APPENDIX 10A: MARINE MAMMAL BASELINE TECHNICAL REPORT

BASELINE CHARACTERISATION UPDATE

Baseline approach

10.1. Characterisation of the baseline environment was undertaken to understand the spatial and temporal diversity, abundance and density of marine mammals that could potentially be impacted by the Seagreen Project. Information for the marine mammal baseline characterisation is taken from the project specific surveys outlined in the 2012 Offshore ES, complemented with additional data that has been collected since its production, compiled through literature reviews. This section of the report summarises the key data sources examined to establish the baseline.

Study area

10.2. The following definitions for the scale of study areas were used in the previous assessment:

- **The Immediate Study Area (ISA)** - the Project area and the potential impact footprint boundaries were defined by original noise modelling outputs. Seagreen specific boat based surveys were focussed in the Firth of Forth Development Zone. FTOWDG data sharing and collaborative studies also provided new data across the ISA. Methodologies for each FTOWDG study and the Seagreen specific boat based surveys are described in full in Technical Appendices (10Ai to 10Avi);
- **The Regional Study Area (RSA)** - Marine mammal connectivity with relevant Special Areas of Conservation (SACs) is considered in relation to the RSA and therefore the RSA for each species is dependent on their natural foraging range. The East Coast Management Area (ECMA) for seals is also included in the RSA. For grey seal, *Halichoerus grypus*, the Isle of May SAC and Berwickshire and North Northumberland Coast SAC are within range. For harbour seal, *Phoca vitulina*, the Firth of Tay and Eden Estuary SAC is included in the study area, and for bottlenose dolphin, *Tursiops truncatus,* there is evidence of connectivity with the Moray Firth SAC. The East Coast Management Area (ECMA) for seals extends from Fraserburgh to the Scotland – England border and provides the relevant population boundary for harbour seals and grey seals to be used in the impact assessment; and
- **The Wider Study Area (WSA)** – the far field study area appropriately defined for the marine mammal species under consideration.

10.3. These definitions largely still apply to the study. However, since the publication of the 2012 Offshore ES, the UK Marine Mammal Interagency working group has defined draft management units for seals (IAMMWG, 2013) and final management units for cetaceans (IAMMWG, 2015). These management units have been adopted as the appropriate reference populations for the Seagreen Project impact assessment. The appropriate management units and associated abundances are provided in the relevant species accounts in the following sections.

Data collection and surveys

Project specific surveys and studies

10.4. ECON was commissioned to undertake boat based surveys for marine mammals and birds in the Zone. Surveys were carried out from December 2009 to November 2011. A full description of the boat survey methodology is provided in the 2012 Appendix 10Ai. SMRU Ltd was commissioned to analyse boat survey data collected between May 2010 and November 2011 (Appendix 10Ai). Additional surveys for birds were undertaken in the Phase 1 area plus 2 km buffer in summer 2017 (May – August inclusive). Incidental recordings of marine mammal presence were recorded during these surveys, where sea state ranged between 1 (excellent) and 4 (average).

10.5. The Crown Estate (TCE) commissioned a series of aerial surveys of offshore wind farm sites during 2009 and 2010 around the UK. SMRU Ltd was commissioned by FTOWDG to evaluate (Appendix 10Aii) and analyse (Appendix 10Aiii) data collected at the STW and Round 3 Zones within the Firths of Forth and Tay.

10.6. Boat based and aerial survey data collected across FTOWDG provide spatially explicit densities to inform the baseline for harbour porpoise *Phocoena phocoena*, minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris* (10F), and also for the impact assessment of harbour porpoise.

10.7. SMRU Ltd was also commissioned to collate baseline information for seals, including aerial surveys at haul out sites, diet, and telemetry data and to generate at sea densities (Appendix 10Aiv). Baseline information on bottlenose dolphin *Tursiops truncatus* was also collated by SMRU Ltd for the FTOWDG (Appendix 10Av).

Other studies and data sources

Small Cetaceans in the European Atlantic and North Sea (SCANS) Surveys

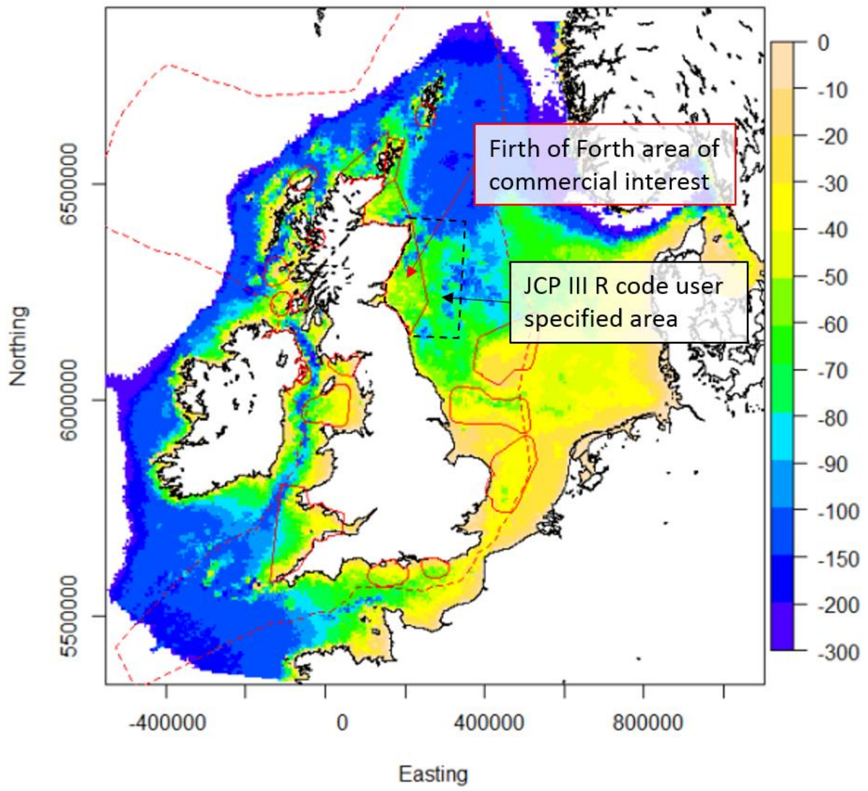
10.8. The main objective of the SCANS surveys was to estimate small cetacean abundance and density in the North Sea and European Atlantic continental shelf waters. The SCANS I surveys were completed in 1994, SCANS II in July 2005 and SCANS III in July 2016 and all comprised of a combination of vessel and aerial surveys. Both aerial and boat-based survey methodologies were designed to correct for availability and detection bias and allow the estimation of absolute abundance. The aerial surveys involved a single aircraft method using circle-backs (or race-track) methods (Hammond et al., 2006) whereas the boat-based surveys involved a double platform 'primary' and 'secondary' tracker methodology. The Seagreen Project is located in the SCANS III survey area R, SCANS II survey area V and the SCANS I survey area C. The ship surveys within survey area C in 1994 covered a total transect length of 1,557km and an area of 43,744km^2 (Hammond et al., 2002). The ship surveys in SCANS II covered a total transect length of 3,022km and an area of 160,517km^2 (Burt et al., 2006). In 2016 the SCANS III aerial survey transect line length was 1,371km and covered an area of 40,383km^2 (Hammond et al., 2017).

10.9. While the SCANS surveys provide sightings, density and abundance estimates at a wide spatial scale, the surveys are conducted during a single month, every 11 years and therefore do not provide any fine scale temporal or spatial information on species abundance and distribution. Furthermore, due to the change in survey blocks used across the SCANS surveys direct comparison between the surveys for abundance and density information is not possible.

Joint Cetacean Protocol (JCP) Phase III Analysis

10.10. The JCP Phase III analysis included datasets from 38 sources, totalling over 1.05 million km of survey effort between 1994 and 2010 from a variety of platforms (Paxton et al., 2016). The JCP Phase III analysis was conducted to combine these data sources to estimate spatial and temporal patterns of abundance for seven species of cetaceans: harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus*, white-beaked dolphin and Atlantic white-sided dolphin (*Lagenorhynchus acutus*). Density surface models were used to predict species density over a fine scale grid of 25km² resolution for one day in each season in each survey year. The data are divided into regions for which seasonal estimates of abundance for winter (January-March), spring (April-June), summer (July-September) and autumn (October-December). The Seagreen Project is situated within the "Firth of Forth area of commercial interest" which is included in the analysis as an area for which abundance estimates are presented for 2010 (Figure 1). The area of the "Firth of Forth area of commercial interest" is 14,241km².

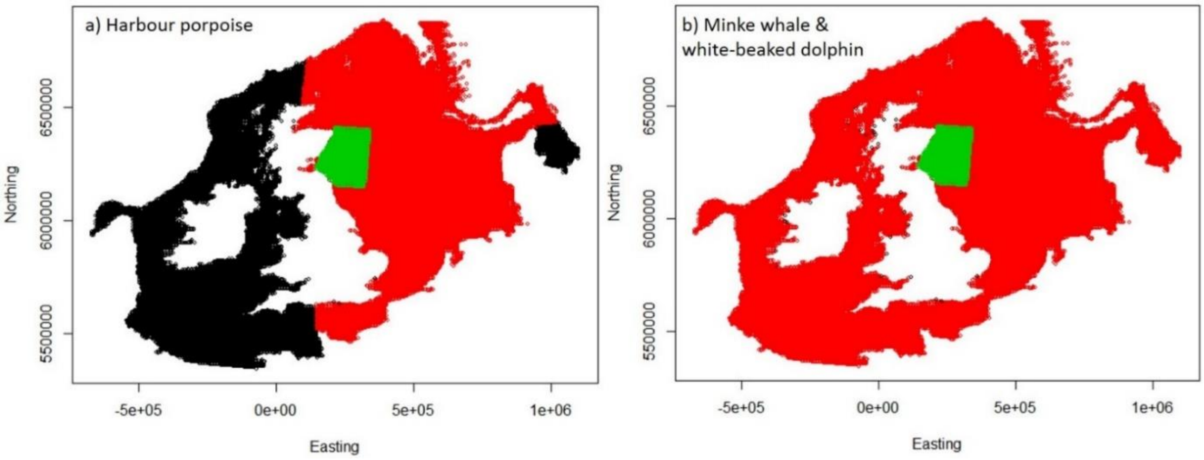
Figure 1. The core JCP Phase III regions showing (red) areas commercial interest. The Firth of Forth area of commercial interest is identified, as is the JCP III R code user specified area for comparison (black dashed line). The colour scale represents water depth.



10.11. However, as stated by Paxton et al. (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available. Therefore, the abundance estimates obtained from site specific and well-designed surveys likely to be better reflections of the true cetacean abundance in the Seagreen Project area.

10.12. In 2017, JNCC released R code[1] that can be used to extract the cetacean abundance estimates for summer 2007-2010 (average) for a user specified area. This code was originally created by Charles Paxton at CREEM, and was modified by JNCC to include abundance estimates that are scaled to the SCANS III results. The user specified area used to extract these abundance estimates is shown in Figure 2 in green and consists of a total area of 36,730 km^2. This area is approximately double the size of that assessed as part of the Firth of Forth area of commercial interest and extends further offshore (the two areas are presented for comparison in Figure 2).

Figure 2. The user specified area (green) used to extract cetacean abundance and density estimates from the JCP III R code. The map shows the whole area under consideration (black), the management unit (red) and the specific area of interest (green) for a) harbour porpoise North Sea MU and b) minke whales and white-beaked dolphins Celtic and Greater North Sea MU.



JNCC Report 544: Harbour Porpoise Density

10.13. Heinanen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify "discrete and persistent areas of high density" that might be considered important for harbour porpoise with the ultimate goal of determining SACs for the species. The approach involved constructing predictive models using corrected sightings rates analysed with respect to topographic, hydrodynamic and anthropogenic covariates and then generating predicted distribution maps of density estimates for the waters around the UK. The analysis grouped data into three subsets: 1994-1999, 2000-2005 and 2006-2011 to account for patchy survey effort and analysed summer (April-September) and winter (October-March) data separately to explore whether distribution patterns were different between seasons. The authors note that "due to the uneven survey effort over the modelled period, the uncertainty in modelled distributions vary to a large extent." It is worth highlighting that the analysis presented in Heinanen and Skov (2015) relies on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models, and makes the assumption that these relationships hold outside of the surveyed areas. Subjective decisions in the retention of covariates in Heinanen and Skov (2015) could limit the wider validity of such extrapolation.

[1] http://jncc.defra.gov.uk/page-7201

Special Committee on Seals (SCOS)

10.14. Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the SCOS. The SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The report includes advice on matters related to the management of seal populations, including general information on British seals, information on their current status, and addresses specific questions raised by regulators and stakeholders. The most recent publically available SCOS report is SCOS (2017) which presents the data collected up to 2016.

SMRU Seal Haul-out Surveys

10.15. SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to NERC's statutory obligation under the Conservation of Seals Act 1970 'to provide the (UK government) with scientific advice on matters related to the management of seal populations'. These SMRU surveys are funded by NERC, SNH and Natural England and constitute the routine, statutory monitoring of seal populations around the UK.

Harbour Seals

10.16. Surveys of harbour seals are carried out during the summer months. The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August, as this is the time of year when the largest numbers of seals are ashore. To maximise the numbers of seals on shore and to reduce the effects of environmental variables on counts, surveys are restricted to within two hours either side of afternoon low tides on days with no rain. Grey seals are also counted on all harbour seal surveys, although these data do not necessarily provide a reliable index of population size. The counts obtained represent the number of seals that were on shore at the time of the survey and are an estimate of the minimum size of the population. They do not represent the total size of the local population since a number of seals would have been at sea at the time of the survey but telemetry data from tagged seals can are used to scale this estimate to take account of the proportion of animals at sea at the time of survey. It is noted that these data refer to the numbers of seals found within the surveyed areas only at the time of the survey; numbers and distribution may differ at other times of the year.

Grey Seals

10.17. Grey seals aggregate in the autumn to breed at traditional colonies. Their distribution during the breeding season can be very different to their distribution at other times of the year. SMRU's main surveys of grey seals are designed to estimate the numbers of pups born at the main breeding colonies around Scotland. Breeding grey seals are surveyed biennialy between mid-September and late November using large-format vertical photography from a fixed-wing aircraft. Over 60 colonies are surveyed between three and seven times, at ten to 12 day intervals, through the breeding season. Total pup production for each colony is derived from the series of counts obtained. Approximately 40 additional colonies are surveyed less regularly. The main grey seal breeding colonies in Shetland, England, Wales and Northern Ireland are counted by other, local, organisations. SNH staff count pups in Shetland in a manner compatible with counts from aerially surveyed colonies.

Designated seal haul-outs

10.18. The Marine (Scotland) Act 2010 contains specific protection for Scottish seal populations. Under the provisions of section 117 of the Marine (Scotland) Act (2010), Marine Scotland, in consultation with the Sea Mammal Research Unit (SMRU), produced a list of specific seal haul-out sites for additional protection from intentional or reckless harassment. In June 2014 a total of 194 haul-out sites were designated under The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014. At these designated seal haul-out sites it is an offense to harass seals, where harassment is defined as "an activity that pesters, torments, troubles or attacks a seal on a designated haul-out site". This includes any action that causes a significant proportion of seals on a haul-out site to leave that site either more than once or repeatedly or, in the worst cases, to abandon it permanently (Marine Scotland 2014). There are two harbour seal designated seal haul-outs and three grey seal designated haul-outs within the East Scotland MU.

Seal Telemetry

10.19. SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. The telemetry tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. Telemetry data are particularly useful as they provide information on seal movement patterns away from their haul-out sites, provide data on the foraging behaviour of seals at sea and demonstrate connectivity between areas.

10.20. There are two types of telemetry tag which differ in their data transmission methods. Data transmission can be through the Argos satellite system (Argos tags) or using the GSM mobile phone network (GPS Phone tags). Both types of transmission result in location fixes, but data from GPS phone tags comprise better quality and more frequent locations by incorporating the Fastloc GPS system (Wildtrack Telemetry Systems, UK) which obtains the GPS location within a fraction of a second and therefore collects data even when the animal surfaces for a short period. Both types of tags use precision wet/dry sensors as well as pressure and temperature sensors to obtain detailed individual dive (max depth, shape, time at depth, etc.) and haul-out records. Data are stored on board the tags and then relayed by a satellite (Argos tags) or by quad-band GSM mobile phone module to SMRU when the animal is within range of the GSM mobile phone network. The data are then stored in databases, cleaned according to methods described in Russell et al. (2011) and processed for analysis.

Seal At-sea Usage

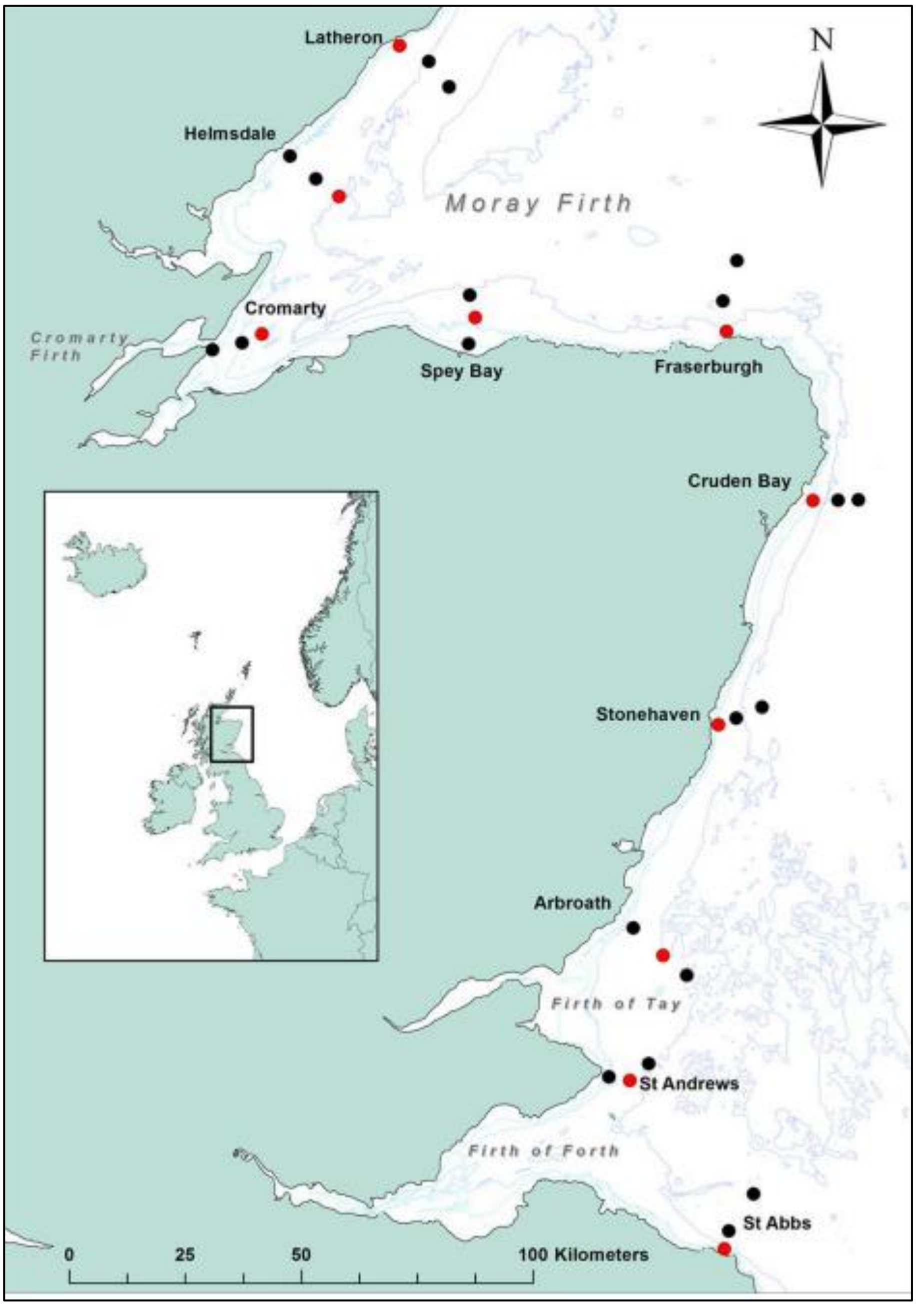
10.21. Russell et al. (2017) have produced revised estimated at-sea distribution usage maps for both grey and harbour seals. The previous usage maps (Jones et al. 2015) contained telemetry data from 259 grey seals and 277 harbour seals tagged in the UK, ROI and France. The revised maps Russell et al. (2017) contain telemetry data from 270 grey seals and 330 harbour seals tagged within the UK only. The revised maps also incorporate count data between 1996 and 2015. The at-sea usage maps represent the number of grey and harbour seals estimated to be in the water in each grid cell at any given time.

The East Coast Marine Mammal Acoustic Study (ECOMMAS)

10.22. The ECOMMAS began in 2013 and involved 30 PAM sites along the east coast of Scotland to collect data on the relative abundance of dolphins and porpoise. Every PAM site contained a CPOD capable of detecting dolphin and porpoise echolocation clicks and some sites also contained an SM2M capable of recording underwater noise and the vocalisations of dolphin species.

10.23. There were 15 locations along the Scottish east coast outside of the Moray Firth. There were three CPOD stations at each of the following locations: Cruden Bay, Stonehaven, Arbroath, St Andrews and St Abbs. Each location had PAM units placed approximately five, 10 and 15km from the coast (Figure 3).

Figure 3. ECOMMAS PAM locations along the Scottish East Coast. Black dots denote CPOD only locations and red dots denote joint CPOD/SM2M locations.



10.24. CPODs are only capable of providing "dolphin" detections and are unable to discriminate between species. Therefore, these data were further analysed to separate the CPOD "dolphin" detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency banded echolocation clicks (made by Risso's and white-beaked dolphins) (Palmer et al. 2017). This was done by comparing the CPOD detections to the data collected on the adjacently deployed SM2M which collect continuous recording which can be used to discriminate between dolphin species. A GAM was used to separate the data into different dolphin groups and the model predictions were then pooled within an acoustic encounter and a likelihood ratio threshold was used to categorize encounters.

EXISTING ENVIRONMENT

10.25. The following sections describe the available data on marine mammals within the defined area in relation to the Seagreen Project, and provides a detailed picture of their spatial and temporal patterns of abundance and density.

Harbour seal baseline

10.26. Harbour seals are the smaller of the two species of seal resident in UK waters. They forage at sea and haul-out on land to rest, moult and breed. Harbour seals normally feed within 40 to 50km around their haul-out sites and take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, octopus and squid (SCOS, 2017).

10.27. Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle.

10.28. Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth (Figure 4).

