Environmental Impact Assessment Report

Volume 4

Appendix 11.3 Baseline Technical Report

Codling Wind Park
Marine Mammal Baseline Characterisation

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1 Introduction

1.1 Purpose of report

In order to develop an offshore windfarm in a sustainable way and in accordance with current legislation and best practice, there is a requirement for *"formal comprehensive knowledge of the existing environment, including its natural variability"* in order to provide a *"necessary benchmark against which change may be predicated, detected, mitigated and measured when seeking to detect change as a result of impact from a project"* (DCCAE, 2018); this is known as the baseline.

The baseline characterisation provides information on the site and the potential impact footprint, in terms of the species that are expected to be present, the abundance of animals expected to be present and the degree of spatial and temporal variation in that abundance. The purpose of the baseline characterisation survey and literature review is to identify the best abundance and density estimates for each marine mammal species that will be used in the quantitative impact assessment.

The purpose of this document is to provide a characterisation of the baseline environment to understand the range of species, and the abundance and density of marine mammals that could potentially be impacted by Codling Wind Park (CWP Project). The baseline data have been compiled through a combination of a literature reviews and data obtained from site-specific surveys.

1.2 Approach

Baseline information was gathered by a combination of desk-based review of existing data sources and consideration of site-specific survey data (see Section 2.1). In total, more than 26 species of marine mammal have been recorded in Irish waters (Wall *et al.*, 2013), though most of these have been recorded off the west coast of Ireland and in deeper waters.

The initial literature review conducted to inform the marine mammal chapter of the scoping report (Codling Wind Park Limited, 2020) identified the key species in the study area as: harbour porpoise, bottlenose dolphins, Risso's dolphins, common dolphins, minke whales, grey seals and harbour seals (Codling Wind Park Limited, 2020).

1.3 Study Area

The marine mammal study area varies depending on the species, considering species specific ecology and behaviour. For all species, the study area covers the CWP Project array site and is extended over an appropriate area considering the scale of movement and population structure for each species. For each species, the area considered in the assessment is defined by the appropriate species Management Unit (MU). Cetacean MUs were defined by IAMMWG (2015) as *"a geographical area in which the animals of a particular species are found to which management of human activities is applied. An MU may be smaller than what is believed to be a 'population' or an 'ecological unit' to reflect spatial differences in human activities and their management"*. Therefore, the MU scale is advised as the most appropriate scale against which to assess and manage human activities.

The study area for marine mammals has been defined at two spatial scales: 1) the MU scale and 2) the marine mammal survey area for an indication of the local densities of each species. CWP Project is located within the following MUs for each species:

- Harbour porpoise: Celtic and Irish Seas MU;
- Bottlenose dolphin: Irish Sea MU;
- Risso's dolphin: Celtic and Greater North Seas MU;
- Common dolphin: Celtic and Greater North Seas MU;
- Minke whale: Celtic and Greater North Seas MU;
- Grey seal: East regions of Republic of Ireland (RoI) and Northern Ireland MU; and
- Harbour seal: East regions of RoI and Northern Ireland MU.

1.4 Protected areas

Within each marine mammal study area there are Special Areas of Conservation (SACs) that have been designated for specific marine mammal species. The SACs are shown in (Figure 1-1). Evidence of connectivity between the SACs and CWP Project is outlined in the species-specific paragraphs. The potential for impacts upon SACs is considered in the Natura Impact Statement (NIS).

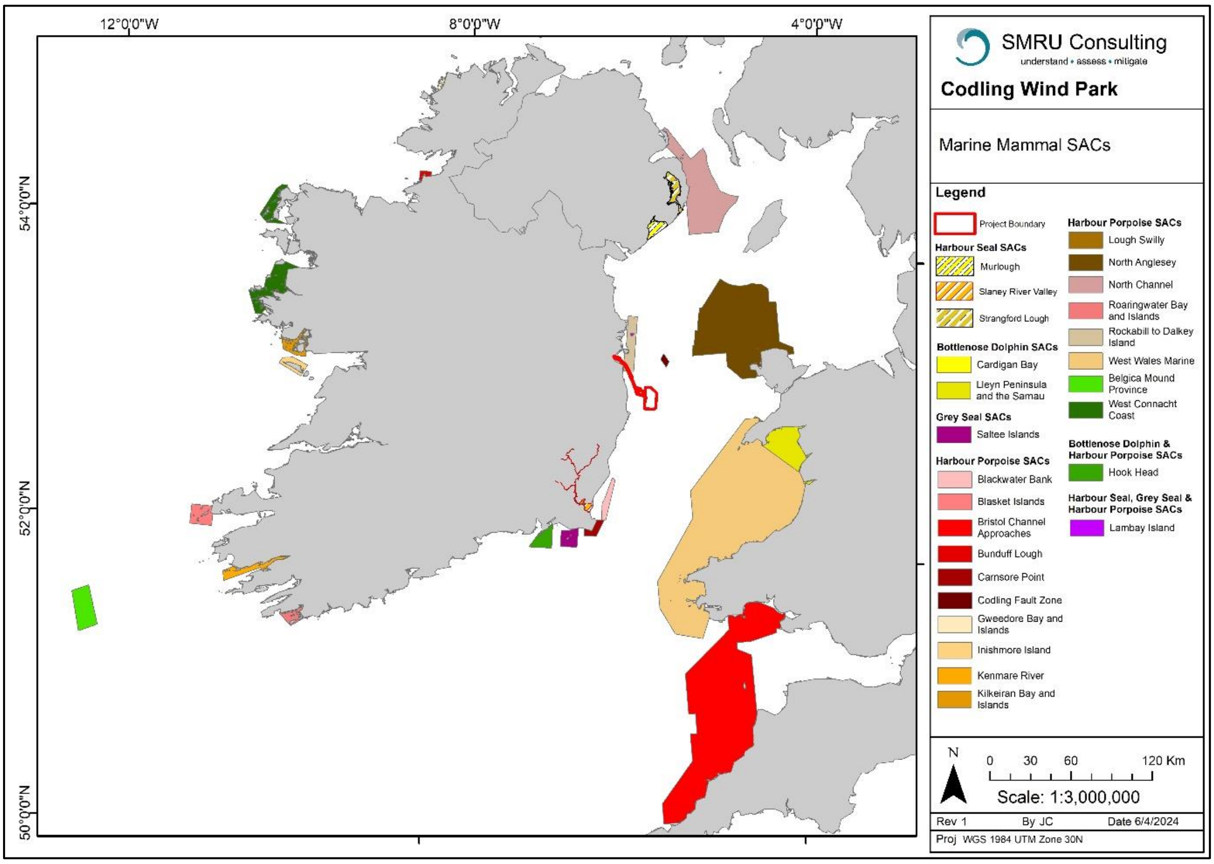


Figure 1-1 Marine mammal Special Areas of Conservation (SACs) relative to the CWP Project.

The IUCN (International Union for Conservation of Nature) Marine Mammal Protected Areas Task Force have recently declared six further areas in Irish waters as 'Important Marine Mammal Areas' or 'IMMAs'. IMMAs are defined as *"discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation".* It should be noted however that IMMAs are not legal designations, and the declaration of these areas by the IUCN are made on the basis of independent, expert-driven assessments on the available peer-reviewed data against a set of criteria. The IMMAs in Ireland that have been agreed by the IUCN are shown in Figure 1-2. While the areas have been identified as important for marine mammals, there are currently no conservation measures identified. The intention of the IMMAs is to inform the design and planning of future MMPAs and protected networks, and it is recognised that not all suggested IMMAs will be granted any form of protection in the future.

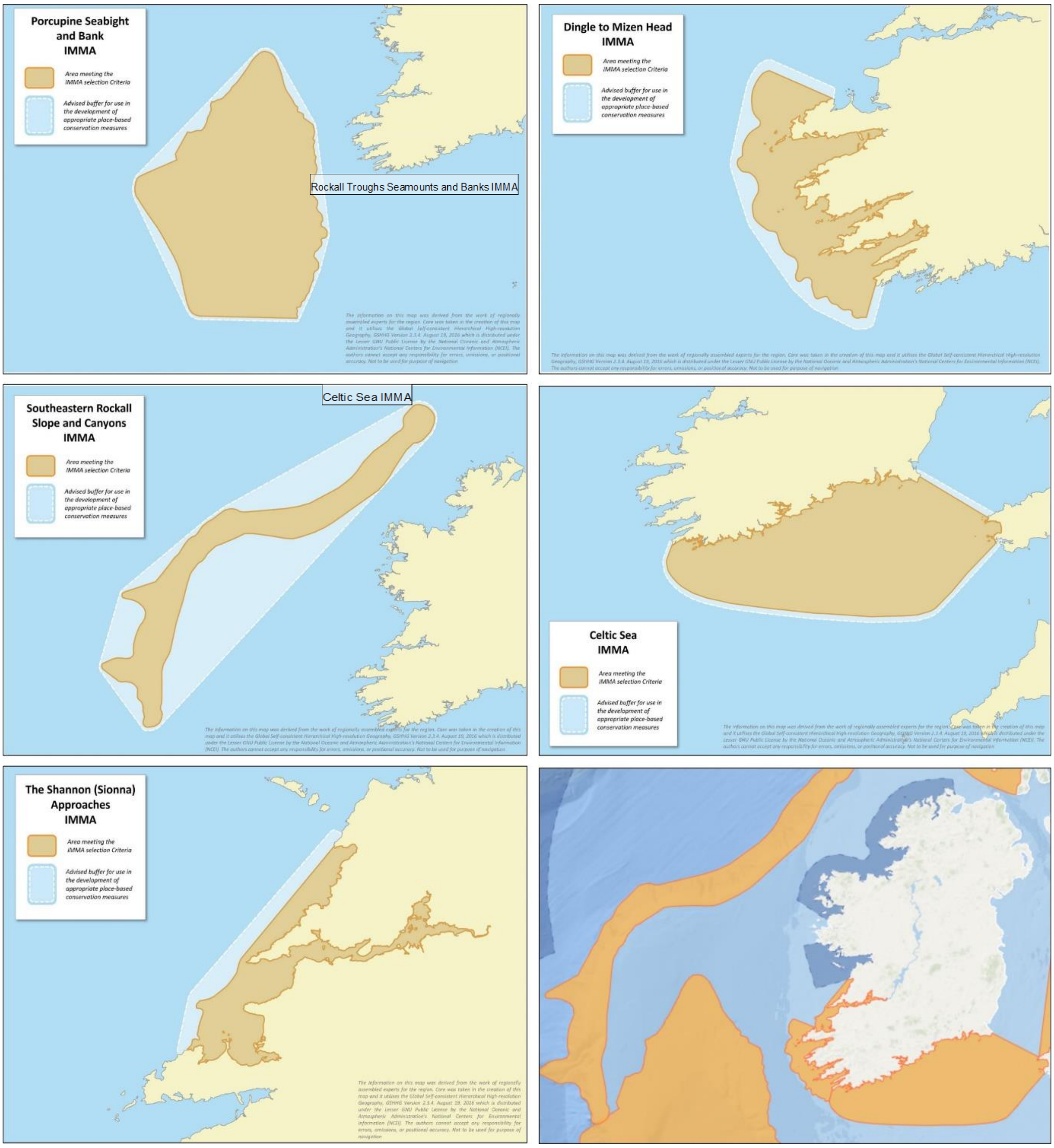


Figure 1-2 The locations of the IUCN Marine Mammal Task Force declared IMMAs in Ireland. Images taken from https://www.marinemammalhabitat.org/imma-eatlas/

2 Data Sources

Table 1 and the following sections provide detail on the key data sources used to characterise the baseline for marine mammals in relation to CWP Project. This section details the survey and analysis methodology implemented in each study and the potential limitations associated with these.

Table 1 Data sources examined to inform the baseline characterisation for marine mammals.

Data source	Type of data	Temporal and spatial coverage
Site-specific surveys	Combination of visual boat-based surveys	Visual surveys: April 2013 – March 2014 and

	and digital aerial surveys (DAS)	October 2018 – January 20202. DAS: May 2020 – April 2022. Includes the CWP Project array site plus a 4km buffer.
ObSERVE (Rogan *et al.*, 2018)	Visual aerial surveys resulting in survey block specific density estimates	4 surveys: summer 2015, winter 2015, summer 2016 and winter 2016. Offshore waters around Ireland, within and beyond Ireland's continental shelf.
SCANS IV (Gilles *et al.*, 2023)	Aerial and vessel visual surveys resulting in survey block specific density estimates	June, July, August 2022. All European Atlantic waters. CWP Project is located in block CS-D (western Irish Sea).
SCANS III density surfaces (Lacey *et al.*, 2022)	Cetacean density maps based on the SCANS III surveys	June & July 2016. All European Atlantic waters.
SCANS III (Hammond *et al.*, 2017, Hammond *et al.*, 2021)	Aerial and vessel visual surveys resulting in survey block specific density estimates	June & July 2016. All European Atlantic waters. CWP Project is located in block E (western Irish Sea).
IWDG bottlenose dolphin surveys (O'Brien *et al.*, 2009)	Photo ID surveys	8 surveys between July and September 2008. Entire Irish coast.
IWDG bottlenose dolphin surveys (Berrow *et al.*, 2012)	Vessel based visual line transect surveys	12 transects (3 per month) between July and October 2010. Lower Shannon candidate Special Area of Conservation.
IWDG Irish Sea surveys (Berrow *et al.*, 2011)	Visual and acoustic survey	2 surveys in August 2011. Inshore surveys in 2 blocks: Block A (northern Irish Sea – including CWP Project) and Block B (southern Irish Sea).
IWDG SAC surveys (Berrow and O'Brien, 2013, O'Brien and Berrow, 2016, Berrow *et al.*, 2021)	Visual and acoustic line transect surveys	1 survey in 2013, 4 surveys in 2016, 6 surveys in 2021. Rockabill to Dalkey Island SAC.
IWDG Irish coastal water surveys (Berrow *et al.*, 2008)	Vessel based visual line transect surveys and T-POD acoustic monitoring	6 survey days between July-September 2008. 5 sites (North County Dublin, Dublin Bay, Cork coast, Roaringwater Bay SAC and Galway Bay).
IWDG Greater Dublin Drainage Project surveys (Meade *et al.*, 2017)	Land based observations, vessel-based surveys and CPOD acoustic monitoring	24 surveys: March 2015-March 2017. Land: North-eastern cliffs of Howth Head Vessel: waters off Loughshinny and Portmarnock area CPODs: 3 sites: East of Loughshinny, North of Lambay Island and off Portmarnock.
MERP maps (Waggitt *et al.*, 2019)	Cetacean density maps based on the collation of data from various data sources (aerial and vessel)	2.68 million km of survey data collated between 1980 to 2018 in north-east European Atlantic waters.

Distribution and abundance of cetaceans Wales and its adjacent waters (Evans and Waggitt, 2023)	Cetacean density maps based on the collation of data from various data sources (aerial and vessel)	440 thousand km of survey data collated between 1990 and 2020 in the Irish Sea, Bristol Channel and the Celtic Deep.
Seal counts 2017-2018 (Morris and Duck, 2019)	Aerial survey	August 2017 and 2018. Entire coastline of Ireland.
Seal telemetry (Cronin *et al.*, 2016)	Telemetry tags	Strangford Lough: 33x harbour seals (2006, 2008 & 2010) Raven Point: 19x grey seals 2013 & 2014 Great Blasket Island: 8x grey seals 2009
Seal habitat preference maps (at-sea density) (Carter *et al.*, 2020, Carter *et al.*, 2022)	Density surface based on telemetry and count data	Telemetry data: 2005-2019 (114 grey seals and 239 harbour seals). Count data: 2001-2018. British Isles.
Seal counts 2005 (Ó Cadhla *et al.*, 2007)	Aerial survey	Spring & summer 2005. Entire coastline of the Republic of Ireland.
Seal counts 2017-2018 (Morris and Duck, 2019)	Aerial survey	August 2017 and 2018. Entire coastline of Ireland.
Seal telemetry (Cronin *et al.*, 2016)	Telemetry tags	Strangford Lough: 33x harbour seals (2006, 2008 & 2010). Raven Point: 19x grey seals 2013 & 2014. Great Blasket Island: 8x grey seals 2009.
Other nearby OWF	North Irish Sea Array (NISA)	The NISA EIA Scoping Report published in 2021 identified 6 main marine mammal species of interest within the development area (ARUP, 2021). Site-specific survey data are not yet published.
	Dublin Array	The Dublin Array EIA Scoping Report published in 2020 identified 7 main marine mammal species of interest within the development area (SLR *et al.*, 2020). Site-specific survey data are not yet published.
	Arklow Bay Wind Park	Monthly vessel surveys: July 1996 and North Irish Sea Array Windfarm Ltd North Irish Sea Array Offshore Windfarm. Digital aerial surveys March 1997, and June 2000 and June 2009. Arklow Bank array site plus a 5 km buffer. Monthly aerial surveys between March 2018 and February 2020. Lease Area plus a 4 km buffer.

2.1 Site-specific surveys

Visual boat-based surveys were undertaken between April 2013 and March 2014 (13 months), and October 2018 and January 2020 (12 months) by Natural Power. In addition to this, 24 months of DAS were undertaken between May 2020 and April 2022 by HiDef Aerial Surveying Limited. The site-specific surveys included the CWP Project array site and a 4 km buffer. To estimate densities of marine mammals within the proposed CWP Project development area, only observational data from both boat-based and aerial surveys which were classified as on-effort (i.e., sightings made by a marine mammal observer) were used (Natural Power, 2023).

2.1.1 Vessel surveys

Boat-based surveys were conducted at CWP Project between April 2013 – April 2014, and October 2018 – August 2020. During boat-based surveys, visual surveying was undertaken along pre-determined track lines, using distance sampling methodology. Global Positioning System (GPS) coordinates were recorded automatically every few seconds, and various environmental variables including sea state were recorded either every 15 minutes or whenever conditions changed. To visually detect marine mammals, two dedicated marine mammal surveyors were present onboard. Each surveyor was required to survey an area of sea spanning 90° either side of the vessel's bow whilst the vessel was in transit. Each surveyor conducted the survey using the naked eye and binoculars. Boat survey transects for each of the vessel survey periods are shown in Figures 2 and 3.

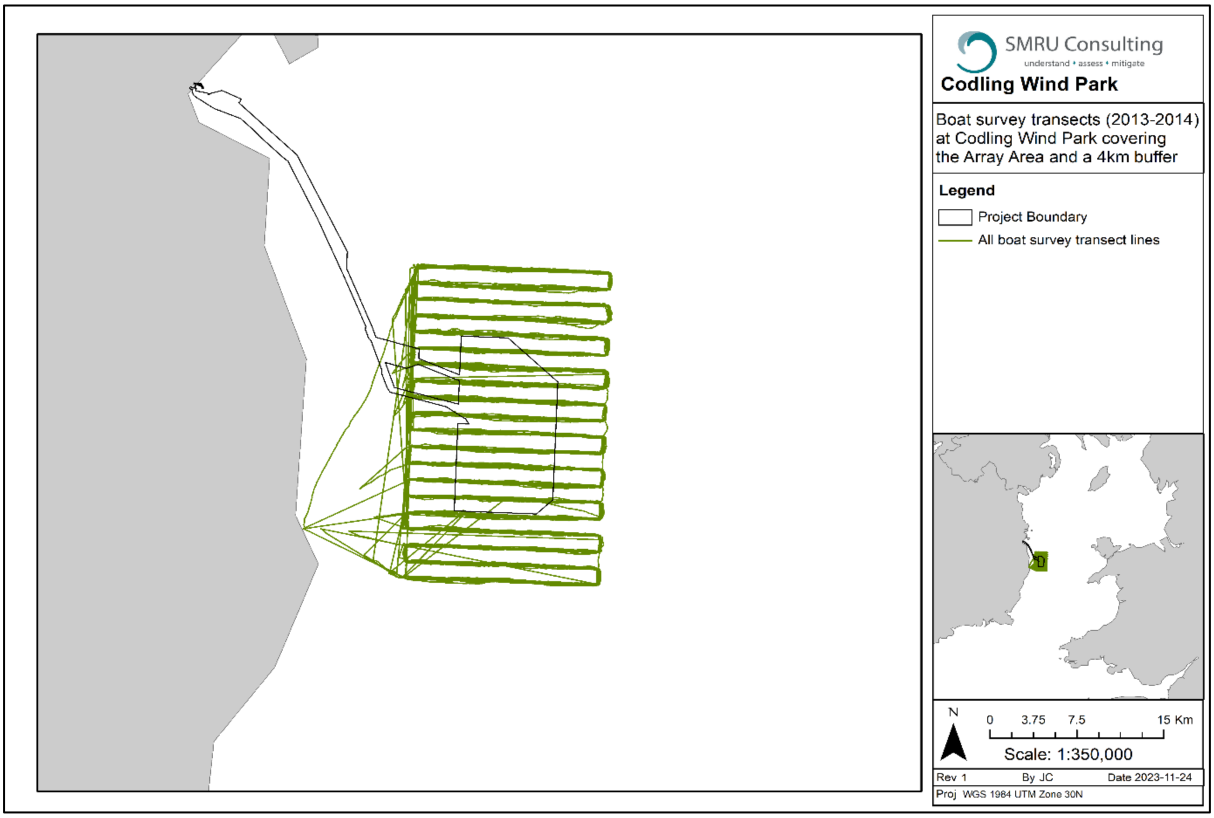


Figure 2-1 Boat survey transects (20) followed during each boat survey between April 2013 and April 2014.

