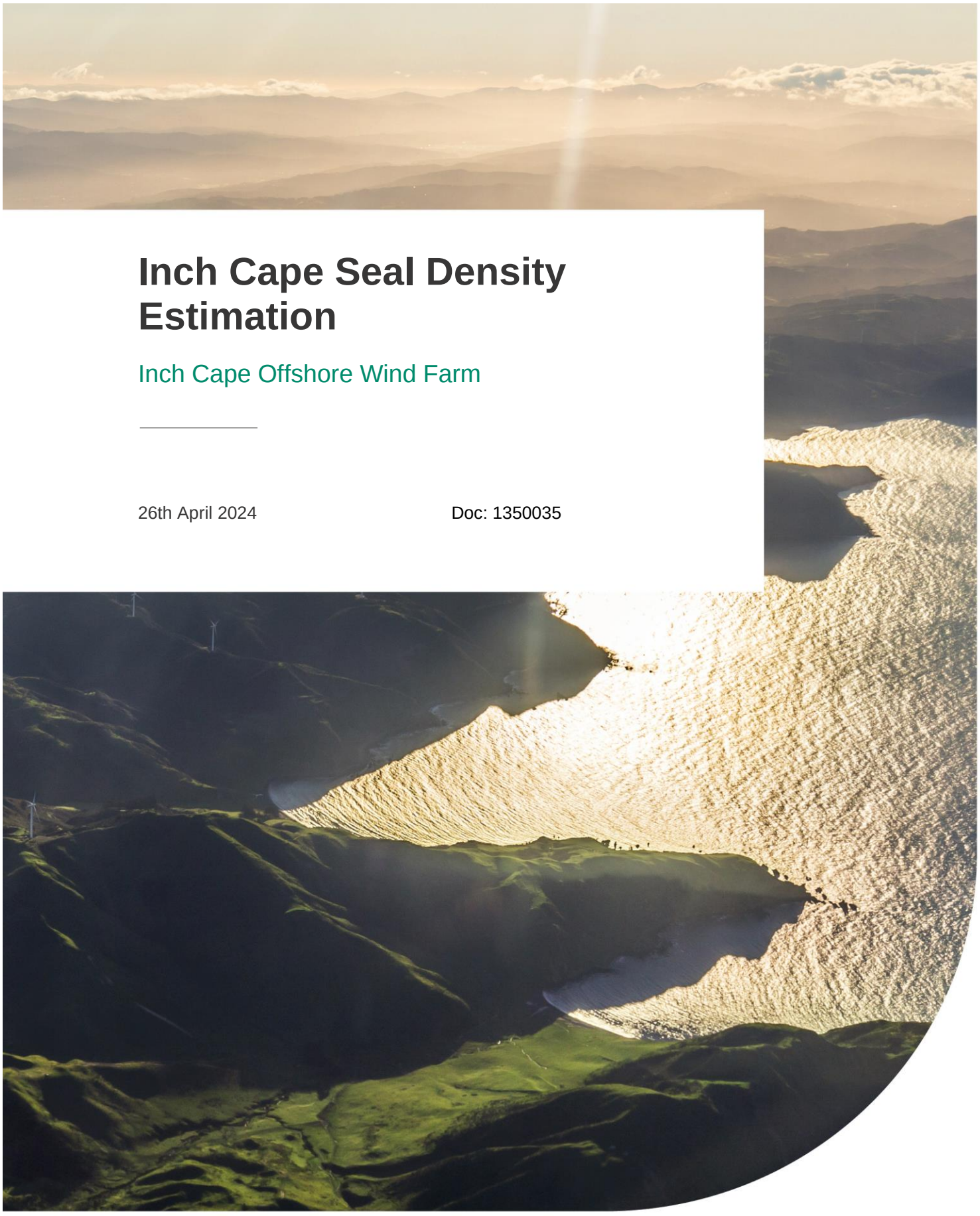

Inch Cape Seal Density Estimation

Inch Cape Offshore Wind Farm

26th April 2024

Doc: 1350035

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1. Methods

Inch Cape Offshore Limited (ICOL) has consent to develop an offshore wind farm (OWF) in the outer Firth of Tay region within Scottish Territorial Waters (STW). The consented Inch Cape Offshore Wind Farm will comprise up to 72 wind turbines and be located approximately 15 km to the east of the Angus coastline. The Development Area is in water depths of between 40 - 57 m.