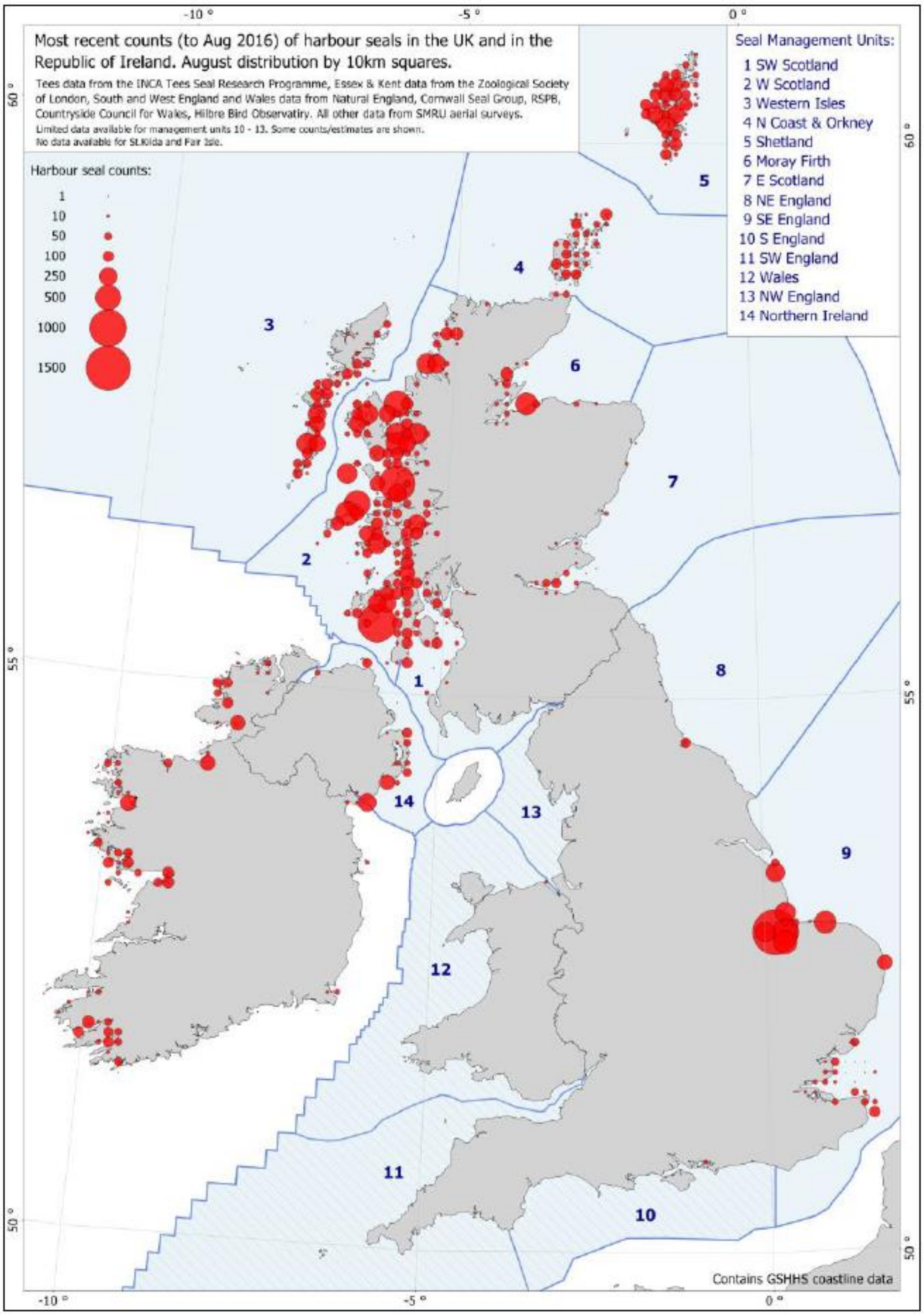
10.29. In the UK, harbour seals are considered to have an Unfavourable Inadequate Conservation Status (JNCC, 2013) which means that "a change in management or policy is required to return the habitat type or species to favourable status but there is no danger of extinction in the foreseeable future" (ETC/BD 2014).

10.30. The following sections describe the available data on harbour seals in the East Scotland seal Management Unit and, specifically, in relation to the Seagreen Project, in order to determine their spatial and temporal patterns of abundance and density.

August haul-out surveys

10.31. The most recent UK wide harbour seal count presented in SCOS (2017) collates data collected between 2011 and 2016. This produced a total count for the UK of 31,300 seals, which, scaled to account for the proportion of animals at sea at the time of the count, gives an estimated population size of 43,500 (95% CI: 35,600 to 58,000), of which 80% are located in Scotland. Overall, the UK harbour seal population has increased since the late 2000s and is close to the level is was in the 1990s prior to the phocine distemper virus epidemic.

Figure 4. August distribution of harbour seals around the British Isles (SCOS, 2017).



10.32. The Seagreen Project is located within the East Scotland seal MU. The most recent harbour seal August moult count presented for this MU is 368 (2011-2016 count period) (SCOS, 2017). Accounting for the proportion of the population at sea during the survey, this scales to a MU population estimate of 511 harbour seals (95% CI: 418 to 681). While the MU has shown a large decline in numbers since the 1996-1997 count period, the most recent haul-out count in the 2011-2016 period (368) was considerably higher than that in the 2007-2009 count period (283) (Table 10.1).

Table 10.1 The most recent August counts (2011-2016) of harbour seals at haul-out sites in the East Scotland MU compared with three previous periods: 1996-1997, 2000-2006 & 2007-2009 (SCOS, 2017).

Count Period	Harbour seal count	Population Estimate	95% CI
1996 – 1997	764	1,061	868 – 1,415
2000 – 2006	667	926	758 – 1,235
2007 – 2009	283	393	322 – 524
2011 - 2016	368	511	418 - 681

10.33. The number of harbour seals in the East Scotland harbour seal MU accounts for approximately 2.5% of the total population of Great Britain. The nearest designated haul-out sites for harbour seals in the MU are Kinghorn Rocks and Inchmickery and Cow and Calves (Figure 5 and Table 10.2).

Figure 5. Designated harbour seal haul-out sites and seal SAC in East Scotland MU.

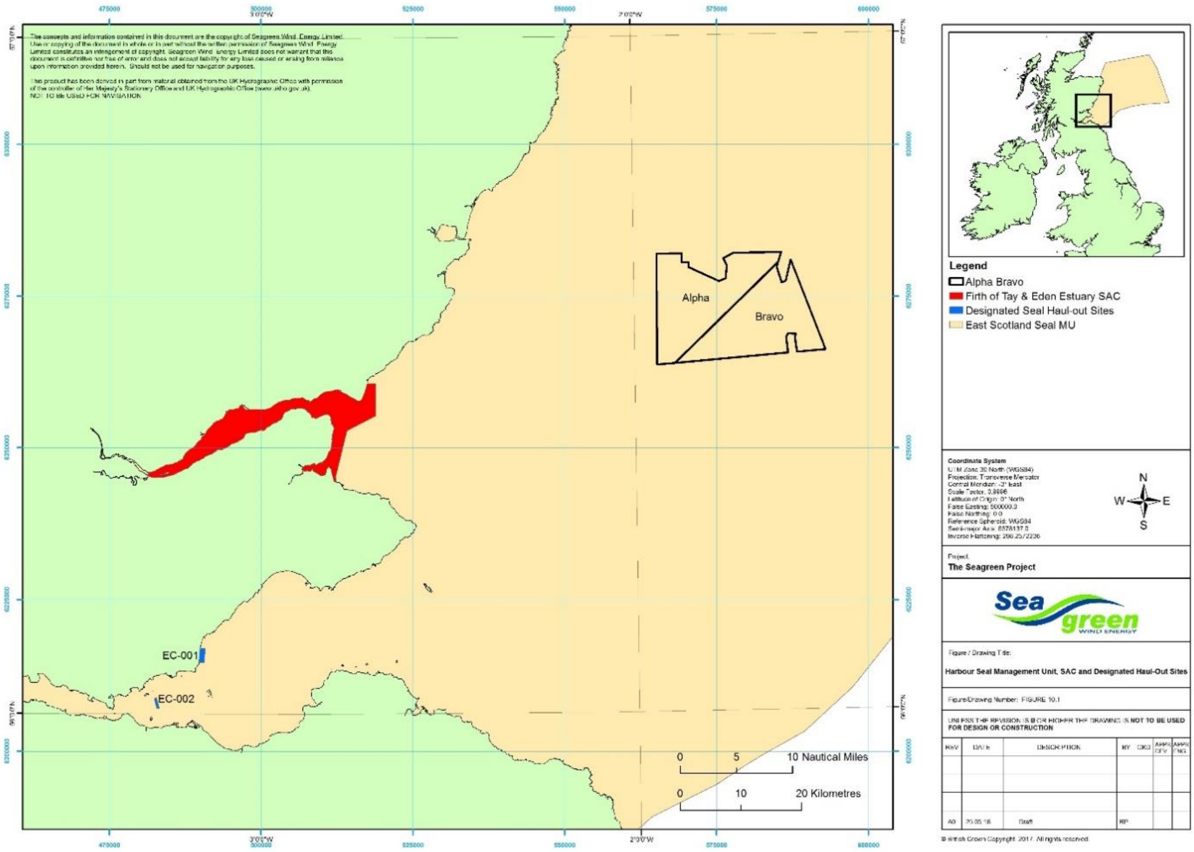


Table 10.2 Designated harbour seal haul-out sites in the East Scotland seal MU.

Site ID	Site Name	Location	Minimum distance the Seagreen Project (km)
EC-001	Kinghorn rocks	Firth of Forth North; intertidal mudbanks and rocky coastline between Long Craig and Linton Court and associated rocky outcrops	88.5
EC-002	Inchmickery and Cow and Calves	Firth of Forth; rocky coastline around Inchmickery and entire islands of Cow, Calves and Oxcars	99.2

10.34. Since 2001 harbour seal counts have continued to decline in the Firth of Tay and Eden Estuary SAC (SCOS, 2017). The Firth of Tay and Eden Estuary SAC population seemed relatively stable between 1990 and 2002, with the highest population estimate being 1,074 (878 – 1,431) in 1992. After 2002 the SAC population experienced a steady decline to the lowest estimated population size of 40 (33 - 54) in 2014 (Figure 6 and Figure 7). The population estimate has increased since the lowest estimate in 2014, with a 2015 estimate of 83 (68 - 111) and a 2016 estimate of 71 (58 - 94).

10.35. Population modelling work conducted for the Firth of Tay and Eden Estuary population has concluded that if this declining trend continues, the population will effectively become extinct within the next 20 years (Hanson et al. 2015).

Figure 6. Firth of Tay and Eden Estuary SAC harbour seal population estimates between 1990 and 2016 (SCOS, 2017). Error bars show the 95% CIs.

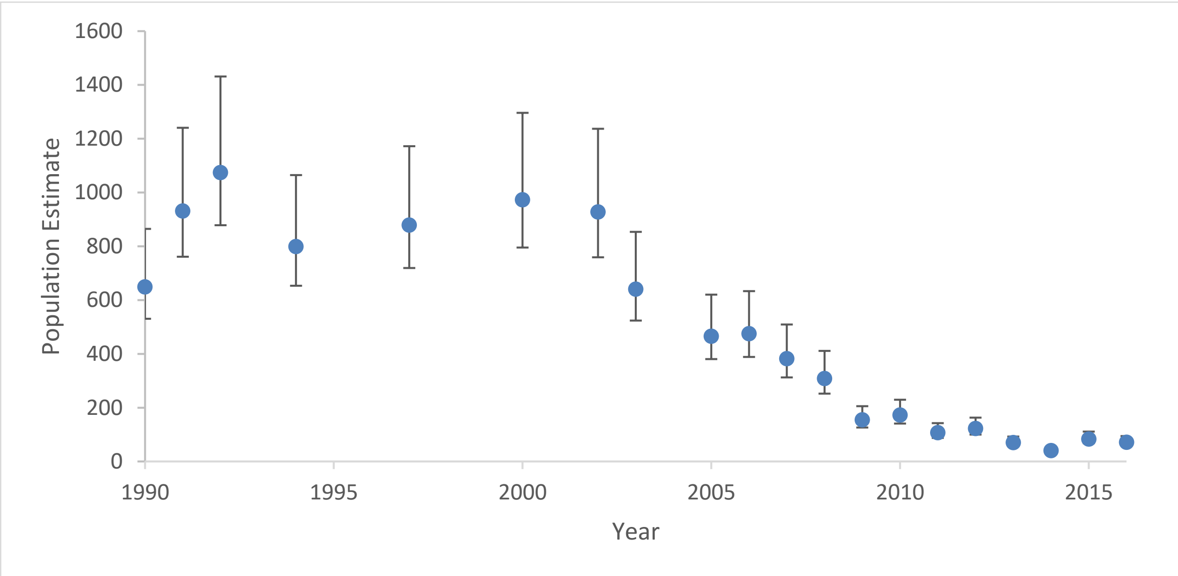


Figure 7. August counts of harbour seals in the Firth of Tay and Eden Estuary, 1990 to 2016 (SCOS, 2017).

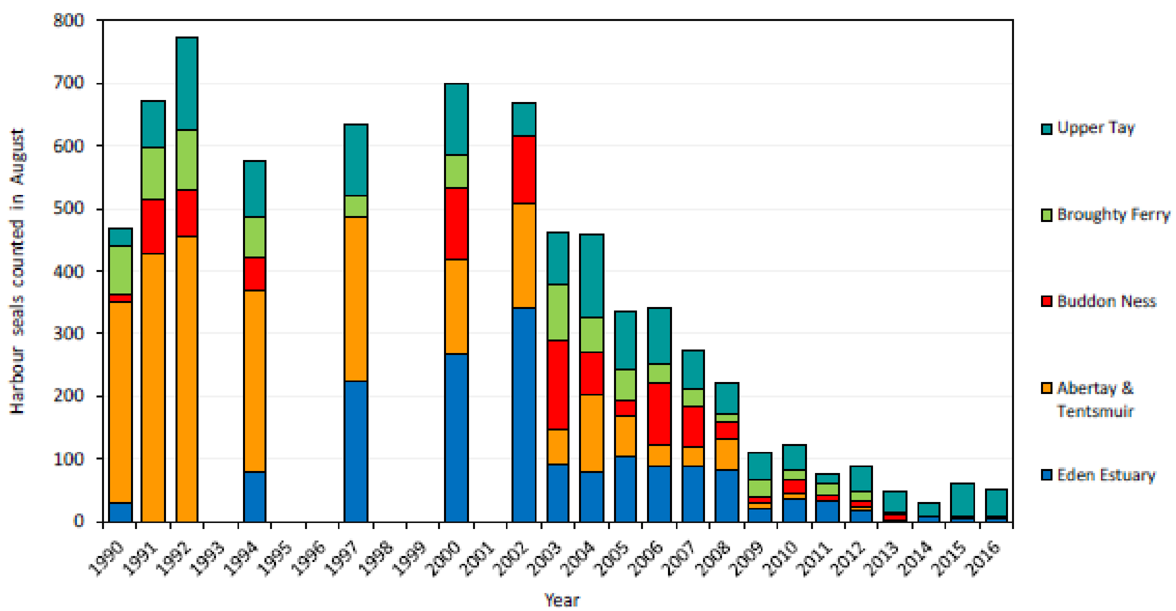
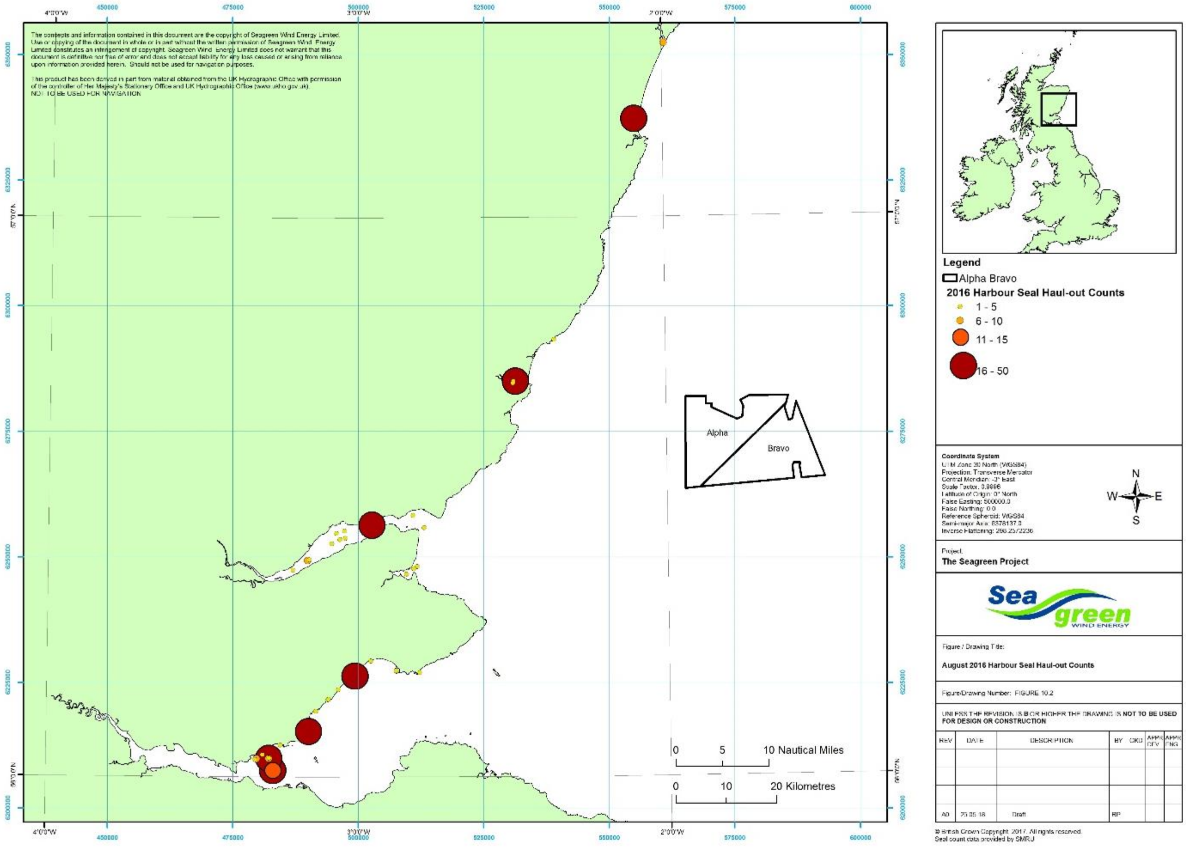


Figure 8. August counts of harbour seals in the east Scotland MU in 2016 only.



Telemetry

10.36. The telemetry data presented in the previous baseline (Figure 9, Figure 10 and Appendix 10Aiv) confirmed harbour seal usage of the ISA including both Project Alpha and Project Bravo.

10.37. Sandeels were the dominant prey species found in the diet of harbour seal in the region; however, spatial variation was evident throughout the region with salmonids the dominant prey type in the Tay in spring and summer, while diet in St Andrews Bay was dominated by sandeels in all seasons (Sharples et al., 2009). Appendix 10Aiv provides more detail on prey species for harbour seal in the RSA. Chapter 12 Natural Fish and Shellfish Resource in the 2012 Offshore ES provides information on the existing environment for fish species. The Wee Bankie sandbank is a key habitat for sandeels in the RSA (Daunt et al., 2008). The Wee Bankie area had high usage of harbour seals and is therefore expected to be an important offshore foraging location.

Figure 9. Locations (a) and tracks (b) of adult harbour seals around and inside the FTOWDG boundaries (2001 – 2008).

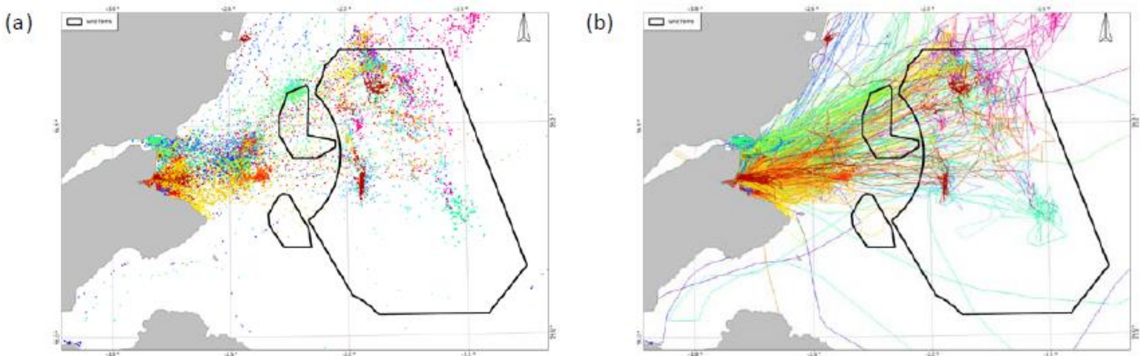
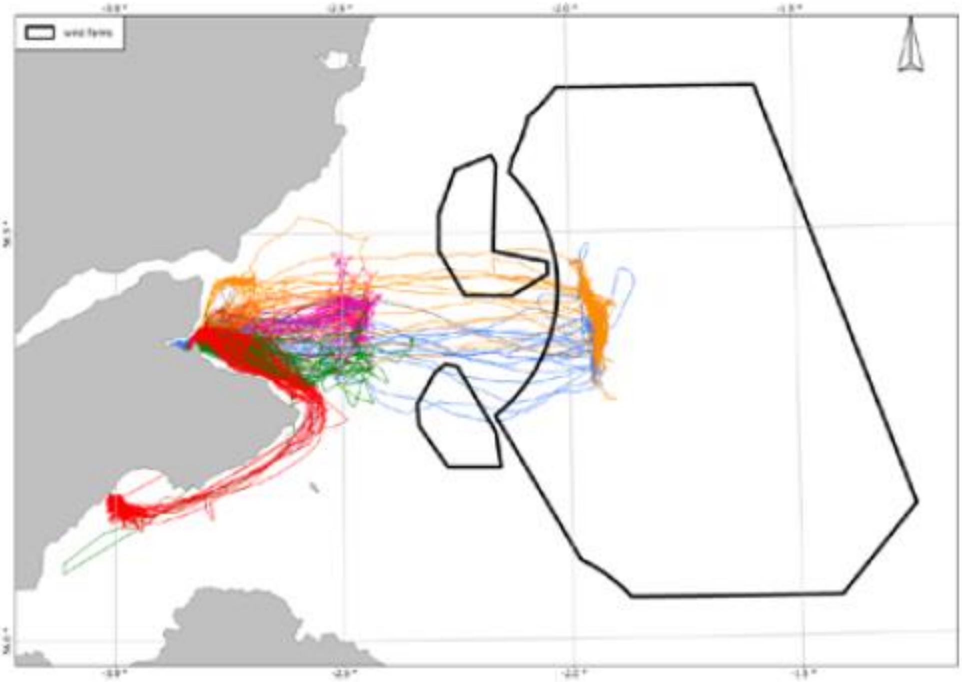
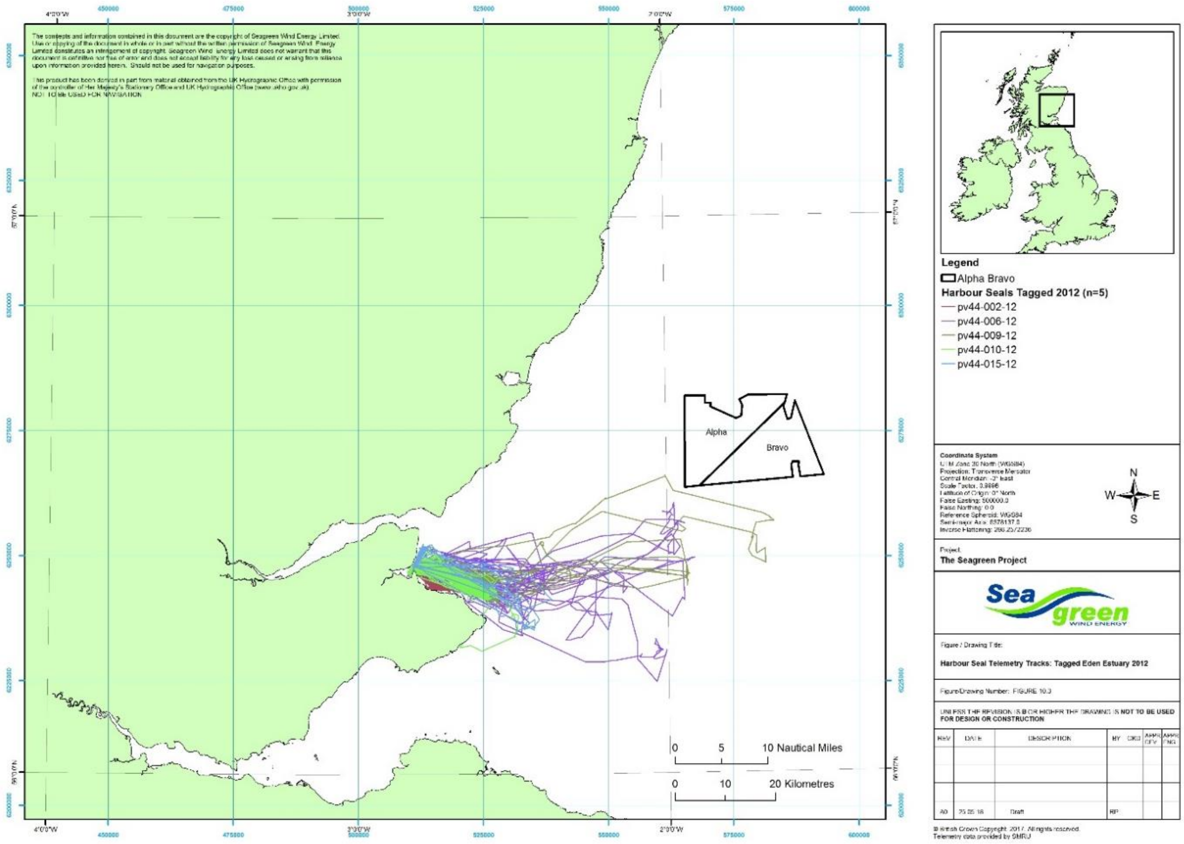


Figure 10. Tracks of adult harbour seals around and inside the FTOWDG boundaries (2011).