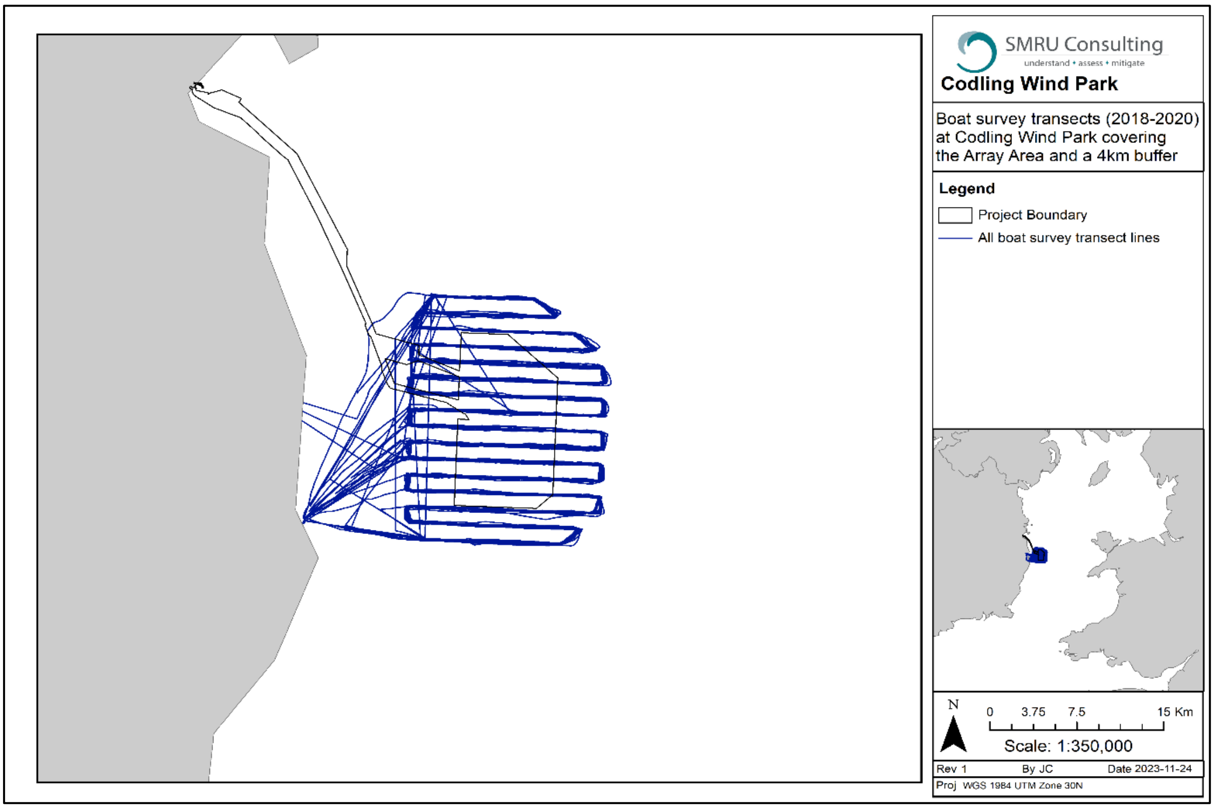


Figure 2-2 Boat survey transects (16) followed during each boat survey between October 2018 and January 2020.

Vessel surveys conducted in 2013 – 2014 identified a total of 7 marine mammal species (Table 2), whereas vessel surveys undertaken between 2018 – 2020 identified a total of 5 marine mammal species (Table 3). Across both survey periods, harbour porpoise were the most commonly sighted marine mammal species (432 individuals observed between 2013 – 2014; 233 individuals observed between 2018 – 2020). The second most commonly sighted species was grey seals, with 42 individuals observed between 2013 – 2014 and 77 individuals observed between 2018 – 2020. A total of 58 seal individuals across both survey periods were classified as were unidentified seal species (Table 2 and Table 3). Common dolphin, Risso's dolphin, harbour seal and killer whale were the least recorded species across both survey periods (<10 individuals sighted for each species).

Vessel survey data, where possible, were used to calculate site-specific density estimates for each marine mammal species sighted. The assumed availability of animals at the surface – used to correct for availability bias in density estimates, are presented in Table 5.

Table 2 Summary of the vessel site-specific surveys conducted at CWP Project in 2013-2014.

Year	Month	Date	No. Transect Lines	Sea State	Marine mammal sightings
2013	April	19-20-21	1-20	0-4	551 total: • 4 common dolphin • 42 grey seal • 432 harbour porpoise • 5 harbour seal • 6 killer whale
2013	May	15-16-17	1-20	1-4	
2013	June	4-5-6	1-20	0-3	
2013	July	4-5-6	1-20	0.5-4	
2013	Aug	6-7-8	1-20	0-5	
2013	Sep	3-4-5	1-20	1-4	

2013	Oct	4-5	1-20	0.5-4	• 11 minke whale • 3 Risso's dolphin • 48 unidentified seal species
2013	Nov	15-16-17	1-20	1-4	
2013	Dec	1-2-3	1-20	2-4	
2014	Jan	29-30	11-20	2-4	
2014	Mar	10-11-12-13	1-20	0-3	
2014	Apr	31-1	1-20	0-3	

Table 3 Summary of the vessel site-specific surveys conducted at CWP Project in 2018-2020.

Year	Month	Date	No. Transect Lines	Sea State	Marine mammal sightings
2018	Oct	24-25	1-16	1-4	328 total • 2 common dolphin • 77 grey seal • 233 harbour porpoise • 1 harbour seal • 5 minke whale • 10 unidentified seal species
2019	Jan	3-4	1-16	1-4	
2019	Feb	26-27	1-16	1-3	
2019	Mar	25-26	1-16	1-4	
2019	Apr	18-19	1-16	0-3	
2019	May	21-22	1-16	0-2	
2019	Jun	27-28	1-16	0-4	
2019	Aug	1-2	1-16	1-3	
2019	Sep	7-8 1-18-19	1-16 1-16	1-4 0-3	
2019	Oct	21-22	1-14	1-4	
2019	Dec	2-3	1-16	2-3	
2020	Jan	18-19	1-16	1-3	
2020	Jul	15-16	1-16	1-2	
2020	Aug	17-18	1-16	<1-2	

2.1.2 Aerial survey

DAS followed the same 16 transect lines during each survey (Figure 2-3). The surveys were flown at an altitude of 550 m and a speed of 220 km/h. In total, 24 aerial surveys were conducted between May 2020 – April 2022.

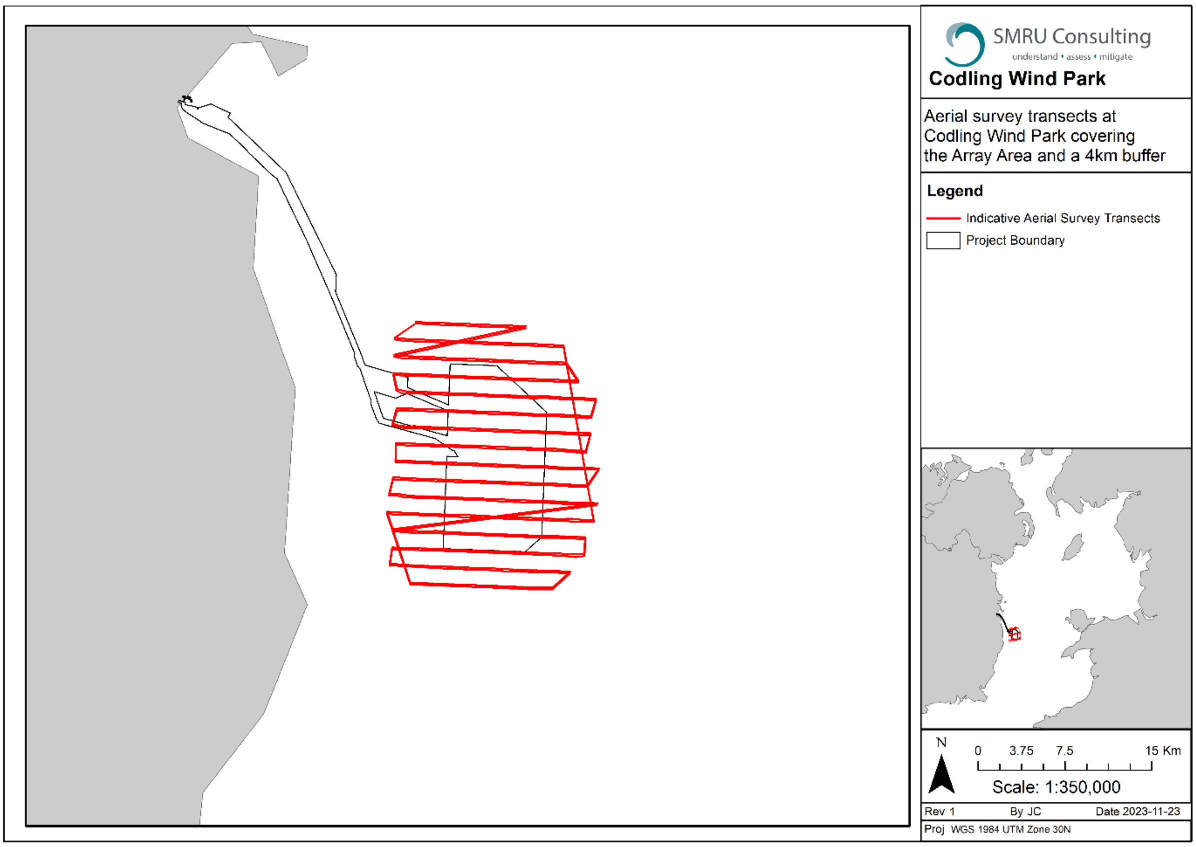


Figure 2-3 Indicative aerial survey transects lines from a DAS undertaken at CWP Project on 29/05/2023. The same transect lines were followed for all 24 DAS.

Marine mammal encounter rates have been calculated per survey (number of individuals per km^2 survey effort). It is difficult to identify to species level sightings of marine mammals that are below the water surface. As such, these sightings get recorded as “cetacean species – no ID”, “Seal/small cetacean species – no ID” or “Seal species – no ID”.

In total, 311 sightings of 4 species of marine mammals were sighted across the aerial surveys. Of the 311 sightings, 29 were not categorised to species level (9.3% of the total sightings). Harbour porpoise were the most commonly sighted marine mammal species (n = 178) followed by common dolphin (n = 82). For harbour porpoise, only 100 sightings were definitive harbour porpoise sightings (56.2%), whilst of the 82 common dolphin sightings, 71 were definitive (86.6%). Both seal species were recorded during the aerial surveys, but with low degrees of confidence (definitive grey seal sightings = 5/19 (26.3%), definitive harbour seal sightings = 0/3 (0%)) (Table 4).

Aerial survey data, where possible, were used to calculate site-specific density estimates for each marine mammal species. The assumed availability of animals at the surface (used to correct for availability bias in density estimates) are presented in Table 5.

Table 4 Summary of the aerial site-specific surveys conducted at CWP Project in 2018-2020.

Year	Month	Date	Marine mammal sightings
2020	May	29	311 total • 82 common dolphin (11 probable, 71 definite) • 19 grey seal (2 possible, 12 probable, 5 definite)
2020	Jun	21	
2020	Jul	10	

2020	Aug	9	• 178 harbour porpoise (9 possible, 69 probable, 100 definite) • 3 harbour seal (2 possible, 1 probable) • 2 cetaceans species – no ID • 4 Seal/small cetacean species – no ID • 23 seal species – no ID
2020	Sep	18	
2020	Oct	15	
2020	Nov	13	
2020	Dec	20	
2021	Feb	3	
2021	Mar	6 & 17	
2021	Apr	19	
2021	May	6	
2021	Jun	7	
2021	Jul	23	
2021	Aug	2	
2021	Sep	11	
2021	Oct	23	
2021	Nov	10	
2021	Dec	2	
2022	Jan	13	
2022	Feb	11	
2022	Mar	12	
2022	Apr	3	

Table 5 Assumed availability of animals at the surface – used to correct for availability bias in density estimates

Species group	Survey method	Reference	Availability
Harbour porpoise	DAS	Teilmann *et al.* (2013)	Jan: 0.492 Feb: 0.425 Mar: 0.525 Apr: 0.615 May: 0.573 Jun: 0.553 Jul: 0.570 Aug: 0.517 Sep: 0.450 Oct: 0.453 Nov: 0.463 Dec: 0.499
	Vessel	N/A	did not account for g(0)
Minke whale	Vessel	N/A	Assumed to be 1

Common dolphin	DAS	Watwood *et al.* (2020)	0.203
	Vessel	N/A	Assumed to be 1
Risso's dolphin	DAS	Watwood *et al.* (2020)	0.383
	Vessel	N/A	Assumed to be 1

2.1.3 Landfall surveys

Site specific landfall surveys were undertaken the at the intertidal area of the project site (Figure 2-4) and were carried out between October 2019 and March 2023. Although marine mammals were not the target group for these surveys, a total of 11 grey seals, two harbour seals and five harbour porpoises were recorded. Density estimates were not derived from this data.

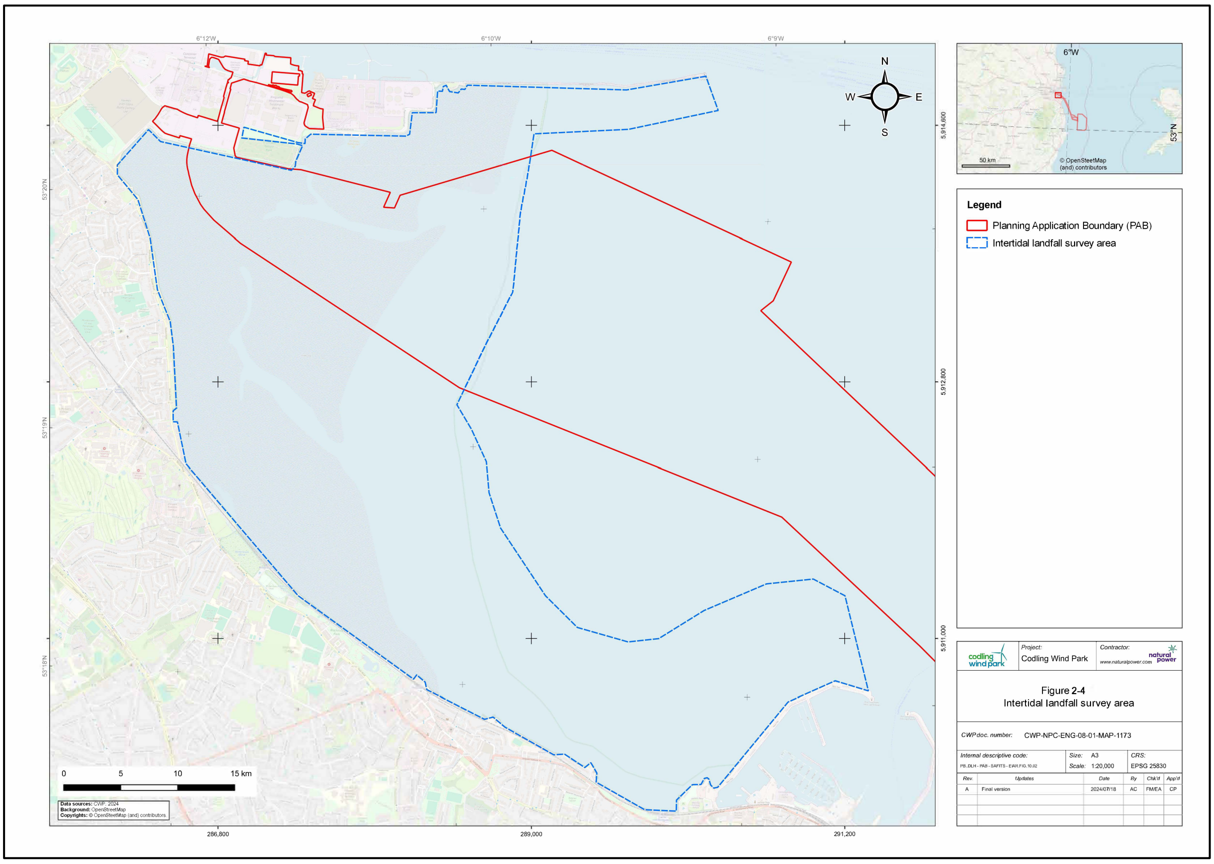


Figure 2-4 Landfall survey area.

2.2 ObSERVE

From 2015-2016, offshore aerial surveys were conducted during the summer and winter months in Ireland (Rogan *et al.*, 2018), collecting data on the distribution and abundance of marine mammal species present within the survey area (Figure 2-5). In 2016, additional inshore/coastal surveys were conducted in both the winter and summer months (Rogan *et al.*, 2018). These surveys represent the first large-scale dedicated line-transect surveys conducted in winter months of cetaceans, and as such provided the first data on inter-seasonal changes in abundance and distribution on a regional scale.

The survey design included a study area consisting of offshore waters around Ireland, both within and beyond Ireland's continental shelf. This study area was initially divided into five strata in 2015, with a further three inshore strata added in 2016. Two zigzag transects were flown within each stratum, with observations recorded and conducted following a standardised protocol designed for aerial surveys. In the case of cetacean sightings, the protocol used was designed using a line-transect methodology, with observer effort restriction to approximately 500 m either side of the aircraft. Two randomly placed transect lines were generated for each stratum. The line-transect positions and start points were changed each year to provide two independent datasets per season per stratum, also providing a more representative coverage of the survey area. In 2015, the total distance flown was 16,802 km within a survey area measuring 297,480 km^2 and in 2016 the distance flown totalled at 20,295 km within a survey area measuring 339,377 km^2.

During all four surveys, four observers were on board the aircraft, with two on each side of the aircraft. The aircrafts position was recorded every two seconds through the use of an on-board GPS. Observers recorded all sightings of marine fauna, as well as Beaufort Sea State, cloud cover, glare extent and severity, the corresponding declination angle of the aircraft to the animal sighted, species, sighting time, group size, presence of calves and behaviours observed.

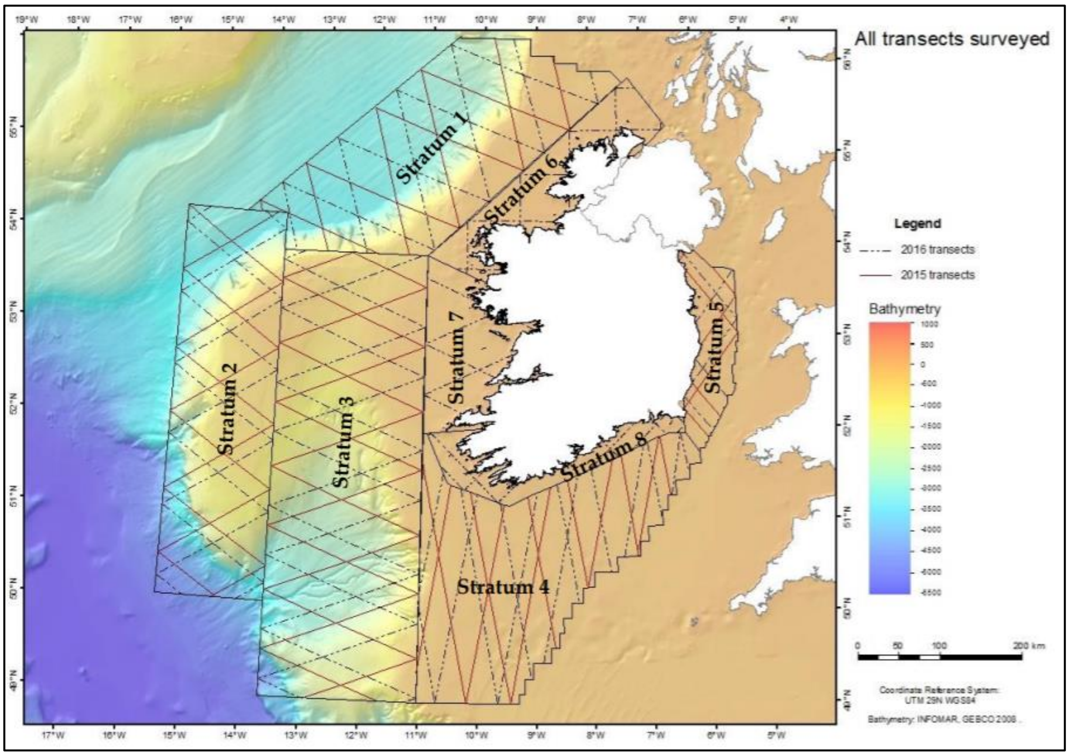


Figure 2-5 Map of the survey area for the ObSERVE surveys in 2015 and 2016 (Rogan *et al.*, 2018).

Across all of the survey periods, a total of 1,844 cetacean sightings were recorded, comprising of 19 species from an estimated 8,633 individuals. When there was sufficient data collected (60 sightings required for a species/species group) two approaches to estimate abundance were utilised including a design-based method and a model-based method.

