Department for Energy Security & Net Zero

Recent Papers from DESNZ Offshore Energy SEA funded projects

Since 1999, the UK's Department for Energy Security & Net Zero (DESNZ) and its forerunner departments Offshore Energy SEA (OESEA) 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 DESNZ SEA studies have been encouraged to submit papers for peer reviewed publication. A list of recent publications is given below arranged chronologically under 4 headings: Birds, Marine mammals (and noise), Seabed and water column, and Other. Where available, links to the paper or journal are included. The OESEA programme has solely or jointly funded a number of PhD studentships. In addition to the papers arising from their research, the PhD candidates, thesis titles and institutions are listed under a separate heading towards the end of this document.

Birds

1. O'Hanlon NJ, Clewley GD, Johnston DT, Thaxter CB, Lopez SL, Quinn LR, Boersch-Supan PH, Masden EA, Daunt F, Wilson J, Burton NHK & Humphreys EM (2025). Partial Niche Partitioning in Three Sympatric Gull Species Through Foraging Areas and Habitat Selection. *Ecology and Evolution* **15**: e71577. https://doi.org/10.1002/ece3.71577

2. Niven HI, Jeglinski JWE, Aarts G, Wakefield ED & Matthiopoulos J (2025). Towards biologically realistic estimates of home range and spatial exposure for colonial animals. *Methods in Ecology and Evolution* **16**: 1002-1014. https://doi.org/10.1111/2041-210X.70019

3. Green RMW, Cook ASCP, Burton NHK, Franks SE & Green JA (2025). Framework for assessing species vulnerability whilst on migration to a spatially explicit anthropogenic pressure. *Biological Conservation* **307**: 111118. https://doi.org/10.1016/j.biocon.2025.111118

4. Jeglinski JWE, Lane JV, Votier SC, Furness RW, Hamer KC, McCafferty DJ, Nager RG, Sheddan M, Wanless S & Matthiopoulos J (2024). HPAIV outbreak triggers short-term colony connectivity in a seabird metapopulation. *Scientific Reports* **14**: 3126. https://doi.org/10.1038/s41598-024-53550-x

5. Jeglinski JWE, Niven HI, Wanless S, Barrett RT, Harris MP, Dierschke J, & Matthiopoulos J (2024). Past and future effects of climate on the metapopulation dynamics of a Northeast Atlantic seabird across two centuries. *Ecology Letters* **27**:e14479 https://doi.org/10.1111/ele.14479

6. Lane JV, Jeglinski JWE, Avery-Gomm S, Ballstaedt E. Banyard AC, Barychka T, Brown IH, Brugger B, Burt TV, Careen N, Castenschiold JHF, Christensen-Dalsgaard S, Clifford S, Collins SM, Cunningham E, Danielsen J, Daunt F, D'entremont KJN, Doiron P, Duffy S, English MD, Falchieri M, Giacinti J, Gjerset B, Granstad S, Grémillet D, Guillemette M, Hallgrímsson GT, Hamer KC, Hammer S, Harrison K, Hart JD, Hatsell C, Humpidge R, James J, Jenkinson A, Jessopp M, Jones MEB, Lair S, Lewis T, Malinowska AA, McCluskie A, McPhail G, Moe B, Montevecchi WA, Morgan G, Nichol C, Nisbet C, Olsen B, Provencher J, Provost P, Purdie A, Rail J-F, Robertson G, Seyer Y, Sheddan M, Soos C, Stephens N, Strøm H, Svansson V, Tierney TD, Tyler G, Wade T, Wanless S, Ward CRE, Wilhelm SI, Wischnewski S, Wright LJ, Zonfrillo B, Matthiopoulos J & Votier SC (2023). High pathogenicity avian influenza (H5N1) in Northern Gannets (*Morus bassanus*): Global spread, clinical signs and demographic consequences. *Ibis*. https://doi.org/10.1111/ibi.13275.

7. Grémillet D, Ponchon A, Provost P, Gamble A, Abed-Zahar M, Bernard A, Courbin N, Delavaud G, Deniau A, Fort J, Hamer KC, Jeavons R, Lane JV, Langley L, Matthiopoulos J, Poupart T, Prudor A, Stephens N, Trevail A, Wanless S, Votier SC, Jeglinski JWE (2023). Strong breeding colony fidelity in northern gannets following high pathogenicity avian influenza virus (HPAIV) outbreak. *Biological Conservation* **286**. 110269. https://doi.org/10.1016/j.biocon.2023.110269.

8. Johnston DT, Thaxter CB, Boersch-Supan PH, Davies JG, Clewley GD, Green RMW, Shamoun-Baranes J, Cook ASCP, Burton NHK & Humphreys EM (2023). Flight heights obtained from GPS versus altimeters influence estimates of collision risk with offshore wind turbines in Lesser Black-backed Gulls *Larus fuscus*. *Movement Ecology* **11**: 66 https://doi.org/10.1186/s40462-023-00431-z

9. Jeglinski JWE, Wanless S, Murray S, Barrett RT, Gardarsson A, Harris MP, Dierschke J, Strøm H, Lorentsen S-H & Matthiopoulos J (2023). Metapopulation regulation acts at multiple spatial scales: Insights from a century of seabird colony census data. *Ecological Monographs* **93**: e1569. https://doi.org/10.1002/ecm.1569.

