



Seal distribution and ecology - Completed Project

A project undertaken by the Sea Mammal Research Unit (SMRU) at the University of St. Andrews, funded by the Department of Energy and Climate Change (DECC) Offshore Energy Strategic Environmental Assessment (OESEA) programme. For further information, contact the Project Coordinator at egm@hartleyanderson.com

Context

SMRU holds a large database of telemetry data on grey and harbour seals (600 tags have been deployed on seals around the UK since 1988), which presented the opportunity to collate, analyse and interpret seal data for UK waters as a whole. Tagging has been carried out over various years, seasons, and regions and with animals of different, ages and sexes. This tagging information represents one of the most comprehensive datasets for two seal species worldwide. The range of spatial, temporal, age and other data enabled a wide variety of analyses to be undertaken. The results provide baseline information and enhanced ecological understanding which in turn can inform conservation and development consenting decisions.

In parallel with this project, SMRU received funding from the Scottish Government to produce at-sea usage maps of grey and harbour seals that haul-out in the British Isles ([Scottish Government website](#)). The concurrent running of both projects allowed synergistic collaboration between the projects.

Project Objectives & Scope

The project aimed to collate and consolidate the seal telemetry data to answer UK wide questions on the at-sea distribution, movements and behaviour of both seal species. With respect to the data and subsequent analysis, the main project objectives were to:

Data

- Collate and consolidate all SMRU UK seal telemetry holdings
- Develop a cleaning protocol for all historic and new telemetry data
- Monitor and manage all incoming telemetry data
- Summarise the data holdings

Analysis

- **Link terrestrial sites with foraging sites.** The relationship between where grey seals forage and breed is not well understood. Such information will enable the determination of where the effects of any given impact at-sea may be reflected on breeding population ashore (especially at Special Areas of Conservation for which grey seals are a qualifying feature).
 - Assign **time budgets** (estimate of proportion of time engaged in an activity) of grey and harbour seals at-sea to foraging and travelling based on the movement characteristics. Such models can be improved by incorporating both activity and movement data into models to define a complete time budget of four states: resting at sea, hauled out on land, foraging and travelling. Once defined, such budgets can be modelled with regard to internal (species, sex, age), and external (region, time of day, day of year) factors.
 - Produce better estimates of foraging **habitat preference**. Previously habitat preference analysis has been conducted using all at-sea activity. Better estimates may be produced by only considering foraging locations.
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Project Outcomes & Outputs

Data

All data were collated and consolidated into the database, *Bioracle*. Protocols were developed to clean historical and incoming telemetry data in a consistent and effective manner.

Overall 269 tags were deployed on grey seals over nine seal management regions between 1988 and 2010 with 69 of these deployed on moulted pups at breeding sites. The resulting tracks (Figures 1a & b) indicated that grey seals ranged widely with pups undergoing more long ranging movements than adults. Harbour seal tracks from 344 tags deployed since 2001 displayed a more coastal distribution with seals not travelling as far from haul-outs (Figure 1c).