The surveys were designed to *"inform the assessment of risk to protected species and their habitats from a range of human activities (e.g., through man-made disturbance or operational interactions)"* (Rogan *et al.*, 2018), and as such, the analysis methodology was designed to achieve the best absolute abundance and density estimates possible, by correcting for biases in Distance sampling methodology. The probability of detecting an animal on the trackline (g(0)) was corrected for using the moderate sightings condition g(0) estimates calculated from the SCANS III surveys (0.279 for porpoise, 0.414 for dolphin species and 0.302 for minke whales), and therefore absolute abundance and density estimates were able to be calculated.

The design-based abundance estimate method consisted of utilising the programme DISTANCE version 7.0 to generate estimated abundances using mark-recapture distance sampling (MRDS) methods. In order to fit the detection functions to the species included in the analyses, all data available were included, consisting of data both on and off-transects in each survey, as well as data from all years and seasons being pooled together. Upon deriving a final detection function for each species, or in some cases, groups of species, individual abundance estimates were calculated. In addition to the design-based abundance estimates, model-based abundance estimates were also calculated using Generalised Additive Models with a set of environmental variables to examine habitat use.

Note: the ObSERVE II project is currently ongoing. While surveys have been completed, data analysis is ongoing and the project is not due to report until summer 2025. As such, this data source will not be available to include in this baseline characterisation.

2.3 SCANS

The SCANS surveys consist of SCANS I, II, III and IV which were conducted in 1994, 2005, 2016 and 2022. These are large-scale surveys which have been specifically designed to generate comprehensive estimates of abundance for marine mammal species within European Atlantic waters. Each of these surveys provides equal coverage probability within survey blocks such that each point within a block has the same probability of being surveyed. As a result, an unbiased abundance estimation is generated when extrapolating sample densities to block-wide density estimates (Hammond *et al.*, 2017, Hammond *et al.*, 2021, Gilles *et al.*, 2023).

A key limitation to these surveys is that they are only conducted during the summer months and as a result, are not representative for other seasons in the year. This can be an issue for marine mammal species with seasonal distributions, and there is the potential to overestimate average annual abundances for such species using the SCANS density estimates alone.

In order to generate an estimation of abundance for marine mammal species sighted during the surveys, only data collected during good and moderate sighting conditions were included. The effective strip width was estimated for good and moderate conditions respectively. Total densities were estimated by dividing the abundance estimates by the area of the associated stratum. Both coefficients of variation (CVs) and 95% confidence intervals (CIs) were estimated through the use of bootstrapping within each stratum. In the case of marine mammal species where sighting and the circle back method was not implemented, the abundance estimates were calculated using conventional line transect methods which assumed a certain detection on the transect line. As a result of this, the estimates generated for these marine mammal species are underestimated to an unknown degree.

2.3.1 SCANS III

The survey blocks used during SCANS III are presented in Figure 2-6. During the SCANS III survey in 2016, the shelf waters on the East coast of Ireland were surveyed using aircraft visual survey methods. The aircraft had three scientific crew members on-board, with two observers at bubble windows and a third crew member completing datasheets. The target altitude for the survey was 183 m, with a speed of 167 km/h. Additional data was collected including turbidity, sighting conditions, and glare. During the detection of marine mammal species, data recorded included time, declination angle to the detected angle, presence of calves, species identification, behaviour, and group size. In order to correct for marine mammals which may have been missed within the transect line, the circle back method was implemented. This approach included the aircraft circling back to resurvey the segment of the transect in which a marine mammal detection was made.

During the SCANS III surveys (Hammond *et al.*, 2017, Hammond *et al.*, 2021), the east coast of Ireland, including the area of CWP Project, was assigned as block E. This block contained a surface area of 34,870 km^2 and the surveys concluded a primary search effort of 2,252.7 km and a trailing search effort of 22.5 km. During these surveys, the most common cetacean species sighted in block E included harbour porpoise, bottlenose dolphin, Risso's dolphin and minke whale.

As part of SCANS III, the survey data were modelled in relation to spatially linked environmental features to produce density surface maps for the following cetacean species: harbour porpoise, bottlenose dolphin, white-beaked dolphin, common dolphin, striped dolphin, long-finned pilot whale, beaked whale species, minke whale and fin whale (Lacey et al. 2022). The cetacean data used in the models were the same as those obtained in 2016 that were used to provide block specific abundance estimates in Hammond et al. (2021). The environmental covariates used in the density surface modelling were selected due to their potential to explain the additional variability in the cetacean density estimates (for example, depth of the seabed, sea surface temperature (see Lacey et al. (2022) for the full list of environmental covariates). The models were fitted using a spatial resolution of 10 km and predicted onto a 10 x 10 km spatial grid. Using the predicted density estimates from the surface models, density and abundance estimates can be generated for an entire survey area or a defined area within it, such as the CWP Project area.

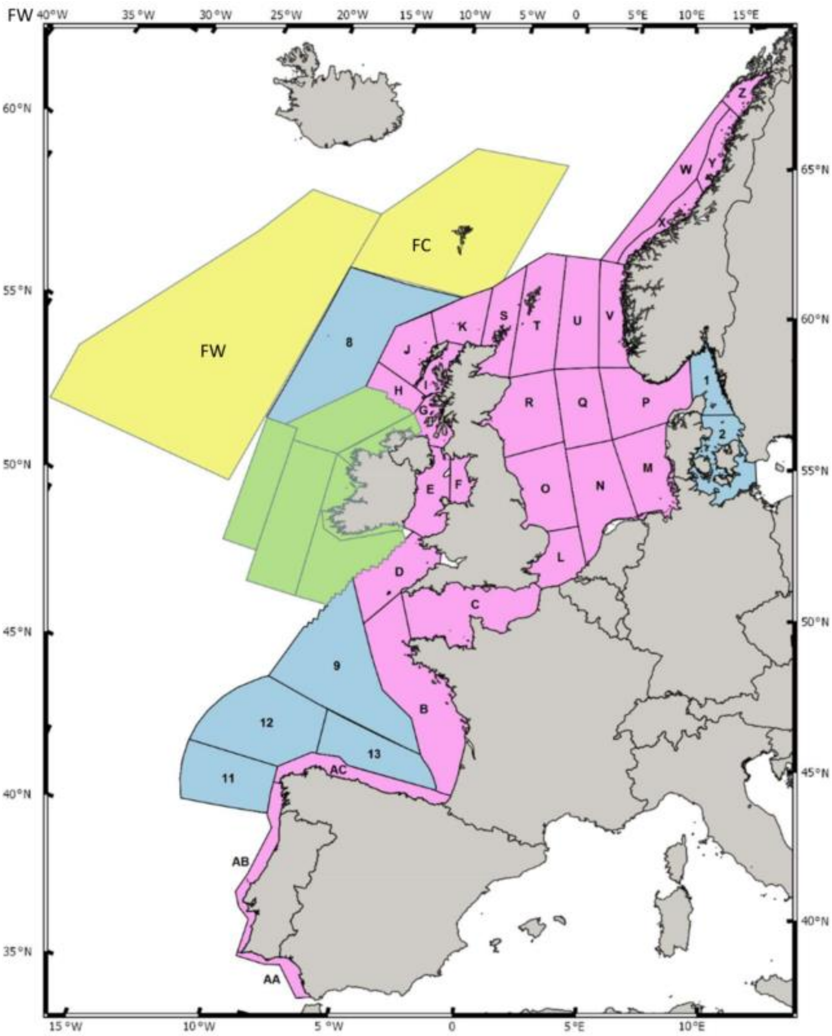


Figure 2-6 Area covered by SCANS III survey blocks. Pink blocks were surveyed by air, blue blocks were surveyed by ship., green blocks were surveyed by ObSERVE in 2015-2016 and yellow blocks were surveyed by the North Atlantic Sightings Survey in 2015. Figure from Hammond *et al.* (2021).

2.3.2 SCANS IV

The SCANS IV surveys were conducted from June to October 2022, and comprised a combination of vessel and aerial surveys. The main objective of the SCANS IV survey was to estimate small cetacean abundance and density in the North Sea and European Atlantic waters. The surveyed area included the offshore waters of Portugal which were not previously surveyed as part of SCANS, but excluded coastal Norwegian waters north to Vestfjorden that were included in SCANS III and waters to the south and west of Ireland that were included in the ObSERVE 2021/2022 project. Species abundance was estimated using the same methodology as for SCANS III (see Hammond *et al.* (2021)).

The survey blocks used during SCANS IV are presented in Figure 2-7. The proposed development is located in SCANS IV block CS-D (formerly block E as per SCANS III). This block contained a surface area of 34,867 km^2 and the surveys concluded a primary search effort of 2,375.2 km and a trailing search effort of 59.2 km. During these surveys, the most common species sighted in block CS-D were harbour porpoise, bottlenose dolphin, common dolphin and minke whale.

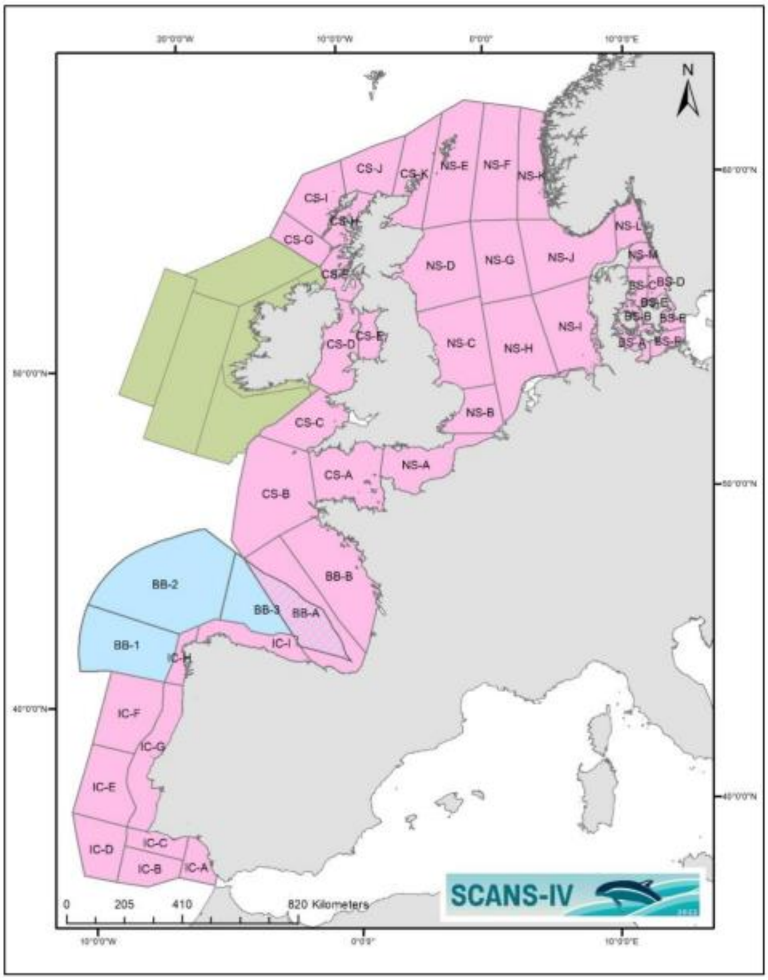


Figure 2-7 Area covered by SCANS IV survey blocks. Pink blocks were surveyed by air and blue blocks were surveyed by ship. Figure from Gilles *et al.* (2023).

2.4 Irish Marine Mammal Atlas

The Irish marine mammal atlas (Wall *et al.*, 2013) collates data collected during the IWDG casual and effort-based sightings scheme from January 2005-2011, the ISCOPE I and II projects, the 2008-2011 ferry surveys programme and the IWDG and GMIT (Galway-Mayo Institute of Technology) marine mammals and megafauna in Irish waters project (PReCAST surveys). Data was collected through the use of vessel surveys and casual sightings which were submitted to an online database and went through a validation process.

Vessel surveys included effort from research vessels, commercial ferries and naval vessels carried out from 2005-2011. During these vessel surveys, environmental data as well as marine mammal sightings were recorded using Logger 2000 software. These surveys were carried out on vessels of opportunity and as a result, marine mammal sightings were not approached as the surveys were conducted in ‘passing mode’. Where possible, marine mammal sightings were recorded at species level, with species identification being labelled as definite, probable, or possible. In cases where species identification was not possible, these sightings were labelled as ‘unidentified dolphin’ etc., following criteria established for the IWDG’s cetacean sightings database.

Casual sightings utilised from the IWDG online database went through a validation process. Approximately 15% of sighting records included images, which assisted in the validation process. These sightings were also identified at species level where possible, and in cases where species identification was not possible, the above method was replicated, labelling these sightings as ‘unidentified whale’ etc.

The total survey effort, defined as hours surveyed within sea states 0 to 6 per 50 km^2, was summed up and mapped, as well as the total number of marine mammals counted per 50 km^2, categorised by species. In the case of species with insufficient amounts of data, both effort and sightings for these species were mapped according to season, defined as the astronomical cycle of seasons (spring, summer etc.). In cases where there was insufficient data for a species to map seasonal effort and sightings, all of the data available were combined into a single map. The relative abundance of species was generated as the number of animals recorded per survey hour. A time-based analysis of relative abundance was used as it was concluded to be more suited than an area-based analysis as data from a variety of different platforms which were travelling at different speeds, were being combined (Reid *et al.*, 2003). The survey effort was categorised based on sea state, with lower sea states utilised for cetacean species which were more challenging to detect, and higher sea states utilised for more easily detectable cetacean species. In cases where non-effort related sightings were reported inside a grid square, but no effort-related sightings occurred in that square, the grid square was marked positive for sightings in order to facilitate species distribution mapping, however no relative abundance was calculated for the grid square.

A total of 1,078 days-at-sea were carried out from 2005-2011 within the Irish EEZ and its adjacent waters (Figure 2-8). From this, 5,084 hours of survey efforted were completed in reported sea states of 6 or less. In total, 2,557 effort-related sightings and 7,454 non-effort-related sightings across 18 marine mammal species including 2 pinniped species and 16 cetacean species, were included in the analysis.

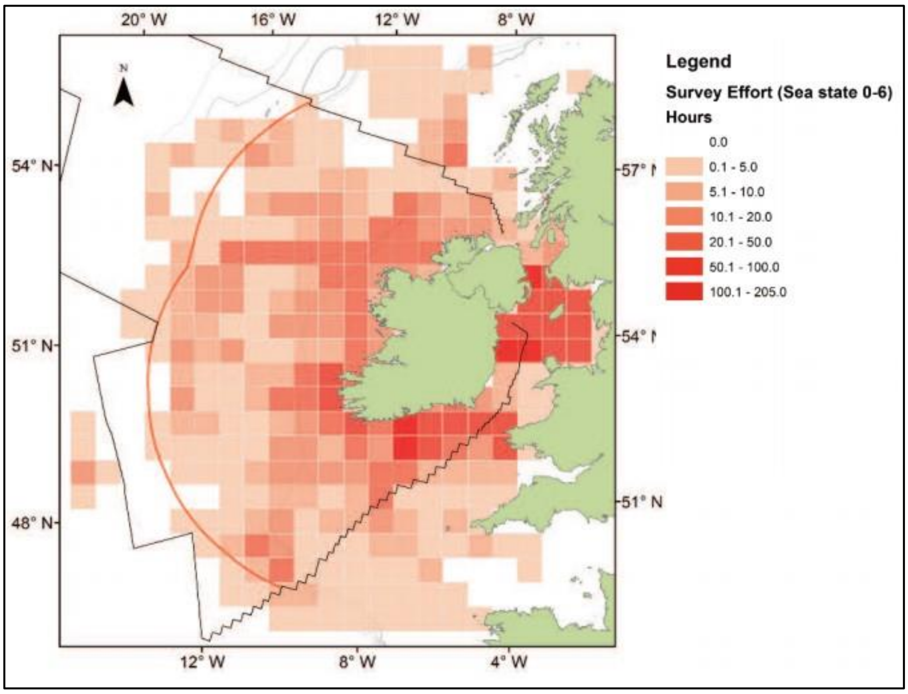


Figure 2-8 Total survey effort achieved under the IWDG and GMIT monitoring programmes from 2005-2011 (Wall *et al.*, 2013).

2.5 MERP maps

The aim of the Marine Ecosystems Research Programme project (MERP) was to produce species distribution maps of cetaceans and seabirds at basin and monthly scales for the purposes of conservation and marine management. A total of 2.68 million km of survey data in the Northeast Atlantic between 1980 and 2018 were collated and standardized. Only aerial and vessel survey data were included where there were dedicated observers and where data on effort, survey area and transect design were available. The area covered by Waggitt *et al.* (2019) comprised an area spanning between Norway and Iberia on a north-south axis, and Rockall to the Skagerrak on an east-west axis. Waggitt *et al.* (2019) predicted monthly densities for each species, estimated the probability of encountering animals using a binomial model (presence-absence model), and estimated the density of animals if encountered using a Poisson model (count model). The product of these two components were used to present final density estimations (Barry and Welsh, 2002). The outputs of this modelling were monthly predicted density surfaces for 12 cetacean species at a 10 km resolution.

The authors list three key limitations of the data analysis and the resulting distribution maps which require the maps to be interpreted carefully. Firstly, the influence of small or sub-populations on the model is limited, secondly, the model does not account for large changes in populations within the study period and thirdly, although seasonal movement were detected, there were also many instances of seasonal changes in densities without changes in overall distribution. The authors state that because of these limitations, the maps *"should not be used as a representation of absolute densities and fine-scale distributions"* and recommend that instead, they are used as a *"general illustration of relative densities and broad-scale distribution over several decades"*. There is no indication of whether the more recent sightings data are weighted more heavily than older data, which limits interpretation of how predictive the maps are to current distribution patterns. Given the limitations of the data, these density maps were not considered in this baseline characterisation.

2.6 Distribution and abundance of cetaceans in Wales and its adjacent waters

Marine mammal distributions and abundances were determined from data collated from dedicated aerial and vessel surveys across Wales and adjacent seas, over three decades (1990-2020) (Evans and Waggitt, 2023). For five cetacean species (harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin and minke whale), modelling was used for density surface predictions, accounting for variation in detection rates between platforms, and key environmental conditions present during surveys. While the data range spans 30 years the authors consider that *"the distributions of both seabirds and cetaceans in this region are thought to have remained similar across decades"*.

The study area is inclusive of the Irish Sea, Bristol Channel, and adjacent Celtic Sea south to the coast of Cornwall. Survey data was screened for typographical and positional errors. This study includes only data from surveys which included essential information to calculate the variations in the surface area surveyed (Table 5). This includes variables such as platform type and height, transect design and recording methods. Density calculations included Effective Strip Width (ESW), Line and ESAS transects, strip transects and subsequent adjustments to ESW (Evans and Waggitt, 2023). The key environmental variables considered in the modelling included temperature, attenuation, depth, current speed, stratification, and seabed roughness.

A total of 443,669 km of survey data was utilised for map production and distribution modelling for cetaceans. Survey effort for cetaceans was greatest in the summer months, particularly July when SCANS and ObSERVE have taken place (Figure 2-9). Winter surveys were conducted primarily by plane and targeted over coastal waters (Evans and Waggitt, 2023). The authors note that *"survey effort has varied greatly in space and time, with many significant gaps even after the collation of several datasets"* and noted that the primary survey methods changed over time from vessel to aerial surveys which can lead to potential biases in the results.

The data were gridded to give species presence, animal density and the surface area covered per grid cell. Species Distribution Models used the hurdle approach outlined in Waggitt *et al.* (2019), using both a presence-absence model to identify species range and a count model to identify areas of high density within the overall range. GLMs and GEEs were then used to estimate the relationship between survey methods and probability of encounter or density, and to estimate the relationship between animal presence and environmental conditions. The probability of encountering an animal was estimated using a binomial model and animal density was estimated using a Poisson model. The result was a predicted density surface for each species over a 2.5 x 2.5 km grid in the Irish Sea.