10.38. Since the 2012 Offshore ES another five adult harbour seals were tagged at the Eden Estuary in 2012. The tracks show very restricted movement and none of the seals had tracks within the Seagreen Project (Figure 11). The average tag duration was 56.2 days (range 41 – 65).

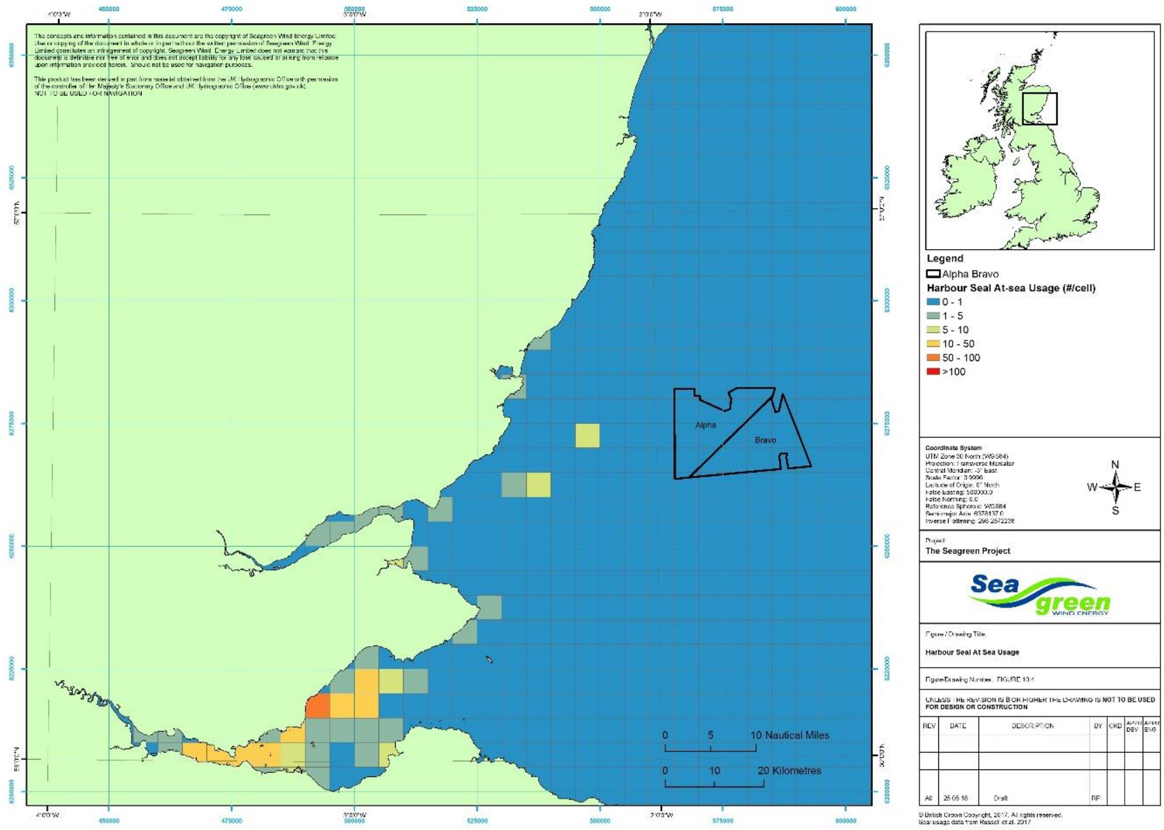
Figure 11. Telemetry tracks of the 5 harbour seals tagged at the Eden Estuary in 2012.



At-sea usage

10.39. Harbour seal at-sea usage in the East Coast Scotland MU is low (Figure 12), with the main area of usage centred within the Firth of Forth where at sea densities reach a maximum of 55.3 harbour seals/cell which, assuming a uniform distribution within grid cells is an estimated density of 2.2 harbour seals/km^2. There is one high density cell that overlaps with the export cable which contains 8.3 harbour seals which, assuming a uniform density within a grid cell is a density of 0.33 harbour seals/km^2. Across the Seagreen Project the grid cell density is low, with <1 seal/cell.

Figure 12. Harbour seal at-sea usage showing the predicted mean number of animals in each 5 x 5 km grid cell (Russell et al. 2017).



Visual surveys

10.40. Figure 13 shows the harbour seal sightings from the boat based surveys within the Project Alpha and Project Bravo Seagreen Project. No harbour seals were recorded during the 2017 Phase 1 area + 2 km buffer breeding season surveys.

10.41. Boat based surveys show that harbour seals were seen in low numbers during most months in 2010, with the only exceptions being October and November when no harbour seals were recorded. Harbour seal sightings were lower in 2011 than 2010 and no harbour seals were recorded in February or April to August 2011 (Figure 14). Highest encounter rates were in May 2010 and Sept 2011 at 0.005 sightings per km^2. Harbour seal sightings at sea are expected to be reduced during June and July when they haul-out for breeding and in August when they moult. When pooled by season, encounter rates are lowest in winter, second lowest in summer and highest in spring and autumn (Figure 14).

10.42. A number of seals were recorded during the aerial surveys, the majority of which were not identified to species (Figure 15).

Figure 13. Positions of all seal sightings recorded during boat surveys (obtained from Appendix 10Ai).

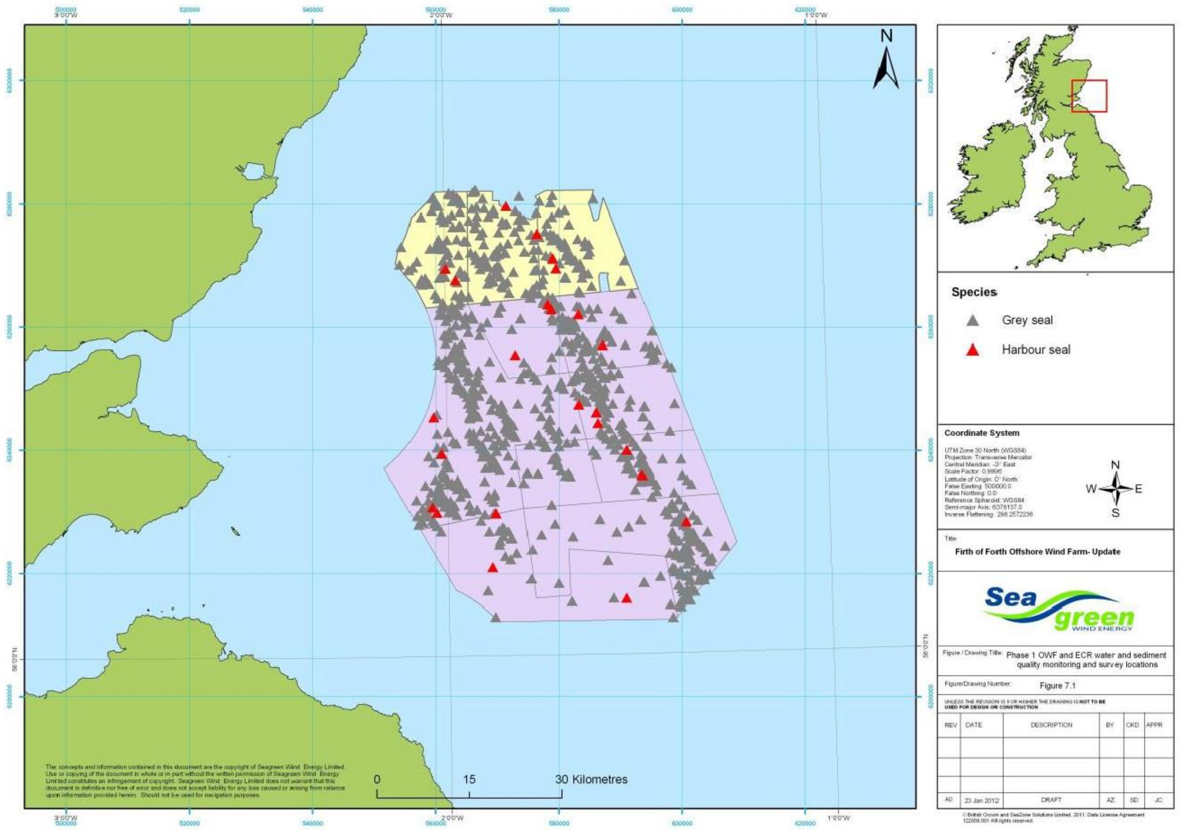


Figure 14. Encounter rate (sightings per km of survey effort) for harbour seals per survey month (Appendix 10Ai).

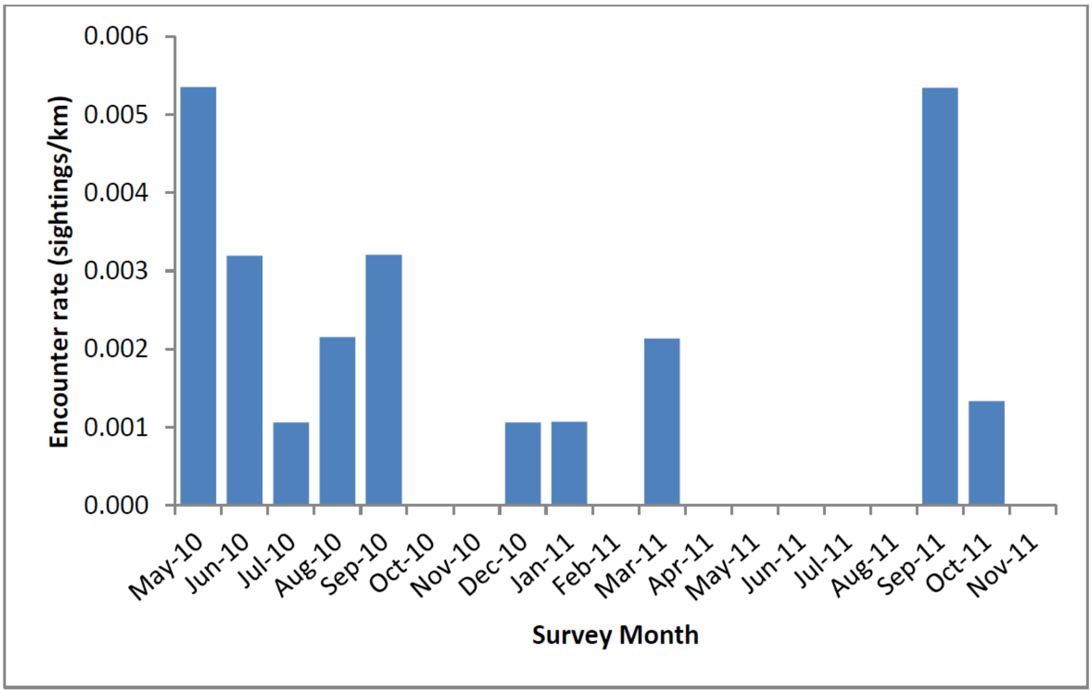
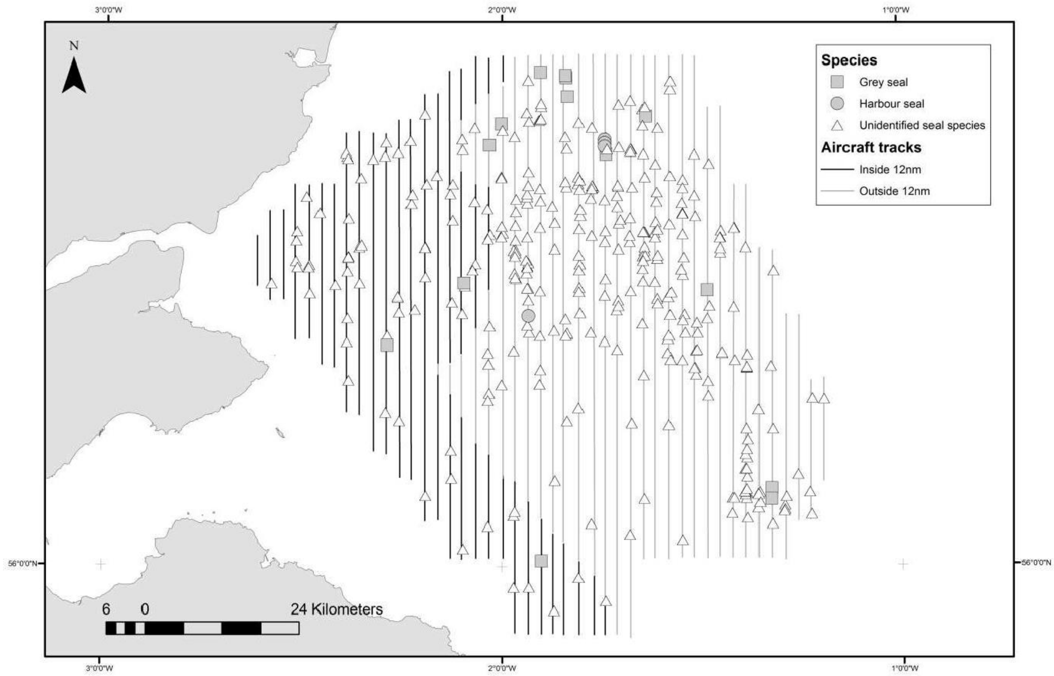


Figure 15. Sightings of all seal species recorded during the aerial surveys (Appendix 10Aiii).



Harbour seal baseline conclusion

10.43. Harbour seals have the potential to be impacted by the effects of underwater noise generated by piling activity, although they are present in very low numbers in the immediate and regional study areas. The spatially explicit harbour seal densities from Figure 12 will be used in the quantitative noise impact assessment to quantify the number of seals that might experience noise levels that could cause disturbance. The results of this process will be presented with reference to the total population of the East Coast Seal Management Unit.

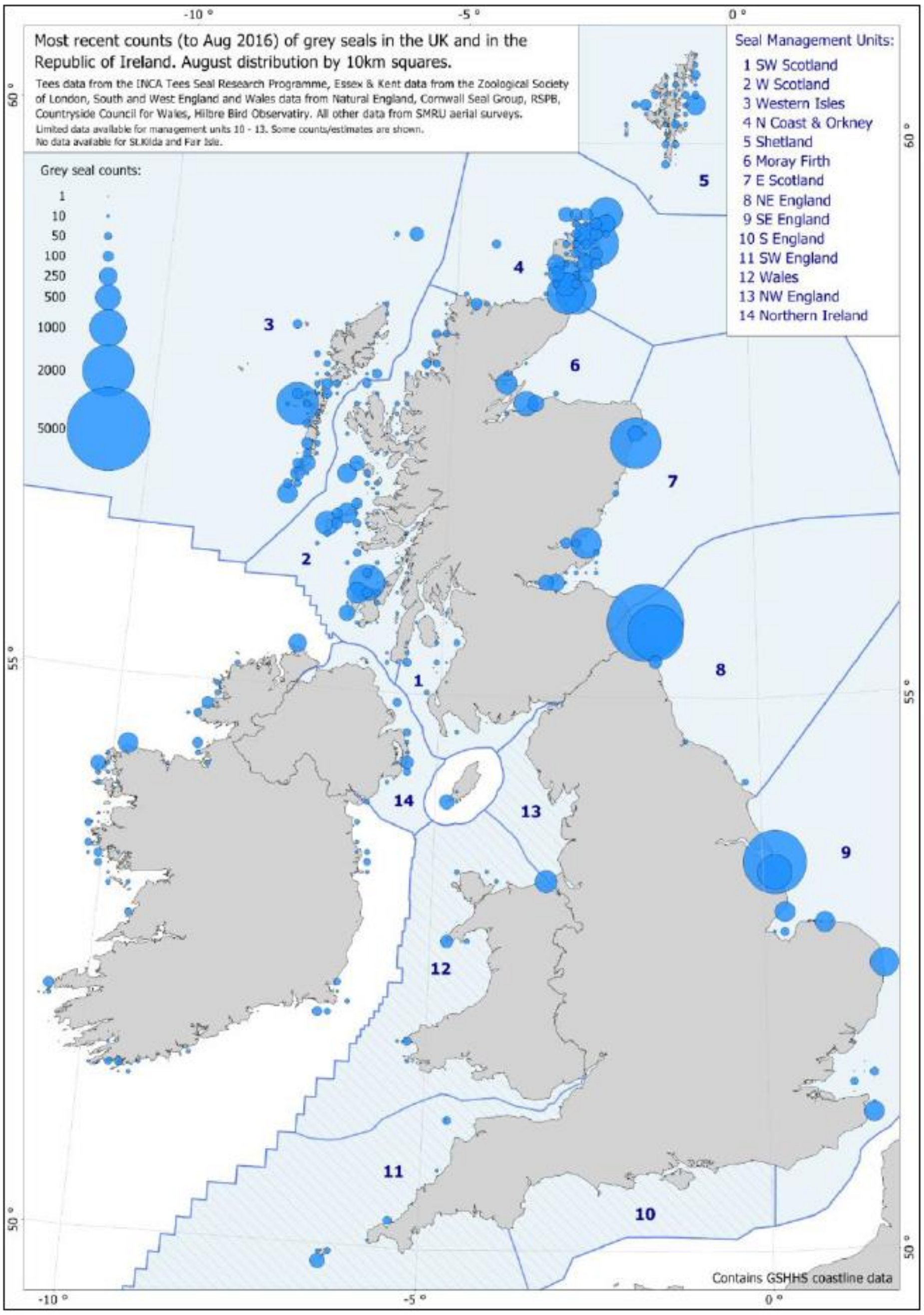
Grey seal baseline

10.44. Grey seals are the larger of the two species of seal resident in UK waters. They haul-out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100 km between haul-out sites (SCOS, 2017). Approximately 38% of the world's grey seal population breeds in the UK with 86% of these breeding in Scotland. Grey seal population data are assessed using pup counts during the autumn breeding season when females haul-out to give birth. The number of pups throughout Britain has grown steadily since the 1960s but there is clear evidence that the population growth is levelling off in all areas except the central and southern North Sea where growth rates remain high. The distribution of grey seal counts during the August surveys are shown in Figure 16.

10.45. In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in caves. Preferred breeding locations allow females with young pups to move inland away from busy beaches and storm surges. Seals breeding on exposed, cliff-backed beaches and in caves may have limited opportunity to avoid storm surges and may experience higher levels of pup mortality as a result. UK grey seals breed in the autumn, but there is a clockwise cline in the mean birth date around the UK. The majority of pups in south west Britain are born between August and September, in north and west Scotland pupping occurs mainly between September and late November and eastern England pupping occurs mainly between early November to mid-December.

10.46. The grey seal is considered to have a Favourable Conservation Status in the UK (JNCC, 2013). The most recent UK wide grey seal pup production count was in 2014, which produced a total UK pup production estimate of 60,500 (95% CI: 53,900 to 66,900), which, modelled to estimate the non-pup portion of the population, gives an estimate of 139,800 aged 1+ grey seals in the UK (95% CI: 116,500 to 167,100) (SCOS, 2017).

Figure 16. August distribution of grey seals around the British Isles (SCOS, 2017).



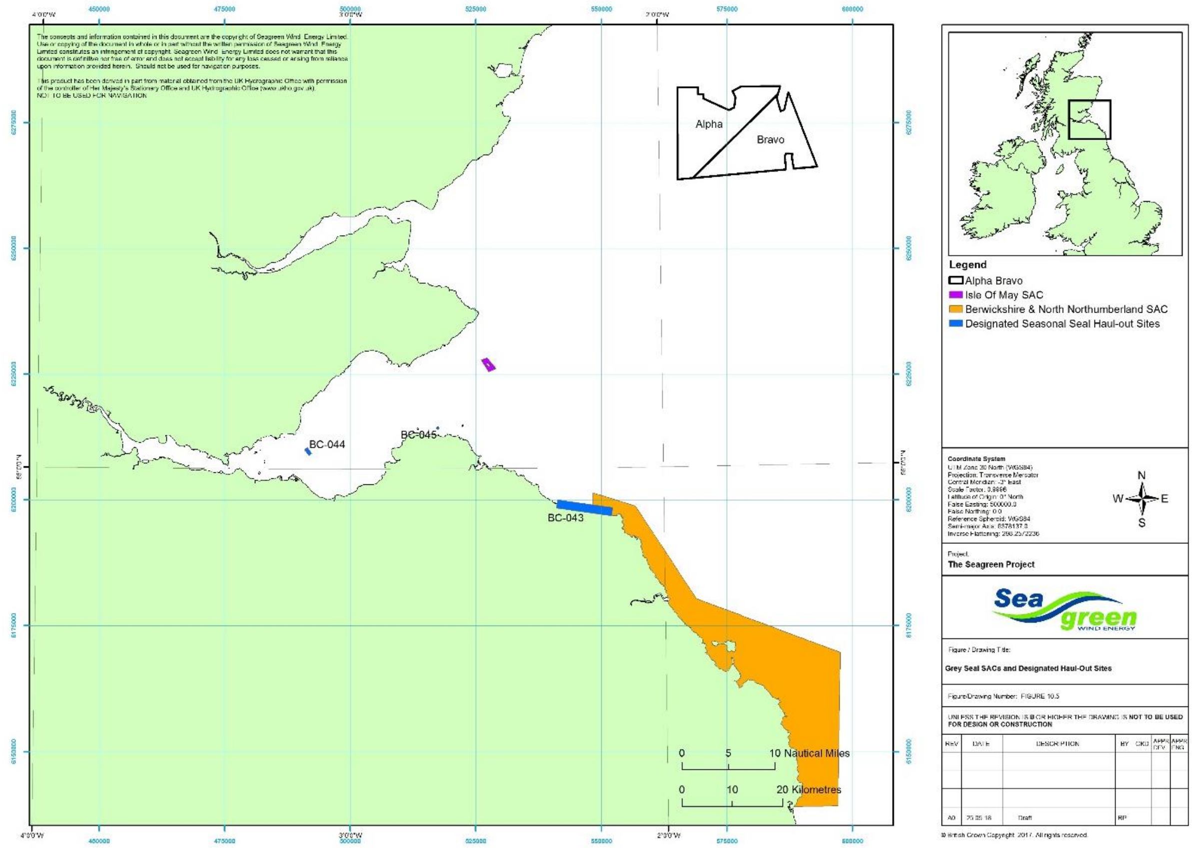
August haul-out surveys

10.47. The Seagreen Project is located within the East Scotland grey seal MU. There are three designated haul-out sites for grey seals in this MU, located at Fast Castle, Inchkeith and Craigleith (Table 10.3 and Figure 17).