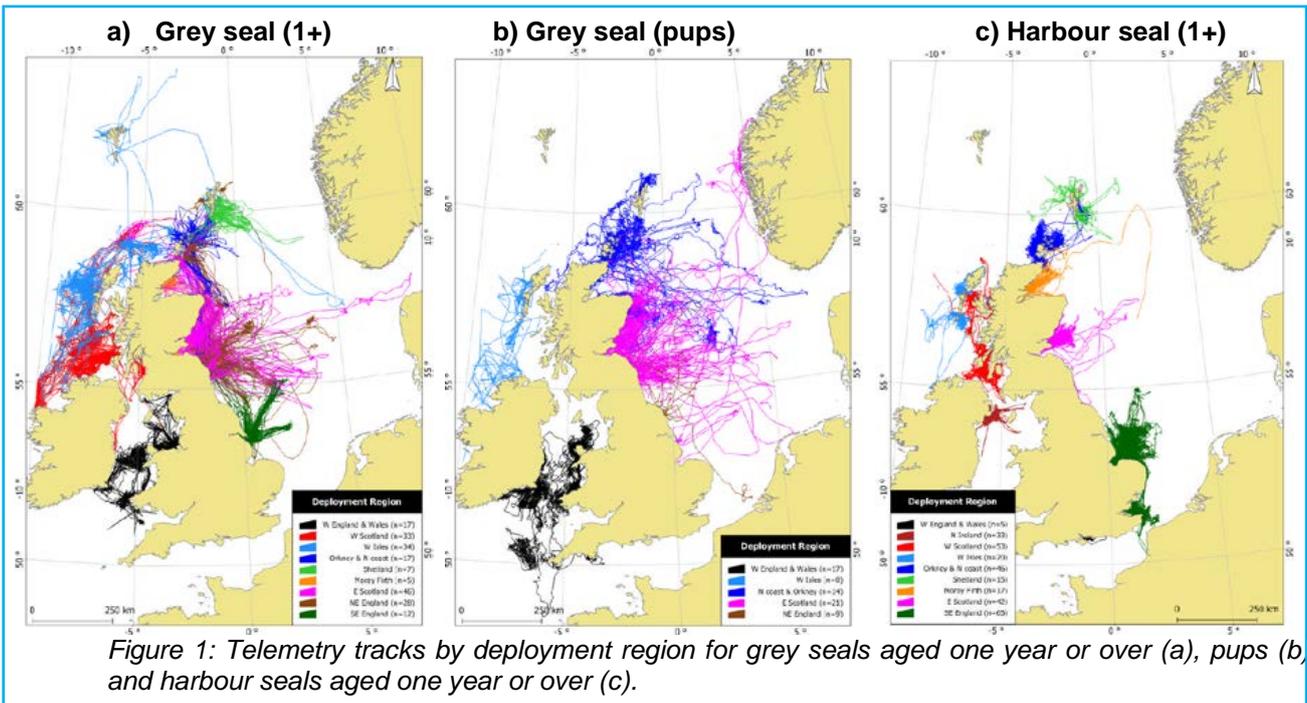
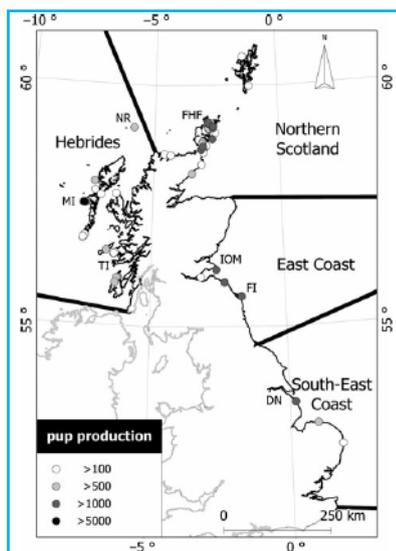


Figure 1: Telemetry tracks by deployment region for grey seals aged one year or over (a), pups (b), and harbour seals aged one year or over (c).

Link terrestrial sites with foraging sites

Figure 2: The 4 regions considered in the study



Telemetry data were used to identify transition events between the region in which a seal spent the majority of the year (foraging region) and the region in which it bred (Russell *et al.* 2013). SMRU had deployed 109 telemetry tags on female grey seals, aged one or older and data from tags that were attached to seals during both the foraging and breeding season were investigated. Breeding was identified and assigned to a region if a female was recorded as hauled out for the majority of an 18-day period during the breeding season and spent <10% of the time diving. Fifteen females, tagged between 1992 and 2008, met this criterion and each was assigned to a foraging region (Figure 2). It was found that between 21% and 58% of females used different regions for breeding and foraging. For example, up to half of the females breeding in Northern Scotland acquired their resources in the East Coast region. By quantifying the link between the foraging and breeding distributions of grey seals, management of breeding populations can be focused on the foraging regions where the resources necessary for reproduction are acquired.

Time budgets

A modelling approach was described by McClintock *et al.* (2013), which integrated location and ancillary biotelemetry (e.g. physiological or accelerometer) data from many individuals to estimate population-level movement parameters and activity. As an example, location and dive activity data

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from 17 harbour seals in the UK was modelled. Three distinct movement behaviour states: resting, foraging, and transit were identified (Figure 3), and population-level activity budgets for the three states were estimated.

