



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 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. Clewley GD, Ponchon A, Davies JG, Humphreys EM, O'Hanlon NJ, Weston E, Boulonier T & Cook ASCP (in press). Acute impacts from Teflon harnesses used to fit bio-logging devices to Black-legged Kittiwake *Rissa tridactyla*. *Ringing & Migration*
2. Duckworth J, O'Brien S, Petersen IK, Petersen A, Benediktsson G, Johnson L, Lehikoinen P, Okill D, Väisänen R, Williams J, Williams S, Daunt F & Green JA (2022). Winter locations of red-throated divers from geolocation and feather isotope signatures. *Ecology and Evolution* DOI: 10.1002/ece3.9209
3. Lane JV, Pollock CJ, Jeavons R, Sheddan M, Furness RW & Hamer KC (2021). Post-fledging movements, mortality and migration of juvenile northern gannets. *Marine Ecology Progress Series* **671**: 207–218 <https://doi.org/10.3354/meps13804>
4. Pollock CJ, Lane JV, Buckingham L, Garthe S, Jeavons R, Furness RW & Hamer KC (2021). Risks to different populations and age classes of gannets from impacts of offshore wind farms in the southern North Sea. *Marine Environmental Research* **171**: 105457
5. Duckworth J, O'Brien S, Petersen IK, Petersen A, Benediktsson G, Johnson L, Lehikoinen P, Okill D, Väisänen R, Williams J, Williams S, Daunt F & Green JA (2021). Spatial and temporal variation in foraging of breeding red-throated divers. *Journal of Avian Biology* **52**: 1–12 <https://doi.org/10.1111/jav.02702>
6. Green RMW, Burton NHK & Cook ASCP (2021). 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. *Ringling & Migration* **34**: 71-83 <https://doi.org/10.1080/03078698.2019.1887670>
7. Martín-Vélez V, van Leeuwen CHA, Sánchez MI, Hortas F, Shamoun-Baranes J, Thaxter CB, Lens L, J. Camphuysen CJ & Green AJ (2021). Spatial patterns of weed dispersal by wintering gulls within and beyond an agricultural landscape. *Journal of Ecology* **109**: 1947–1958. <https://doi.org/10.1111/1365-2745.13619>
 8. Masden EA, Cook ASCP, McCluskie A, Bouten W, Burton NHK & Thaxter CB (2021). When speed matters: The importance of flight speed in an avian collision risk model. *Environmental Impact Assessment Review* **90**: 106622
 9. Clewley GD, Clark NA, Thaxter CB, Green RM, Scragg ES & Burton NHK (2021). Development of a weak-link wing harness for use on large gulls (Laridae): methodology, evaluation and recommendations. *Seabird* **33**: 18-34.
 10. Brown JM, van Loon EE, Bouten W, Camphuysen KCJ, Lens L, Müller W, Thaxter CB & Shamoun-Baranes J (2021). Long-distance migrants vary migratory behaviour as much as short-distance migrants: an individual level comparison from a seabird species with diverse migration strategies. *Journal of Animal Ecology* **90**: 1058–1070 DOI: 10.1111/1365-2656.13431
 11. Lane JV, Jeavons R, Deakin Z, Sherley RB, Pollock CJ, Wanless RJ & Hamer KC (2020). Vulnerability of northern gannets to offshore wind farms; seasonal and sex-specific collision risk and demographic consequences. *Marine Environmental Research* **162** <https://doi.org/10.1016/j.marenvres.2020.105196>
 12. 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>.
 13. 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>
 14. 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. *Journal of the Royal Society Interface* **15**: 20180084. <http://dx.doi.org/10.1098/rsif.2018.0084>.
 15. Langston R & Teuten (2018). Ranging behaviour of northern gannets. *British Birds* **111**: 131-143.
 16. 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.