Table 6 List of data providers and kilometres of effort surveyed for cetaceans in the study area of Wales and surrounding seas (Evans and Waggitt, 2023)

Data source	Platform Type	km surveyed
Cardigan Bay Marine Wildlife Centre (CBMWC)	Vessel	7,016
Crown Estate	Aerial digital	24,868
European Seabirds at Sea (ESAS)	Aerial visual and Vessel	76,837
Horizon	Vessel	1,716
Irish Whale and Dolphin Group	Vessel	65,582
Joint Nature Conservation Committee (JNCC)	Aerial digital and Vessel	2,623
Marine Awareness North Wales (MANW)	Vessel	788
Manx Whale and Dolphin Watch (MWDW)	Vessel	6,331

Natural England	Vessel	1,179
Irish National Parks and Wildlife Service (NPWS)	Vessel	1,283
Irish ObSERVE Surveys	Aerial visual	2,717
ORCA	Vessel	6,313
ORSTED	Aerial digital	6,505
PELTIC	Vessel	3,237
SCANS-I	Vessel	444
SCANS-II	Aerial visual and Vessel	2,627
SCANS-III	Aerial visual	4,254
Sea Watch Foundation (SWF)	Vessel	102,787
Whale and Dolphin Conservation (WDC)	Vessel	1,702
WWT Consulting	Aerial visual	128,672
Total		**447,526**

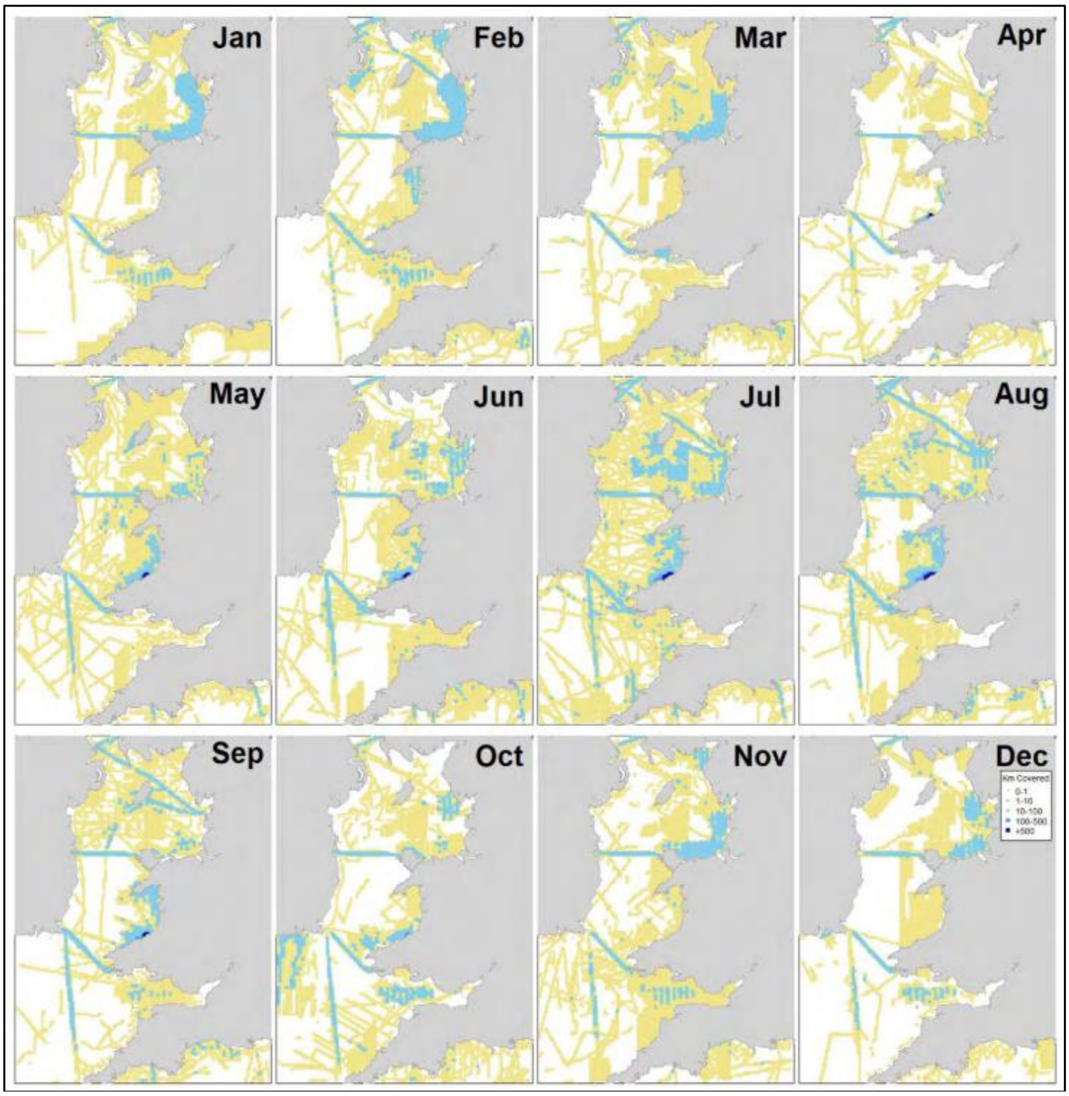


Figure 2-9 Cetacean survey effort (all providers) by month (Evans and Waggitt, 2023).

2.7 IWDG surveys

2.7.1 Bottlenose dolphin Photo-ID surveys

A total of eight systematic photo-ID surveys were carried out by the Irish Whale and Dolphin Group (IWDG) between July and September 2008 (O'Brien *et al.*, 2009). Data from these surveys were then combined with two other sources including images of bottlenose dolphins obtained from GMIT and images collected by members of the public and IWDG. All of these images combined are referred to as the Irish Coastal Bottlenose Dolphin Catalogue. A total of 120 bottlenose dolphins were compared to determine if matches could be found between them (O'Brien *et al.*, 2009). All images were obtained using high resolution digital cameras, in some cases, images submitted by members of the public were of lower image quality but still deemed usable. Using Adobe Photoshop imaging software, each image was reviewed for unique markings in order to identify individuals. Images were graded using a Q-scale (1-3), in which grade 1 images were categorised as being of good quality, grade 2 were of lesser quality but still usable and grade 3 were of poor quality and as a result, unusable. The distance between re-sightings of individuals was possible to obtain as the latitude and longitude of each sighting had been recorded, this was calculated using Garmin MapSource software. To further explore the movements of individuals in the ICBDC, data comparisons were made between this dataset and two additional datasets, one from the RoI provided by the Shannon Dolphin and Wildlife Foundation and one from the UK, provided by the Sea Watch Foundation.

Berrow *et al.* (2012) conducted an abundance assessment of bottlenose dolphins in the Lower Shannon SAC between July and October 2010. Line transect surveys were carried out on fixed, predetermined routes within the Shannon Estuary from a watercraft. Three transects were carried out each month, totalling to 12 transects in total for this survey. Surveys were only carried out during Beaufort Sea State 2 or less and at a maximum speed of 20 km per hour. Group size was recorded as the total number of individuals present, with the total number of adults, juveniles and calves also being recorded. Photo-ID was utilised during this survey, all images were categorised, and markings were graded on a severity scale from 1-3 (Berrow *et al.*, 2012). All images were also scored for quality, with only good quality images included in the final analysis in order to minimise error in matching images. Abundance estimates were calculated using validated datasets of all sightings/re-sightings of individuals. These datasets were then incorporated into a closed model which included a heterogeneity in capture probability, using MARK and CAPTURE software. This was used to obtain overall population size estimates, taking into account the weighted mean proportion of well-marked individuals and measure of survival/migration obtained from the model.

Whilst this study was not conducted in close proximity to the study area, it's inclusion is considered of relevance due to the connectivity between the east and west coast of Ireland populations.

2.7.2 Inshore surveys – Irish Sea

Visual and acoustic surveys for cetaceans were carried out in two survey blocks in the Irish Sea to gain information on species distributions, relative abundances and absolute abundances where possible (Berrow *et al.*, 2011) (Figure 2-10). Single platform line-transect surveys were conducted in the northern Irish Sea in July and in the southern Irish Sea in August 2011. In total, 348 km of survey effort was carried out across these two blocks along 23 track lines, in which 100% of the northern Irish Sea and 79% of the southern Irish Sea were surveyed in sea state 3 or less. Each block was 1,152 km^2 in surface area, with a perimeter of 48 nm by 7 nm and was located approximately between 6 nm and 12 nm offshore on the east coast. Block A and Block B overlap with the CWP Project site. One vessel was used to cover both survey blocks during the survey period. For each sighting, the position of the vessel was recorded in LOGGER as well as the angle of the sighting from the track of the vessel and the radial distance of the sighting. In order to obtain absolute abundance estimations, the statistical package DISTANCE was used to calculate the density of animals within a prescribed area which had been passed through by the vessel. Passive Acoustic Monitoring (PAM) was also conducted using a towed hydrophone approximately 200 m astern of the survey vessel at a depth of c.2 to 5 m beneath the sea surface. An acoustic monitor continuously monitored the incoming audio both visually through the use of audio-spectrograms and aurally using PAMGUARD. Acoustic detections of cetacean vocalisations were noted, described and their time and GPS locations were recorded. The acoustic survey effort track line was recorded using a GPS receiver which provided NMEA data to the PAMGUARD software.

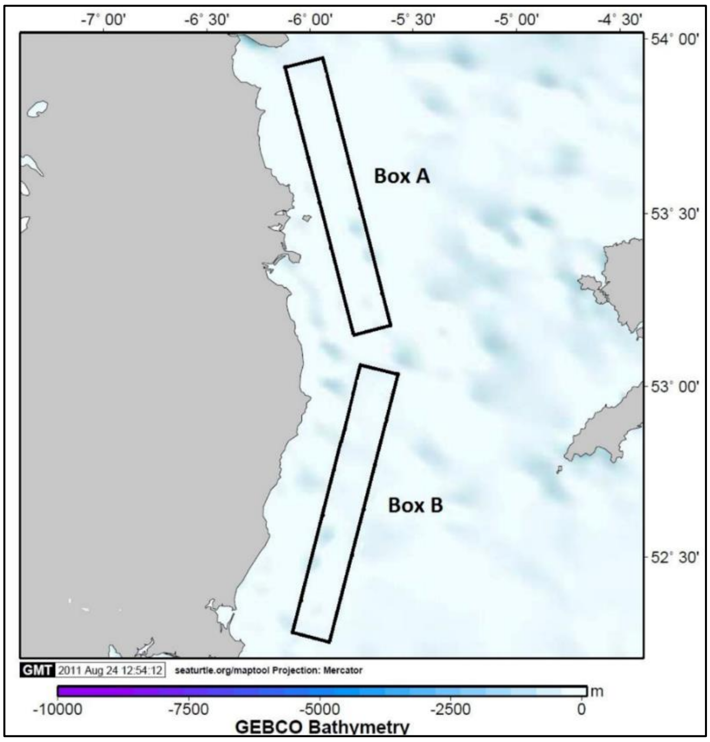


Figure 2-10 Map of east Ireland showing the locations of survey blocks surveyed for cetaceans in 2011 (Berrow *et al.*, 2011).

2.7.3 Rockabill to Dalkey Island SAC surveys (2013, 2016 & 2021)

A visual and PAM survey of harbour porpoises was carried out in 2013 at two SACs (Rockabill to Dalkey Island SAC, Co Dublin and Roaringwater Bay and Islands SAC, Co Cork) in order to calculate local density and abundance estimates (Berrow and O'Brien, 2013). These surveys were in close proximity to the south and west part of the survey area. Line-transects were utilised for this survey, with an estimated 273.3 km2 covered for the survey area around the Dublin area coastline (Figure 2-11). The survey was conducted using a vessel, with conventional single platform line-transect surveys carried out within or in close proximity to the boundaries of the survey sites along pre-determined track lines. All sightings were recorded, however sightings which occurred more than 200 m from the track line (300 m if sea-state 0) were not used in the distance sampling model. During each sighting, the position of the vessel was recorded as well as the angle of the sighting from the track of the vessel, along with the estimated radial distance of the sighted animal from the vessel. Distance sampling was used to obtain density estimates and to calculate an abundance estimate for each site where possible. In this survey, it was assumed that all animals on the track line were accounted for. The overall pooled density and abundance estimates for each site were obtained from all track lines which were surveyed in sea state 2 or less, combined across all days. The data were fitted to a number of models in the DISTANCE software. The recorded data were grouped into equal distance intervals of 0-20 m, 20-40 m up to 180-200 m for most sites. Acoustic data was collected during the survey through the use of a towed hydrophone array which was deployed during visual surveys. Track lines of acoustic survey effort were recorded using a GPS receiver which provided NMEA data for use by the PAMGUARD software. Recordings were made when the designated PAM operator recognised detections either visually through the use of audio-spectrograms or aurally through headphones.

In the summer of 2016 (June to September), line transect surveys were conducted within the Rockabill to Dalkey Island SAC to estimate density and abundance (O'Brien and Berrow, 2016). In total four survey days were conducted, all with Beaufort Sea State ≤2, totalling 506 km of the track line surveyed. During each survey the position of the survey vessel was continuously tracked using a GPS receiver, and survey effort such as environmental conditions were recorded every 15 minutes using LOGGER software. Upon the occurrence of a sighting, the position of the vessel was recorded as well as the angle of the sighting from the track of the vessel, and the estimated radial distance of the sighted animal using LOGGER software. Distance sampling was utilised to obtain a density estimate and to calculate an abundance estimate for each individual survey where possible. During these surveys, it was assumed that all animals on the track line were accounted for. Density was calculated using "day" as the sample regime. The DISTANCE modelling process was used to generate estimates of abundance and density for each survey day. Data including as transects, sightings, abundance and density were processed via GIS to produce sighting distribution maps.

In the summer of 2021 (July and August), line transect surveys were conducted within the Rockabill to Dalkey Island SAC to estimate density and abundance (Berrow *et al.*, 2021). In total six survey days were conducted, all with Beaufort Sea State ≤2, totalling 728 km of the track line surveyed overall. Survey protocols remained the same as those from the 2016 survey.

The main limitation of these surveys is the fact that the Distance analysis assumed perfect detection of marine mammals on the trackline (e.g., g(0)=1). As such, the resulting abundance and density estimates are considered to be relative estimates which will underestimate the absolute abundance and density at the site.

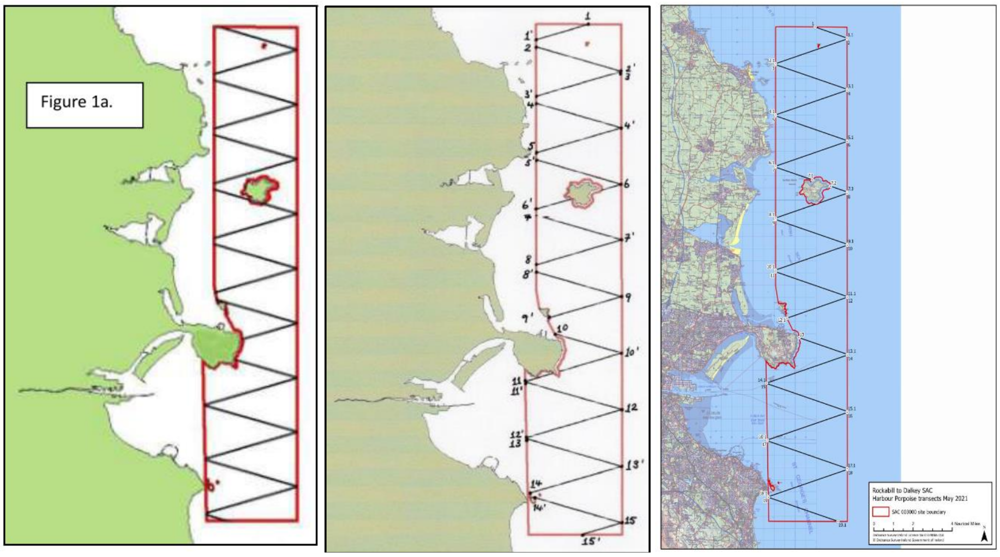


Figure 2-11 Rockabill to Dalkey Island SAC showing track lines selected for survey coverage in 2013 (left; Berrow and O'Brien, 2013), 2016 (middle; O'Brien and Berrow, 2016) and 2021 (right; Berrow *et al.*, 2021).

2.7.4 Harbour porpoise surveys (2008)

The north county Dublin area (104 km^2) and the Dublin Bay area (116 km^2) was surveyed from July-September in 2008 (Berrow *et al.*, 2008). These surveys were in close proximity to the south and west part of the survey area. Single vessel line-transect surveys were carried out within or in close proximity to the survey site boundaries along pre-determined routes (Figure 2-12). Distance sampling was utilised to calculate a density estimate and to calculate an abundance estimate of individuals. During these surveys, it was assumed that all harbour porpoises were accounted for along the track line. All sightings were recorded but sightings which occurred over 200 m (300 m if sea state 0) were not included in the distance-model. During each transect the position of the survey vessel was continuously tracked and survey effort data such as environmental conditions were recorded every 15 minutes using LOGGER software. Upon the occurrence of a sighting, the position of the vessel was recorded along with the angle of the sighting from the track of the vessel, and the perpendicular distance of the sighting from the vessel was recorded using LOGGER software. The DISTANCE software programme was used to calculate the density of harbour porpoises present along the track of the vessel, which derived abundance estimates. Only sightings recorded in sea-state 2 or less were included in the analysis. As highlighted previously, the main limitation of this survey is the fact that the Distance analysis assumed perfect detection of marine mammals on the trackline and therefore the resulting abundance and density estimates are considered to be relative estimates which will underestimate the absolute abundance and density at the site.

Acoustic monitoring was conducted through the deployment of T-PODs which consist of a self-contained computer and hydrophone which logs the times and durations of echolocation clicks. The T-PODs were only set to log harbour porpoise clicks, using the generic harbour porpoise settings. Two T-PODs were deployed in the Dublin Bay, one T-POD was recovered on the 28th of September however the other T-POD on the south side of Dublin Bay and was lost.

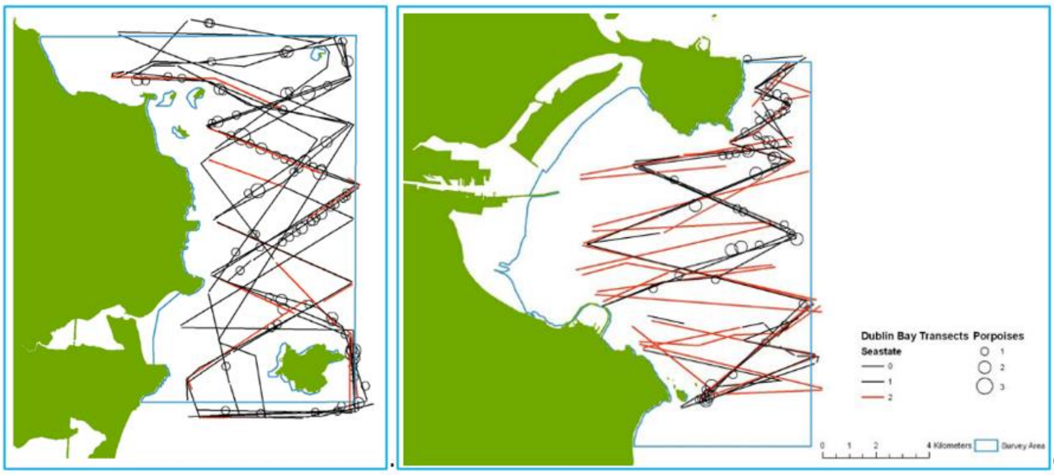


Figure 2-12 Map showing location of all track lines surveyed and harbour porpoise observed for the North Dublin transects (left) and Dublin Bay Transects (right) (Berrow *et al.*, 2008).

2.7.5 Greater Dublin Drainage Project (2015-2017)

Land-based observations of marine mammals were conducted from the Martello Tower at Loughshinny for six months and from the north-eastern cliffs of Howth Head for 24 months (March 2015-March 2017) (Meade *et al.*, 2017). Each survey lasted 7-8 hours. Two types of visual observations were conducted, including scan sampling and focal follow observations. For each sighting, data including species, group size and location were recorded. The location of each sighting was recorded using a theodolite, or in cases where this was restricted, location was determined by estimating distance (km) and bearing (degrees) from the observation site using reticle binoculars.

Additionally, vessel-based surveys were conducted using conventional single line transect surveys along a pre-determined route. Four routes were used, with surveys 1-4 including the waters off Loughshinny and surveys 5-11 covering the Portmarnock area (Figure 2-13) and were in close proximity to the south and west part of the survey area. These surveys were conducted every two months and were carried out in sea-state 2 or less and in visibility of ≥6 km. Distance sampling was used to obtain a density estimate and an abundance estimate for the study area where possible. Since it was assumed that all animals were accounted for along the track line (which was likely violated), the resulting abundance and density estimates are considered to be relative estimates which will underestimate the absolute abundance and density at the site.

Static acoustic monitoring was also implemented in this study. Two C-PODS were moored at a site 3 km East of Loughshinny, Co. Dublin, and 6 km North of Lambay Island. Additional deployments took place off Portmarnock, Co. Dublin (Figure 2-14). C-PODs operate in a passive mode and constantly record for tonal clicks, with all data recorded on an internal secure digital flash card. All data were analysed using only high probability clicks, with both dolphin and porpoise detections extracted as detection positive minutes per day (DPM).