Table 10.3 Designated grey seal haul-out sites in the East Coast seal MU.

Site ID	Site Name	Location	Minimum distance the Seagreen Project (km)
BC-043	Fast Castle	Between Dunbar and Eyemouth; rocky coastline at the foot of the cliffs between Coldingham Loch and Cove Harbour	66.5
BC-044	Inchkeith	Halfway between Kinghorn and Leith; Entire coast of Inchkeith	91
BC-045	Craigleith	Off North Berwick; southern half of Craigleith	68.8

Figure 17. Designated grey seal haul-out sites and grey seal SAC.



10.48. The number of grey seals counted during the August surveys within the East Scotland MU has varied between years from 2,328 hauled-out in the count period 1996-1997, 1,238 for the count period 2007-2009 and 3,812 in the count period 2008-2016 (SCOS, 2017). Accounting for the fact that grey seals only haul-out for approximately 35% of the time (95% CI 32 – 38) (Lonergan et al. 2011), this results in a 2008-2016 count period East Coast Scotland MU grey seal population size of 10,891 (10,032 – 11,913).

10.49. The number of grey seals counted within the Firth of Tay and Eden Estuary SAC during the August haul-out surveys has also varied considerably between years, with lowest total counts of 450 in 2009 and highest in 2000 with 2,253. Most of the grey seals counted in the Firth of Tay and Eden Estuary SAC during the August surveys are located in the Abertay and Tentsmuir area (Figure 18 and Figure 19).

10.50. It is important to note that since the timing of the surveys are conducted to coincide with the harbour seal moult, these surveys are not conducted during a key haul-out period for grey seals. Counts of greys seals during these surveys can be highly variable and although these counts are not used as a population index, they provide useful information on the distribution of grey seals in August.

Figure 18. August counts of grey seals in the Firth of Tay and Eden Estuary SAC between 1990 and 2016 (SCOS, 2017).

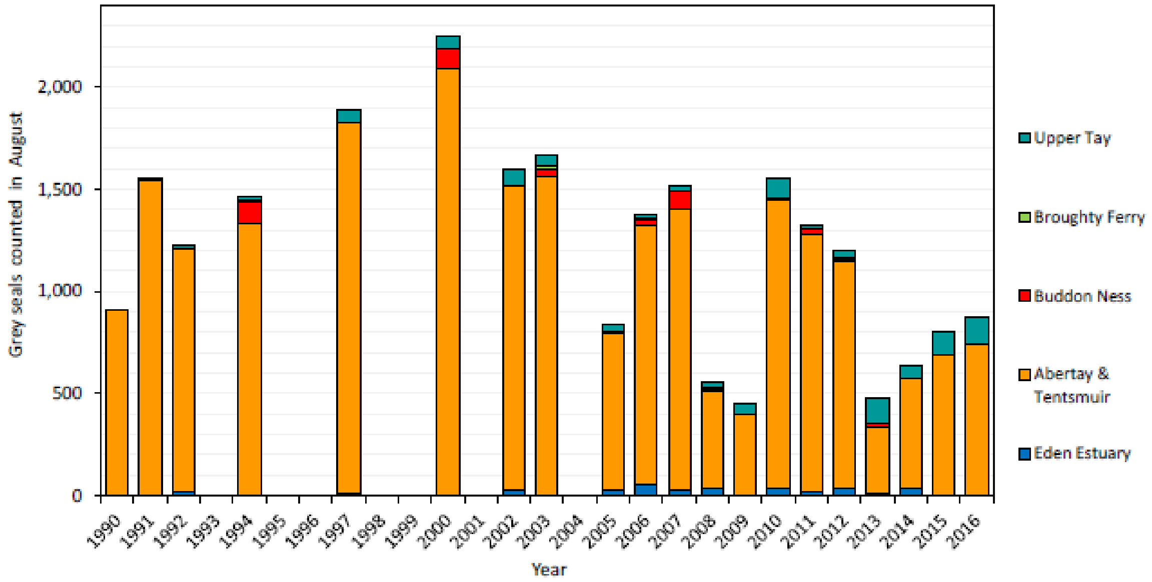
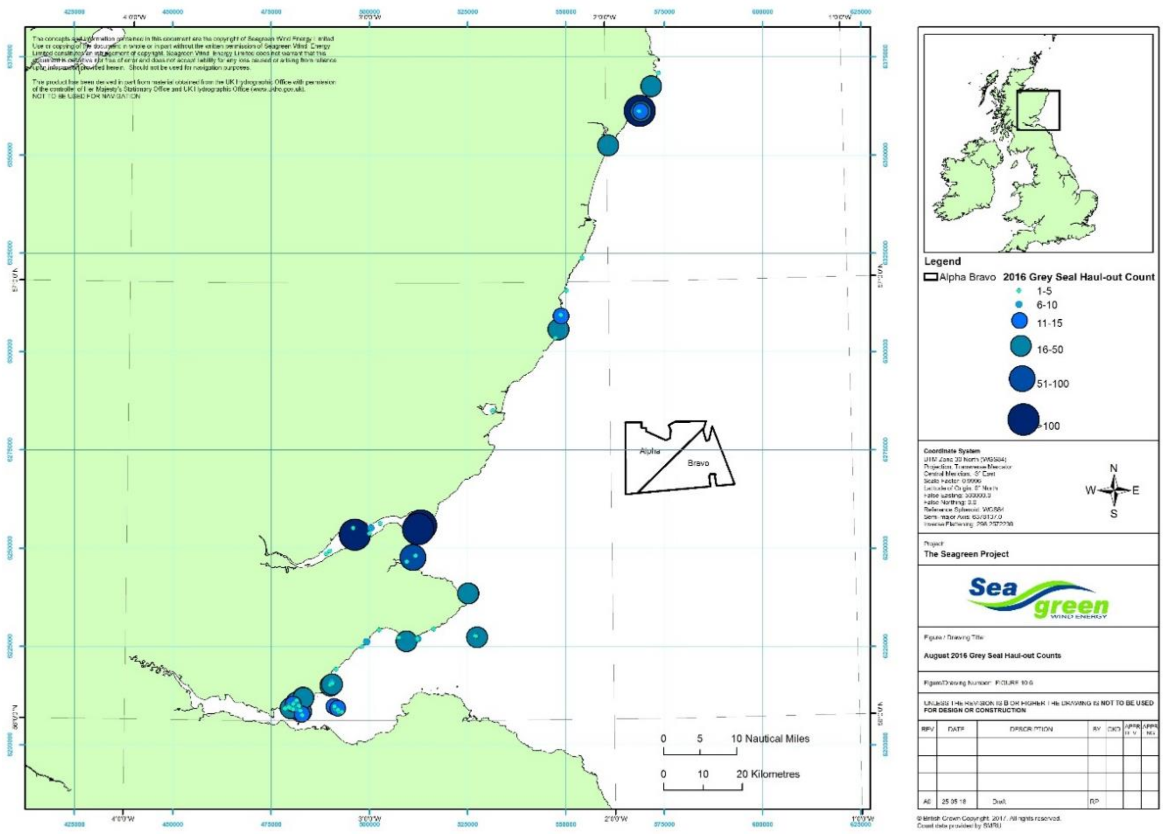


Figure 19. August distribution of grey seals in the East Scotland MU in 2016.



Pup production

10.51. Grey seals aggregate in the autumn to breed at traditional colonies. Their distribution during the breeding season can be very different to their distribution at other times of the year. SMRU's main surveys of grey seals are designed to estimate the numbers of pups born at the main breeding colonies around Scotland. Breeding grey seals are surveyed biennially between mid-September and late November using large-format vertical photography from a fixed-wing aircraft. Over 60 colonies are surveyed between three and seven times, at 10 to 12 day intervals, through the breeding season. Total pup production for each colony is derived from the series of counts obtained. Approximately 40 additional colonies are surveyed less regularly. The main grey seal breeding colonies in Shetland, England, Wales and Northern Ireland are counted by other, local organisations. SNH staff count pups in Shetland in a manner compatible with counts from aerial surveyed colonies.

10.52. The Special Committee on Seals has reported a continual increase in the total UK pup production since regular surveys began in the 1960s (Figure 21). In the North Sea pup production continued to increase rapidly up to 2014 mainly due to the rapid expansion of colonies in Berwickshire, Lincolnshire, Norfolk and Suffolk. The main grey seal pupping sites in relation to Seagreen Phase 1 are; Craigleith, Fast Castle, Inchcolm, Inchkeith and the Isle of May all of which are located in the Firth of Forth (Figure 20).

10.53. Grey seal pup production at surveyed breeding sites in the Firth of Forth has increased over the last 10 years (Table 10.4). The closest grey seal breeding site to Seagreen Project is the Isle of May which is approximately 47km away.

Table 10.4 Grey seal pup production counts between 2005 and 2014 for the Firth of Forth grey seal survey region (Individual breeding site data within the Firth and Forth provided by Chris Morris, SMRU and North Sea pup production estimates obtained from SCOS, 2017).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Firth of Forth grey seal survey region											
Craigleith	39	33	32	23	36	30	51	35	40	40	52
Fast Castle	659	764	804	1,005	1,265	1,715	1,844		2,417		2,940
Inchcolm			5				2	3	2	5	9
Inchkeith	55	67	130	178	206	267	252	341	405	460	535
Isle of May	1,953	1,954	1,827	1,751	1,875	2,065	2,153		2,355		2,272
North Sea estimate of grey seal pup production											
North Sea	4,921	5,132	5,322	5,560	6,617	7,637	8,314		10,143		12,435

Figure 20. Pup production at the main grey seal breeding colonies in the UK in 2014 (SCOS, 2017). The blue circles show breeding colonies grouped by area for reporting. The North Sea group consists of two sub-groups (dashed lines): the Firth of Forth and East of England.

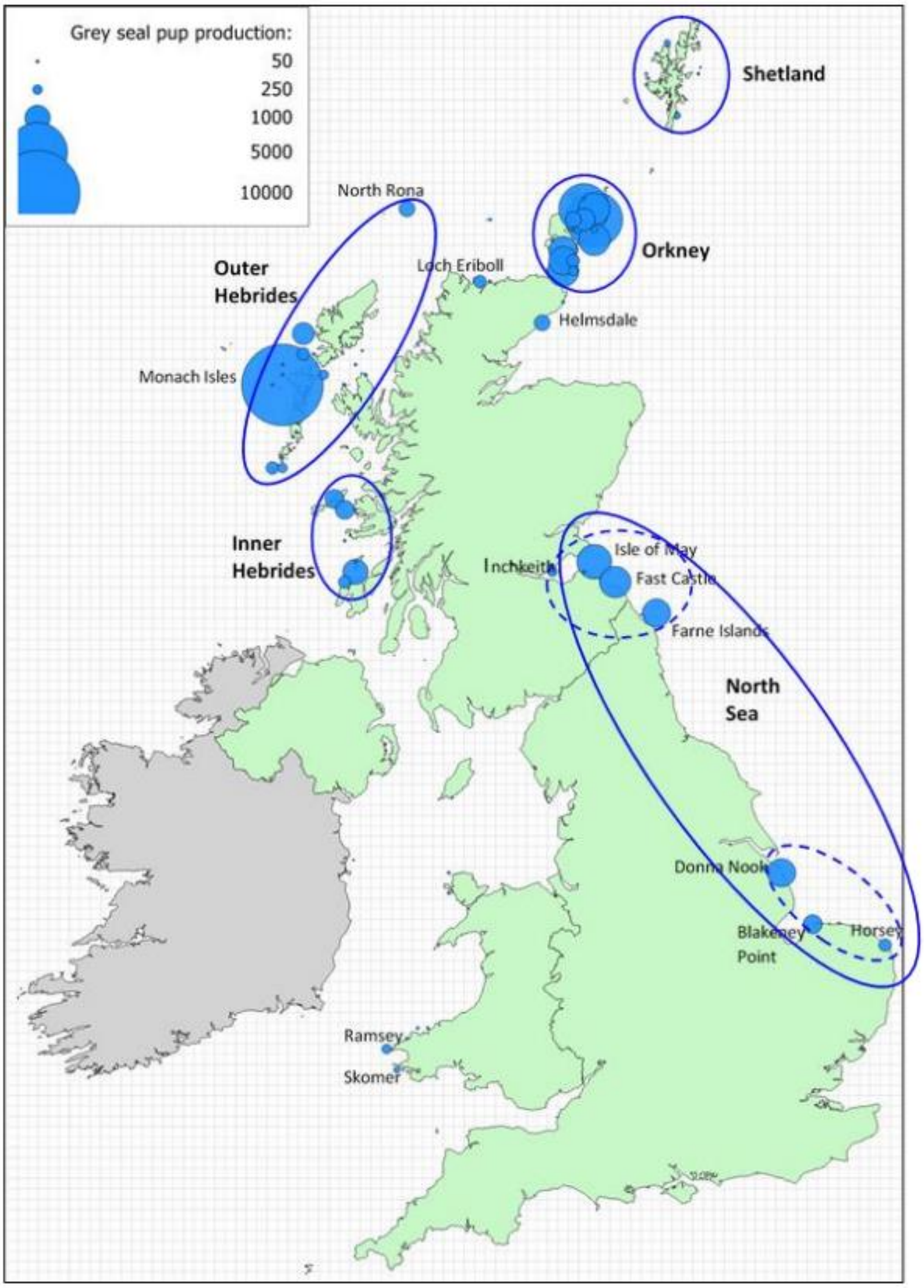
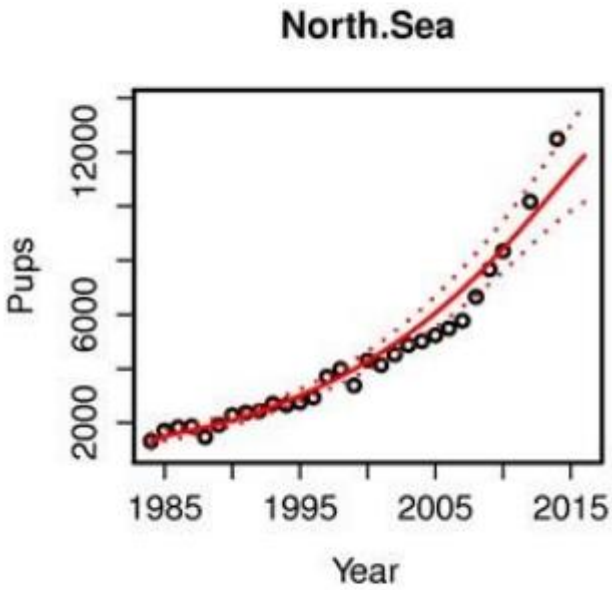


Figure 21. Mean estimates of pup production (solid lines) and 95% confidence intervals (dashed lines) from the model of grey seal population dynamics, fit to pup production estimates from 1984-2014 (circles) (SCOS 2017).



Telemetry

10.54. SMRU has deployed telemetry tags on grey seal in the UK since 1988. Ninety-two of the tagged adult grey seal entered a buffer of 100km around the Seagreen Project area (Figure 22). Thirty grey seal pups tagged at breeding colonies had locations within the buffer (Figure 23). Grey seal recorded within the Zone are associated with a number of sites along the east coast of England and Scotland.

10.55. The Appendix 10Aiv shows grey seal locations have been recorded over the whole of the Project Alpha area. The sightings in Project Bravo are most numerous to the west, with few sightings to the offshore extent of the Project Bravo.

10.56. Grey seal sightings were concentrated to the north of the Zone (Scalp Bank) and on two parallel concentrations of sightings running approximately north north-west through the ISA, following Marr Bank and Wee Bankie, with another concentration in the south east corner of the ISA (Berwick Bank; Figure 22). These areas are thought to be important areas for sandeels, an important part of grey seal diet in the region (Hammond and Prime, 1990, Hammond and Grellier, 2006, Hall et al. 2000).

Figure 22. Telemetry tracks of the 92 grey seals that entered the 100 km buffer zone (Appendix 10Aiv).

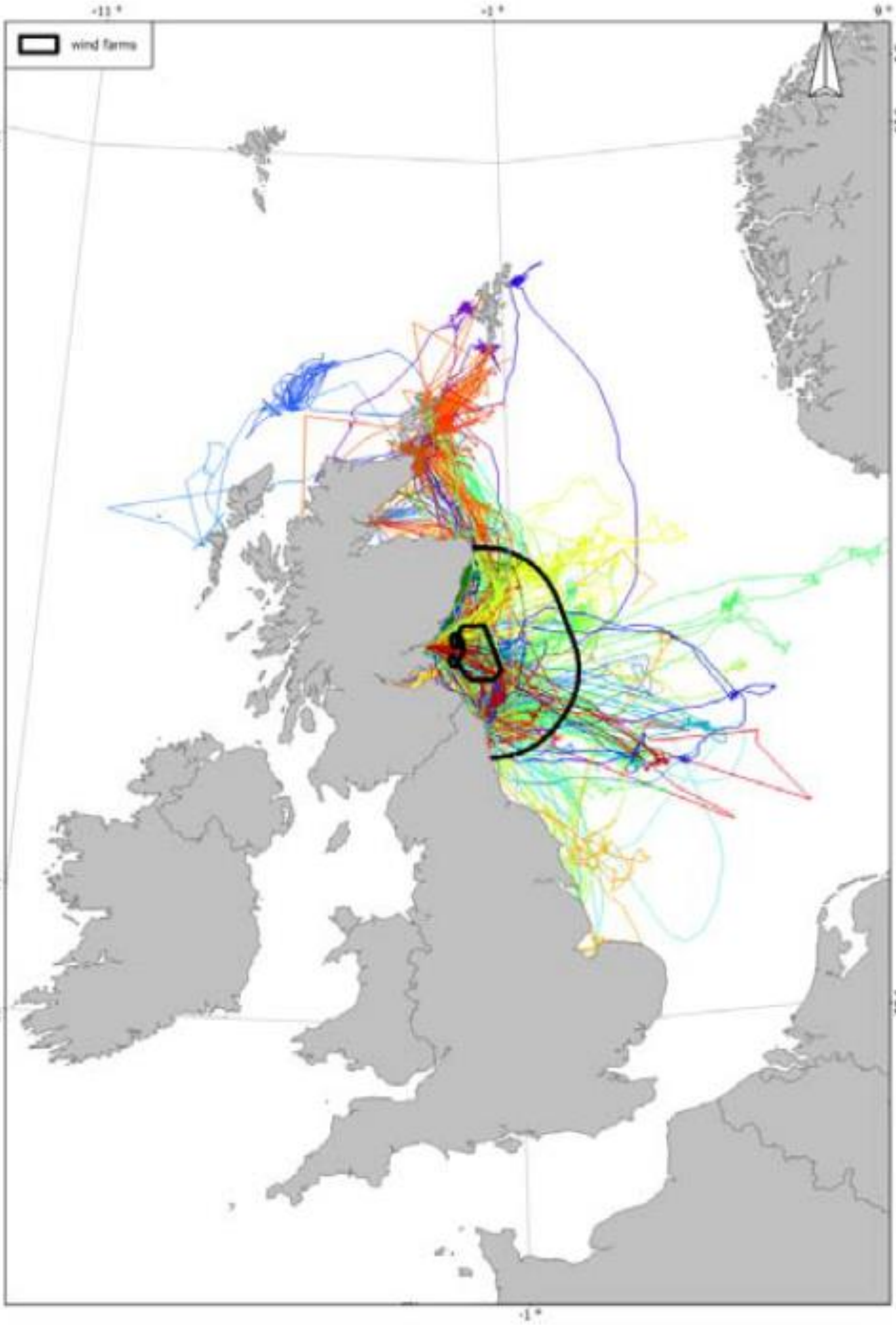
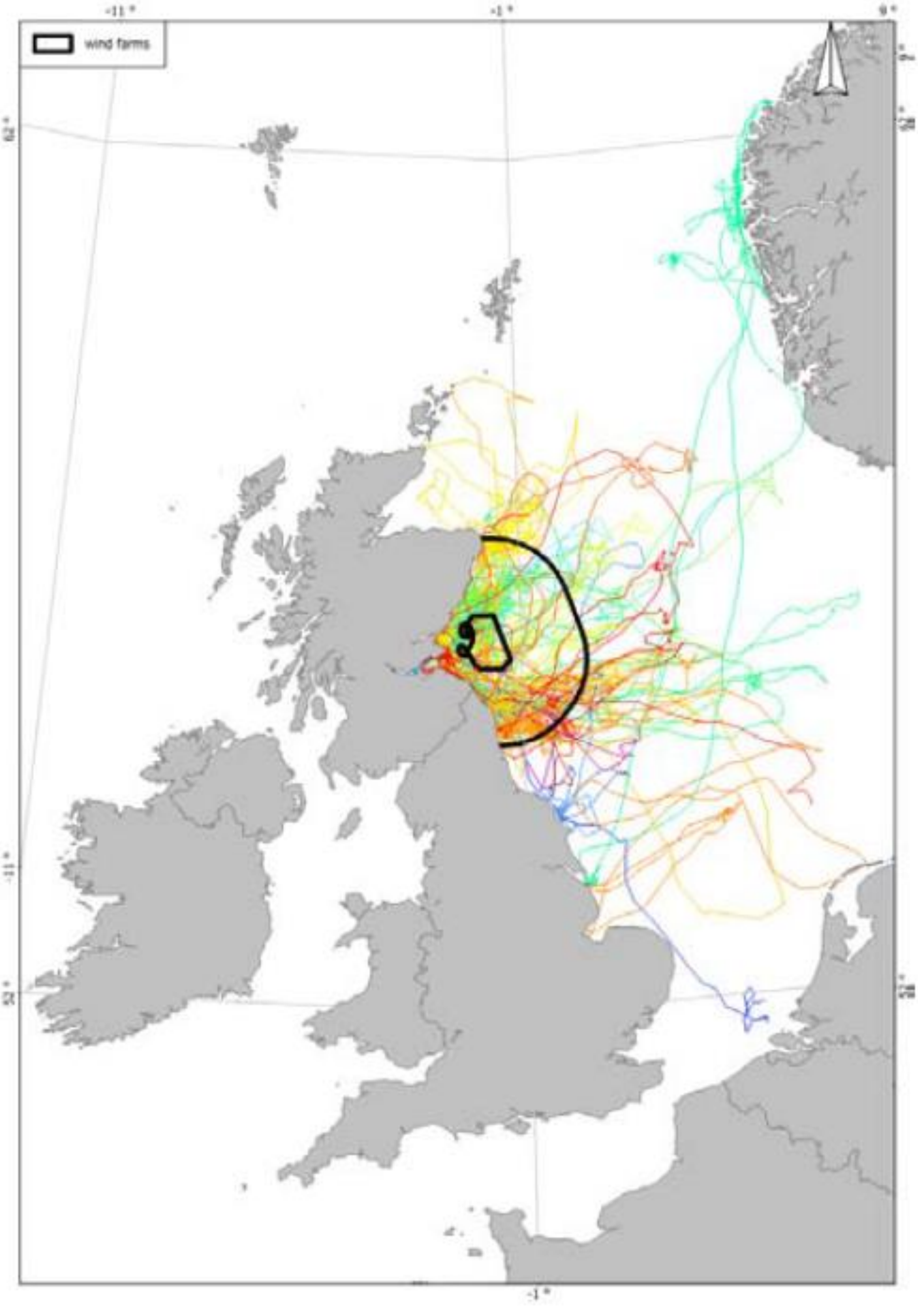
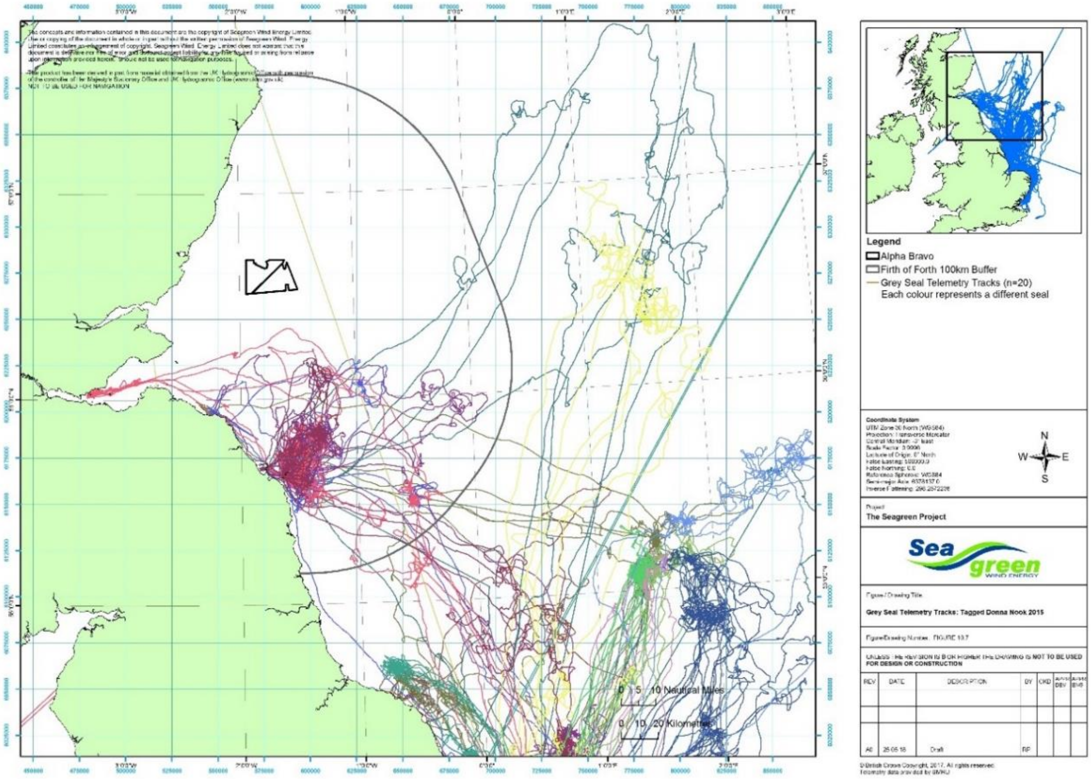


Figure 23. Telemetry tracks of the 30 grey seal pups that entered the 100 km buffer zone (Appendix 10Aiv).