17. 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>
18. Shamoun-Baranes J, van Gasteren H & Ross-Smith V (2017). Sharing the Atmosphere: Conflicts and Potential Solutions. In: Chilson P, Frick W, Kelly J & Liechti F (eds) *Aeroecology*. Springer, Cham, pp.465-497.
19. 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>
20. 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](#).
21. 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>
22. 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* **158**: 279-290. <https://doi.org/10.1111/ibi.12340>
23. 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>
24. 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>
25. 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.
26. 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. *Ringling & Migration* **29**: 65-76. <https://doi.org/10.1080/03078698.2014.995546>
27. 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>
28. 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](#).
29. 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)

30. Robinson SP, Wang L, Cheong S-H, Lepper PA, Hartley JP, Thompson PM, Edwards E & Bellmann M (2022). Acoustic characterisation of unexploded ordnance disposal in the North Sea using high order detonations. *Marine Pollution Bulletin* **184** 114178.
31. Fernandez-Betelu O, Graham IM & Thompson PM (2022). Reef effect of offshore structures on the occurrence and foraging activity of harbour porpoises. *Frontiers in Marine Science* **9**: 980388. doi: 10.3389/fmars.2022.980388
32. Wyles HME, Boehme L, Russell DJF & Carter MID (2022). A Novel Approach to Using Seabed Geomorphology as a Predictor of Habitat Use in Highly Mobile Marine Predators: Implications for Ecology and Conservation. *Frontiers in Marine Science* **9**: 818635. doi: 10.3389/fmars.2022.818635
33. Carter MID, Boehme L, Cronin MA, Duck CD, Grecian WJ, Hastie GD, Jessopp M, Matthiopoulos J, McConnell BJ, Miller DL, Morris CD, Moss SEW, Thompson D, Thompson PM & Russell DJF (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. *Frontiers in Marine Science* **9**: 875869. doi: 10.3389/fmars.2022.875869
34. McKnight JC, Ruesch A, Bennett K, Bronkhorst M, Balfour S, Moss SEW, Milne R, Tyack PL, Kainerstorfer J & Hastie GD (2021). Shining new light on sensory brain activation and physiological measurement in seals using wearable optical technology. *Philosophical Transactions of the Royal Society B* **376**: 20200224. <https://doi.org/10.1098/rstb.2020.0224>

35. McKnight JC, Mulder E, Ruesch A, Kairnerstorfer J, Wu J, Hakimi N, Balfour S, Bronkhorst M, Horschig JM, Pernet F, Sato K, Hastie GD, Tyack P & Schagatay E (2021). 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* **376**: 20200349 <https://doi.org/10.1098/rstb.2020.0349>
36. Nelms SE, Alfaro-Shigueto J, Arnould JPY, Avila IC, Bengtson Nash S, Campbell E, Carter MID, Collins T, Currey RJC, Domit C, Franco-Trecu V, Fuentes MMPB, Gilman E, Harcourt RG, Hines EM, Hoelzel AR, Hooker SK, Johnston DW, Kelkar N, Kiszka JJ, Laidre KL, Mangel JC, Marsh H, Maxwell SM, Onoufriou AB, Palacios DM, Pierce GJ, Ponnampalam LS, Porter LJ, Russell DJF, Stockin KA, Sutaria D, Wambiji N, Weir CR, Wilson B & Godley BJ (2021). Marine mammal conservation: over the horizon. *Endangered Species Research* **44**: 291–325 <https://doi.org/10.3354/esr01115>
37. Williamson BJ, Blondel P, Williamson LD & Scott BE (2021). Application of a multibeam echosounder to document changes in animal movement and behaviour around a tidal turbine structure. *ICES Journal of Marine Science* <https://doi.org/10.1093/icesjms/fsab017>
38. 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>
39. 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>
40. Whyte KF, Russell 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>
41. 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>.
42. 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>
43. 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>

44. 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>
45. 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>
46. 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>
47. 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>
48. 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. <https://doi.org/10.1038/s41598-017-11174-4>
49. 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>
50. 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
51. 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>
52. 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>
53. 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>
54. 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>
55. 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>
56. 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>
57. 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>
58. 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>
59. 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>.
60. 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>
61. 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

62. Kurekin AA, Land PE & Miller PI (2020). Internal Waves at the UK Continental Shelf: Automatic Mapping Using the ENVISAT ASAR Sensor. *Remote Sensing* **12**: <https://doi.org/10.3390/rs12152476>
63. 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>

64. Wasson B & de Blauwe H (2014). Two new records of cheilostome Bryozoa from British waters. *Marine Biodiversity Records* **7**: [e123](#).
65. 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>
66. 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>
67. Oliver PG, Holmes AM, Killeen IJ & Turner JA (2010). Marine bivalve shells of the British Isles (Mollusca: Bivalvia). [Amgueddfa Cymru - National Museum Wales](#).
68. 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 oepe@beis.gov.uk