During all stages of the pre-construction, construction and decommissioning of the Inch Cape OWF appropriate risk assessments will need to be produced for potential impacts on marine mammals. To inform these assessments accurate baseline information is required on the density and abundance of the different species.

The aim of the following work was to estimate harbour and grey seal densities within (1) the East Scotland Seal Management Area and (2) a 30 km buffer of the Inch Cape development area and cable route to inform impact assessments from the development of the Inch Cape OWF. To achieve this, published relative density surfaces are scaled by recent estimates of the at-sea population of each species; effectively distributing abundance across UK and Irish waters. This spatial distribution of abundance is then used to estimate both density and abundance in each area of interest.

1.1. Density surfaces

Carter *et al.*, 2022 predicted the relative at-sea distribution of harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*), covering UK and Irish waters. The predicted distributions are derived for each species from telemetry data collected by grey (n=114) and harbour (n=239) seals from 26 sites between 2005 and 2019. Generalised Additive Mixed Models were used to predict regional distributions, while accounting for environmental drivers and location uncertainty from GPS tags. Model predictions were then weighted by the most recent regional counts of hauled out individuals and combined into a single distribution map for seals (of each species) at sea around the UK and Ireland. These predictions were used for the present work as they are available at a suitably fine-scale resolution (5 x 5 km grid cells), and entirely cover the region of interest.

These predicted density surfaces contain model-predicted relative densities that sum to 100% across each surface. For each species, a mean fitted surface with lower and upper 95% confidence intervals as separate layers were published. In both the lower and upper 95% confidence interval surfaces, the values do not sum to 100% (instead 48.6% and 172% respectively for harbour seals, for example). As a result, if these relative density surfaces are used to distribute abundance, the range of the confidence intervals of abundance will be inflated, as these relate to relative rather than absolute densities (Carter *et al.*, 2022, supplementary material). Consequently, the upper and lower confidence intervals of the density surfaces are not used here.

Since surfaces produced by Carter *et al.* 2022 are derived from telemetry data collected from seals from the UK and Ireland, densities do not contain animals from other countries which may visit UK and Irish waters. This also excludes animals that were hauled out during the peak foraging period, which these surfaces encompass. It should be noted that the metadata associated with the density surfaces urges caution when considering the relative density of both seal species on the east coast of the UK due to a lack of recent telemetry data or paucity of environmental data in this area (Carter *et al*., 2022, Supplementary material). However, given these distribution maps constitute the best available information they are used for this work.

1.2. Scaling surfaces from relative density to absolute abundance and density

To enable the conversion of relative seal density maps to absolute density, at-sea distribution density surfaces from Carter *et al.*, 2022 were scaled by the August population count for each species in Britain and Ireland, reported in the 2022 Special Committee on Seals (SCOS) report. Seals are counted in August as this is when harbour seals undergo an annual moult and therefore the majority of the population are hauled out and available to be counted. Grey seals are counted at the same time, despite being outside of their breeding period when they are also surveyed, and therefore a lower proportion of the population will be available to be counted. Since the SCOS counts only included hauled out individuals, this number was divided by the proportion of seals hauled out at the time of the count to give a total predicted population size. Proportions of grey seals hauled out originate from SCOS-BP 21/02, and harbour seal proportions are from Lonergan *et al.,* 2013. Since the desired outcome was an annual estimate of at-sea density based on the Carter surfaces, this number was then multiplied by an annual estimate for the proportion of seals at sea taken from the SCOS 2021 report which is based on work presented in Russell *et al.*, 2015, to give a predicted at-sea population count. The equation to calculate this count was therefore:

$$\widehat{N} = \frac{N}{H} \times S$$

Where N is the counted population (see table below), H is the haul out proportion, and S is the proportion at sea. When $\widehat{N}$ is multiplied by mean relative density values in each raster cell provided by Carter as a proportion, the sum totals the population estimate across the UK and Ireland. Values used are provided in Table 1.1. This method was used to create estimates of absolute abundance across UK and Irish waters, at 5 x 5 km resolution. The density per grid cell was also calculated by dividing the abundance by the cell area, resulting in a density of seals per km^2.