10. Clewley GD, Cook ASCP, Davies JG, Humphreys EM, O'Hanlon NJ, Weston E, Boulinier T & Ponchon A (2022). Acute impacts from Teflon harnesses used to fit bio-logging devices to Black-legged Kittiwake *Rissa tridactyla*. *Ringing & Migration* **36***: 69-77.* https://doi.org/10.1080/03078698.2022.2151065

11. Johnston DT, Thaxter CB, Boersch-Supan PH, Humphreys L, Bouten W, Clewley GD, Scragg ES, Masden EA, Barber LJ, Conway G, Clark NA, Burton NHK & Cook ASCP (2022). Investigating avoidance and attraction responses in Lesser Black-backed Gulls *Larus fuscus* to offshore wind farms. *Marine Ecology Progress Series* **686**: 187-200. https://doi.org/10.3354/meps13964

12. 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* **12**: e9209 https://doi.org/10.1002/ece3.9209

13. 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

14. 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 https://doi.org/10.1016/j.marenvres.2021.105457

15. 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

16. 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. *Ringing & Migration* **34**: 71-83 https://doi.org/10.1080/03078698.2019.1887670

17. 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

18. 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 https://doi.org/10.1016/j.eiar.2021.106622

19. 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.

20. 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 https://doi.org/10.1111/1365-2656.13431

21. 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

22. 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.

23. 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* **56**:2410-2422. https://doi.org/10.1111/1365-2664.13488

24. 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.

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

26. 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.

27. 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

28. 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.

29. 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

30. 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.

31. 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

32. 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

33. 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

34. 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

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36. 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

37. 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

38. 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.

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Marine mammals (and noise)

40. McKnight JC, Bønnelycke E-M, Balfour S, Milne R, Moss SEW, Armstrong HC, Downie C, Hall AJ & Kershaw JL (2025). Cognitive perception of circulating oxygen in seals is the reason they don't drown. *Science* **387**: 1276-1280. https://doi.org/10.1126/science.adq4921

41. Fernandez-Betelu O, Graham IM, Malcher F, Webster E, Cheong S-H, Wang L, Iorio-Merlo V, Robinson S & Thompson PM (2024). Characterising underwater noise and changes in harbour porpoise behaviour during the decommissioning of an oil and gas platform. *Marine Pollution Bulletin* **200**: 116083. https://doi.org/10.1016/j.marpolbul.2024.116083

42. Lepper PA, Cheong S-H, Robinson SP, Wang L, Tougaard J, Griffiths ET & Hartley JP (2024). In-situ comparison of high-order detonations and low-order deflagration methodologies for underwater unexploded ordnance (UXO) disposal. *Marine Pollution Bulletin* **199**: 115965. https://doi.org/10.1016/j.marpolbul.2023.115965

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44. 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. https://doi.org/10.1016/j.marpolbul.2022.114178

45. 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. https://doi.org/10.3389/fmars.2022.980388

46. 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. https://doi.org/10.3389/fmars.2022.818635

47. 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. https://doi.org/10.3389/fmars.2022.875869

48. 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

49. 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 (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

50. 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

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52. 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

53. 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

54. 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

55. 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**: e01906. https://doi.org/10.1002/eap.1906

56. 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

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58. Arso Civil, M, Quick, N, Cheney, B, Islas-Villanueva, V, Graves, JA, Janik, V, Thompson, PM & Hammond, PS (2019). Variations in age- and sex-specific survival rates could explain population trend in a discrete marine mammal population. *Ecology and Evolution* **9**: 533-544. https://doi.org/10.1002/ece3.4772

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65. 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

66. 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

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74. 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

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Seabed and water column

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processes in the Faroe-Shetland Channel. *Deep Sea Research Part I: Oceanographic Research Papers* **146**: 55-61. https://doi.org/10.1016/j.dsr.2019.03.005

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PhD Studentships

89. Whyte KF (awarded 2022). Behavioural responses by seals to offshore energy activities. University of St Andrews. https://doi.org/10.17630/sta/222. Jointly funded with the University of St Andrews.

90. Duckworth JA (awarded 2023). Using behavioural and energetic insights to assess the impacts of displacement from offshore wind farms on red-throated divers (*Gavia stellata*). University of Liverpool. http://doi.org/10.17638/03170909. Jointly funded with NERC, The Crown Estate, and various wind farm developers.

91. Wyles H (awarded 2024). Predicting impacts of climate change on the at-sea and terrestrial habitats of UK grey seals. University of St Andrews. https://doi.org/10.17630/sta/1125. Jointly funded with the University of St Andrews.

92. Declerck M (awarded 2025). Bayesian modelling of the cumulative effect of offshores energies. University of Aberdeen. Jointly funded with the University of Aberdeen.

93. Green R (*in progress*). Understanding the annual cycle of a wildfowl migrant, the common shelduck, and the risks posed by offshore wind farm developments. University of Liverpool. Jointly funded with the British Trust for Ornithology.

94. Nixon H *(in progress*). Developing the theory of disturbances in metapopulations: applications to seabirds and renewables. University of Glasgow.

95. Farr J (*in progress*). Acoustic techniques for measurement, monitoring and verification of marine CCUS storage facilities. University of Southampton. Jointly funded with the National Physical Laboratory.

DESNZ 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@energysecurity.gov.uk