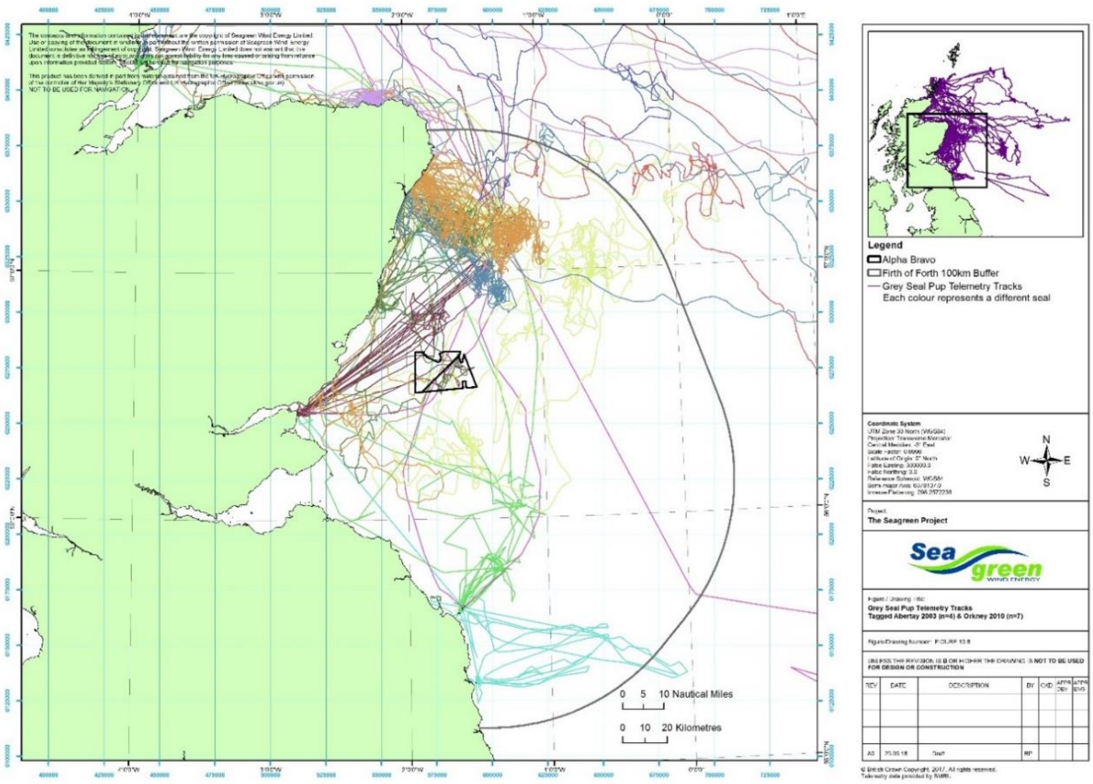
10.57. Since the 2012 Offshore ES there has been one additional grey seal tag deployment at Donna Nook. In 2015 a total of 20 grey seal adults were tagged at Donna Nook. Of these, seven seals have telemetry tracks that are within the 100km buffer however none of the tracks crossed into the Seagreen Project (Figure 24).

Figure 24. Telemetry tracks of all 20 grey seals tagged at Donna Nook in 2015.



10.58. Since the 2012 Offshore ES there have been two grey seal pup tag deployments that have resulted in pups entering into the 100km buffer zone. In 2003 four grey seal pups were tagged in Abertay. In 2010 a total of 14 grey seal pups were tagged at Greenholm and Stroma, of which, seven pups entered into the 100km buffer zone (Figure 25).

Figure 25. Tracks of the 11 grey seal pups that entered into the buffer zone (4 from 2003 Abertay and 7 from 2010 Orkney).

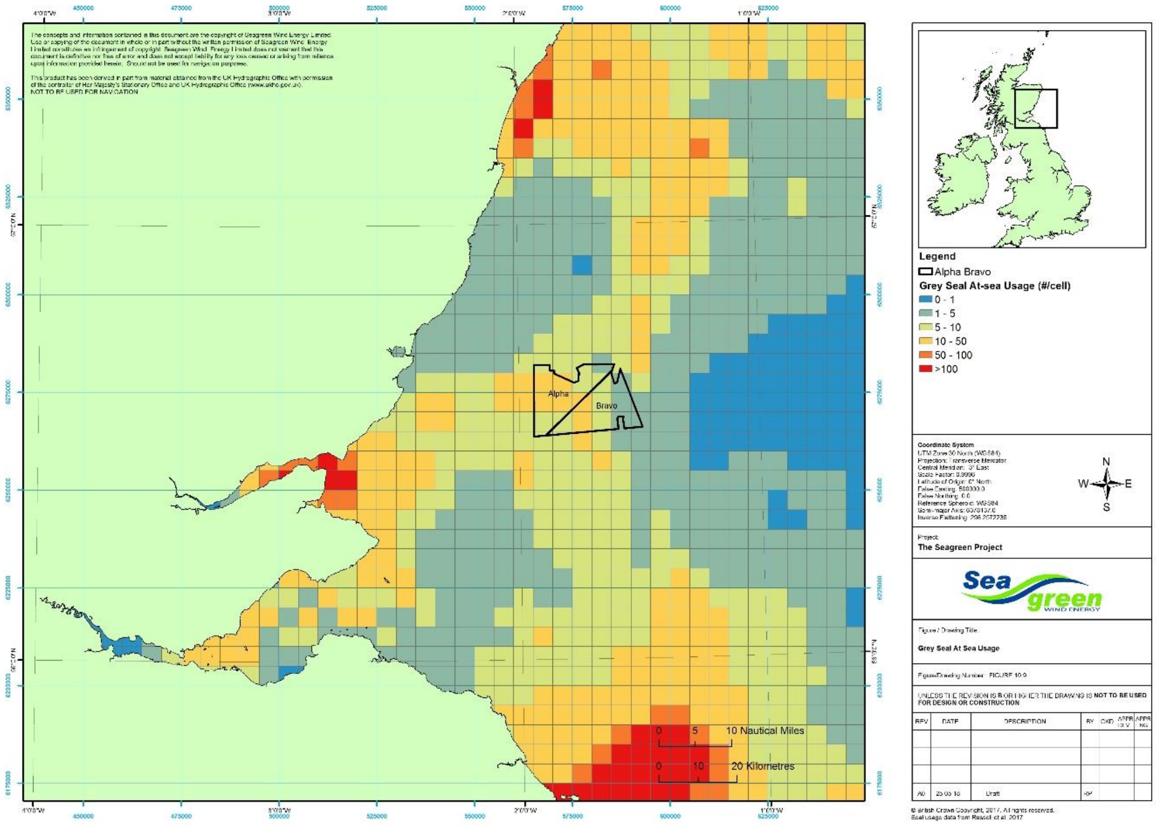


At-sea usage

10.59. Grey seal at sea usage in the East Coast Scotland MU is variable with hotspots at the Tay and Eden Estuary and north of Aberdeen at the Ythan Estuary and The Scares (Figure 26). The highest density within the Tay and Eden Estuary area is 300 grey seals/cell which, assuming a uniform density across a grid cell, equates to 12 grey seals/km^2. There is also a hotspot that extends offshore from the Berwickshire and North Northumberland Coast SAC in northeast England.

10.60. Within the Seagreen Project the highest predicted usage is 37.8 grey seals/cell which, assuming a uniform density across a grid cell, equates to a density of 1.5 grey seals/km^2. The minimum distance between the Seagreen Project and the high density grid cells at the Tay and Eden Estuary is 46km.

Figure 26. Grey seal at-sea usage showing the predicted mean number of animals in each 5 x 5 km grid cell (Russell et al. 2017).

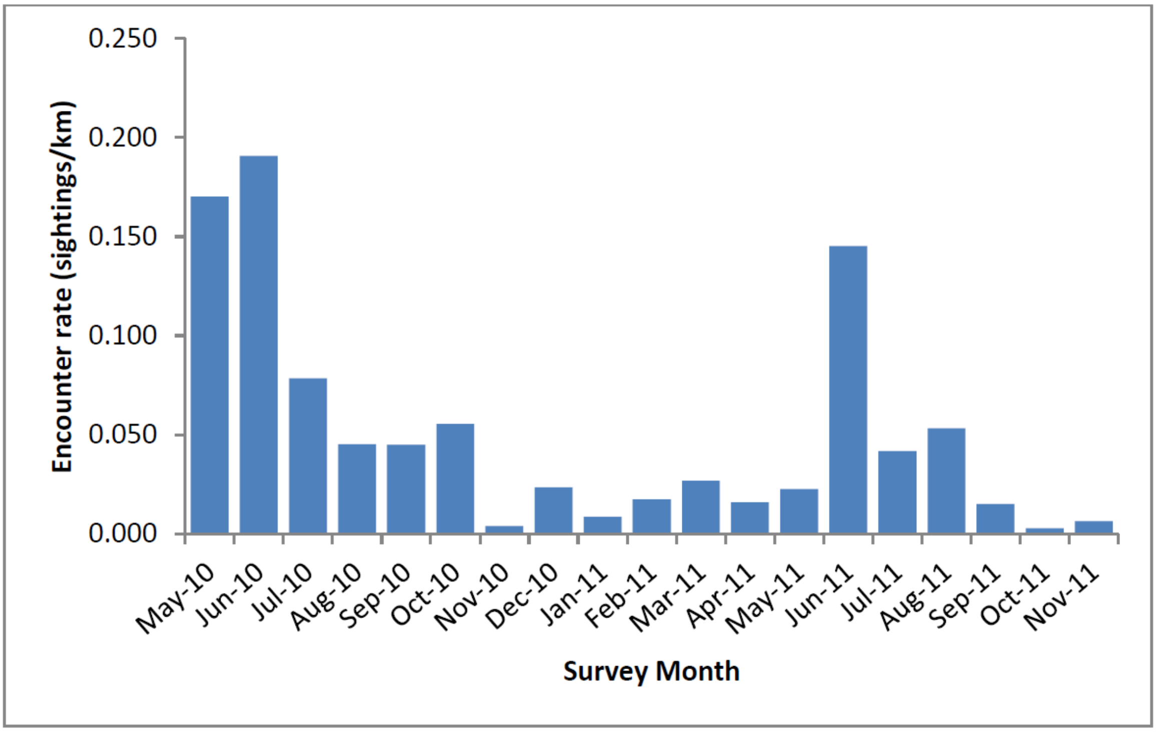


Visual surveys

10.61. Appendix 10Ai shows grey seal sighting rates during the boat based surveys were lowest over the autumn and winter. Overall, encounter rates were reduced in 2011 compared to 2010 (Figure 27). Grey seal were seen in every month of the boat based survey, but encounter rates were highly variable between months, with highest encounter rates in June in both years (Figure 27). This may be a result of grey seal spending a period of intense foraging at-sea, to build energy reserves prior to the breeding season.

10.62. The 2017 boat based surveys recorded grey seals in the Phase 1 area + 2km buffer on every trip. Numbers of grey seals recorded was highest, 45 animals in early summer (9/10 May) and lowest in late summer, 15 animals (15/16 August). Mid-summer surveys recorded 22 animals (24/25 May), 25 animals (20/21June) and 20 animals (25/26 July).

Figure 27. Encounter rate (sightings per km of survey effort) for grey seals per survey month (Appendix 10Ai).



Grey seal baseline conclusion

10.63. Grey seals have the potential to be impacted by the effects of underwater noise generated by piling activity. The spatially explicit grey seal densities from Figure 26 will be used in the quantitative noise impact assessment to quantify the number of seals that might experience noise levels that could cause disturbance. The results of this process will be presented with reference to the total population of the grey seal East Coast Management Unit.

Bottlenose dolphin baseline

10.64. In the UK, bottlenose dolphins are considered to have a Favourable Conservation Status (JNCC, 2013) and the most recent site condition monitoring report for the Moray Firth Special Area of Conservation (Cheney et al. 2018) recommends that the condition status remains the same. The Moray Firth population of bottlenose dolphins is the only known remaining resident population in the North Sea and it was for this reason that the Moray Firth SAC was established in order to protect this population. The conservation objectives of the Moray Firth SAC are to avoid the deterioration of the bottlenose dolphin habitat, to achieve a favourable conservation status and to ensure the population size and distribution of the bottlenose dolphins is maintained in the long-term.

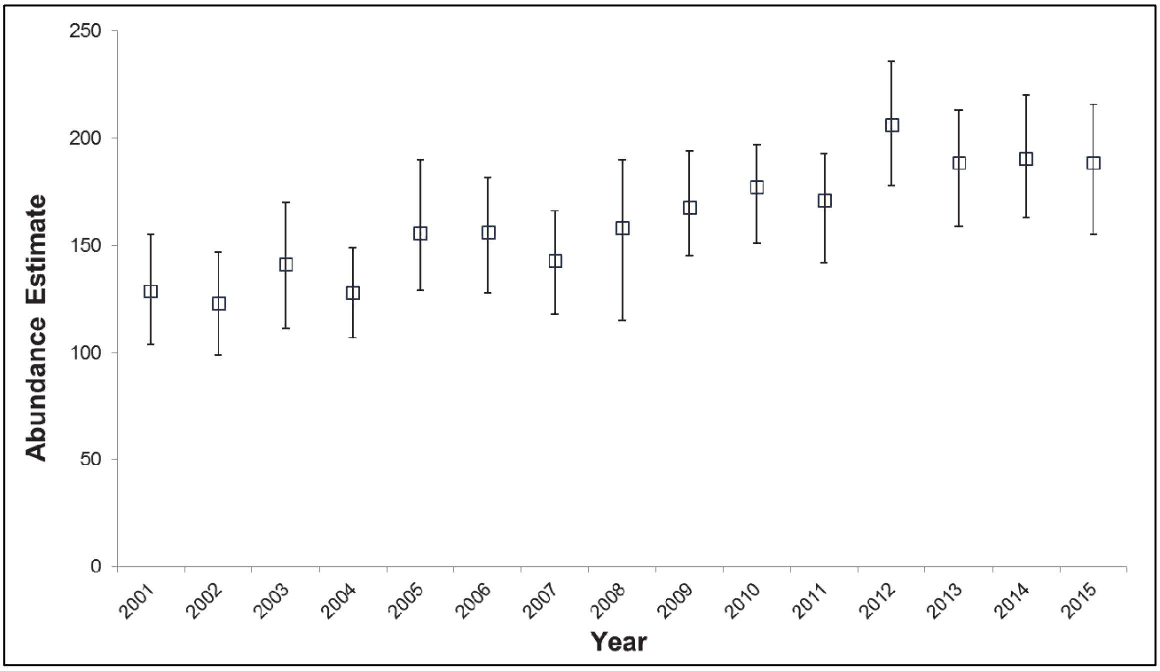
10.65. Analysis of stomach contents from bottlenose dolphins stranded around Scotland reveal that their main prey species are cod (*Gadas morhua*), saithe (*Pollachius virens*) and whiting (*Merlangius merlangus*) with other fish species such as salmon (*Salmo salar*), haddock (*Melanogrammus aeglefinus*) and cephalopod species also present (Santos et al. 2001).

10.66. The following sections describe the available data on bottlenose dolphins in the Coastal East Scotland MU and, specifically, in relation to the Seagreen Phase 1 site, in order to determine their spatial and temporal patterns of abundance and density.

Photo-ID surveys

10.67. The current population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU population is 195 individuals (95% Highest Posterior Density Intervals (HPDI): 162 to 253) based on photo-ID counts between 2006 and 2007 (Cheney et al. 2013). This resulted in a population growth rate estimate of 1.018 (Cheney et al. 2013). The results of further surveys suggests that the east coast Scotland population has continued to increase in size since 2007, therefore the current population size is likely to be larger than this (Figure 28) (Cheney et al. 2018).

Figure 28. Annual estimates of the east coast of Scotland bottlenose dolphin population from1990 to 2015 with 95% highest posterior density intervals (HPDI) (Cheney et al., 2018).



10.68. The estimate of the number of dolphins using the SAC in the summer of 2016 was 103 (95% CI: 93-115) (Cheney et al. 2018). Despite inter-annual variability the number of dolphins using the SAC between 2001 and 2016 appears to be stable, whilst the population size overall has increased (Cheney et al. 2018). This means that the proportion of the population that uses the SAC has declined most probably due to an overall increase in population size (Cheney et al. 2018). Whilst the Moray Firth is clearly an important area for this population, they are not restricted to the either the Moray Firth SAC or the wider Moray Firth. Instead, these animals are highly mobile, and have a large range that extends east along the outer Moray Firth coastline and south to the Firth of Forth (Cheney et al. 2013).

10.69. Breeding in bottlenose dolphins is usually seasonal and varies with location; in the Moray Firth the peak calving period is in the late summer. Between 2001 and 2016 a total of 169 calves were identified on the east coast of Scotland, with an average of 11 calves born each year (range 3 to 20) (Cheney et al. 2018). The survival rate for bottlenose dolphins in the SAC has been estimated as 0.93 (95% CI: 0.91 to 0.94) based on data from 161 well marked animals sighted between 1990 and 2014 (Graham et al. 2016).

10.70. Overall, the long-term photo-ID data have shown that the East Coast Scotland bottlenose dolphin population has increased since 1990 and is currently considered a healthy population with a favourable conservation status.

10.71. A more detailed analysis of the Photo-ID data in the Forth and Tay region has been published since the completion of Seagreen (2012). Quick et al. (2014) demonstrated that individuals from the Moray Firth are known to range up and down the coast (Figure 29 and Figure 30) but there is much spatial and temporal variability in individual movements. Across all years of data, females show a significantly higher probability of presence within the Moray Firth SAC than males, and males appear to move between areas more frequently than females. In the Tayside and Fife area dolphins were encountered more often in and around the Tay estuary in waters less than 20m deep and within 2km of the coast (Figure 29 and Figure 30). The Tay estuary has consistently high encounter rates of bottlenose dolphins over the years. Between 71 (95% CI 63-81) and 91 (95% CI 82-100) bottlenose dolphins from the east coast population were estimated to be using the Tay area during 2009-2013, representing approximately 35-46% of the total Scottish east coast population. Bottlenose dolphins were also frequently encountered along the coast between Montrose and Aberdeen in waters less than 20m deep and within 2km of the coast. Dolphins were frequently found at the entrance to Aberdeen Harbour and adjacent waters. Data collected in 2012-13 indicate that around 25% of the total Scottish east coast population uses the area between Stonehaven and Aberdeen. Based on these recent data, 118 (95% CI: 98-143) and 119 (95% CI: 101-140) individuals were estimated to be using the area between Aberdeen and the Firth of Forth in 2012 and 2013, respectively, representing greater than 60% of the total Scottish east coast bottlenose dolphin population (Quick et al. 2014).

Figure 29. Encounter locations from all years 1997-2013 between Aberdeen and the Firth of Forth (from Quick et al. 2014).