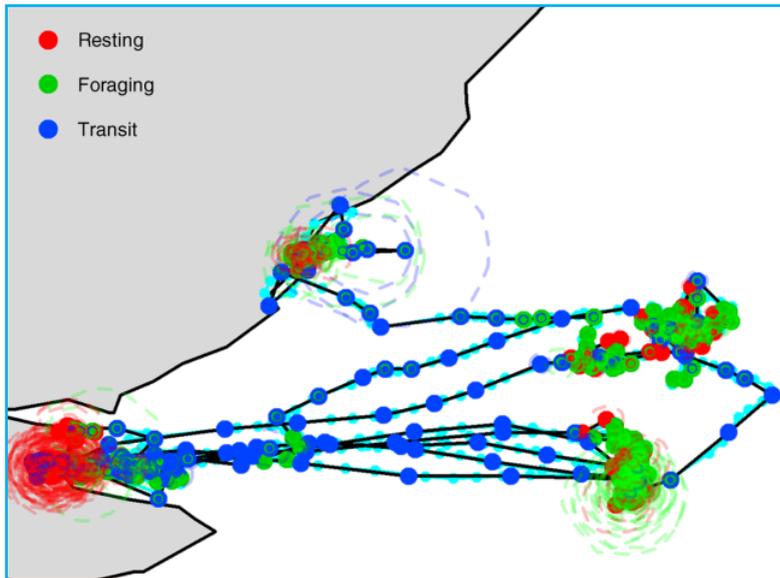


Figure 3: Predicted locations and movement behaviour states for a male harbour seal in southeastern Scotland. Estimated movement states for the predicted locations correspond to resting (red), foraging (green), and transit (blue) movement behaviour states. Light blue points indicate observed locations. Uncertainty in predicted locations indicated by dashed lines.

Behavioural and location data from telemetry tags deployed on 63 grey seals and 126 harbour seals in the UK was combined to investigate how the proportion of time spent in four states (resting on land, resting at sea, foraging and travelling) was influenced by internal and external

factors. Russell *et al.* (in preparation) found that although the activity budgets of the increasing grey seal population were similar to that of the decreasing harbour seal, the drivers of their behaviour differed, with grey seals appearing more resilient to external factors.

Habitat preference

The habitat preference of both grey (n=35) and harbour seals (n=81) was examined by Russell *et al.* (in preparation) who compared preference metrics using all at-sea locations and only foraging locations (categorised using both behavioural and movement data). The differences in the at-sea and foraging models were more marked in grey than harbour seals, probably as a result of the longer trip distances and thus more spatially distinct travelling and foraging areas in grey seals. The differing at-sea and foraging models led to differences in the predicted spatial at-sea and foraging use by grey seals. Although models of both seal species retained the same covariates (distance from haul-out, bathymetry, percentage mud, percentage gravel, and sea surface temperature), the differences in the shape of the relationships resulted in differing spatial areas of predicted high and low usage.

Project outputs

Russell DJF, 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.

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.

Russell DJF, McClintock B, Matthiopoulos J, Thompson P, Thompson D, Hammond P, MacKenzie M, Jones E, Moss S & McConnell BJ. Activity budgets in sympatric seal species: intrinsic and extrinsic covariates. In preparation.

Russell DJF, McConnell BJ, Jones E, McClintock B, Thompson D, Hammond P, Thompson P, Moss S & Matthiopoulos J. Foraging habitat preference in two sympatric seal species. In preparation.

DECC 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, DECC has conducted a series of offshore energy SEAs, the latest covering wind, tidal stream and range, CO₂ and hydrocarbon gas storage, and oil & gas – see right.

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@decc.gsi.gov.uk

A data portal for previous SEA reports and data is at <http://www.bgs.ac.uk/data/sea>

	Area	Sector
SEA 1	The deep water area along the UK and Faroese boundary	Oil & Gas (19 th Licensing Round, 2001)
SEA 2	The central spine of the North Sea which contains the majority of existing UK oil and gas fields	Oil & Gas (20 th Licensing Round, 2002)
SEA 2 Extension	Outer Moray Firth	Oil & Gas (20 th Licensing Round, 2002)
SEA 3	The remaining parts of the southern North Sea	Oil & Gas (21 st Licensing Round, 2003)
R2	Three strategic regions off the coasts of England and Wales in relation to a second round of offshore wind leasing	Offshore wind (R2 of Leasing, 2003)
SEA 4	The offshore areas to the north and west of Shetland and Orkney	Oil & Gas (22 nd Licensing Round, 2004)
SEA 5	Parts of the northern and central North Sea to the east of the Scottish mainland, Orkney and Shetland	Oil & Gas (23 rd Licensing Round, 2005)
SEA 6	Parts of the Irish Sea	Oil & Gas (24 th Licensing Round, 2006)
SEA 7	The offshore areas to the west of Scotland	Oil & Gas (25 th Licensing Round, 2008)
OESEA	UK offshore waters*	Oil & Gas (26 th Licensing Round, 2009) Gas storage Offshore wind (R3 of Leasing, 2009)
OESEA2	UK offshore waters*	Oil & Gas (27 th Licensing Round, 2012) Gas storage Carbon dioxide transport and storage Offshore wind, wave and tidal energy

*For renewable energy included potential leasing in the UK Renewable Energy Zone (REZ) and the territorial waters of England and Wales but not the Scottish Renewable Energy Zone and Northern Irish waters within the 12 nautical mile territorial sea limit