To account for uncertainty in the proportion of seals hauled out in August, a range of three values (a middle estimate, and associated low and high estimates) were used to estimate three different population sizes for each species. Each estimate was then scaled by the annual at-sea proportion to result in low, middle, and high estimates of the at-sea population size (see Table 1.1).

Table 1.1: Inputs used for surface scaling

Species	Count (hauled out, August)	Proportion hauled out in August (low-high estimates)	Total population size	Annual at-sea proportion	Annual at sea estimate for scaling Carter surfaces
Grey seal	44833	0.2515 (0.2907 - 0.2145)	178262 (154224 - 209012)	0.8616	153591 (132880 - 180084)
Harbour seal	34862	0.72 (0.88-0.54)	48419 (39615 - 64559)	0.8236	39878 (32627 - 53171)

Source: Grey seal proportions hauled out from SCOS-BP 21/02. Harbour seal proportion hauled out from Lonergan et al., 2013.

1.3. Areas assessed

Two subset areas were considered which are most relevant for the proposed works. 1) A 30 km buffer around the Inch Cape OWF boundary, and export cable corridor; 2) East Scotland Seal Management Area. The former approximately covers the maximum area estimated to be affected by unexploded ordnance (UXO) clearance during the Inch Cape OWF development, while the latter is a delineated management unit for seal conservation.

In each area, abundance for each species was summed under the three scenario levels based on the variance around the estimate of the proportion of seals hauled out during the counts. This is presented as absolute abundance and is also used to calculate the percentage of animals relative to the at-sea population. Additionally for each subset

area, the density per grid cell was calculated by dividing the abundance by the cell area (25 km^2), resulting in a density of seals per km^2. For cells that overlap the area of interest, the mean, 2.5th and 97.5th quantiles were calculated, once cells that overlapped land with zero seals estimated were removed – as the grid continues across the entire landmass of the UK and Ireland and including this would artificially decrease estimates.

2. Results

2.1. Summary

Grey seals are estimated to occur in higher densities in both areas of interest, compared to harbour seals, with mean densities spanning 1.10 – 1.48 grey seals per km^2 within a 30 km buffer of the Inch Cape development area, compared to 0.04 – 0.06 harbour seals per km^2 (see Table 2.1). Similarly in the East Scotland Seal Management Area, mean densities of grey seals were 0.26 – 0.35, compared to 0.005 – 0.008 for harbour seals. Further summary statistics are presented in Table 2.1 and Figure 2.1, and abundances of grey seals and harbour seals are examined in Sections 3.2 and 3.3 respectively.

Table 2.1: Density of grey and harbour seals (animals per km^2) at Inch Cape (with 30 km buffer) and within the East Scotland Seal Management Area. Densities are presented as means and lower and upper 95th quantiles

Species	Area	Scenario	Mean	2.5th quantile	97.5th quantile
Grey seal	Inch Cape	high	1.484405	0	4.287362
Grey seal	Inch Cape	low	1.095304	0	3.163533
Grey seal	Inch Cape	mid	1.266024	0	3.656617
Grey seal	East Scotland	high	0.353574	0.005737	2.048222
Grey seal	East Scotland	low	0.260893	0.004233	1.51133
Grey seal	East Scotland	mid	0.301557	0.004893	1.746893
Harbour seal	Inch Cape	high	0.063228	0	0.648302
Harbour seal	Inch Cape	low	0.038799	0	0.397822
Harbour seal	Inch Cape	mid	0.047421	0	0.486226
Harbour seal	East Scotland	high	0.008307	0	0.05254
Harbour seal	East Scotland	low	0.005097	0	0.03224
Harbour seal	East Scotland	mid	0.00623	0	0.039405