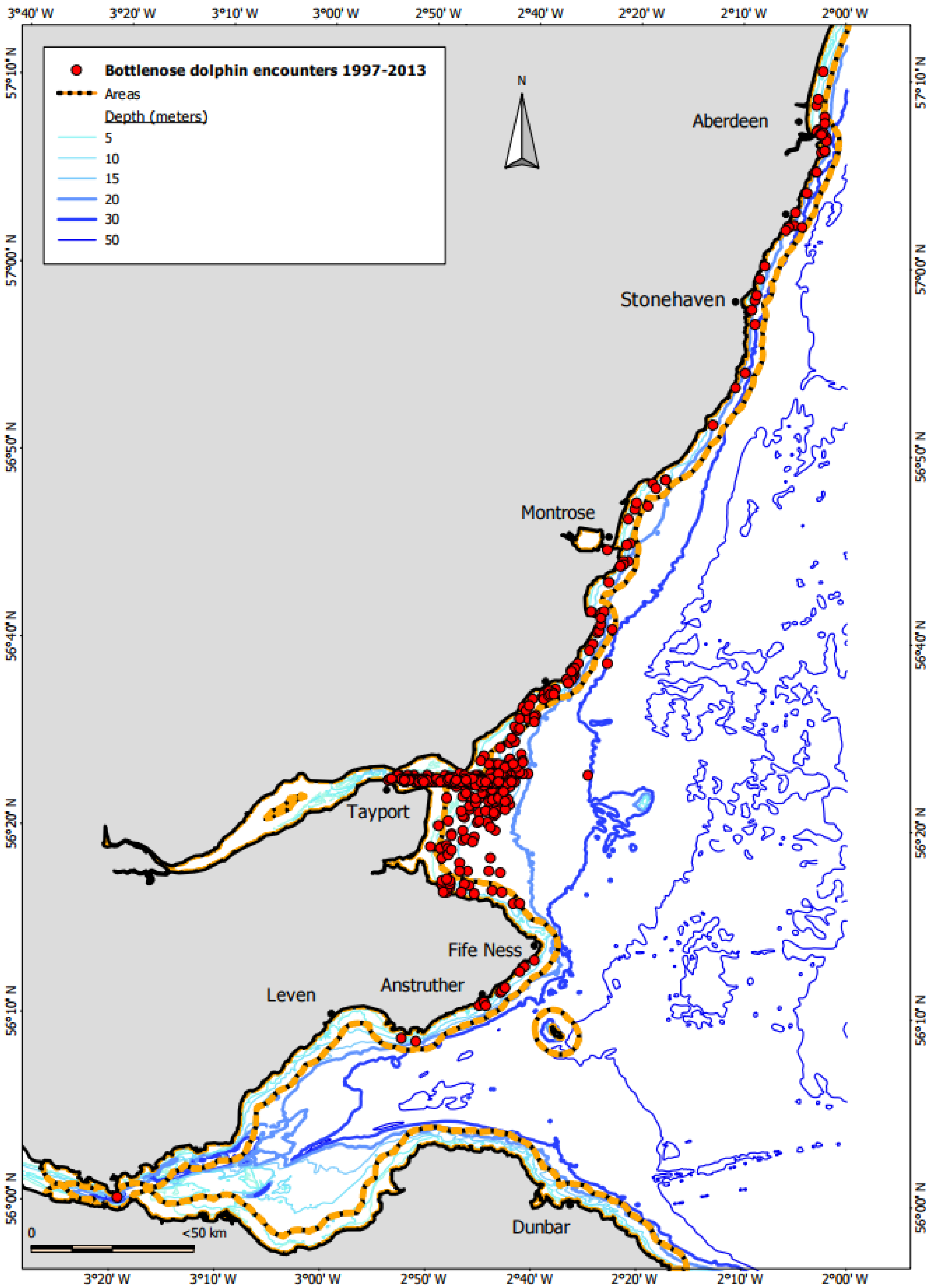
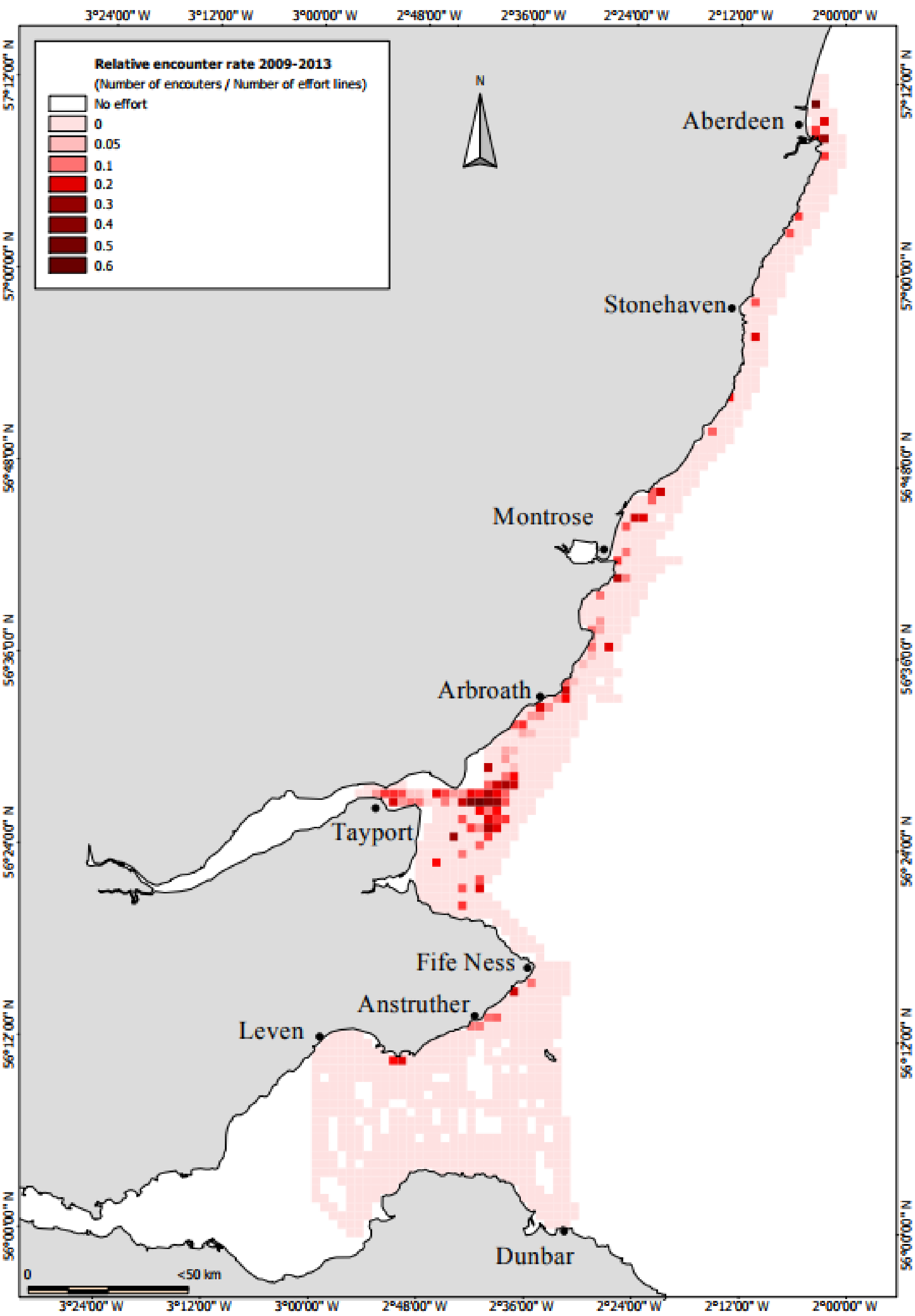


Figure 30. Relative encounter rates from dedicated phot-identification surveys, 2009-2013 (from Quick et al. 2014).



TPOD acoustic surveys

10.72. Appendix 10Av presents the findings of passive acoustic surveys from 2006 to 2009. The T-PODs used allow discrimination between dolphin species and harbour porpoise but cannot distinguish between bottlenose dolphin and other dolphin species such as white-beaked dolphin. As a precautionary approach it is assumed that all dolphins detected could be bottlenose dolphin. T-POD data from Fife Ness show no significant inter-annual difference in the number of days of detections between 2007 and 2008 (the years with most data), however, in Arbroath there were significantly more days with dolphin detections in 2008 (Table 10.5 and Figure 31).

10.73. Dolphins were detected on 24% of days in Arbroath and 18% of days in Fife Ness. Both of these sites show lower detection rates in comparison with a core sites in the SAC (the mouth of the Cromarty Firth), where dolphin were detected on over 70% of days over the same time period (Thompson et al. 2012).

10.74. Figure 32 shows some seasonal differences between Fife Ness and Arbroath. At Fife Ness there was a decrease in detections during the winter. This is in line with trends outlined in Anderwald and Evans (2010). However, at Arbroath the numbers were relatively consistent throughout the months.

Table 10.5 Summary of Chi-Square test comparing the proportion of dolphin positive days in 2007 and 2008 from T_PODS around the Firth of Tay, where N= the total number of days sampled and P= proportion of days in which dolphins were detected (from Appendix 10Av).

Area	2007		2008		Chi-Sq	DF	P-Value
	N	P	N	P			
Arbroath	365	0.18	366	0.28	9.3041	1	0.002
Fife Ness	365	0.21	363	0.18	0.9791	1	0.322

Figure 31. Occurrence of bottlenose dolphins around the Firth of Tay in 2007 and 2008. Pie charts represent the proportion of dolphin positive days (Appendix 10Av).

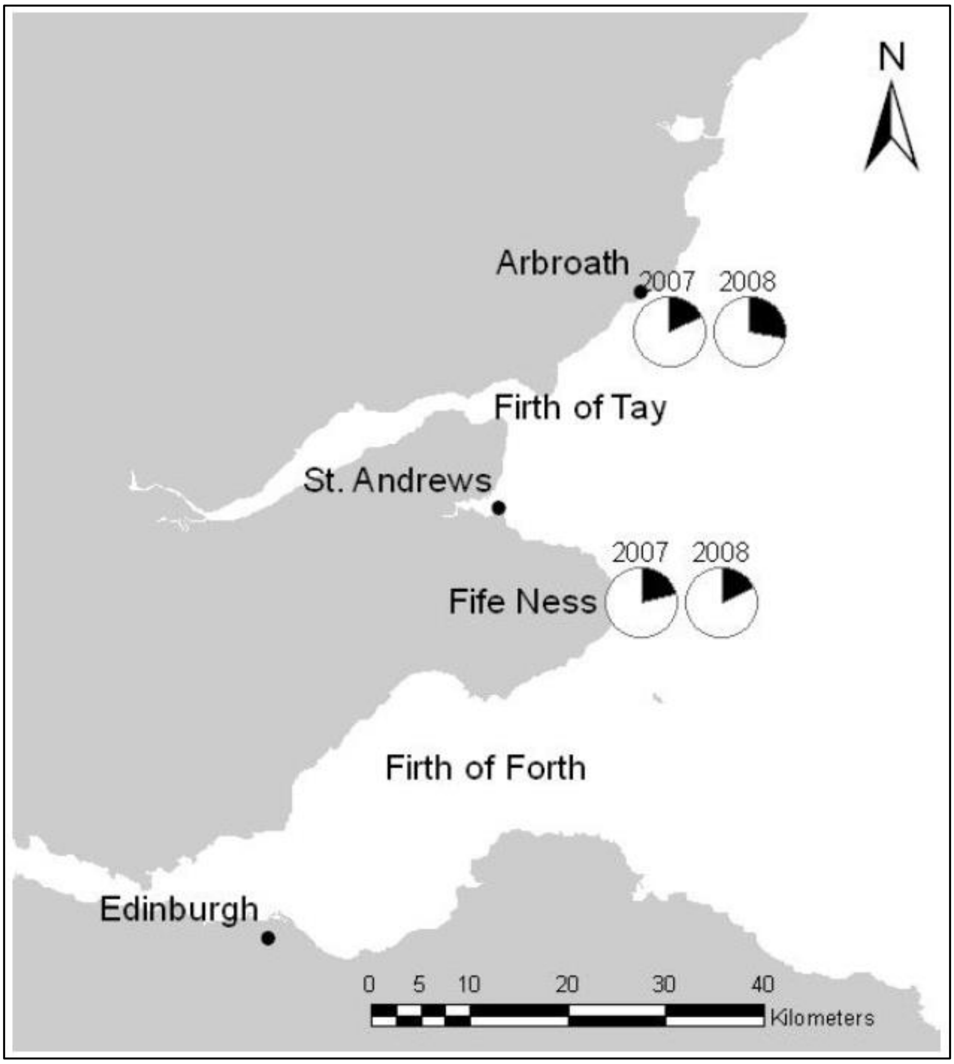
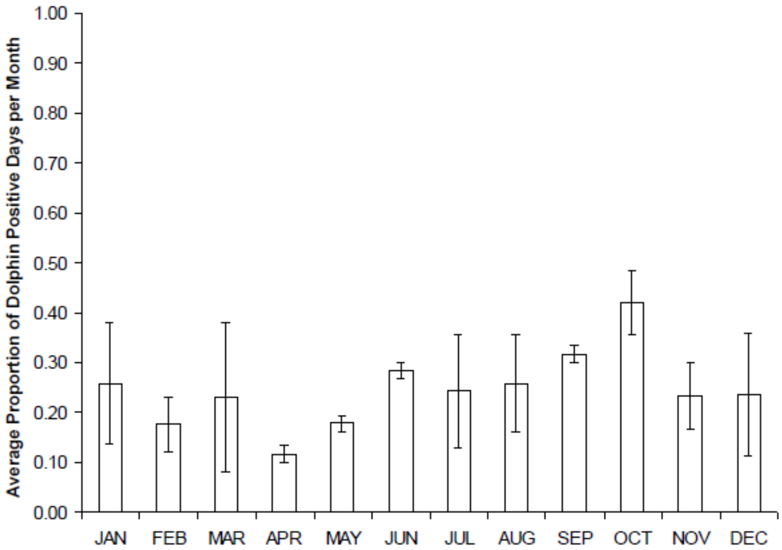
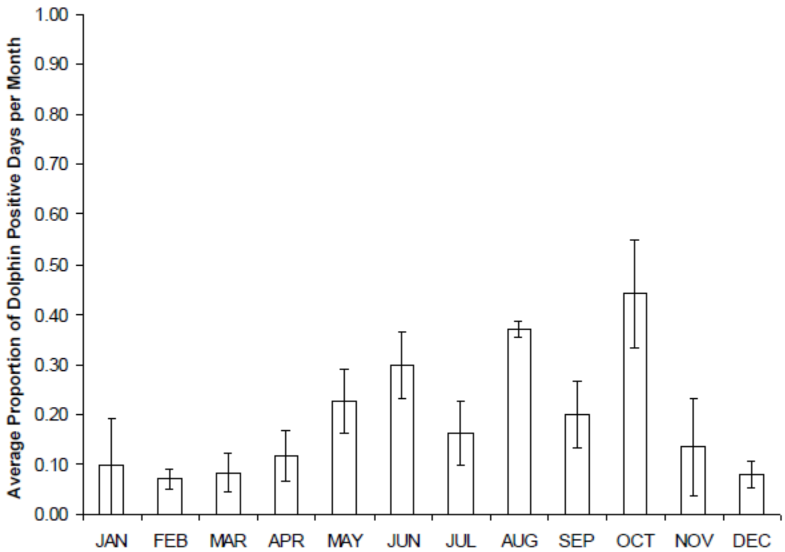


Figure 32. The average proportion of dolphin positive days in each month (+/- SE) for T_POD sites a) Arbroath and b) Fife Ness for the entire TPOD deployment period (Appendix 10Av).



a.



b.

ECOMMAS

10.75. Dolphin acoustic detection rates were low across all sites; on average dolphins were detected on between 2% and 30% of the surveyed days. Dolphin detection rates were lowest at the sites; Arbroath 5, St Abbs 5, St Abbs 10, St Andrews 5, and St Andrews 10 where dolphins were detected on average on less than 5% of the survey days (Table 10.6). Given the data presented in Quick et al. (2014) it is highly likely that only the recording stations closest to the shore in each location was regularly detecting bottlenose dolphins.

10.76. These data have been further analysed to separate the CPOD "dolphin" detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency banded echolocation clicks (made by Risso's and white-beaked dolphins) (Palmer et al. 2017). The analysis of the CPOD data from the ECOMMAS surveys have shown that the proportion of these two categories varies amongst the sites closest to the Seagreen phase 1 site. At the inshore Arbroath site, dolphins were detected on average only 2% of days with approximately 60% of these detections being potentially bottlenose dolphins. The St Andrews inshore site only recorded dolphins on 2% of days with similarly, approximately 60% of these detections being potentially bottlenose dolphins. Further offshore, the proportion of dolphin positive days were higher (10% and 19% at Arbroath 10 and 15 respectively) and ten and 18 at the respective St Andrews sites. A large proportion of the offshore Arbroath detections have mostly been frequency banded echolocation clicks (Figure 33) and so are likely to be either Risso's or white-beaked dolphins.

Figure 33. The proportion of click trains recorded at ECOMMAS PAM sites within the ECOMASS study area classified as broadband (black), frequency banded (grey) or unknown (white) by the combination of the Generalised Additive model (GAM) click-train classification and the encounter likelihood ratio (Palmer et al. 2017). Asterisks indicate joint C-POD/SM2M deployment locations from which training data were derived and where CPODs were displaced no data are presented.

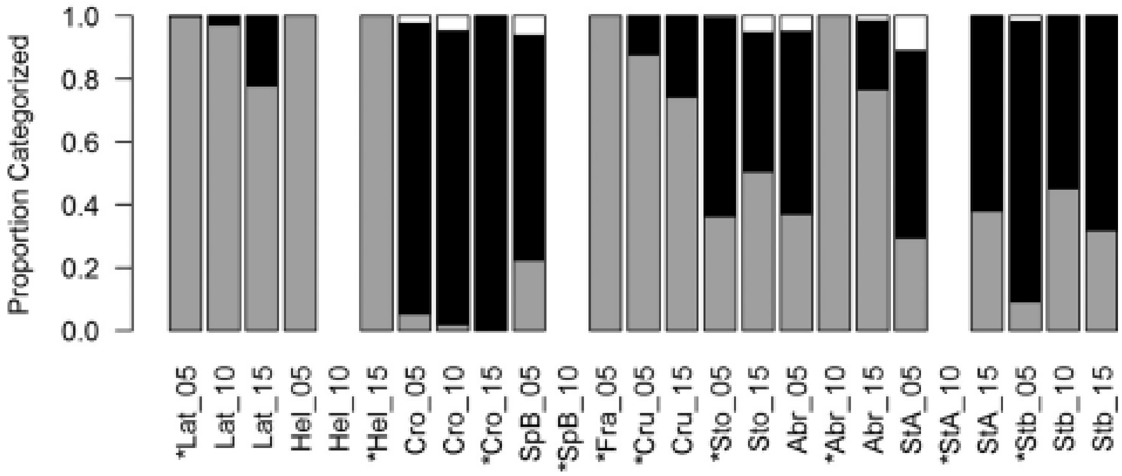


Table 10.6 Percentage of dolphin detection positive days at each ECOMMAS PAM site.

PAM Site	% Dolphin Detection Positive Days					~% of clicks categorised as broad-band
	2013	2014	2015	2016	Average	
Arbroath 5	2	2	5	0	2	60
Arbroath 10	25		3	2	10	0
Arbroath 15	17	11	27	20	19	25
Cruden Bay 5		15	20	7	14	15
Cruden Bay 10	16	15		8	13	
Cruden Bay 15	19	6	13	1	10	25
St Abbs 5	3	2	2	4	3	90
St Abbs 10	4		1	1	2	55
St Abbs 15	5	6	4	8	6	70
St Andrews 5	0	1	2	7	3	60
St Andrews 10	3	2	2	10	4	
St Andrews 15	18	7	10	18	13	65
Stonehaven 5		14	7	7	9	65
Stonehaven 10	30	10	12	8	15	
Stonehaven 15	17		36	36	30	45

SCANS

10.77. The SCANS III estimated abundance for block R was 1,924 bottlenose dolphins (95% CI: 0 – 5,048), with an estimated density of 0.030 dolphins/km² (Hammond et al. 2017). This is a much higher estimate than the abundance estimate for the Coastal East Scotland population derived from the dedicated photo-ID surveys (Cheney et al. 2018). However, the Coastal East Scotland population are strictly coastal with most animals encountered in waters less than 30m deep and within 2km from the coastline, except St Andrews Bay and the Tay estuary where encounters also occurred further out (Quick et al. 2014).

JCP Phase III

10.78. The JCP Phase III analysis provides estimated abundances for bottlenose dolphins in 2010 by season and estimates highest abundance in the Firth of Forth area of commercial interest (see Figure 1) in spring and summer (460 – 430 animals respectively, Table 10.7). This equates to density estimates between 0.016 dolphins/km² in the winter and 0.032 dolphins/km² in the summer (Table 10.7). This is more than double the abundance estimate for the Coastal East Scotland population derived from the dedicated photo-ID surveys (Cheney et al. 2018). However, as stated by Paxton et al. (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated, targeted abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available. Therefore, the abundance estimates obtained from the photo-ID surveys in the Moray Firth, Firth of Forth and St Andrews Bay and Tay Estuary are likely to be better reflections of the true Scottish East coast bottlenose dolphin population abundance.

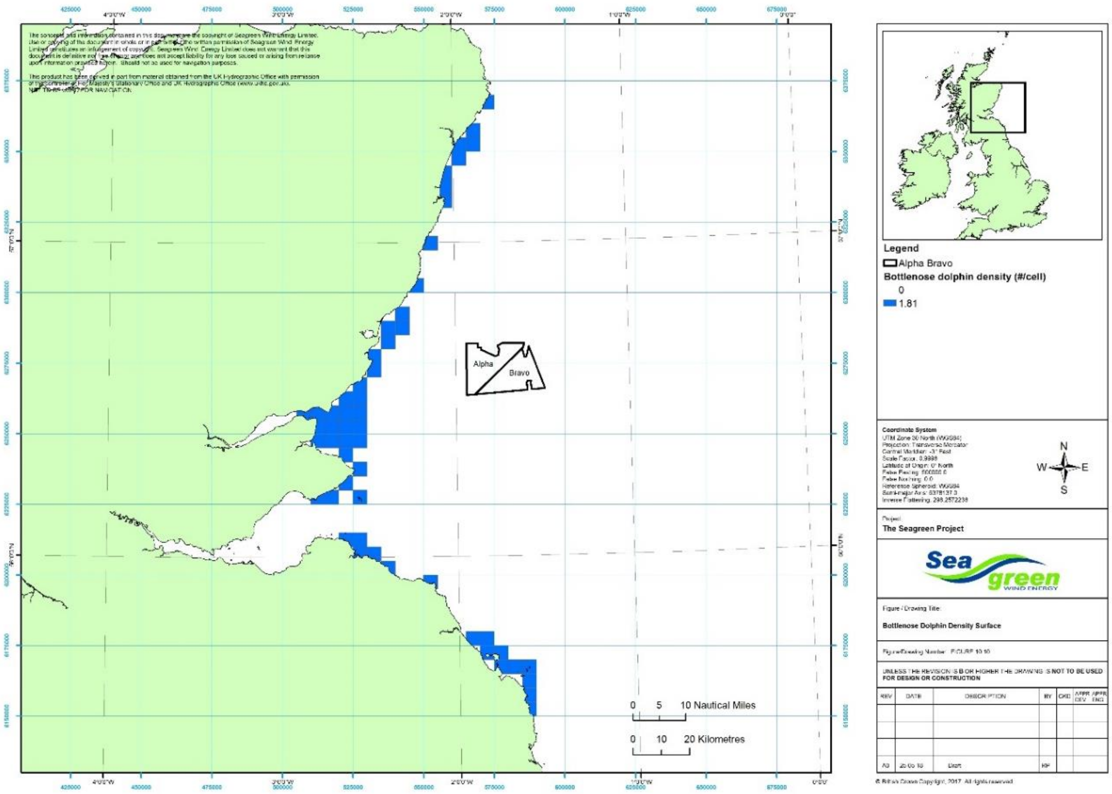
Table 10.7 Estimated bottlenose dolphin abundance and density (#/km²) (and 95% confidence intervals) for the Firth of Forth in 2010 using the JCP Phase III data (Paxton et al. 2016).

	Winter		Spring		Summer		Autumn	
	Abundance	Density	Abundance	Density	Abundance	Density	Abundance	Density
Point Estimate	230	0.016	460	0.032	430	0.030	190	0.013
2.5%	90	0.006	130	0.009	190	0.013	80	0.006
97.5%	450	0.032	1,340	0.094	780	0.055	290	0.020

Bottlenose dolphin baseline conclusion

10.79. The East Coast bottlenose dolphin population has the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of dolphins potentially affected, it is assumed that half of the total management unit population (98) will be spread evenly across the area inside the 20m depth contour as agreed in the Scoping Opinion and in subsequent discussion with SNH and MSS (meeting in Nov 2017). The resulting density surface is presented in Figure 34.

Figure 34. Bottlenose dolphin density grid to be used for impact assessment.



Harbour porpoise baseline

10.80. Harbour porpoise are the smallest and most abundant cetacean species in UK waters (Reid et al. 2003). They are typically sighted in small groups between one and three individuals. Animals are frequently sighted throughout coastal habitats with studies suggesting they are highly mobile and cover large distances (Nabe-Nielsen et al. 2011). Harbour porpoise in the UK are considered to have a Favourable Conservation Status (JNCC, 2013). The Seagreen Project is located within the ICES North Sea Assessment Unit for harbour porpoise, which is estimated to have an abundance of 345,373 porpoise (95% CI: 246,526 to 495,752) based on estimates from Hammond et al. (2017).

