offshore wind farms in the North Sea. *Ringing & Migration*.

2. Carroll MJ, Wakefield ED, Scragg ES, Owen E, Pinder S, Bolton M, Waggitt JJ & Evans PGH (2019). Matches and mismatches between seabird distributions estimated from at-sea surveys and concurrent individual-level tracking. *Frontiers in Ecology and Evolution* **7**:333. https://doi.org/10.3389/fevo.2019.00333.

3. Thaxter CB, Ross-Smith VH, Bouten W, Clark NA, Conway GJ, Masden EA, Clewley GD, Barber LJ & Burton NHK (2019). Avian vulnerability to wind farm collision through the year: Insights from lesser black-backed gulls (*Larus fuscus*) tracked from multiple breeding colonies. *Journal of Applied Ecology*. https://doi.org/10.1111/1365-2664.13488

4. Grecian WJ, Lane JV, Michelot T, Wade HM & Hamer KC (2018). Understanding the ontogeny of foraging behaviour: insights from combining marine predator bio-logging with satellite-derived oceanography in hidden Markov models. J. R. Soc. Interface 15: 20180084. http://dx.doi.org/10.1098/rsif.2018.0084.

5. Langston R & Teuten (2018). Ranging behaviour of northern gannets. *British Birds* **111**: 131-143.

6. Thaxter CB (2017). Chapter 15: Tracking and telemetry of marine birds. In: Perrow, M. (ed.) Wildlife and Wind Farms: Offshore Volume 2: Conflicts and Solutions. Conservation Handbooks. Pelagic Publishing.

7. Thaxter CB, Ross-Smith VH, Bouten W, Masden EA, Clark NA, Conway GJ, Barber L, Clewley GD & Burton NHK (2018). Dodging the blades: new insights into three dimensional space use of offshore wind farms by lesser black-backed gulls *Larus fuscus*. *Marine Ecology Progress Series* **587**: 247–253. http://dx.doi.org/10.3354/meps12415

8. Shamoun-Baranes J, van Gasteren H & Ross-Smith V (2017). Sharing the Aerosphere: Conflicts and Potential Solutions. In: Chilson P, Frick W, Kelly J & Liechti F (eds) Aeroecology. Springer, Cham, pp.465-497.

9. Thaxter CB, Clark NA, Ross-Smith VH, Conway GJ, Bouten W & Burton NHK (2017). Sample size required to characterise area use of tracked seabirds. *Journal of Wildlife Management* **81**: 1098-1109. https://doi.org/10.1002/jwmg.21283

10. Ross-Smith V, Thaxter C, Clark N, Shamoun-Baranes J, Bouten W & Burton N (2016). GPS telemetry reveals differences in the foraging ecology of breeding lesser black-backed gulls between three Special Protection Area colonies. BOU Proceedings – Birds in time and space: avian tracking and remote sensing.

11. Ross-Smith V, Thaxter CB, Masden EA, Shamoun-Baranes J, Burton NHK, Wright LJ, Rehfisch MM & Johnston A (2016). Modelling flight heights of lesser black-backed gulls and great skuas from GPS: a Bayesian approach. *Journal of Applied Ecology* **53**: 1635-1891. https://doi.org/10.1111/1365-2664.12760

12. Thaxter CB, Ross-Smith VH, Clark JA, Clark NA, Conway GJ, Masden EA, Wade HM, Leat EHK, Gear SC, Marsh M, Booth C, Furness RW, Votier SC & Burton NHK (2016). Contrasting effects of GPS device and harness attachment on adult survival of lesser black-backed gulls *Larus fuscus* and great skuas *Stercorarius skua*. Ibis doi: 0.1111/ibi.12340.

13. Cleasby IR, Wakefield ED, Bearhop S, Bodey TW, Votier SC & Hamer KC (2015). Three-dimensional tracking of a wide-ranging marine predator: flight heights and vulnerability to offshore wind farms. *Journal of Applied Ecology* **52**: 1474-1482. https://doi.org/10.1111/1365-2664.12529

14. Thaxter CB, Ross-Smith VH, Bouten W, Clark NA, Conway GJ, Rehfisch MM & Burton NHK (2015). Seabird-wind farm interactions during the breeding season vary within and between years: A case study of lesser black-backed gull *Larus fuscus* in the UK. *Biological Conservation* **186**: 347-358. https://doi.org/10.1016/j.biocon.2015.03.027

15. Thaxter CB, Ross-Smith VH, Clark NA, Bouten W & Burton NHK (2015). GPS telemetry reveals within-wind farm behavior of lesser black-backed gulls during the breeding season. In: Köppel J & Schuster E (eds.) Book of Abstracts (page 65).