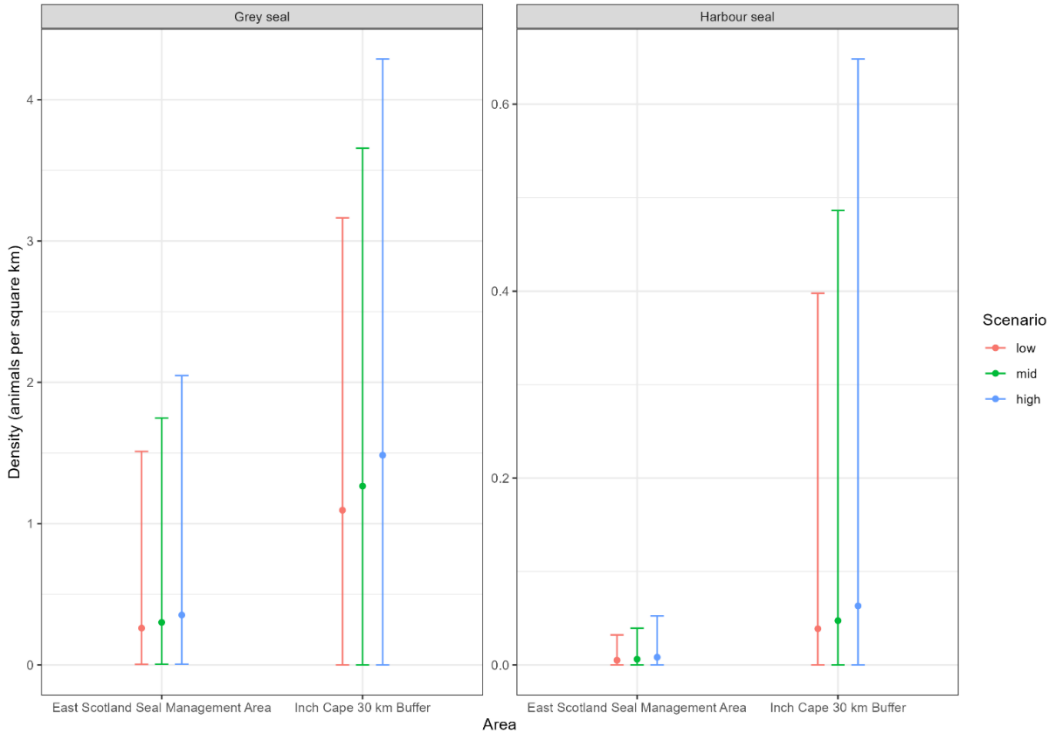

Figure 2.1: Estimated density of seals within a 30 km buffer of the Inch Cape Project development area (the windfarm footprint and export cable corridor), and the East Scotland Seal Management Area. Low, mid and high scenarios represent ranges of haul out proportion estimates used in calculations.

2.2. Grey seal

11.9% of the UK and Ireland at-sea population of grey seals are predicted to occur in the East Scotland Seal Management Area whilst 5.99% are predicted occur in the Inch Cape 30 km buffer (see Table 2.2). This equates to 18,259 (15,797 – 21,409) grey seals using the East Scotland Seal Management Area, compared to 9,210 (7,968 – 10,799) in the Inch Cape 30 km buffer. While the Inch Cape 30km buffer covers 10.5% of the total at-sea area of the East Scotland Seal Management Area, it contains an estimated 50.4% of the grey seals. This indicates that the Inch Cape development area is of relative importance within the East Scotland Seal Management Area. Grey seals appear to be predominantly distributed coastally; although to a lesser extent than harbour seals (Figure 2.2 and 2.3).