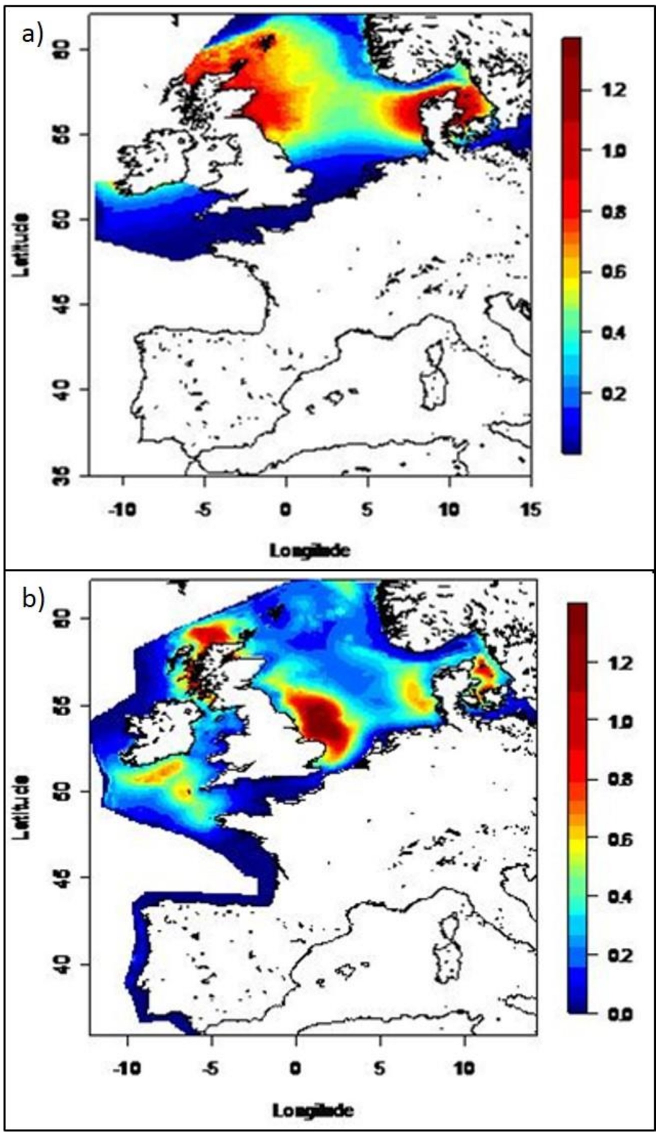
10.81. Breeding occurs mainly between May and August, with a peak in June, though some calves can be born as early as March. Social groups often gather in late summer (August-September) for mating (Anderwald and Evans, 2010). The gestation period of the harbour porpoise is ten months, with peak mating activity likely to occur in August. Evidence for social and sexual activity in late summer has been widely reported. Females are believed to nurse their calves for between eight and twelve months. Weaning is a gradual process with young starting to take solid food after a month or two.

10.82. The following sections describe the available data on harbour porpoise within the North Sea Management Unit and, specifically, in relation to the Seagreen Project, in order to determine their spatial and temporal patterns of abundance and density.

SCANS

10.83. As part of the SCANS II survey analysis, model-based estimates of harbour porpoise abundance were obtained by fitting a General Additive Model (GAM) -based density surface to the survey data that included longitude, latitude, depth and distance to coast. The predictions from these models were used to obtain local density estimates (animals/km^2) on a two minute grid (i.e. ~8.15km^2). Figure 35 shows the North Sea harbour porpoise surface densities derived from the SCANS II dataset (Hammond et al. 2013). A southern shift in density is shown in 2005 compared to 1994 with relatively low density estimates around the Seagreen Project in 2005 of between 0.3 and 0.6 animals per km^2. The reason for this shift is unknown although a change in distribution and availability of prey species is considered the most likely cause (Hammond et al. 2013). Despite the change in distribution, SCANS and SCANS II surveys showed no significant change in the population size between 1994 and 2005.

Figure 35. Harbour porpoise estimated density surface (animals per km2) in (a) 1994 and (b) 2005 (SMRU, 2006).



10.84. The average density estimate from the SCANS II survey Block V of 0.293 porpoise/km^2 was used in the previous impact assessment presented in the 2012 Offshore ES. This uniform density was higher than the ISA specific density generated by the aerial surveys alone (Appendix 10Aiii) and as such, represented a more precautionary estimate of density. A uniform density was used in the assessment of behavioural impacts, as it could represent a more appropriate metric than the use of more local scale spatially explicit densities for the assessment of impacts over a wide spatial and temporal scale. Densities have been shown to change over time (Appendix 10Avi) and an average estimate should enable uncertainty in this variation to be incorporated in the assessment. This approach was agreed on consultation with JNCC and SNH (Meeting 10/05/2012).

10.85. The SCANS III estimated abundance for block R was 38,646 porpoise (95% CI: 20,584 to 66,524) with an estimated density of 0.599 porpoise/km² (Hammond et al. 2017). As mentioned above, the survey areas were not consistent between surveys but the estimated density for the block that contained the Seagreen Project in SCANS III was considerably higher than the density from SCANS II used in the original assessment. It was agreed with SNH and MSS (meeting Nov 2017) that the SCANS III density estimate for Block R would be used in the assessment.

JCP Phase III

Firth of Forth area of commercial interest 2010

10.86. The JCP Phase III analysis provides estimated abundances for harbour porpoise in 2010 by season for the Firth of Forth area of commercial interest region (see Figure 1). This estimates highest abundance in the winter months, with an estimate of 7,000 animals, similar estimates in spring and summer: 3,500 and 4,400 respectively and lowest estimates in autumn of 2,500 animals (Paxton et al. 2016) (Table 10.8). These equate to density estimates of 0.492 porpoise/km² in the winter, 0.246 porpoise/km² in the spring, 0.309 porpoise/km² in the summer and 0.176 porpoise/km² in the autumn (Table 10.8). However, as stated by Paxton et al. (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available.

Table 10.8 Estimated harbour porpoise abundance and density (#/km²) (and 95% confidence intervals) for the Firth of Forth in 2010 using the JCP Phase III data (Paxton et al. 2016).

	Winter		**Spring**		**Summer**		**Autumn**	
	Abundance	Density	Abundance	Density	Abundance	Density	Abundance	Density
Point Estimate	7,000	0.492	3,500	0.246	4,400	0.309	2,500	0.176
2.5%	5,200	0.365	1,900	0.133	2,900	0.204	1,600	0.112
97.5%	11,800	0.829	6,600	0.463	6,800	0.477	3,600	0.253

User specified area summer 2007-2010 (averaged)

10.87. The R code provided by JNCC was used to determine the number of harbour porpoise within the area defined in Figure 1 (which is approximately double the size of the Firth of Forth area of commercial interest and extends further offshore). This resulted in a harbour porpoise abundance estimate for the area averaged for summer 2007-2010 of 11,683 (95% CI 5,675 – 17,358) which equates to a density estimate of 0.318 porpoise/km² (95% CI 0.154 – 0.473) (Table 10.9). Despite this user specified area being larger than the Firth of Forth area of commercial interest presented above, the density estimate for the summer is almost the same (0.309 porpoise/km² vs 0.318 porpoise/km²). The JCP III R code for the user specified area estimates approximately half the density value estimated by SCANS III (0.599 porpoise/km²) but this JCP III density estimate is averaged over the summers between 2007 and 2010 while the SCANS III density estimate is a single snapshot from July 2016, in addition to the fact that the two study areas differ in size.

Table 10.9 Estimated harbour porpoise abundance and density (#/km²) (and 95% confidence intervals) for the user specified area for summer 2007-2010 (averaged) as output by the JNCC JCP III R code.

	Point Estimate	Lower CI	Upper CI
User area abundance (scaled to SCANS III)	11,683	5,675	17358
User area density	0.318	0.154	0.473

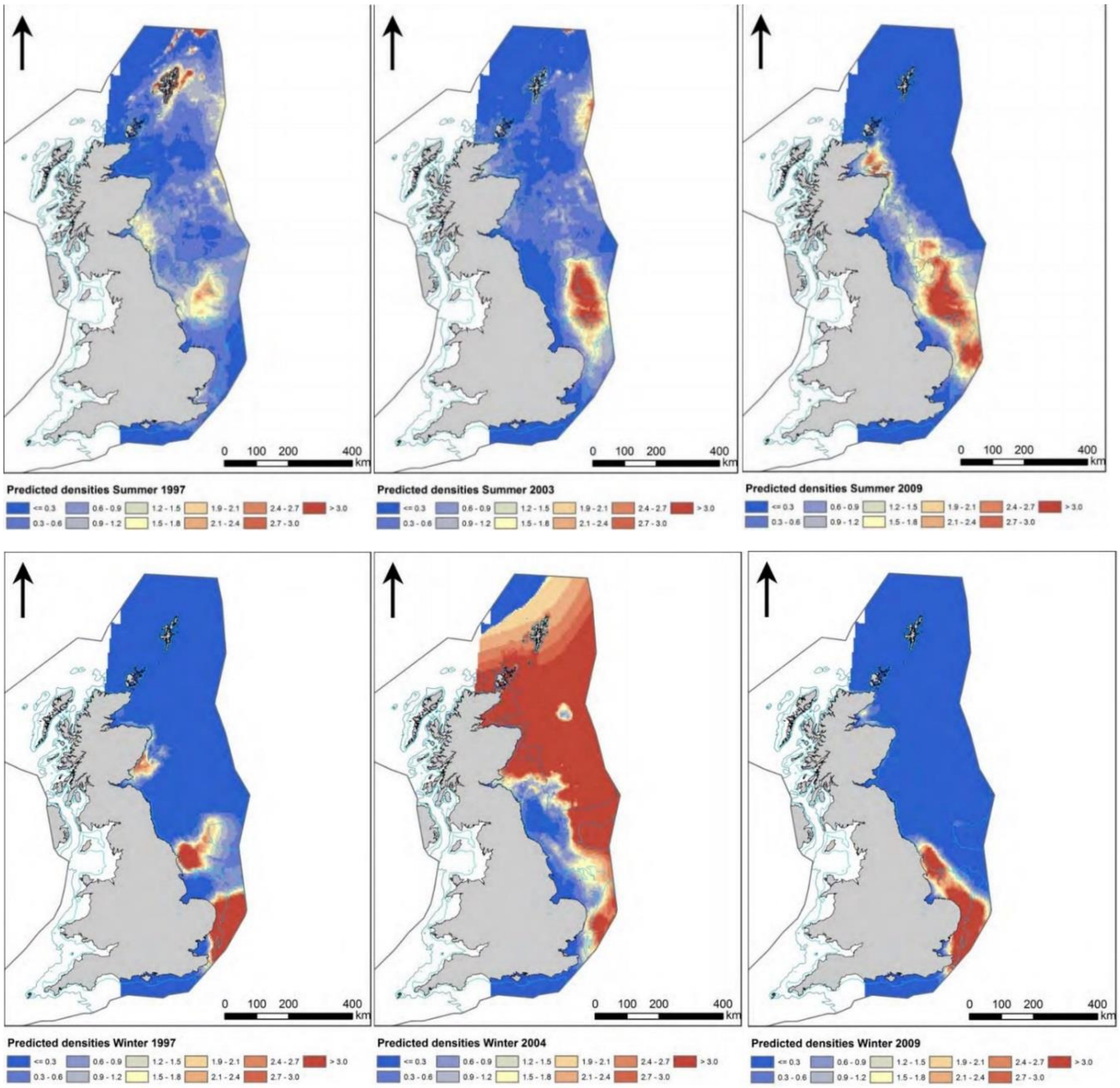
JNCC Report 544: Harbour Porpoise Density

10.88. The Heinanen and Skov (2015) analysis concluded that in the summer months, harbour porpoise presence in the North Sea MU was best predicted by season, water depth, surface salinity and eddy potential, while the density was best predicted by season, the water depth and the vertical temperature gradient. For the summer months the modelling showed a peak in densities at the inner shelf waters (30-50m depth) and that animals seemed to avoid well mixed areas and waters with high current speeds as well as avoiding areas with muddy or hard bottom substrates.

10.89. In the winter months the presence of harbour porpoise was best predicted by the season, water depth, eddy potential and the surface sediments. For the winter months the modelling showed a peak in presence was observed at water depths of 30 to 40 m and that animals seemed to avoid waters with high current speeds as well as avoiding areas with muddy bottom substrates.

10.90. Overall, this analysis predicted varying densities in both the summer and winter months in the central part of the North Sea MU (Figure 36). The density estimates within the outer Forth and Tay region were predicted to be relatively low compared to other parts of the North Sea It is also worth highlighting here that the analysis presented in Heinanen and Skov (2015) relies on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models, as opposed to predictions within the support of the data. Subjective decisions in the retention of covariates in Heinanen and Skov (2015) calls into question the validity of such extrapolation.

Figure 36. Predicted densities (number/km2) during summer (top) and winter (bottom) in the North Sea Management Unit for three different years in each model period (Heinänen and Skov 2015).



ECOMMAS

10.91. Harbour porpoise were detected at all ECOMMAS PAM sites in all survey years (Table 10.10). Detection rates were high, with average porpoise positive days across all survey years ranging between 57 and 100%. Most sites (14 of the 15) had average porpoise detection positive days for over 90% of the time surveyed. Porpoise positive days was lowest at location St Andrews 5 where the lowest detection positive days was 52%.

10.92. The number of median positive hours per day varied on average between 1 at the inshore site at St Andrews and 14 at the middle site at Arbroath. Most sites had between about 8 and 12 porpoise positive hours per day.

10.93. Together these data suggest that harbour porpoises are frequently found in the coastal area monitored by ECCOMAS. There was no clear pattern in detections with distance to shore based on these metrics.

Table 10.10 Percentage of porpoise detection positive days and porpoise median positive hours per day at each ECOMMAS PAM site.

PAM Site	% Porpoise Detection Positive Days					Porpoise Median Positive Hours				
	2013	2014	2015	2016	Average	2013	2014	2015	2016	Average
Arbroath 5	100	98	97	100	99	15	9	12	13	12
Arbroath 10	100	100	100	100	100	14	13.5	13	16	14
Arbroath 15	100		100	100	100	11		9	13	11
Cruden Bay 5	99	93	97	100	97	14	6	8	13	10
Cruden Bay 10		99	100	96	98		10	14	14	13
Cruden Bay 15	99	100		96	98	10	12		13.5	12
St Abbs 5	100	100	99	100	100	6	8	6	6	7
St Abbs 10	100	100	99	99	100	8	11	8	9	9
St Abbs 15	100		99	100	100	9		10	11	10
St Andrews 5	54	67	56	52	57	1	1	1	1	1
St Andrews 10	100	100	99	100	100	12	9	8	13	11
St Andrews 15	100	100	98	100	100	9	6	8	10	8
Stonehaven 5	100		92	96	96	13		8	9	10
Stonehaven 10		99	99	85	94		8	12	5	8
Stonehaven 15	86	100	95	100	95	12	11	7	13	11

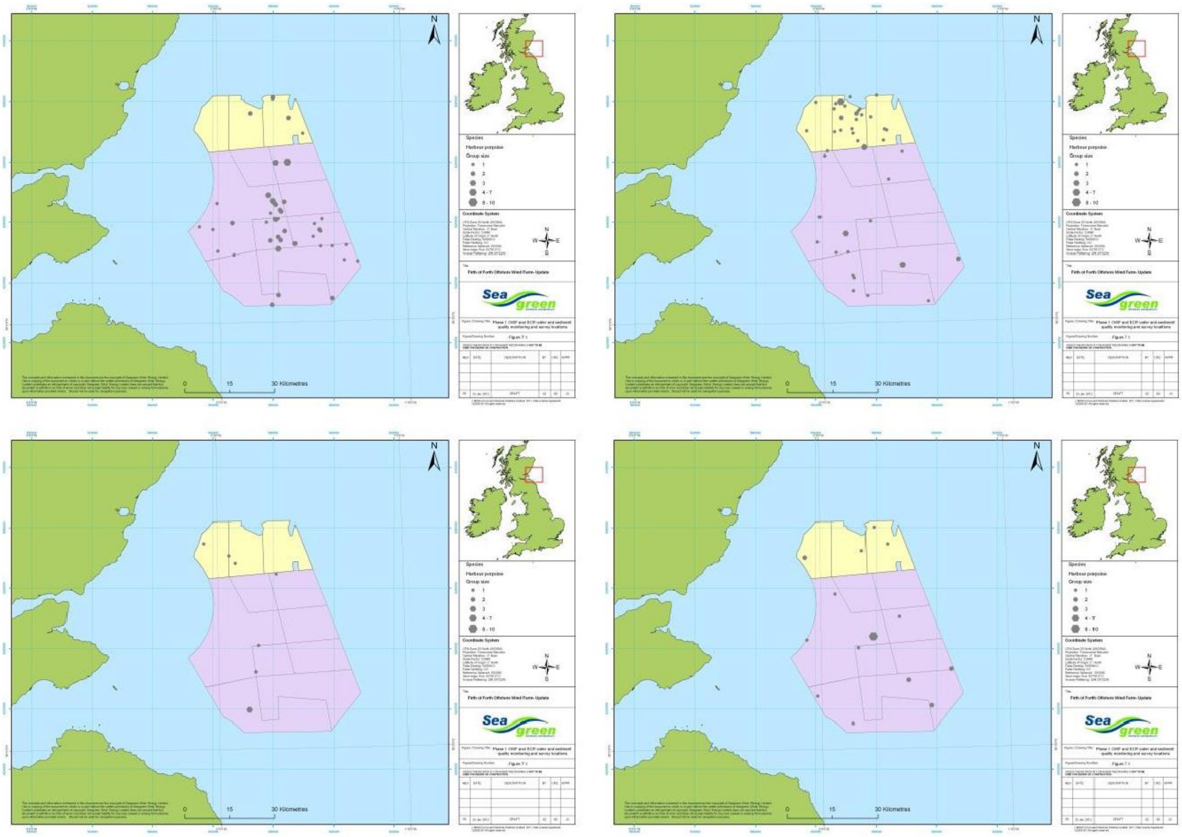
Visual surveys

10.94. Seagreen specific boat based survey data presented in the Appendix 10Ai (Figure 37) show increased sighting rates and some larger pod sizes within Project Alpha compared to Project Bravo. However, the sightings were widely distributed with concentrations in the northern part of the ISA around Scalp Bank and in the central and southern parts of Marr Bank. Sightings were most common in the northern part of the ISA in the summer and more central and southerly in the spring (Figure 37).

10.95. Boat based sightings of harbour porpoise were made in all months, apart from June 2010, November 2010, May 2011 and October 2011 (Figure 37). Generally encounter rates were highest in the spring and summer and relatively low in autumn and winter. Overall, encounter rates during the boat based surveys were reduced in 2011 compared to the previous year's surveys, but this pattern is driven mainly by a high sightings rate in May 2010.

10.96. Boat based surveys in Phase 1 area + 2km buffer in summer 2017 recorded the highest counts of harbour porpoise on 9/10 May; 56 animals and 25/26 July; 39 animals. In all other surveys the number of animals counted was less than 10; 6 animals 24/25 May, 4 animals 20/21 June and 7 animals 15/16 August.

Figure 37. Positions of all harbour porpoise sightings a) spring (Mar – May), b) summer (Jun – Aug), c) autumn (Sep – Nov) and d) winter (Dec – Feb) (Appendix 10Ai).



10.97. During the 2009 and 2010 TCE aerial surveys the greatest number of harbour porpoise (31 out of 50) were recorded during the summer (Appendix 10Aiii). Anderwald and Evans (2010) also provides confirmation of peaks in sightings of harbour porpoise in summer months.

10.98. Appendix 10Aiii provides density estimates for harbour porpoise of 0.08 (CV 0.11) individuals per km^2 based on TCE aerial surveys from 2009 to 2010. Summer density estimates were calculated to be 0.099 (CV 0.12) individuals per km^2, and winter 0.048 (CV 0.24) individuals per km2. These density estimates are minimum estimates based on inherent negative bias due to the survey methodology (Appendix 10Aii, Page 4). In addition to the negative bias in the survey methods, the large numbers of unidentified small cetaceans in the report are likely to be harbour porpoise, and if included in the estimates would increase the density.

10.99. In addition to the average density estimates generated from TCE aerial surveys, spatially explicit density surfaces have been generated using all FTOWDG aerial and boat based sightings (Appendix 10Avi, Section 5.2). When all data across all years are pooled, depth was a significant predictor of occurrence, with fewer animals in shallow water. The data show a great deal of variation in the spatial distribution of harbour porpoise across the survey years, with the main predictor of density being survey methodology. The likely explanation for variation in densities across the Zone will relate to changes in prey distribution. But differences in survey method beyond simple differences in detection properties could also be an underlying cause (e.g. seeing below the surface during aerial surveys will increase sighting rate due to greater availability to observers; Appendix 10Avi, Section 5.2.2). Densities were also predicted to be higher in the summer and spring.

Harbour porpoise baseline conclusion

10.100. Harbour porpoise are relatively common in the study area and have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of harbour porpoises potentially affected, it is proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys will be used.

Minke whale baseline

10.101. Minke whales are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid et al. 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Minke whales in the UK are considered to have a Favourable Conservation Status (JNCC, 2013) and all minke whales in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 23,528 animals (95% CI: 13,989 to 39,572), of which 12,295 (95% CI: 7,176 to 21,066) are estimated within the UK Exclusive Economic Zone (EEZ); however, these abundance estimates are based on data from SCANS II (Hammond et al. 2013) and the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) surveys (Hammond et al. 2009) which are likely to be underestimates due to the SCANS II aerial survey estimate not being corrected for perception bias and the CODA estimate not being corrected for either perception or availability bias.

SCANS

10.102. The average density estimate from the SCANS II survey Block V of 0.023 minke whales /km^2 was used in the previous impact assessment of behavioural impacts as presented in the 2012 Offshore ES.

10.103. The SCANS III estimated abundance for block R was 2,498 minke whales (95% CI: 604 to 6,791) with an estimated density of 0.039 whales/km^2 (Hammond et al. 2017). As mentioned above, the survey areas were not consistent between surveys but the estimated density for the block that contained the Seagreen Project in SCANS III was slightly higher than the density from SCANS II used in the original assessment.

JCP Phase III

Firth of Forth area of commercial interest 2010

10.104. The JCP Phase III analysis provides estimated abundances for minke whales in 2010 by season for the Firth of Forth area of commercial interest region (see Figure 1), and estimates highest abundance in the summer months, 360 animals, with similar low estimates in all other seasons (20 to 60 animals) (Table 10.11). This equates to density estimates between 0.001 whales/km^2 and 0.025 whales/km^2 (Table 10.11). However, as stated by Paxton et al. (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available.

Table 10.11 Estimated minke whale abundance and density (#/km²) (and 95% confidence intervals) for the Firth of Forth in 2010 using the JCP Phase III data (Paxton et al. 2016).

	Winter		Spring		Summer		Autumn	
	Abundance	Density	Abundance	Density	Abundance	Density	Abundance	Density
Point Estimate	20	0.001	60	0.004	360	0.025	20	0.001
2.5%	0	0.000	0	0.000	140	0.010	0	0.000
97.5%	150	0.011	480	0.034	990	0.070	60	0.004

User specified area summer 2007-2010 (averaged)

10.105. The R code provided by JNCC was used to determine the number of minke whales within the area defined in Figure 1 (which is approximately double the size of the Firth of Forth area of commercial interest and extends further offshore). This resulted in a minke abundance estimate for the area averaged for summer 2007-2010 of 709 (95% CI 402 - 863) which equates to a density estimate of 0.019 whales/km² (95% CI 0.011 – 0.023) (Table 10.12). This is slightly lower than the summer 2010 density estimate for the Firth of Forth area of commercial interest presented above (0.025 whales/km²). The JCP III R code for the user specified area estimates approximately half the density value estimated by SCANS III (0.039 whales/km²) but this JCP III density estimate is averaged over the summers between 2007 and 2010 while the SCANS III density estimate is a single snapshot from July 2016, in addition to the fact that the two study areas differ in size.