Conference on Wind energy and Wildlife impacts (CWW 2015), March 10-12, 2015. Berlin, Germany.

16. Thaxter CB, Ross-Smith VH, Clark JA, Clark NA, Conway GJ, Marsh M, Leat EHK & Burton NHK (2014). A trial of three harness attachment methods and their suitability for long-term use on lesser black-backed gulls and great skuas. *Ringing & Migration* **29**: 65-76. https://doi.org/10.1080/03078698.2014.995546

17. Wade HM, Masden EA, Jackson AC, Thaxter CB, Burton NHK, Bouten W & Furness RW (2014). Great skua (*Stercorarius skua*) movements at sea in relation to marine renewable energy developments. *Marine Environmental Research* **101**: 69-80. https://doi.org/10.1016/j.marenvres.2014.09.003

18. Thaxter C, Ross-Smith V, Burton N, Wade H, Masden E & Bouten W (2013). Connectivity between seabird features of protected sites and offshore wind farms: lesser black-backed gulls and great skuas through breeding, migration and non-breeding seasons. BOU proceedings – Marine Renewables and Birds.

19. Wakefield ED, Bodey TW, Bearhop S, Blackburn J, Colhoun K, Davies R, Dwyer RG, Green J, Grémillet D, Jackson AL, Jessopp MJ, Kane A, Langston RHW, Lescroël A, Murray S, Le Nuz M, Patrick SC, Péron C, Soanes L, Wanless S, Votier SC & Hamer KC (2013). Space partitioning without territoriality in gannets. *Science* **341**: 68-70. https://doi.org/10.1126/science.1236077

Marine mammals (and noise)

20. McKnight JC, Ruesch A, Bennett K, Bronkhorst M, Balfour S, Moss SEW, Milne R, Tyack PL, Kainerstorfer J & Hastie GD (in press). Shining new light on sensory brain activation and physiological measurement in seals using wearable optical technology. *Philosophical Transactions of the Royal Society B*

21. McKnight JC, Mulder E, Ruesch A, Kairnerstorfer J, Wu J, Hakimi N, Balfour S, Bronkhorst M, Horschig JM, Pernett F, Sato K, Hastie GD, Tyack P & Schagatay E (in press). When the Human Brain Goes Diving: Using NIRS to Measure Cerebral and Systemic Cardiovascular Responses to Deep, Breath-Hold Diving in Elite Freedivers. *Philosophical Transactions of the Royal Society B*

22. Williamson BJ, Blondel P, Williamson LD & Scott BE (in press). Application of a multibeam echosounder to document changes in animal movement and behaviour around a tidal turbine structure. *ICES Journal of Marine Science*

23. Robinson SP, Wang L, Cheong S-H, Lepper PA, Marubini F & Hartley JP (2020). Underwater acoustic characterisation of unexploded ordnance disposal using deflagration. *Marine Pollution Bulletin* **160**: 111646. https://doi.org/10.1016/j.marpolbul.2020.111646

24. Trigg LE, Chen F, Shapiro GI, Ingram SN, Vincent C, Thompson D, Russell DJF, Carter MID & Embling CB (2020). Predicting the exposure of diving grey seals to shipping noise. *The Journal of the Acoustical Society of America* **148**, 1014 https://doi.org/10.1121/10.0001727

25. Whyte KF, Russel DJF, Sparling CE, Binnerts B & Hastie GD (2020). Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities. *Journal of the Acoustical Society of America* **147**: 3948-3958. https://doi.org/10.1121/10.0001408

26. Hastie G, Merchant ND, Götz T, Russell DJF, Thompson P & Janik VM (2019). Effects of impulsive noise on marine mammals: investigating range-dependent risk. *Ecological Applications* **29**: https://doi.org/10.1002/eap.1906.