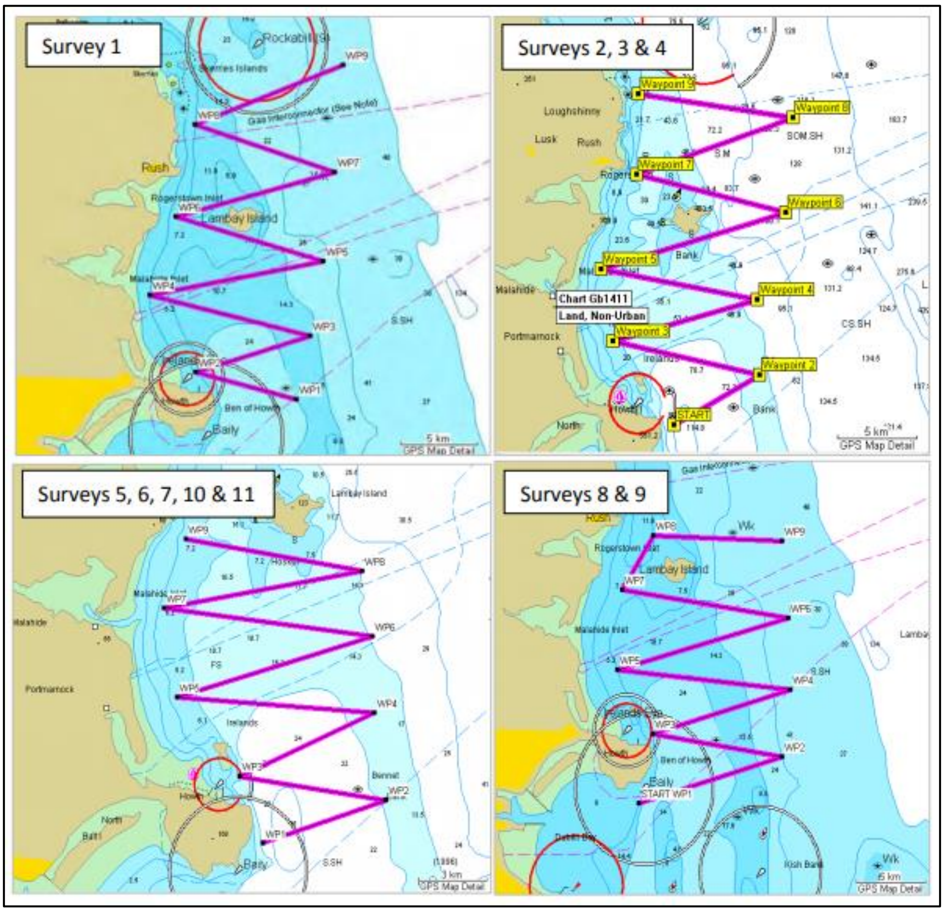


Figure 2-13 Line Transect Route for boat-based marine mammal surveys (Meade *et al.*, 2017).

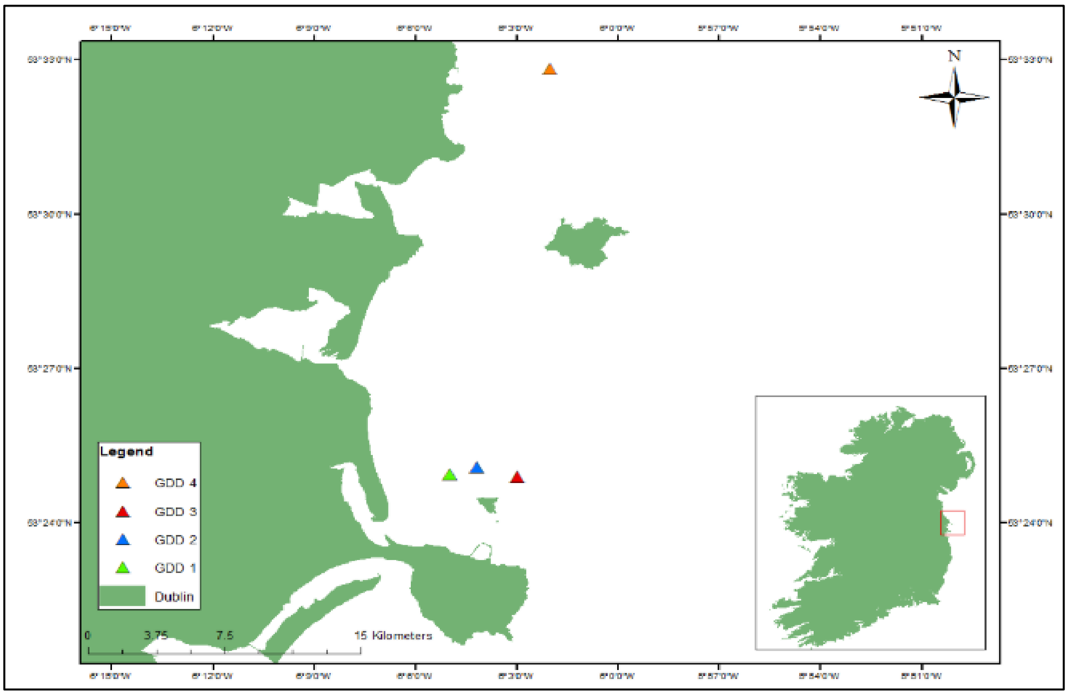


Figure 2-14 C-PODs locations off Portmarnock (GDD1, GDD2 and GDD3) and Loughshinny (GDD4) (Meade *et al.*, 2017).

2.8 Seal counts

2.8.1 Morris and Duck (2019)

In August 2017 and 2018, Morris and Duck (2019) conducted aerial surveys of harbour and grey seals around Ireland using a multi-camera, gyro-stabilised gimbal fitted externally beneath the cockpit of a helicopter. The gimbal used contained a laser ranger-finder, a colour high definition digital video camera, a mid-wavelength (3-5 µm) thermal-imaging video camera and a digital single-lens reflex camera which was equipped with a 300 mm telephoto lens. Using this equipment, the aerial surveys conducted followed standard SMRU harbour seal survey protocols. Due to these protocols, surveys were restricted to August and early September which is peak harbour seal moult season. Surveys were also restricted to time scales of within two hours either side of low tides occurring between 12:00 and 19:30, with no surveys occurring during periods of moderate, heavy, or prolonged rainfall. All intertidal areas were surveyed using thermal imaging. Both colour and thermal-image videos were recorded alongside the digital still images onto computers, with the mapping system, TrakkaMap, recorded detailed flight paths as well as target centre co-ordinates for each photo and video frame. Complete flight tracks were also recorded onto two Garmin Foretrex 401 GPS units. The Irish coastline was split into five nominated regions, including the East coast, with each of these regions being further subdivided into 29 smaller coastal areas. Changes in seal haul-out behaviour between survey years was not accounted for (e.g., weather related influences), and it was assumed that weather did not significantly influence the haul-out behaviour and resulting counts.

The counts obtained represent the number of seals that were onshore 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. However, telemetry data from tagged seals can be 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. The surveys were conducted in August since this is the period when harbour seals are moulting and is therefore the time of year when the largest numbers of harbour seals are ashore. While grey seals are also counted during these August surveys, these data do not necessarily provide a reliable index of population size. Grey seals aggregate in the autumn to breed at traditional colonies, therefore their distribution during the breeding season can be very different to their distribution at other times of the year.

2.8.2 Ó Cadhla *et al.* (2007) and Ó Cadhla *et al.* (2013)

Ó Cadhla *et al.* (2007) conducted a data review in conjunction with a series of aerial surveys of the Irish coastline in collaboration with the Irish Air Corps during the spring and summer of 2005. These surveys covered five broad areas of the Irish coastline, including the East (site D) which encompassed the coastlines of the following counties: Louth, Meath, Dublin, Wicklow, and Wexford (Figure 2-15). The CWP Project is located within site D.

These survey locations were discrete identifiable units and were classified according to their potential for grey seal breeding. Due to the relatively small number of survey locations identified in the east coast area, this area was surveyed primarily through the use of ground- and boat-based survey methods. Ground- and boat-based survey methods were implemented for Lambay Island and Ireland's Eye in County Dublin. Both of these sites were included as part of grey seal surveys carried out along the eastern Irish Sea coasts between 1977 and 1999 (Kierly *et al.*, 2000, Lidgard *et al.*, 2001). Boat-based surveys took place for a total of 7 seven pup production surveys at approximate two-week intervals with all live and dead pups counted and classified according to five developmental stages (Kovacs and Lavigne, 1986).

All of the information on pup production in the East coast region was collected in the form of ground counts of living and dead pups. In order to make it comparable, the statistical analysis used to estimate total pup production was the same as that which has been used. This methodology included a production estimation model (PEST) which has been used for UK grey seal pup production estimation since 1984 by SMRU. This model allowed for various parameters such as time to moulting and time to leaving the breeding site to be accounted for in order to produce the most accurate model of fit for the observed counts of pups, as a result, this reduced the error (CV) of each production estimate. Upon the completion of the statistical analysis and total pup production estimates were made available for each breeding colony, ancillary counts of pups were added where applicable. Total pup production estimates were subjected to a multiplication factor of 3.5 – 4.5 in order to represent the ratio of new-born pups to an increasing all-age population (Harwood and Prime, 1978). This method has been deemed the standard method which has been applied previously in Ireland, due to the absence of additional life history data and limitations of a lack of time-series pup production estimates from key breeding colonies (Ó Cadhla and Strong, 2003).

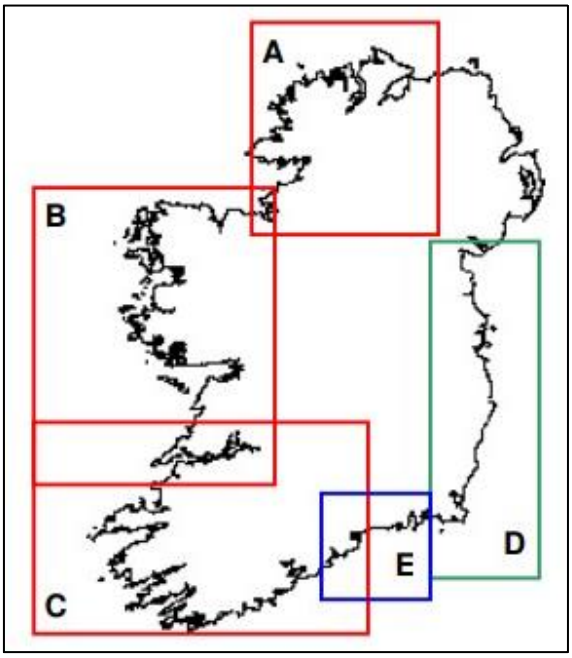


Figure 2-15 Designated aerial survey sites for grey seal population estimates in the spring and summer of 2005 (Ó Cadhla *et al.*, 2007).

Following the first assessed comprehensive national survey by Ó Cadhla *et al.* (2007), the monitoring of all key populations for grey seals in Ireland continued during repeat regional surveys in 2009, 2011 and 2012. The work undertaken was presented in Ó Cadhla *et al.* (2013). The main findings presented in Ó Cadhla *et al.* (2013) provides an update to the results reported in Ó Cadhla *et al.* (2007) for seven main breeding sites:

- Sturrall (near Glen Head) to Maghera in south-west Co. Donegal;
- the Inishkea island group (a.k.a. Inishkea Group) off north-west Co. Mayo;
- Inishshark, Inishgort and associated islands off north-west Co. Galway;
- islands around Slyne Head, Co. Galway;
- the Blasket Islands, Co. Kerry;
- the Saltee Islands, Co. Wexford; and
- Lambay Island and Ireland's Eye, Co. Dublin.

2.8.3 SCOS Northern Ireland MU

The main harbour seal population surveys are carried out when harbour seals are moulting, during the first three weeks of August. The greatest and most consistent numbers of harbour seals are hauled out ashore during their annual moult. To maximise the proportion of seals likely on shore and to reduce the effects of environmental variables, surveys are restricted to within two hours either side of low tides and are not conducted in the rain. The moult counts represent the number of harbour seals that were on shore at the time of the survey and are a minimum estimate of the size of the population. Note that these data refer to the numbers of seals found within the surveyed areas only at the time of the survey; numbers and distribution are likely to differ at other times of the year (such as the breeding period).

August haul-out counts in the Northern Ireland seal MU have been conducted by SMRU and funded by Northern Ireland Environment Agency (NIEA) in 2002, 2011 & 2018 (Morris & Duck, 2019a) and Marine Current Turbines Ltd in 2006-2008 & 2010 (SMRU Ltd, 2010).

It is estimated that 72% of the total harbour seal population are hauled-out and available to count during August surveys (Lonergan *et al.*, 2013). The harbour seal counts can be scaled by the proportion of seals hauled-out at the time of the counts, providing an estimated population size for a seal MU.

Numbers of grey seals are also counted during the harbour seal August haul out count surveys. Counts of greys seals during the summer months are highly variable, however they provide useful information on the summer and non-breeding season distribution of grey seals. It is estimated that 25.15% (95% CI: 21.45-29.07%) of the total grey seal population are hauled-out and available to count during the August haul-out count surveys (Russel and Carter, 2021) and, therefore, the total number of grey seals in the population for any given count period can be estimated by using the proportion of seals hauled-out.

2.8.4 NPWS surveys for harbour and grey seals

The “Summary of National Parks & Wildlife Service surveys for common (harbour) seals (Phoca vitulina) and grey seals (Halichoerus grypus), 1978 to 2003” by Lyons (2004) formed the first summary of seal census work that had been undertaken by the NPWS between 1978 – 2003. Although information on local populations was provided, due to the variety of methods in which data were collated over the years, a national level population estimate could not be derived for either species (Lyons, 2004).

At the time of writing, a total of 1,504 observations have been made on seal populations since 1978 with the greatest sampling effort being made along the west coast of Ireland at the Blasket and Inishkea Island groups for grey seals. For harbour seals, sampling was greatest on the southern coast of Ireland at Bantry Bay (Lyons, 2004)

Due to changes in methodology since the publication of this report, no direct comparisons can be made and as such, this data source shall not be used in the baseline characterisation of seals.

2.9 Seal telemetry

SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. These tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. There are two types of telemetry tag which differ by their data transmission methods. Data transmission can be through the Argos satellite system (Argos tags) or mobile phone network (phone tags). Both types of transmission result in location fixes, but data from phone tags comprise better quality and more frequent locations.

SMRU have tagged a total of 33 harbour seals in Strangford Lough in Northern Ireland (12 in 2006, 10 in 2008 and 11 in 2010). In addition to this, 13 juvenile harbour seals were tagged in 2019-20, but the data have yet to be processed and are not available for use yet (pers. comm. Dr Mark Jessop, University College Cork). No grey seals have been tagged by SMRU in Northern Ireland.

There have been few grey seal telemetry studies conducted in the Republic of Ireland. These include:

- 19 grey seals tagged with Fastloc/GSM tags at haul-outs at Raven Point, Wexford Harbour Co. Wexford, southeast Ireland in March 2013 (n=9) and 2014 (n=10) (Cronin *et al.*, 2016). Six of the tags malfunctioned and so only 11 seals were successfully tracked. The tags operated for 3-4 months (mean 97 days) resulting in 1,074 days of data from the 11 seals, with up to 12 locations per seal per day;

- 8 grey seals were tagged at Great Blasket Island in February 2009 (Cronin *et al.*, 2011, Cronin *et al.*, 2013b). The tags operated for 7-8 months (mean duration 226 days), in total 1,813 days of data were collected from the 8 seals;
- Additionally, 10 male grey seals were tagged on the Blaskets in March 2011 and 2012, and 10 in Inishkeas in 2019, however, most of these tags failed, resulting in very few tracks available. As such they have not been published or reported upon and so cannot be included in this baseline characterisation (pers. comm. Dr Mark Jessop, University College Cork).

Telemetry data for grey seals tagged in UK waters also show connectivity between the west coast of the RoI, Northern Ireland, Wales, Southwest England, and the southwest coast of Scotland (Figure 2-16 and Figure 2-17).

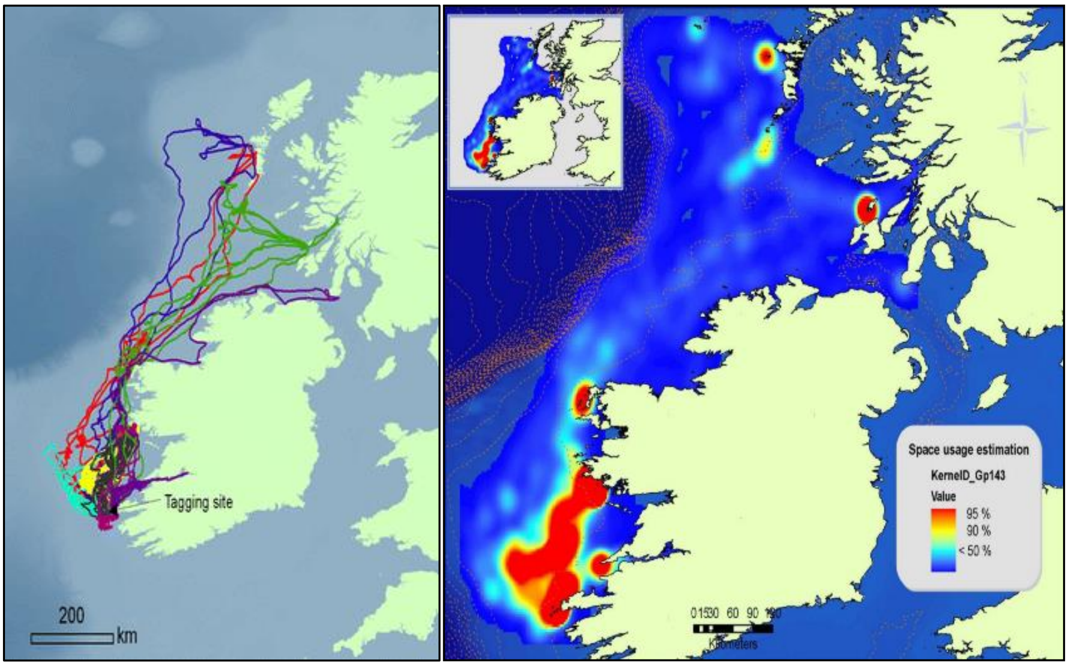


Figure 2-16 Left: Tracks of 8 female grey seals tagged with GPS/GSM tags between February and December 2009 (Cronin *et al.*, 2013b). Right: Space use of all 8 tagged grey seals (Cronin *et al.*, 2011).

2.10 Seal at-sea density

The UK Department for Business, Energy and Industrial Strategy funded a large-scale deployment of high resolution GPS telemetry tags on seals around the UK, and analyses to create up-to-date estimates of the at-sea distribution for both seal species (Carter *et al.*, 2020). Telemetry data from 114 grey seals and 239 harbour seals were included in the analysis (Figure 2-17). To estimate the at-sea distribution, a habitat modelling approach was used, matching seal telemetry data to habitat variables (such as water depth, seabed topography, sea surface temperature) to understand the species-environment relationships that drive seal distribution. Haul-out count data (Figure 2-18) were then used to generate predictions of seal distribution at sea from all known haul-out sites in the British Isles. This resulted in predicted distribution maps on a 5x5 km grid. The estimated density surface gives the percentage of the British Isles at-sea population (excluding hauled-out animals) estimated to be present in each grid cell at any one time during the main foraging season. It is estimated that grey seals spent 77% of their time at sea on average (Russell *et al.*, 2015); therefore, using the SCOS 2020 best estimate of the grey seal population size in the British Isles (SCOS, 2020), the total at-sea population size for the British Isles is estimated to be ~150,700 individual grey seals (Carter *et al.*, 2020). It is estimated that harbour seals spend 83.4% of their time at sea on average

(Russell *et al.*, 2015); therefore, using the SCOS 2020 best estimate of the harbour seal population size in the British Isles (SCOS, 2020), the total at-sea population size for the British Isles is estimated to be ~42,800 individual harbour seals (Carter *et al.*, 2020).

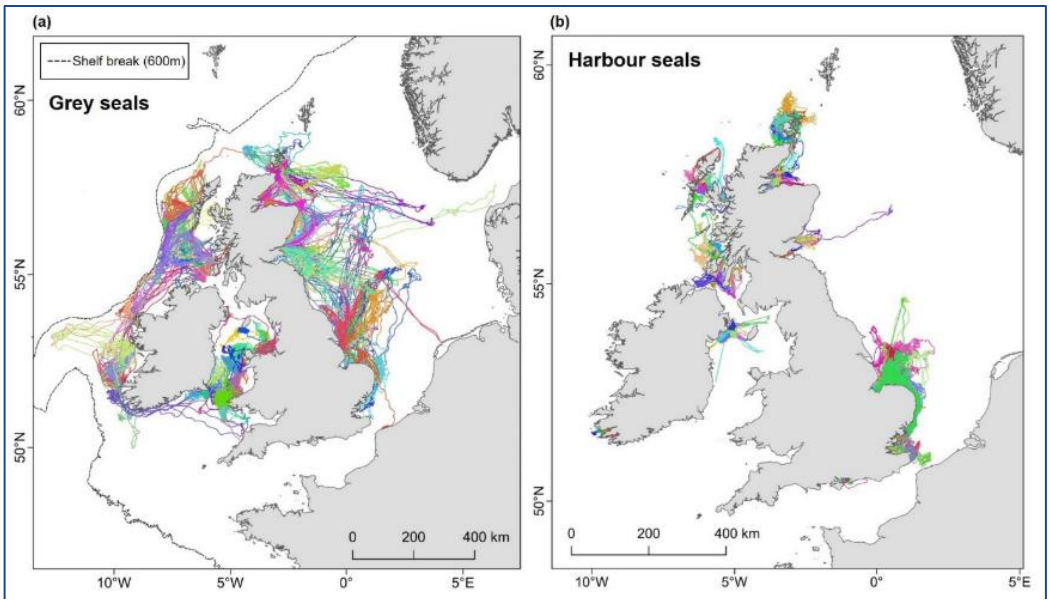


Figure 2-17 GPS tracking data for (a) grey and (b) harbour seals available for habitat preference models (Carter *et al.*, 2020).