Table 2.2: Abundance estimates for grey seal within a 30 km buffer of the Inch Cape development ('Inch Cape') and East Scotland Seal Management Area ('East Scotland'). Low, mid and high scenarios represent ranges of haul out proportion estimates used in calculations. Abundance estimates are also presented as a percentage of the total estimated at-sea population in the UK and Ireland

Area	Level	Estimated abundance in Area	Estimated population at sea in UK & Ireland	Percentage of at sea population
East Scotland	Low	15797.08	132879.6	11.89
East Scotland	Mid	18259.29	153590.9	11.89
East Scotland	High	21408.91	180084.4	11.89
Inch Cape	Low	7968.34	132879.6	5.99
Inch Cape	Mid	9210.32	153590.9	5.99
Inch Cape	High	10799.05	180084.4	5.99

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Figure 2.2: Abundance of grey seals within the 30 km buffer of Inch Cape OWF

Key

- Development Area
- 30 km buffer from Development Area

Grey seal abundance per 5 km × 5 km grid cell

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 100
- 100 - 160

Carter *et al.*, 2022 published relative density of at-sea distribution of harbour and grey seals, covering UK and Irish waters.

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Scale @ A3: 1:600,000

Coordinate System: WGS 84 UTM Zone 30N

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Date: 18-04-24 | Prepared by: [redacted] | Checked by [redacted]

Ref: GB200491_M_604_A

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Figure 2.3: Abundance of grey seals within the East Scotland Management Unit

Key

- Development Area
- East Scotland Seal Management Unit

Grey seal abundance per 5 km × 5 km grid cell

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 100
- 100 - 160

Carter *et al.*, 2022 published relative density of at-sea distribution of harbour and grey seals, covering UK and Irish waters.

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Scale @ A3: 1:1,500,000

Coordinate System: WGS 84 UTM Zone 30N

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2.3. Harbour seal

0.95% of the UK and Ireland at-sea population of harbour seals are predicted to occur in the East Scotland Seal Management Area. However, a considerable proportion of these are expected to be present in the Inch Cape 30 km buffer which is predicted to contain 0.87% of the at-sea population (see Table 2.3). This equates to 377 (309 – 503) harbour seals using the East Scotland Seal Management Area, assuming a middle estimate of haul out proportion, compared to 345 (282 – 460) in the Inch Cape 30 km buffer. While the Inch Cape 30km buffer covers 10.5% of the total at-sea area of the East Scotland Seal Management Area, it contains an estimated 91.4% of the harbour seals. This indicates that the Inch Cape development area is of relative importance within the East Scotland Seal Management Area, due to a relatively high concentration of seal density occurring coastally within the development buffer (see Figure 2.4 and 2.5). It should be noted that where low abundances are shown in Figure 2.4 which are displayed as within the range of 0-10 seals, such as within the Tay and Eden Estuary SAC, there is variation within this and it does not represent an absence in all of these cells.

Table 2.3: Abundance estimates for harbour seal within a 30 km buffer of the Inch Cape development ('Inch Cape') and East Scotland Seal Management Area ('East Scotland'). Low, mid and high scenarios represent ranges of haul out proportion estimates used in calculations. Abundance estimates are also presented as a percentage of the total estimated at-sea population in the UK and Ireland

Area	Level	Estimated abundance in Area	Estimated population at sea in UK & Ireland	Percentage of at sea population
East Scotland	Low	308.64	32627.66	0.95
East Scotland	Mid	377.22	39878.25	0.95
East Scotland	High	502.97	53171.01	0.95
Inch Cape	Low	282.26	32627.66	0.87
Inch Cape	Mid	344.99	39878.25	0.87
Inch Cape	High	459.98	53171.01	0.87

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Figure 2.4: Abundance of harbour seals within the 30 km buffer of Inch Cape OWF

Key

- Development Area
- 30 km buffer from Development Area

Harbour seal abundance per 5 km × 5 km grid cell

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60

Carter *et al.*, 2022 published relative density of at-sea distribution of harbour and grey seals, covering UK and Irish waters.

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Scale @ A3: 1:600,000

Coordinate System: WGS 84 UTM Zone 30N

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Title:

Figure 2.5: Abundance of harbour seals within the East Scotland Management Unit

Key

- Development Area
- East Scotland Seal Management Unit

Harbour seal abundance per 5 km × 5 km grid cell

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60

Carter *et al.*, 2022 published relative density of at-sea distribution of harbour and grey seals, covering UK and Irish waters.

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