27. Carter MID, McClintock BT, Embling CB, Bennett KA, Thompson D &. Russell DJF (2019). From pup to predator: generalized hidden Markov models reveal rapid development of movement strategies in a naïve long-lived vertebrate. *Oikos* **129**: 630-642 https://doi.org/10.1111/oik.06853

28. Arso Civil M, Quick N Cheney B Pirotta E, Thompson P & Hammond P (2019). Changing distribution of the east coast of Scotland bottlenose dolphin population and the challenges of area-based management. *Aquatic Conservation: Marine and Freshwater Ecosystems* **29**: 178-196. https://doi.org/10.1002/aqc.3102

29. Joy R, Wood JD, Sparling CE, Tollit DJ, Copping AE & McConnell BJ (2018). Empirical measures of harbor seal behavior and avoidance of an operational tidal turbine. *Marine Pollution Bulletin* **136**: 92–106. https://doi.org/10.1016/j.marpolbul.2018.08.052

30. Sparling C, Lonergan M & McConnell B (2017). Harbour seals (*Phoca vitulina*) around an operational tidal turbine in Strangford Narrows: no barrier effect but small changes in transit behaviour. *Aquatic Conservation: Marine and Freshwater Ecosystems* **28**: 194-204. https://doi.org/10.1002/aqc.2790

31. Graham IM, Pirotta E, Merchant ND, Farcas A, Barton TB, Cheney B, Hastie GD & Thompson PM (2017). Responses of bottlenose dolphins and harbour porpoises to variations in piling noise during harbour construction. *Ecosphere* **8**: 1-16. https://doi.org/10.1002/ecs2.1793

32. Quick NJ, Cheney B, Thompson PM & Hammond PS (2017). Can the camera lie? A non-permanent nick in a bottlenose dolphin (*Tursiops truncatus*). *Aquatic Mammals* **43**: 156-161. https://doi.org/10.1578/AM.43.2.2017.156

33. Jones EL, Sparling CE, McConnell BJ, Morris CD & Smout S (2017). Fine-scale harbour seal usage for informed marine spatial planning. *Scientific Reports* **7**: 11581.

34. Farcas A, Thompson PM & Merchant ND (2016). Underwater noise modelling for environmental impact assessment. *Environmental Impact Assessment Review* **57**: 114-122. https://doi.org/10.1016/j.eiar.2015.11.012

35. Hastie GD, Russell DJF, McConnell BJ, Thompson D & Janik VM (2016). Multiple-pulse sounds and seals: results of a harbour seal (*Phoca vitulina*) telemetry study during windfarm construction. *Advances in Experimental Medicine and Biology* **875**: 425-430. https://doi.org/10.1007/978-1-4939-2981-8_50

36. Lucke K, Hastie GD, Jurczynski K, McConnell B, Moss S, Russell DJF, Weber H & Janik VM (2016). Aerial low frequency hearing in captive and free-ranging harbour seals (*Phoca vitulina*) using auditory brainstem responses. *Journal of Comparative Physiology A* **202**: 859-868. https://doi.org/10.1007/s00359-016-1126-8

37. Russell DJF, Hastie GD, Thompson D, Janik VM, Hammond PS, Scott-Hayward LAS, Matthiopoulos J, Jones EL & McConnell BJ (2016). Avoidance of wind farms by harbour seals is limited to pile driving activities. *Journal of Applied Ecology* **53**: 1642-1652. https://doi.org/10.1111/1365-2664.12678

38. Hastie GD, Russell DJF, McConnell B, Moss S, Thompson D & Janik VM (2015). Sound exposure in harbour seals during the installation of an offshore wind farm: predictions of auditory damage. *Journal of Animal Ecology* **52**: 631–640. https://doi.org/10.1111/1365-2664.12403

39. Jones EL, McConnell BJ, Smout S, Hammond PS, Duck CD, Morris CD, Thompson D, Russell DJF, Vincent C, Cronin M, Sharples RJ & Matthiopoulos J (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Marine Ecology Progress Series* **534**: 235–249. https://doi.org/10.3354/meps11370

40. Russell DJF, McClintock BT, Matthiopoulos J, Thompson PM, Thompson D, Hammond PS, Jones EL, MacKenzie ML, Moss S & McConnell BJ (2015). Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. *Oikos* **124**: 1462-1472. https://doi.org/10.1111/oik.01810