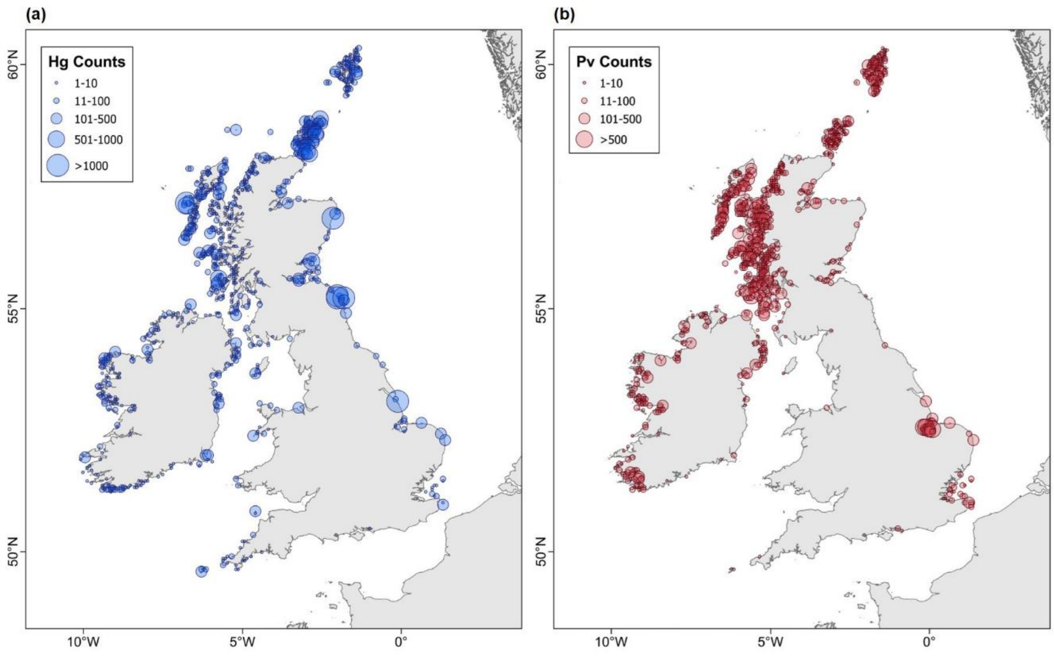


Figure 2-18 Most recent available August count data for (a) grey and (b) harbour seals per 5 km x 5 km haul-out cell used in the distribution analysis (Carter *et al.*, 2020).

2.11 Other OWFs

2.11.1 NISA

The NISA EIA Scoping Report published in 2021 identified 6 main marine mammal species of interest within the development area (ARUP, 2021). These were:

- Harbour porpoise;
- Bottlenose dolphin;
- Risso's dolphin;
- Minke whale;
- Grey seal; and
- Harbour seal.

Each of the species identified as likely present within the NISA development area are part of the same MUs as those likely present within the CWP Project development area. Both boat and aerial marine mammal surveys have been undertaken as part of NISA (ARUP, 2021) but these data are yet to be published.

2.11.2 Dublin Array

The Dublin Array OWF is located a minimum of 3 km from the CWP Project, and therefore the site-specific surveys conducted for the Dublin Array are of relevance to the marine mammal baseline characterisation for CWP Project. However, these data are yet to be published and thus information on the site-specific surveys cannot be detailed at this time and thus, information from the Dublin Array Scoping Report shall be used to outline the marine mammal baseline at this development (SLR *et al.*, 2020).

As part of the Dublin Array EIA Scoping Report, a review of existing data sources indicated that the key species likely to be present within the proposed Dublin Array and its surrounding area were:

- Harbour porpoise;
- Bottlenose dolphin;
- Risso's dolphin;
- Common dolphin;
- Minke whale;
- Grey seal; and
- Harbour seal.

Each of the species identified as likely present within the Dublin Array (SLR *et al.*, 2020) are part of the same MUs as those likely present within the CWP Project development area.

2.11.3 Arklow Bay Wind Park

The Arklow Bay Wind Park conducted monthly site-specific were conducted vessel transect surveys between July 1996 and March 1997, and June 2000 and June 2009 for Phase 1 and digital aerial surveys between March 2018 – February 2020 inclusive for Phase 2. Surveys were also completed during April 2020 as data was not available for April 2019. The aerial surveys were conducted over the Lease Area, plus a 4 km buffer which also extended to the coast to cover the offshore export cable routes (RPS, 2020). Surveys recorded harbour porpoise, Risso's dolphin and seals (RPS, 2020).

3 Harbour porpoise

The harbour porpoise is the most widely distributed and most common cetacean species in the waters of Britain and Ireland (NPWS, 2019). They occur in all parts of the British and Irish continental shelf and are recorded year-round within most of their range (Figure 3-1). The conservation status of harbour porpoise in Irish waters has been categorised as Favourable (NPWS, 2019).

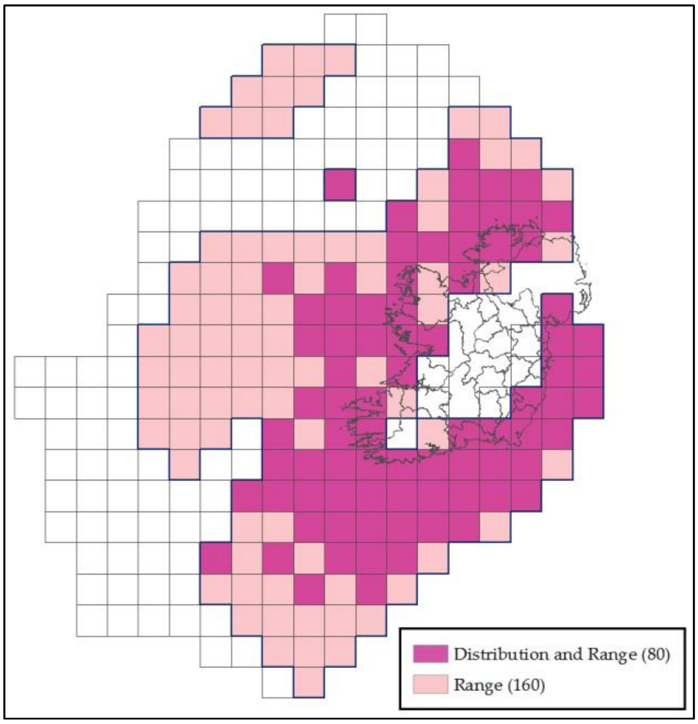


Figure 3-1 The range and distribution of harbour porpoise in Irish waters (NPWS, 2019).

3.1 MU

The Inter Agency Marine Mammal Working Group (IAMMWG) identified MUs for harbour porpoise and provided recommended abundance estimates for each MU. CWP Project is located within the Celtic and Irish Seas MU, where the most recent estimate of abundance for harbour porpoises is 62,517 (CV: 0.13, 95% CI: 48,324 – 80,877) (IAMMWG, 2023) based on data collected during SCANS III and the ObSERVE surveys (Rogan *et al.*, 2018, Hammond *et al.*, 2021).

3.2 Site-specific surveys

Harbour porpoise were the most commonly sighted cetacean during both the aerial and boat-based surveys (Figure 3-2).

Harbour porpoise sightings during aerial surveys were corrected for availability bias using the correction factors in Teilmann *et al.* (2013), whilst a detection function representing the decline in detectability with distance was used in boat-based survey data to account for individuals that were missed by observers (Buckland *et al.*, 2001, Natural Power, 2023). Scaled observations were then combined to construct density surface models using the Marine Renewables Strategic environmental assessment model (MRsea)[1] (Natural Power, 2023). This means that the resulting density estimates from these data are absolute density estimates.

The density surface average using MRSea (using both boat and DAS data with depth and survey type retained) was 0.1225 porpoises per km^2 across the survey area (0.1147 – 0.1313) (Figure 3-3).

[1] https://www.creem.st-andrews.ac.uk/software/mrsea-and-mrseapower/

Figures relating to the seasonal and monthly sightings of harbour porpoise during site-specific surveys are presented in Section 3.8.

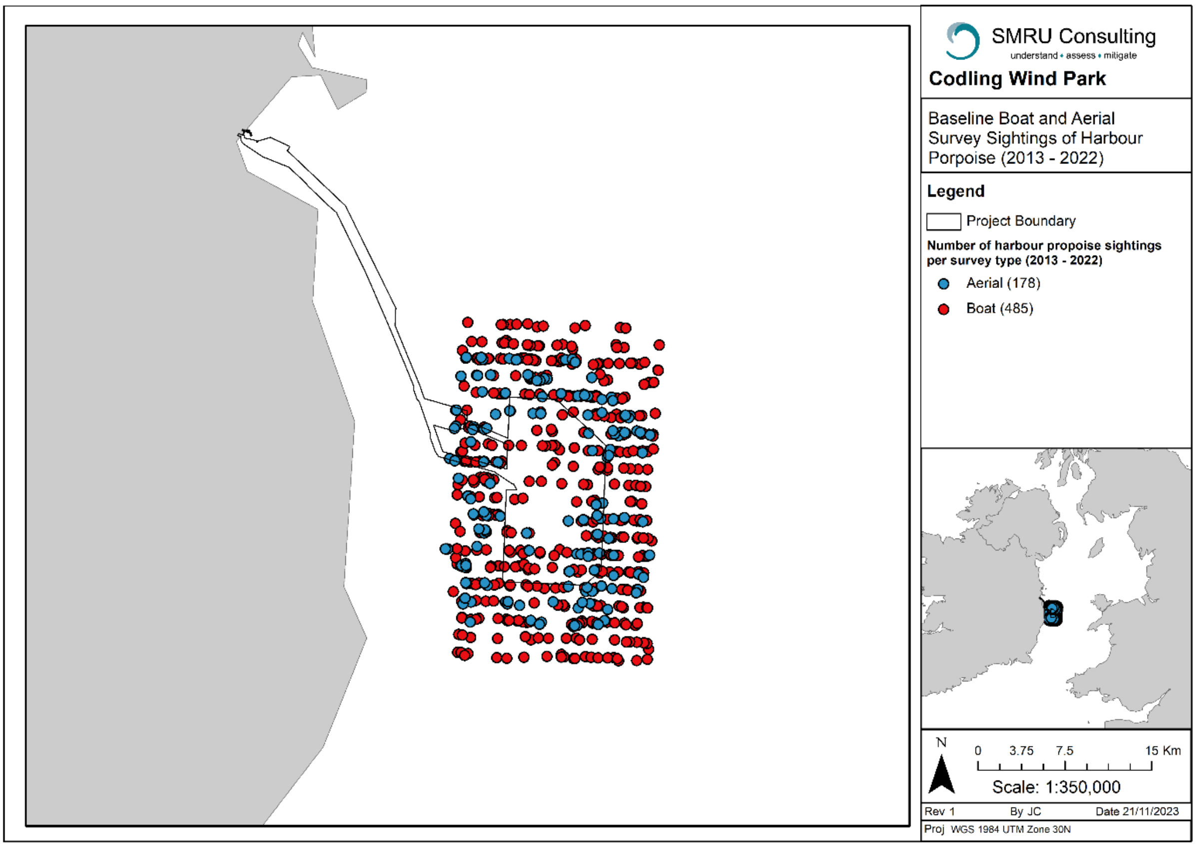


Figure 3-2 Number of harbour porpoise sightings within the project array site, ECC and surrounding area. All data were collated as part of baseline boat and aerial surveys.

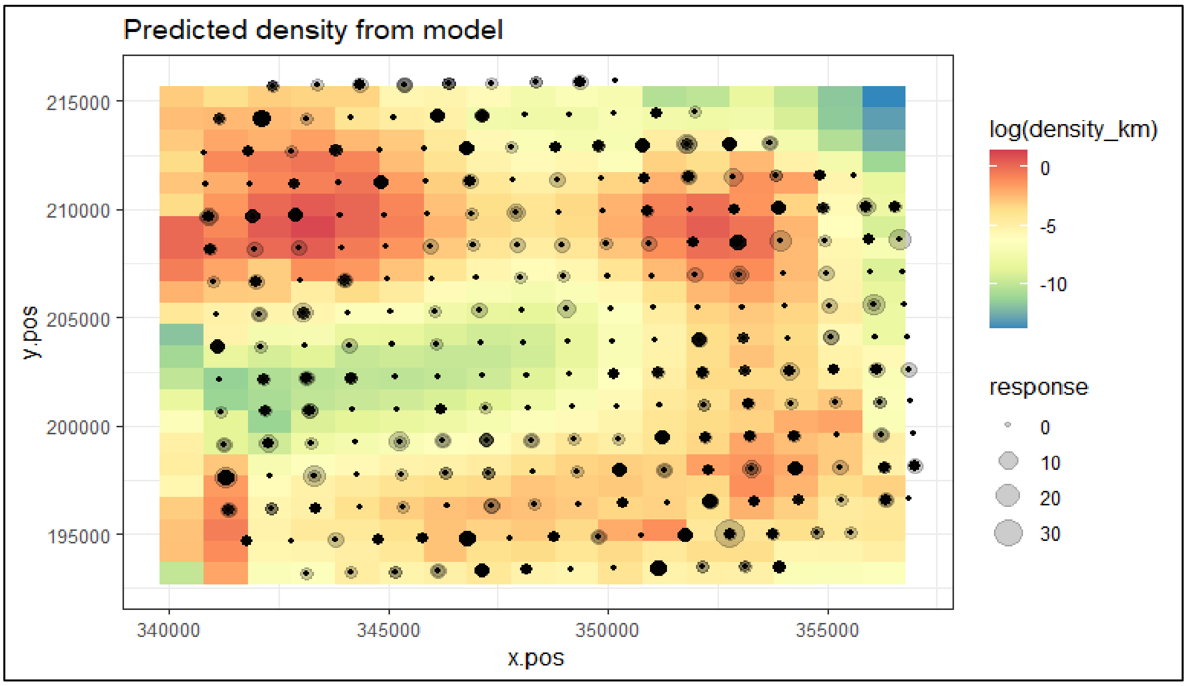


Figure 3-3 Predicted harbour porpoise point density estimates derived from combined aerial and boat-based survey data. Circles are harbour porpoise sightings attributed to survey transect segment centroids (Natural Power, 2023).

3.3 ObSERVE

Across both ObSERVE survey years (2015 and 2016), there was a total of 296 sightings of harbour porpoises across the survey areas (Rogan *et al.*, 2018). These individuals were primarily sighted in neritic waters across the continental shelf and Irish Sea (Figure 3-4), with no sightings in stratum 2. The majority of sightings were recorded as single individuals, however mean group size of harbour porpoises was higher during winter months at 1.7 individuals, in comparison to summer months at 1.3 individuals (Figure 3-5). In relation to the estimated abundances of harbour porpoises within the survey areas, the results concluded that these individuals had higher summer abundances (Season 1 and 3) compared to winter abundances (Season 2 and 4). Within survey stratum 5, in which CWP Project is located, the harbour porpoise density estimate was highest in summer, where estimates reached 1.046 and 0.942 for design-based and model-based density estimates respectively (Table 7).

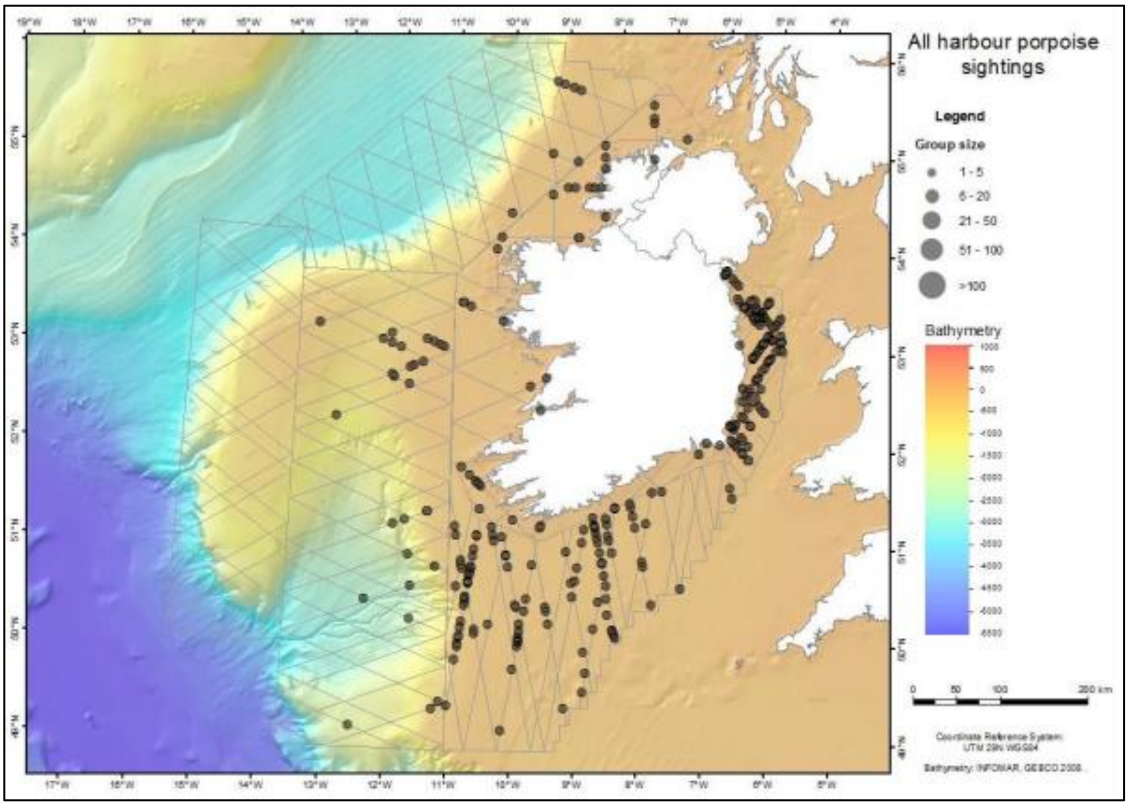


Figure 3-4 All harbour porpoise sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

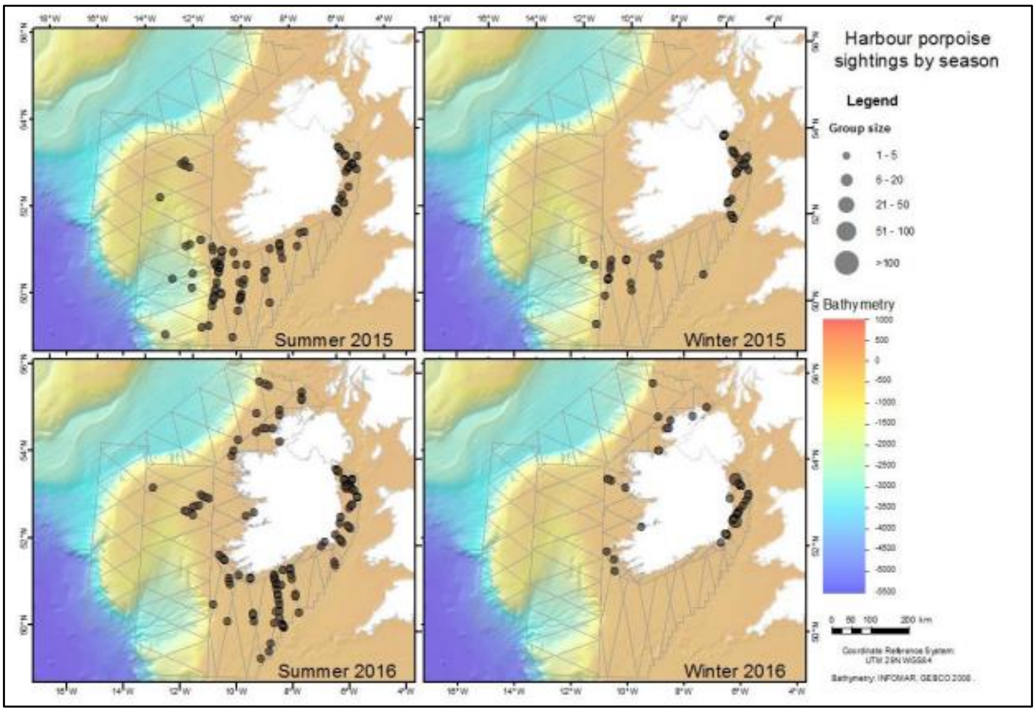


Figure 3-5 Seasonal harbour porpoise sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

Table 7 Harbour porpoise groups, design-based and model-based density (#/km²) and abundance estimates for stratum 5 of the ObSERVE surveys (Rogan *et al.*, 2018).

	Corrected design based estimates				Corrected model based estimates			
Season	**Density**	**Abundance**	**Lower CI**	**Upper CI**	**Density**	**Abundance**	**Lower CI**	**Upper CI**
1 (summer 2015)	0.696	7,734	5,247	11,398	0.675	7,495	4,789	11,729
2 (winter 2015-16)	0.867	9,636	5,633	16,482	NA			
3 (summer 2016)	1.046	11,624	8,725	15,486	0.942	10,466	7,923	13,816
4 (winter 2016-17)	0.924	10,263	7,555	13,942	NA			

3.4 SCANS

3.4.1 SCANS III

During the SCANS III survey effort in 2016, harbour porpoises were surveyed through the use of aerial survey techniques in the block E, covering the East coast of Ireland (Hammond *et al.*, 2017, Hammond *et al.*, 2021). Results from this survey conclude that harbour porpoises in block E had an estimated abundance of 8,320 individuals with lower and upper CIs of 4,643 and 14,354 respectively. Density estimates for this block were concluded to be 0.239 porpoise/km^2.