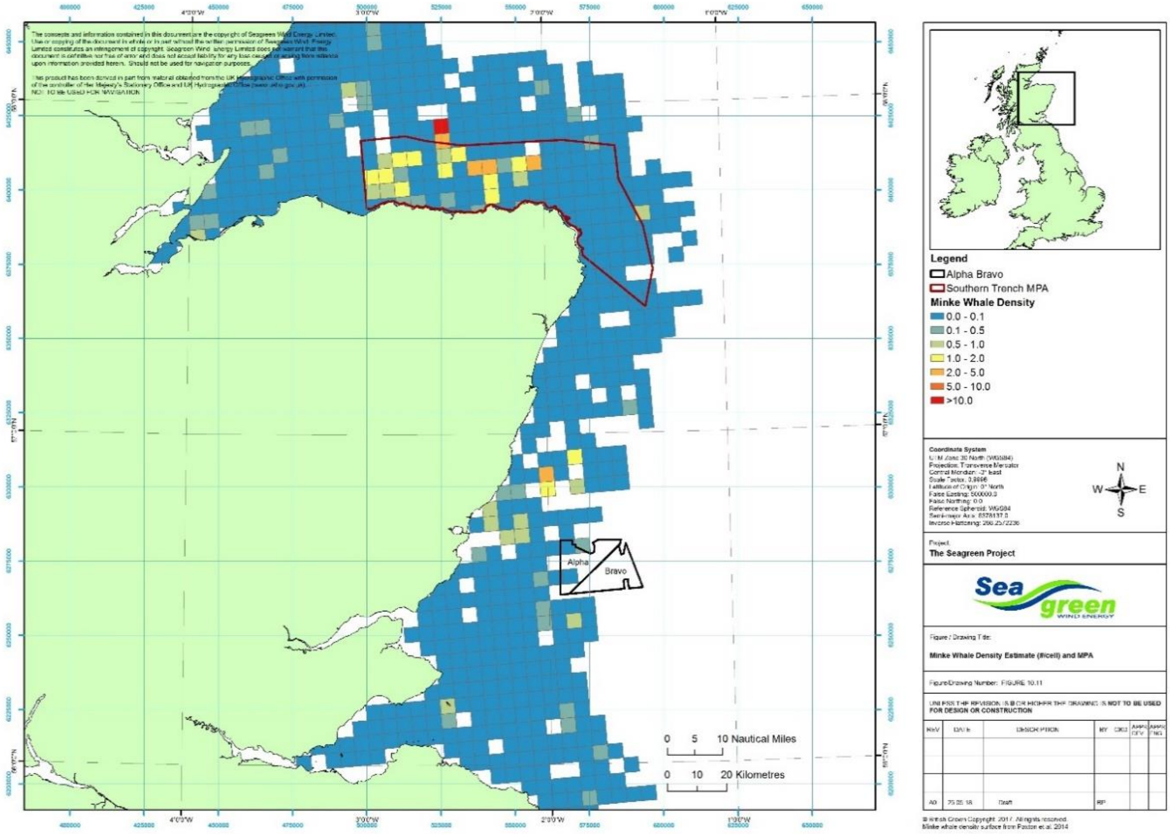
Table 10.12 Estimated minke whale abundance and density (#/km²) (and 95% confidence intervals) for the user specified area for summer 2007-2010 (averaged) as output by the JNCC JCP III R code.

	Point Estimate	Lower CI	Upper CI
User area abundance (scaled to SCANS III)	709	402	863
User area density	0.019	0.011	0.023

Minke whale density

10.106. According to modelling work carried out to inform MPA selection (Paxton et al. 2014), off the east coast of Scotland the highest minke whale density is located around the proposed Southern Trench SAC in the outer Moray Firth where densities reach a predicted >10 minke whales/km² (Figure 38). Outside of the Moray Firth, the area with the highest predicted density is located off the coast between Stonehaven and Inverbervie where there is a grid cell with a predicted density of 3.6 minke whales/km² (Figure 38).

Figure 38. Minke whale predicted density (#/km²) (Paxton et al. 2014). The proposed Southern Trench MPA is shown.



Visual surveys

10.107. Sixty-two minke whale (0.003 sightings/hour) were recorded during the 2010/11 Seagreen specific boat based surveys. Appendix 10Ai (Figure 39) shows minke whale were seen throughout the survey area, including both Project Alpha and Project Bravo, with nine sightings locations in each.

10.108. A strong seasonal pattern to the sightings data for minke whale was recorded during the boat based surveys, with most encountered during the spring and summer months in 2010 and 2011 (Figure 40), with high rates in May 2010 and June 2011. This seasonal pattern is supported by Anderwald and Evans (2010).

10.109. The greatest number of minke whales counted from boat based surveys in the Phase 1 area + 2km buffer was 13 animals on 25/26 July 2017 where 2 unidentified whales were also recorded. No minke whales were sighted on the June survey and only 1 animal per survey was recorded on 9/10 May, 24/25 May and 15/16 August.

Figure 39. Positions of all minke whale sightings recorded during all surveys (Appendix 10Ai).

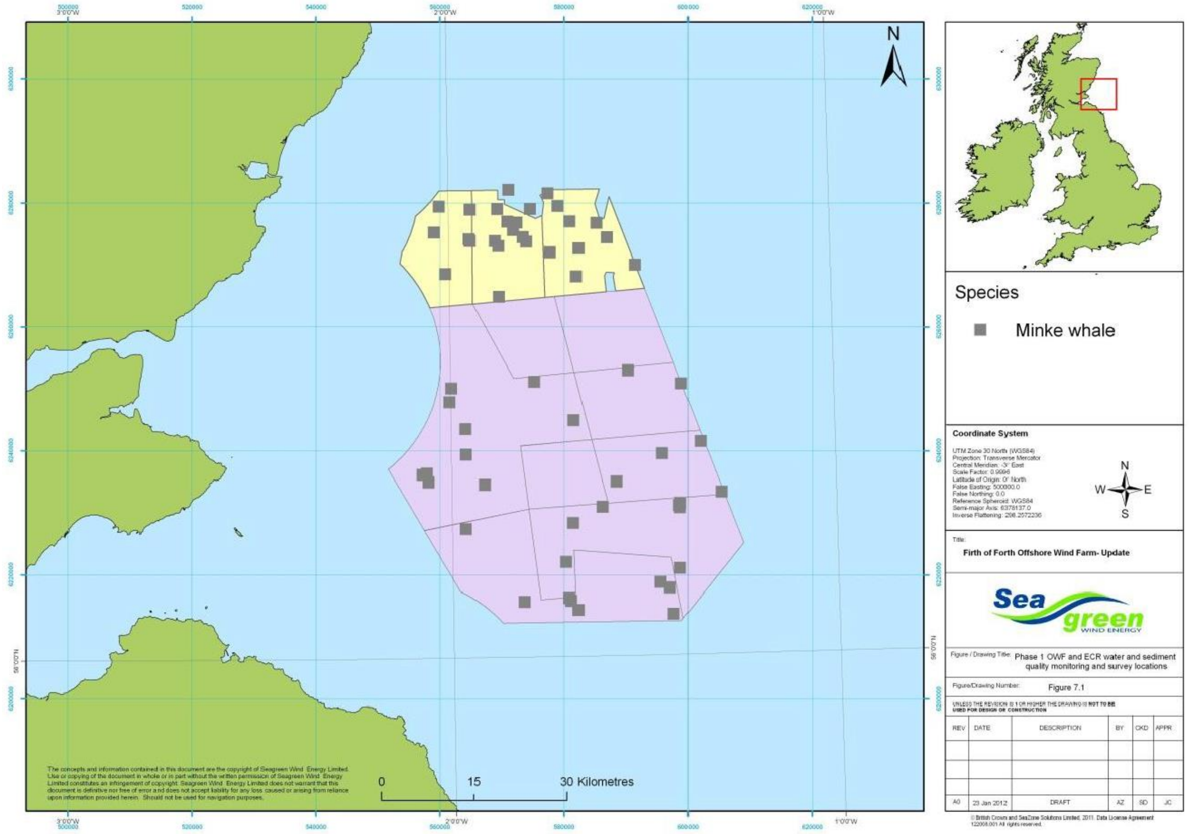
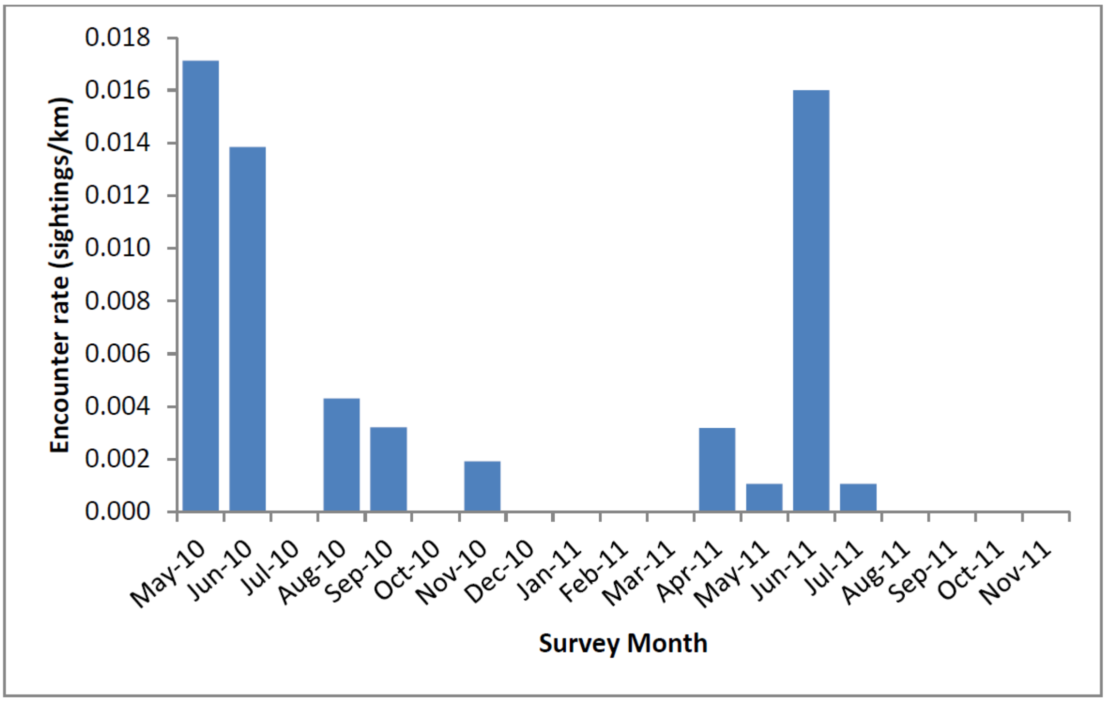


Figure 40. Encounter rate (sightings per km of survey effort) for minke whales per survey month (Appendix 10Ai).



10.110. Integrated analysis of Seagreen specific boat based and TCE aerial surveys was able to generate spatially explicit density surfaces (Appendix 10Avi, Section 5.4). These absolute densities were very low, but surfaces showed high uncertainty with large confidence limits. Absolute abundance across the survey period and area was estimated as 594 but also showed a high level of uncertainty due to the low number of sightings (95% CI 108-2695).

10.111. Insufficient sightings were made during TCE aerial surveys to estimate average densities of minke whale in the RSA using these data alone (Appendix 10Aiii).

Minke whale baseline conclusion

10.112. Minke whale have been sighted relatively often in the study area, much more frequently in the summer months. Although present at low densities, they have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of minke whales potentially affected, it is proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys will be used.

White-beaked dolphin baseline

10.113. White-beaked dolphin are wide-spread across the northern European continental shelf. The species is the most abundant cetacean after the harbour porpoise in the North Sea (Banhuera-Hinestroza et al. 2009), and the waters off the coast of Scotland and north east England are one of the four global centres of peak abundance. The species occurs mainly in waters of 50-100m in depth (Reid et al. 2003). Evidence supports the assumption that white-beaked dolphin from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banhuera-Hinestroza et al. 2009).

10.114. White-beaked dolphins in the UK are considered to have a Favourable Conservation Status (JNCC, 2013). The relevant MU for white-beaked dolphins is the Celtic and Greater North Seas MU which has an estimated population size of 15,895 animals (95% CI 9,107-27,743) (IAMMWG, 2015). However, this information is clearly out of date since the SCANS III surveys suggest a much higher abundance than the SCANS II surveys. The estimate for the relevant SCANS III Block is almost the same as the previous estimate for the entire CGNS MU. The SCANS III surveys produced a white-beaked dolphin abundance estimate of 36,287 across all surveyed blocks (95% CI 18,694 – 61,869) (Hammond et al. 2017), however, this is not equivalent to the previous estimate for the total Celtic and Greater North Seas MU as the SCANS III surveys did not cover all of the MU. In the absence of an alternative updated abundance estimate for the entire MU, the SCANS III white-beaked dolphin abundance estimate is considered the most appropriate to take forward as the reference population size for impact assessment. This approach was agreed with the statutory consultees (Meeting 06/03/2018).

10.115. The mating season for white beaked dolphin is in July and August with the gestation period lasting about 11 months (Culik, 2010). White-beaked dolphin feed upon mackerel, herring, cod, poor-cod, sandeels, bib, whiting, haddock, and hake, as well as squid, octopus, and benthic crustaceans (Anderwald and Evans, 2010). The region is used both for feeding and breeding. They breed mainly between May and August, although some may occur also in September and October (Anderwald and Evans, 2010).

SCANS

10.116. SCANS II density estimates (animals per km^2) for the blocks which included the area covered by TCE surveys provide a comparable density estimate of 0.049 (Appendix 10Aiii, Table 7). The SCANS II estimate was used for the original impact assessment presented in the 2012 Offshore ES, as it is the higher estimate compared to the site specific visual surveys, and thus more precautionary.

10.117. However, since the 2012 Offshore ES, SCANS III has been conducted and has resulted in a lower density estimate for the survey block. The SCANS III estimated abundance for survey Block R was 15,694 white-beaked dolphins (95% CI: 3,022 to 33,340) and a density of 0.243 dolphins/km^2 (Hammond et al. 2017).

JCP Phase III

Firth of Forth area of commercial interest 2010

10.118. The JCP Phase III analysis provides estimated abundances for white-beaked dolphin in 2010 by season for the Firth of Forth area of commercial interest, and estimates highest abundance in the spring months (1,760 animals) with lower estimates in all other seasons; summer (720 animals), autumn (540 animals) and winter (410 animals) (Table 10.13) This equates to density estimates between 0.038 dolphins/km^2 and 0.124 dolphins/km^2 (Table 10.13). However, as stated by Paxton et al. (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardizing the data and the spatial and temporal patchiness of the data available.

Table 10.13 Estimated white-beaked dolphin abundance and density (#/km^2) (and 95% confidence intervals) for the Firth of Forth in 2010 using the JCP Phase III data (Paxton et al. 2016).

	Winter		**Spring**		**Summer**		**Autumn**	
	Abundance	Density	Abundance	Density	Abundance	Density	Abundance	Density
Point Estimate	410	0.029	1,760	0.124	720	0.051	540	0.038
2.5%	170	0.012	620	0.44	360	0.025	220	0.015
97.5%	1,110	0.078	4,530	0.318	1,840	0.129	1,130	0.079

User specified area summer 2007-2010 (averaged)

10.119. The R code provided by JNCC was used to determine the number of white-beaked dolphins within the area defined in Figure 1 (which is approximately double the size of the Firth of Forth area of commercial interest and extends further offshore). This resulted in an abundance estimate for the area averaged for summer 2007-2010 of 3,700 (95% CI 2,300 – 8,400) which equates to a density estimate of 0.137 dolphins/km^2 (95% CI 0.003 – 0.165) (Table 10.14). This is much higher than the Firth of Forth area of commercial interest density estimate for summer 2010 (0.051 dolphins/km^2). The JCP III R code for the user specified area estimates approximately half the density value estimated by SCANS III (0.243 dolphins/km^2) but this JCP III density estimate is averaged over the summers between 2007 and 2010 while the SCANS III density estimate is a single snapshot from July 2016, in addition to the fact that the two study areas differ in size.

Table 10.14 Estimated white-beaked dolphin abundance and density (#/km^2) (and 95% confidence intervals) for the user specified area for summer 2007-2010 (averaged) as output by the JNCC JCP III R code.

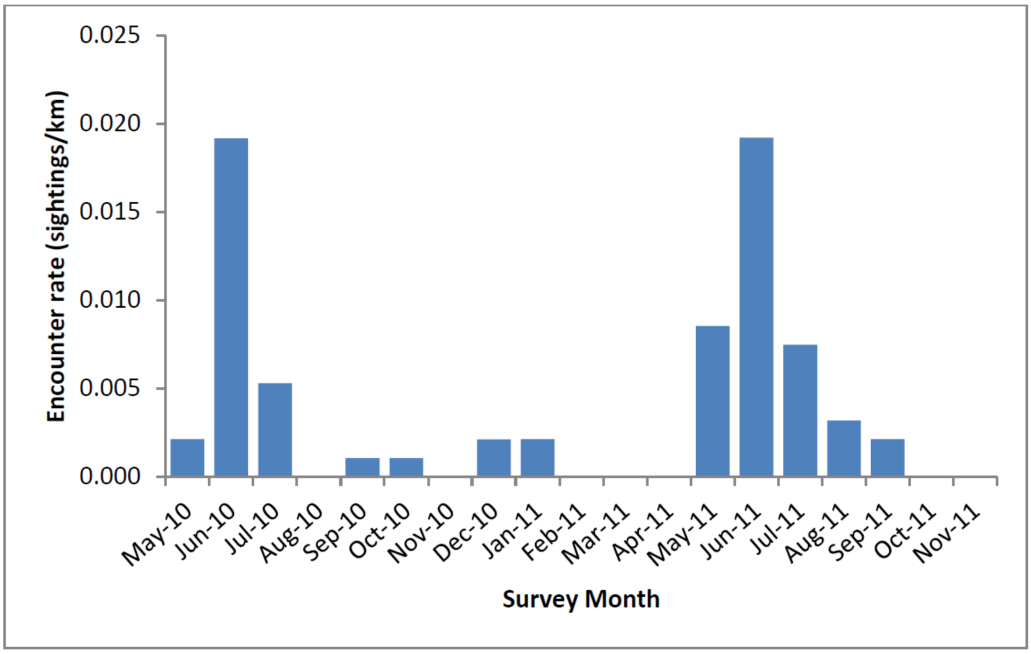
	Point Estimate	**Lower CI**	**Upper CI**
User area abundance (scaled to SCANS III)	5,027	108	6068
User area density	0.137	0.003	0.165

Visual surveys

10.120. During the Seagreen specific boat based survey, white-beaked dolphin was recorded most often during the summer in both 2010 and 2011 (Plot 1.37). This seasonal peak is in line with a previous study that also found white-beaked dolphin to be present in Aberdeenshire waters during June to August with the main peak in August (Weir et al., 2007). Low numbers were seen in September, October and December 2010, and January 2011 (Figure 41). Anderwald and Evans (2010) also show peaks in the sightings rate in summer months, in particular during August.

10.121. The boat based surveys of Phase 1 area + 2km buffer in summer 2017 recorded white-beaked dolphins on two of the five surveys, 2 animals were sighted 20/21 June and 17 animals 25/26 July. A single dolphin of unidentified species was sighted on the 9/10 May, 25/26 July and 15/16 August surveys.

Figure 41. Encounter rate (sightings per km of survey effort) for white-beaked dolphins per survey month (Appendix 10Ai).



10.122. Appendix 10Aiii provides density estimates for white beaked dolphin of 0.042 (CV 0.031) individuals per km2 based on TCE aerial surveys. Summer and winter estimates are 0.052 (CV 0.35) and 0.024 (CV 0.66) individuals per km^2, respectively.

10.123. Integrated analysis of the boat based and aerial survey data (Appendix 10Avi) has also been completed. The analysis shows that due to the low number of sightings, there is a high level of uncertainty in the data. Absolute abundance across the survey period and RSA was 293 (95% CI 266-1055) (Appendix 10Avi, Page 32). Absolute density estimates also had high uncertainty associated with them, and ranged from 0 to 1 individual per km2 in a single grid cell over the survey period. A peak in sightings and therefore density was apparent to the north east of the survey area. Spatially and temporally explicit densities have not been incorporated into the assessment due to high uncertainty and variability across the Zone.

White-beaked dolphin baseline conclusion

10.124. White-beaked dolphins have been sighted occasionally in the study area, and similar to minke whales, are seen more frequently in the summer months. Although present at low densities, they have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of white-beaked dolphins potentially affected, it is proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys will be used.

Baseline Summary

10.125. Based on the data obtained from the baseline characterisation desk based study and the site-specific surveys conducted for Seagreen, the abundance and density values for each marine mammal species presented in Table 10.15 have been identified as the most robust values to take forward for the impact assessment. For comparison, Table 10.15 also shows the abundance and density values used for the impact assessment in the 2012 Offshore ES.

Table 10.15 Current species specific MU and density estimates to be taken forward for impact assessment. For comparison both the value used currently and in the 2012 Offshore ES are provided.

Species		MU	MU Size	MU Source	Density Estimate	Density Source
Harbour seal	Current	East Coast Scotland	511	August 2016 haul-out count	5x5 km grid cell specific at-sea usage	Russell et al. (2017)
	2012 Offshore ES	East Coast Scotland	540	August 2001 and 2007 haul-out counts	5x5 km grid cell specific at-sea usage	Sparling et al. (2011)
Grey seal	Current	East Coast Scotland	10,891	August 2016 haul-out count	5x5 km grid cell specific at-sea usage	Russell et al. (2017)
	2012 Offshore ES	East Coast Scotland	5,657 – 12,011	Lonergan et al. (2011) and Thomas (2011)	5x5 km grid cell specific at-sea usage	Sparling et al. (2011)
Bottlenose dolphin	Current	Coastal East Scotland	195	Cheney et al. (2013)	98 bottlenose dolphins spread evenly across the area inside the 20 m depth contour	As agreed in the Scoping Opinion
	2012 Offshore ES	Coastal East Scotland	195	Cheney et al. (2013)	SCANS II Block V 0.0008 dolphins/km2	SCANS II
Harbour porpoise	Current	North Sea (ICES Assessment Unit)	345,373	SCANS III	SCANS III Block R 0.599 porpoise/km2	SCANS III
	2012 Offshore ES	North Sea	385,617	SCANS II	SCANS II Block V 0.294 porpoise/km2	SCANS II
Minke whale	Current	Celtic and Greater North Seas	23,528	IAMMWG (2015)	SCANS III Block R 0.039 whales/km2	SCANS III
	2012 Offshore ES	European	25,379	SCANS II + CODA	SCANS II Block V 0.023 whales/km2	SCANS II
White-beaked dolphin	Current	Celtic and Greater North Seas	36,287	SCANS III	SCANS III Block R 0.243 dolphins/km2	SCANS III
	2012 Offshore ES	European (excl. North Norwegian population)	22,664		SCANS II Block V 0.049 dolphins/km2	SCANS II

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LIST OF APPENDICES

Appendix 10Ai: Seagreen Firth of Forth Round 3 Zone Marine Mammal Surveys

Appendix 10Aii: Assessment of The Crown Estate Aerial survey marine mammal data for the Firth of Forth development areas

Appendix 10Aiii: Analysis of The Crown Estate Aerial survey data for marine mammals for the FTOWDG

Appendix 10Aiv: Baseline seal information for the FTOWDG area.

Appendix 10Av: Cetacean baseline characterisation for the Firth of Tay based on existing data: bottlenose dolphins

Appendix 10Avi: Cetacean survey data analysis report for FTOWDG.