41. Cheney B, Corkrey R, Durban JW, Grellier K, Hammond PS, Isals-Villanueva V, Janik VM, Lusseau SM, Parsons KM, Quick NJ, Wilson B & Thompson PM (2014). Long-term trends in the use of a protected area by small cetaceans in relation to changes in population status. *Global Ecology and Conservation* **2**: 118-128. https://doi.org/10.1016/j.gecco.2014.08.010

42. Hastie GD, Donovan C, Götz T & Janik VM (2014). Behavioral responses by grey seals (*Halichoerus grypus*) to high frequency sonar. *Marine Pollution Bulletin* **79**: 205-210. https://doi.org/10.1016/j.marpolbul.2013.12.013

43. Russell DJF, Brasseur SMJM, Thompson D, Hastie G, Janik VM, Aarts G, McClintock BT, Matthiopoulos J, Moss SEW & McConnell B (2014). Marine mammals trace anthropogenic structures at sea. *Current Biology* **24**: 638-639. https://doi.org/10.1016/j.cub.2014.06.033

44. Silva MA, Jonsen I, Russell DJF, Prieto R, Thompson D & Baumgartner MF (2014). Assessing performance of Bayesian state-space models fit to Argos satellite telemetry

locations processed with Kalman filtering. *PLoS ONE* **9(3)**: https://doi.org/10.1371/journal.pone.0092277.

45. McClintock BT, Russell DJF, Matthiopoulos J & King R (2013). Combining individual animal movement and ancillary biotelemetry data to investigate population-level activity budgets. *Ecology* **94**: 838-849. https://doi.org/10.1890/12-0954.1

46. Russell DJ, McConnell BJ, Thompson D, Duck CD, Morris C, Harwood, J & Matthiopoulos J (2013). Uncovering the links between foraging and breeding regions in a highly mobile mammal. *Journal of Applied Ecology* **50**: 499-509. https://doi.org/10.1111/1365-2664.12048

Seabed and water column

47. Kurekin AA, Land PE & Miller PI (2020). Internal Waves at the UK Continental Shelf: Automatic Mapping Using the ENVISAT ASAR Sensor. *Remote Sensing* **12**(15). https://doi.org/10.3390/rs12152476

48. Williamson B, Fraser S, Williamson L, Nikora V & Scott B (2019). Predictable changes in fish school characteristics due to a tidal turbine support structure. *Renewable Energy* **141**: 1092-1102. https://doi.org/10.1016/j.renene.2019.04.065

49. Wasson B & de Blauwe H (2014). Two new records of cheilostome Bryozoa from British waters. *Marine Biodiversity Records* **7**: e123.

50. Gafeira J, Long D & Diaz-Doce D (2012). Semi-automated characterisation of seabed pockmarks in the central North Sea. *Near Surface Geophysics* **10**: 303-314. https://doi.org/10.3997/1873-0604.2012018

51. Howell KL, Davies JS & Narayanaswamy BE (2010). Identifying deep-sea megafaunal epibenthic assemblages for use in habitat mapping and marine protected area network design. *Journal of the Marine Biological Association of the United Kingdom* **90**: 33–68. https://doi.org/10.1017/S0025315409991299

52. Oliver PG, Holmes AM, Killeen IJ & Turner JA (2010). Marine bivalve shells of the British Isles (Mollusca: Bivalvia). Amgueddfa Cymru - National Museum Wales.

53. Hastie LC, Pierce GJ, Wang J, Bruno I, Moreno A, Piatkowski U & Robin JP (2009). Cephalopods in the north-eastern Atlantic: species, biogeography, ecology, exploitation and conservation. *Oceanography and Marine Biology: An Annual Review* **47**: 111-190. https://doi.org/10.1201/9781420094220

BEIS Offshore Energy SEA

The SEA process aims to help inform licensing and leasing decisions by considering the environmental implications of a plan/programme and the activities which could result from its implementation. Since 1999, the Department has conducted a series of offshore energy SEAs, the latest covering wind, tidal stream and tidal range, carbon dioxide and hydrocarbon gas storage, and oil & gas.

Since the first SEA, the associated research programme has targeted key information gaps on the marine environment and potential industrial impacts, to inform the SEA process, developers, consenting bodies and others. Research priorities are discussed with the SEA Steering Group and a range of other stakeholders.

For more information on the OESEA programme, visit the offshore SEA web pages on https://www.gov.uk/ or email oep@beis.gov.uk