The SCANS III data was used to obtain predicted density surfaces (Lacey *et al.*, 2022). This shows that the predicted SCANS III harbour porpoise distribution across the MU is not uniform, with higher densities found in the northeast of the Irish Sea. Densities of harbour porpoise in the vicinity of the CWP Project are relatively low with values below 0.25 harbour porpoise/km^2 (Figure 3-7).

When comparing the harbour porpoise density surface between the 2005 and 2016 surveys (Figure 3-6), the authors stated the following: *"The most noticeable difference between the modelled distributions is that the high density predicted in the Celtic Sea (southwest of Britain and Ireland) in 2005 is not predicted in 2016. However, part of the Celtic Sea was surveyed by ObSERVE instead of SCANS-III in 2016 and high densities of harbour porpoise were predicted in this area in the summers of 2015 and 2016 (Rogan et al. 2018). In addition, high harbour porpoise density was predicted to the west of Ireland (Rogan et al. 2018). One explanation for the lower predicted density of harbour porpoises in the Celtic Sea in SCANS-III in 2016 could therefore be a distributional shift into Irish waters covered by the ObSERVE surveys."* (Lacey *et al.*, 2022). Therefore, the lower densities of harbour porpoise in the Irish Sea may not represent a population decline, but rather a shift in distribution to the west of Ireland.

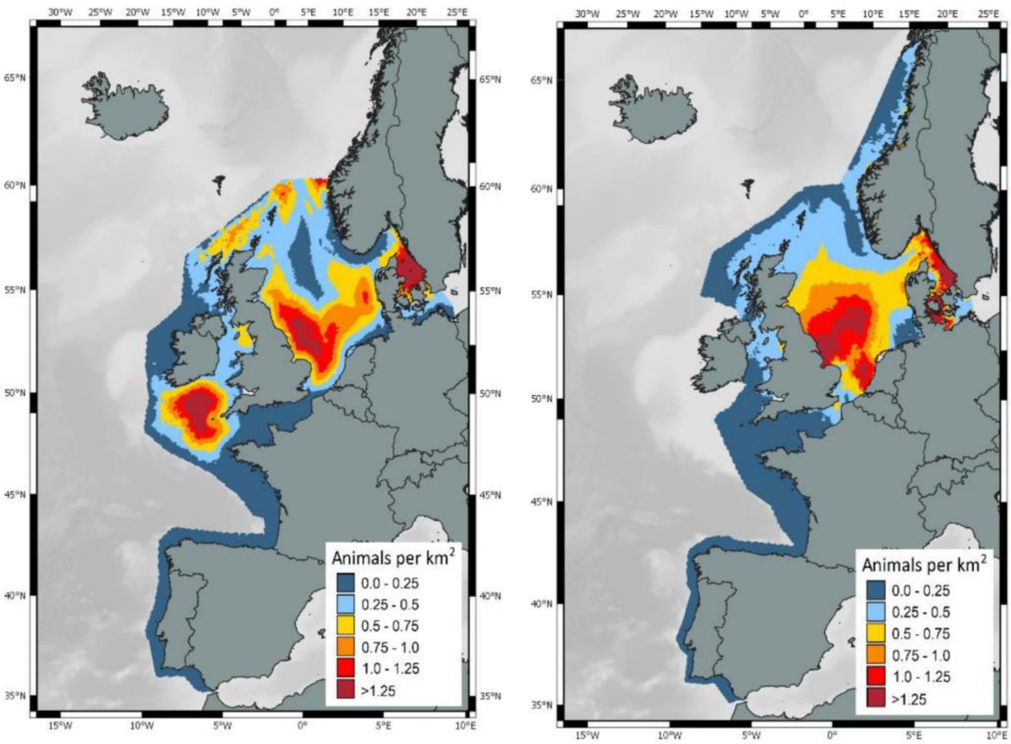


Figure 3-6 Predicted surfaces of estimated density for harbour porpoise in SCANS-II (2005) [left] SCANS-III (2016) [right] (Lacey *et al.*, 2022).

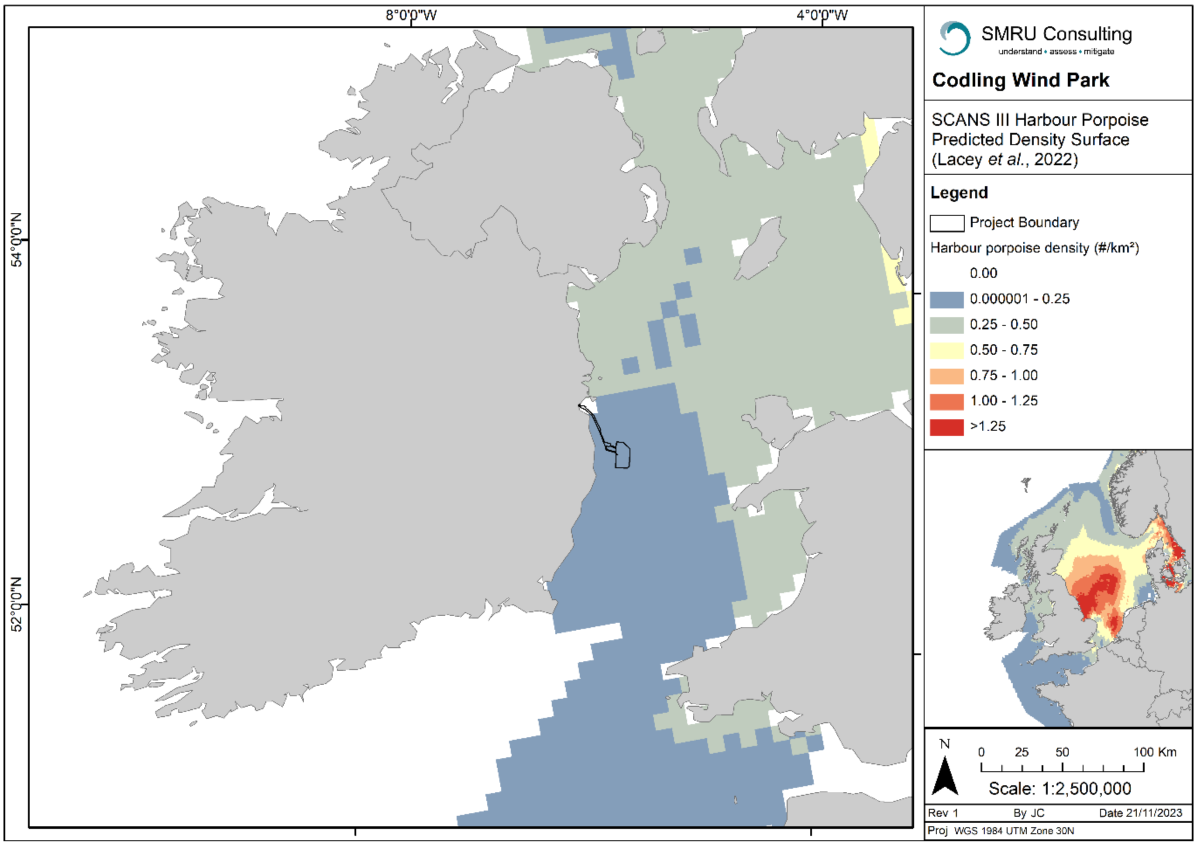


Figure 3-7 Predicted surface for harbour porpoise in SCANS III. Data from Lacey et al. (2022).

3.4.2 SCANS IV

The SCANS IV surveys used different survey block names to SCANS III, and CWP Project is located within SCANS IV survey block CS-D (which covered the western Irish Sea). Harbour porpoise were sighted throughout SCANS IV survey block CS-D, resulting in a block wide abundance estimate of 9,773 porpoise (95% CI: 4,764 – 18,125) and a uniform density across the survey block of 0.2803 porpoise/km^2 (CV 0.316) (Gilles *et al.*, 2023).

3.5 Irish Sea distribution

Evans and Waggitt (2023) modelled harbour porpoises throughout the Irish Sea and Bristol Channel, and showed varying distribution by season (Figure 3-8). Highest densities were found between May and September, which coincides with the breeding season for harbour porpoise (peak births in June). In general, porpoise showed preferences for coastal areas. The modelled outputs below indicate that the main areas of high density are inclusive of the outer part of Cardigan Bay, the eastern Irish coastal area (particularly from south Dublin to Waterford), west Pembrokeshire in Wales, and the area between north Anglesey and the Isle of Man. Using the maximum density per cell across all months, the estimated density in the CWP Project array site is 0.3 – 0.4 porpoise/km^2 (Figure 3-9).

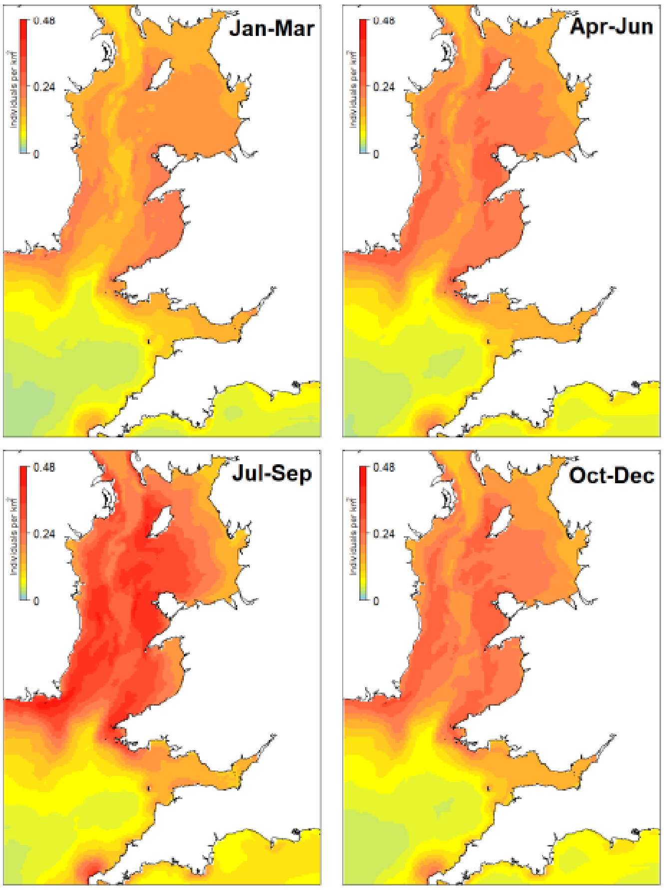


Figure 3-8 Harbour porpoise modelled densities by quarter, measured as the mean density per cell across months per season (Evans and Waggitt, 2023).

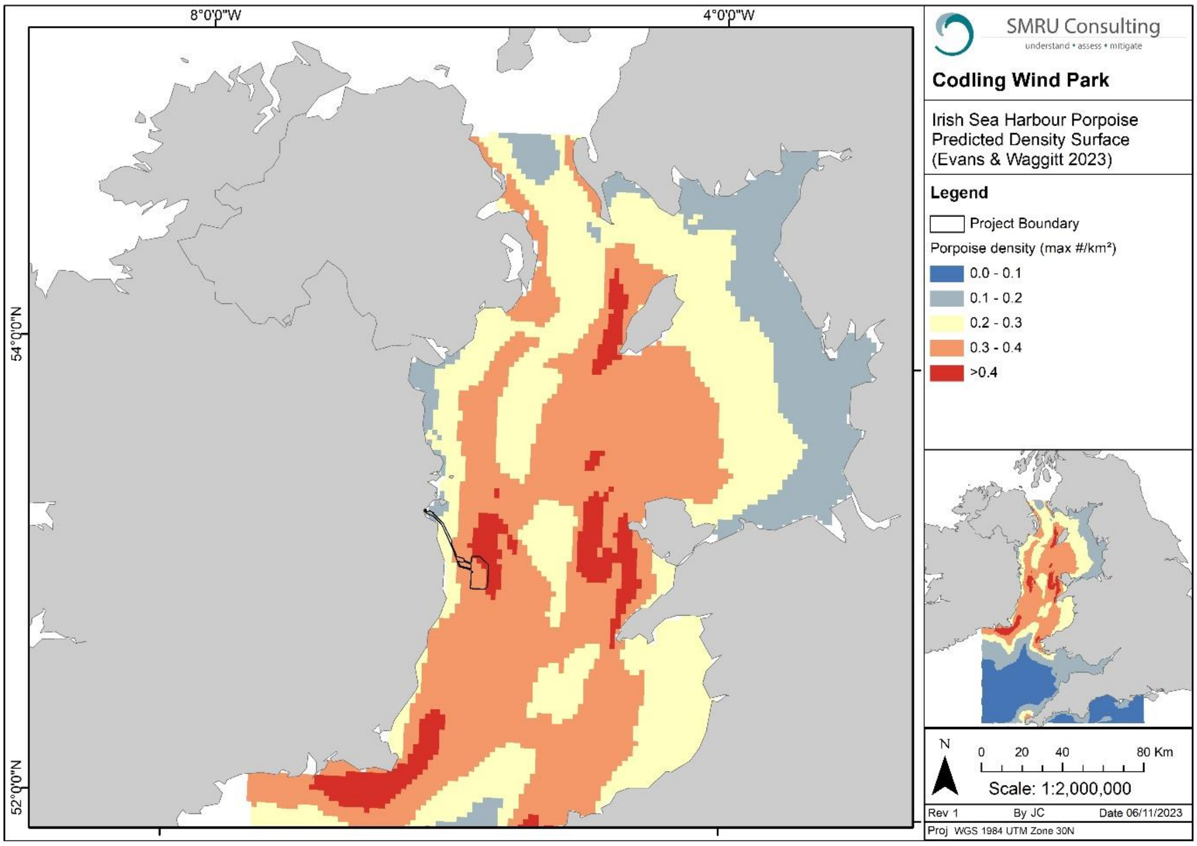
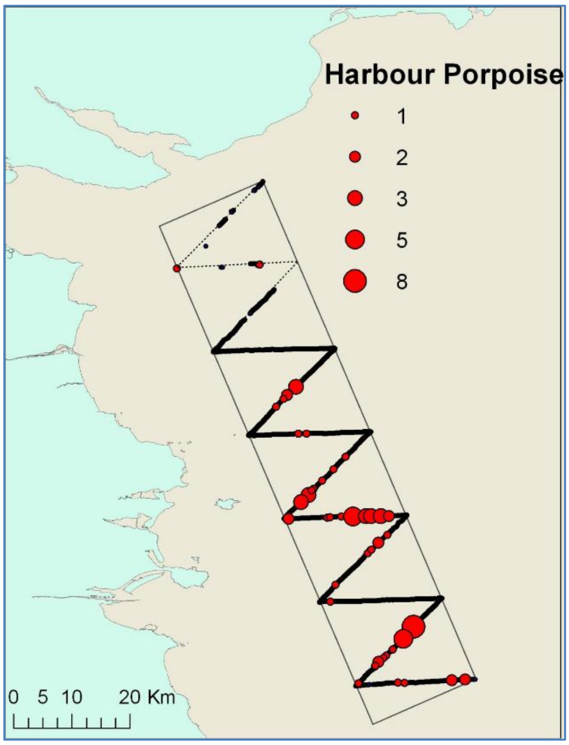


Figure 3-9 Harbour porpoise modelled densities (maximum density per cell across months) (Evans and Waggitt, 2023).

3.6 IWDG surveys

3.6.1 IWDG Irish Sea Block A and Block B (Berrow *et al.*, 2011)

The inshore Irish Sea surveys conducted in 2011 (Berrow *et al.*, 2011) concluded that harbour porpoise were the most frequently sighted cetacean species, with 57 sightings in block A (89 individuals) (Figure 3-10) and 14 sightings in block B (22 individuals). The CWP Project overlaps Block A to its south, and Block B to its north. The authors calculated a density estimate for porpoise in the northern Irish Sea (block A) of 1.585 porpoise/km^2 (SE 0.219) (which is almost identical to that estimated by the 2016 SAC surveys), however, there were too few sightings in block B to do the same for the southern Irish Sea. The surveys sighted both adults, juveniles, and calves, resulting in an estimate of 14.7% of the population being considered to be sub-adults.



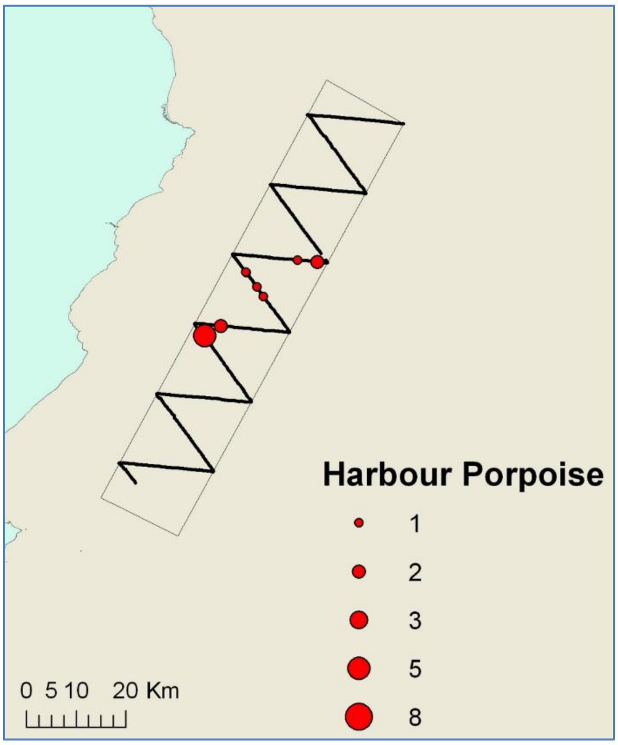


Figure 3-10 Sighting records of harbour porpoise in Block A (left) and B (right) (Berrow *et al.*, 2011).

3.6.2 IWDG North County Dublin including Dublin Bay (Berrow *et al.*, 2008)

Within the North County Dublin area, the 2008 summer abundance estimates over the six survey days was 2.03 porpoise/km^2, which was higher than that estimated for the Dublin Bay area, where the summer abundance estimates over the six survey days was 1.19 porpoise/km^2 (Berrow *et al.*, 2008). The static PAM locations at Dublin Bay (Howth Head), Roaringwater Bay (Sherkin Island and Castlepoint) and Cork (Galley Head and Old Head) recorded harbour porpoise on every day of the deployment between July, August, and September (with the exception of August at Roaringwater Bay where only 70% of the days had porpoise detections). The T-POD at Howth Head in Dublin Bay recorded much higher detection rates compared to the other sites, with detections of harbour porpoise occurring on between 74 to 81% of the hours monitored (Table 8).

Table 8 Monthly distribution of acoustic data from T-PODs (Berrow *et al.*, 2008)

Location	Month	No. days deployed	Encounters per month	% of days with porpoise detections	% Porpoise Positive Hours	Total Porpoise Positive Minutes	Porpoise Positive Minutes per hour
Howth Hd	July	19	852	100	81	3891	8.9
	Aug	12	969	100	79	4336	15.6
	Sept	16	911	100	74	5491	13.5
Castlepoint	Jul	22	231	100	33	540	1.0
	Aug	31	296	100	29	667	0.9
	Sept	10	84	100	24	172	0.8
Sherkin Island	July	9	154	100	48	109	0.6
	Aug	14	193	71	39	598	2.1
	Sept	-	-	-	-	-	-
Galley Head	July	22	151	100	25	372	0.8
	Aug	20	209	100	32	550	1.2
	Sept	21	257	100	34	692	1.4
Old Head of Kinsale	July	-	-	-	-	-	-
	Aug	11	76	100	27	130	0.6
	Sept	11	135	100	39	266	1.0

3.6.3 IWDG Rockabill to Dalkey Island SAC (2021)

In the summer of 2021 (Sep-Aug), line transect surveys were conducted within the Rockabill to Dalkey Island SAC to estimate density and abundance (Berrow *et al.*, 2021). In total, six survey days were conducted, all with Beaufort sea state ≤ 2, totalling 728 km of trackline surveyed and 137 sightings totalling 181 individual porpoise. The density estimates for each survey ranged between 0.50 porpoises/km^2 to a maximum of 0.98 porpoises/km^2, with an overall pooled density of 0.83 ±0.14 porpoises/km^2.

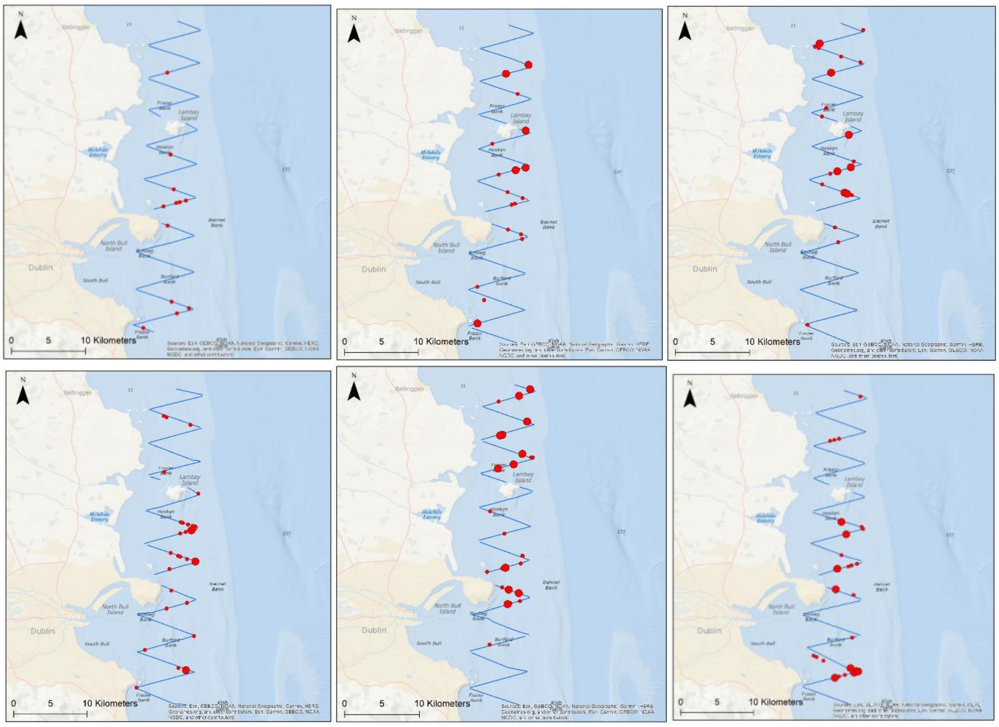


Figure 3-11 Track-lines and distribution of harbour porpoise sightings (Berrow *et al.*, 2021)

3.6.4 IWDG Rockabill to Dalkey Island SAC (2016)

In the summer of 2016 (Jun-Sep), line transect surveys were conducted within the Rockabill to Dalkey Island SAC to estimate density and abundance (O'Brien and Berrow, 2016). In total, four survey days were conducted, all with Beaufort sea state ≤ 2, totalling 506 km of trackline surveyed and 152 sightings totalling 246 individual porpoise (Figure 3-12). The density estimates for each survey ranged between 1.37 porpoises/km^2 to a maximum of 1.87 porpoises/km^2, with an overall pooled density of 1.55 ±0.17 porpoises/km^2 (CV: 0.10). These density estimates within the SAC were very similar to those obtained in 2013 (1.44 ±0.09 porpoise/km^2, CV: 0.06) (Berrow and O'Brien, 2013) which suggests that the summer population within the SAC was stable between these two timepoints.

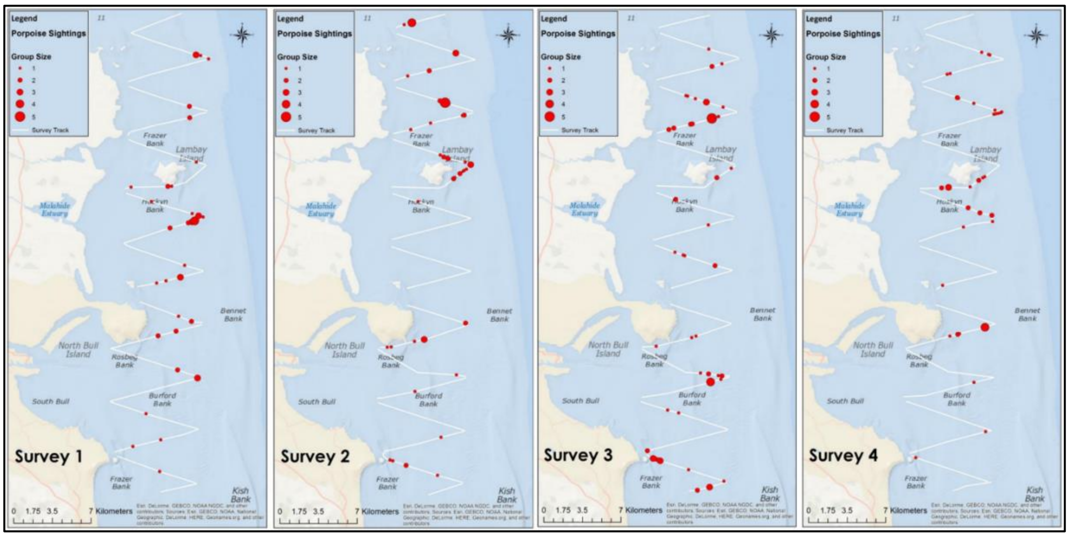


Figure 3-12 Locations of harbour porpoise sightings and corresponding group sizes recorded during each one-day survey of Rockabill to Dalkey Island SAC in 2016 (O'Brien and Berrow, 2016).

3.6.5 Greater Dublin Drainage Project (Meade *et al.*, 2017)

The visual and static PAM surveys conducted as part of the Greater Dublin Drainage project also identified harbour porpoise in the area year round (Meade *et al.*, 2017). A total of 23 land-based surveys were conducted between March 2015 and March 2017 at Howth Head, where harbour porpoise were detected on 83% of the survey days (consisting of 167 sightings, totalling 293 individuals, including juvenile and calves). Sightings were highest between August and January 2015 and August and October 2016. A total of 897 km of trackine was surveyed between April 2015 to January 2017 (11 surveys), with harbour porpoise being detected on every survey day (with a peak in sightings in November 2015 and August 2016). Harbour porpoise density estimates from the transect surveys ranged between 0.61 to 2.29 porpoise/km^2, with a mean density of 1.312 porpoise/km^2 (Meade *et al.*, 2017).

3.7 Other OWFs

3.7.1 NISA

Harbour porpoise were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial site-specific marine mammal surveys have been undertaken as part of the NISA project (ARUP, 2021), these data are yet to be published and site-specific density estimates are not yet available.

3.7.2 Dublin Array

Harbour porpoise were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although boat site-specific marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

3.7.3 Arklow Bay Wind Park

Surveys conducted for the Arklow Bay Wind Park indicated that harbour porpoise regularly occurred within the Bank and survey areas with seasonal peaks in summer and early autumn, and occasional larger counts were made of harbour porpoise inshore along the offshore export cable route (RPS, 2020). A summary of the number of groups, individual abundance, number of sightings and/or individual density estimates derived from site specific surveys for Arklow Bay Wind Park were not provided within the Scoping Report, thus no information on these numbers can be provided within the baseline report.

3.8 Seasonality

In the British Isles, it is estimated that the breeding season typically occurs between June and September, with births predominantly in June (Lockyer, 1995). They are considered a slowly reproducing species as they give birth only once a year and therefore are dependent on a successful breeding season (Kesselring *et al.*, 2017). Dynamic energy budget modelling has shown that female porpoise are expected to be most vulnerable to disturbance (reduction in food intake) between the time the calf is born until it is able to acquire at least some food independently (June – Sept inclusive) (Harwood *et al.*, 2020). The population will, therefore, be more vulnerable to disturbance during this breeding and early lactation season.

Sightings during the site-specific aerial surveys were highly variable, but peak harbour porpoise sightings occurred during the spring and summer seasons (Table 9, Figure 3-13, Figure 3-14). Based on the site-specific survey data, harbour porpoise were most common within the CWP Project during the months of March and August, with the lowest number of sightings occurring in February. Several other surveys conducted (e.g., Berrow *et al.*, 2008, Rogan *et al.*, 2018) also found harbour porpoise density and abundance to be higher during the summer months.

Table 9 Number of individual harbour porpoise sighted per month during site-specific surveys

Month	Season	Surveys Conducted	Number of Individuals Observed
January	Winter	Boat-based visual & DAS	26
February	Winter	Boat-based visual & DAS	9
March	Spring	Boat-based visual & DAS	148
April	Spring	Boat-based visual & DAS	101
May	Spring	Boat-based visual & DAS	42
June	Summer	Boat-based visual & DAS	92
July	Summer	Boat-based visual & DAS	50
August	Summer	Boat-based visual & DAS	142
September	Autumn	Boat-based visual & DAS	100
October	Autumn	Boat-based visual & DAS	41
November	Autumn	Boat-based visual & DAS	46
December	Winter	Boat-based visual & DAS	32

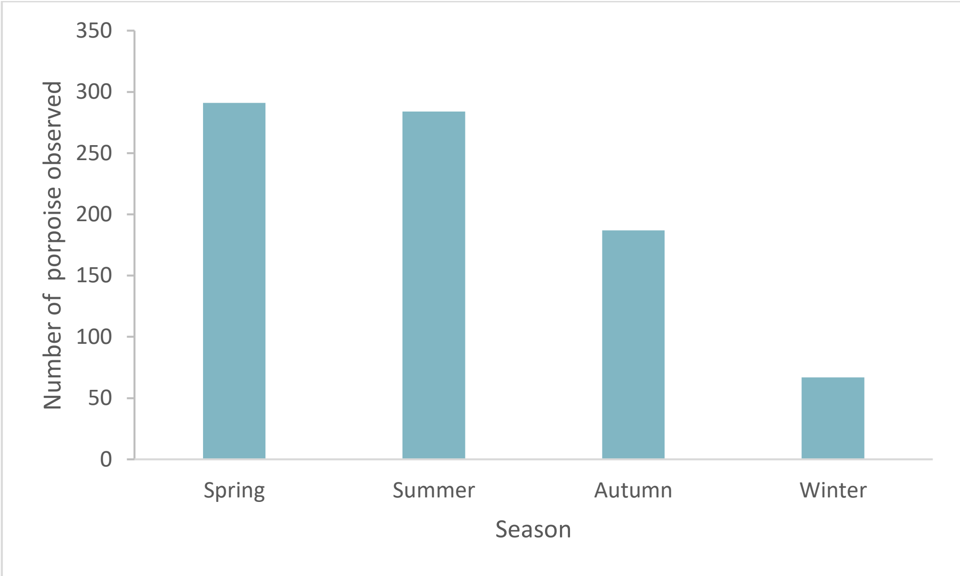


Figure 3-13 Seasonal differences in harbour porpoise sightings across the site-specific surveys.

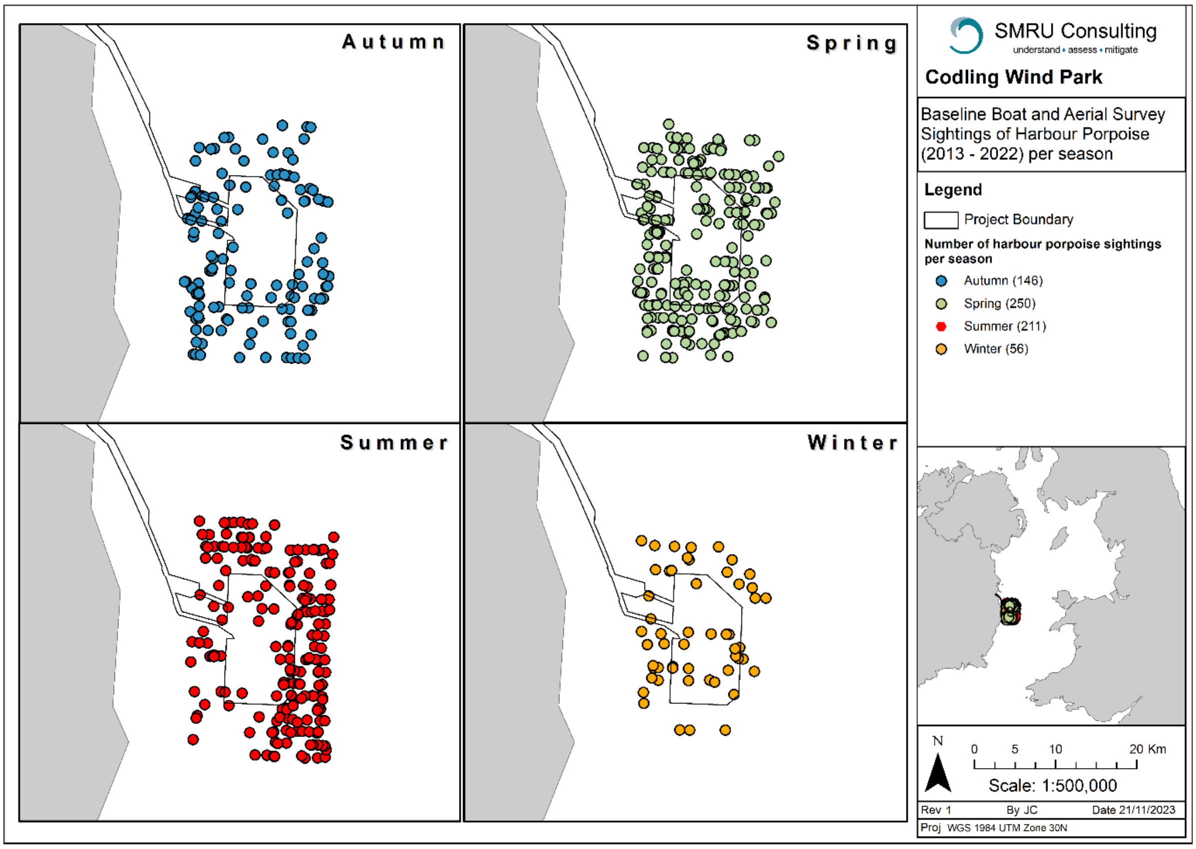


Figure 3-14 Seasonal differences in harbour porpoise sightings across the site-specific surveys.

3.9 Summary

There have been several studies of harbour porpoise in the Irish Sea and in the vicinity of the CWP Project. This has resulted in a range of density estimations for the area (Table 10). The site-specific survey data are considered the best representation of harbour porpoise density in the CWP Project. However, given the range of density estimates available and the different areas covered by the density estimates, a range will be taken forward to the quantitative impact assessment. This will include: the site-specific survey estimate, the SCANS IV uniform density estimate, the SCANS III density surface estimate and the Evans and Waggitt (2023) density surface.

Table 10 Harbour porpoise density estimates (porpoise/km^2)

Data source	Reference	Density estimate
CWP Project site specific surveys	Natural Power (2023)	0.1225 (Density surface estimate) 0.2486 (Point density estimate)
ObSERVE summer stratum 5	Rogan *et al.* (2018)	Season 1: 0.696 Season 3: 1.046
ObSERVE winter stratum 5	Rogan *et al.* (2018)	Season 2: 0.867 Season 4: 0.924
SCANS IV block CS-D	Gilles *et al.* (2023)	0.2803
SCANS III density surface	Lacey *et al.* (2022)	Grid cell specific <0.25 in the CWP Project array site
SCANS III block E	Hammond *et al.* (2017)	0.239
Welsh and Irish Sea distribution	Evans and Waggitt (2023)	Grid cell specific 0.3 – 0.4 in the CWP Project array site
IWDG Irish Sea Block A	Berrow *et al.* (2011)	1.585
IWDG North County Dublin	Berrow *et al.* (2008)	2.03
IWDG Dublin Bay	Berrow *et al.* (2008)	1.19
IWDG Rockabill to Dalkey Island SAC (2021)	Berrow *et al.* (2021)	0.83
IWDG Rockabill to Dalkey Island SAC (2016)	O'Brien and Berrow (2016)	1.55

4 Bottlenose dolphin

Bottlenose dolphins are described as being *"one of the most frequently recorded and familiar cetaceans occurring in Ireland"*, occurring in group sizes between 3 and 30 in coastal waters, and larger groups of hundreds of individuals in offshore waters (NPWS, 2019) (Figure 4-1). Bottlenose dolphins were sighted off all Irish coasts, with evidence that an offshore ecotype of bottlenose dolphins exists in Irish waters (Mirimin *et al.*, 2011). While the highest relative abundances of these individuals were reported to be in the offshore waters in the west of Ireland, small densities of bottlenose dolphins were reported along the east coast (Figure 4-2). Mother-calf pairs of bottlenose dolphins are primarily reported in Irish waters during the summer months (Berrow *et al.*, 2012).

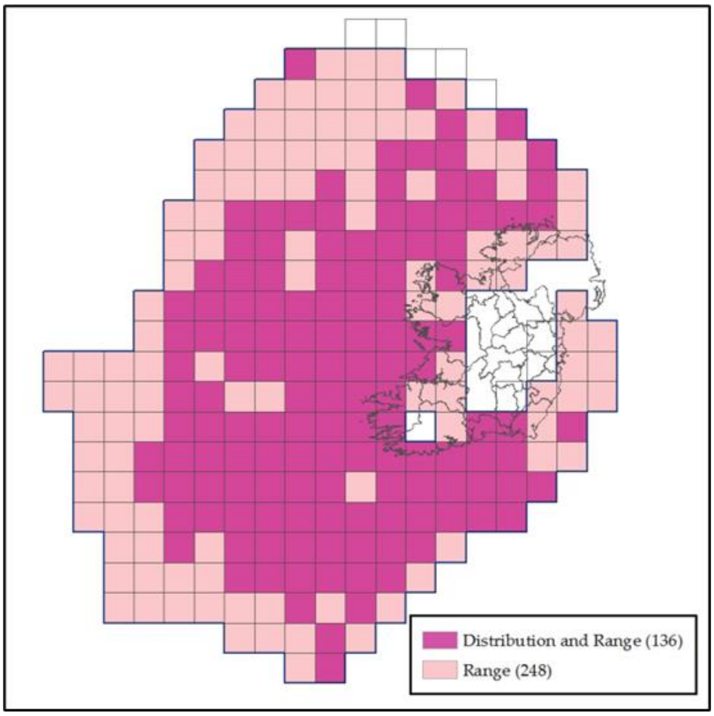


Figure 4-1 The range and distribution of bottlenose dolphins in Irish waters (NPWS, 2019).

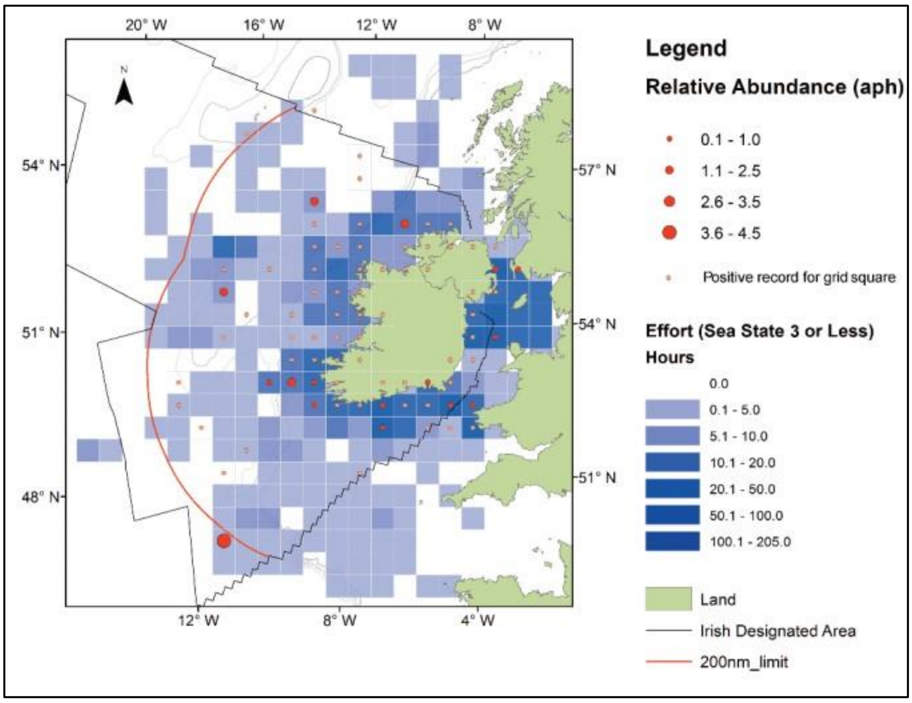


Figure 4-2 Relative abundance of bottlenose dolphins from the Irish marine mammal atlas (Wall *et al.*, 2013)

4.1 MU

CWP Project is located within the Irish Sea MU for bottlenose dolphins, where there is an estimated abundance of 293 bottlenose dolphins (CV: 0.54, 95% CI: 108 - 793) (IAMMWG, 2023) based on data collected during SCANS III and the ObSERVE surveys (Rogan *et al.*, 2018, Hammond *et al.*, 2021).

Previous research, combining genetic and photo-ID data has concluded that a high degree of site fidelity for bottlenose dolphins in Irish waters is present amongst Ireland's coastal populations (Nykänen *et al.*, 2018, Nykänen *et al.*, 2020). However, studies have also found that bottlenose dolphins can undertake movements of up to a few hundred kilometres around Ireland (O'Brien *et al.*, 2009). There has also been some evidence of movement from the Atlantic to the North Sea, with these long-distance movements reported by Robinson *et al.* (2012) suggesting confirmation of individual exchange between previously considered discrete populations in the UK and Ireland. Further to this research, movements of bottlenose dolphins have been recorded from the East of Scotland, with individuals from known populations here also being sighted in Irish coastal waters. Due to this, it must be considered that the west coast population of bottlenose dolphins in the RoI may demonstrate connectivity to individuals found on the east coast.

4.2 Site-specific surveys

No bottlenose dolphins were recorded during any of the aerial or boat-based CWP Project site-specific baseline surveys.

4.3 ObSERVE

Bottlenose dolphin sightings during the ObSERVE surveys were mainly located in the west and the south of Ireland (Figure 4-3). Bottlenose dolphins were only sighted in the ObSERVE strata 5 in season 4 (winter 2016), where the resulting design-based estimate was 0.036 dolphins/km^2 and the model-based estimate was 0.020 dolphins/km^2 (Rogan *et al.*, 2018).

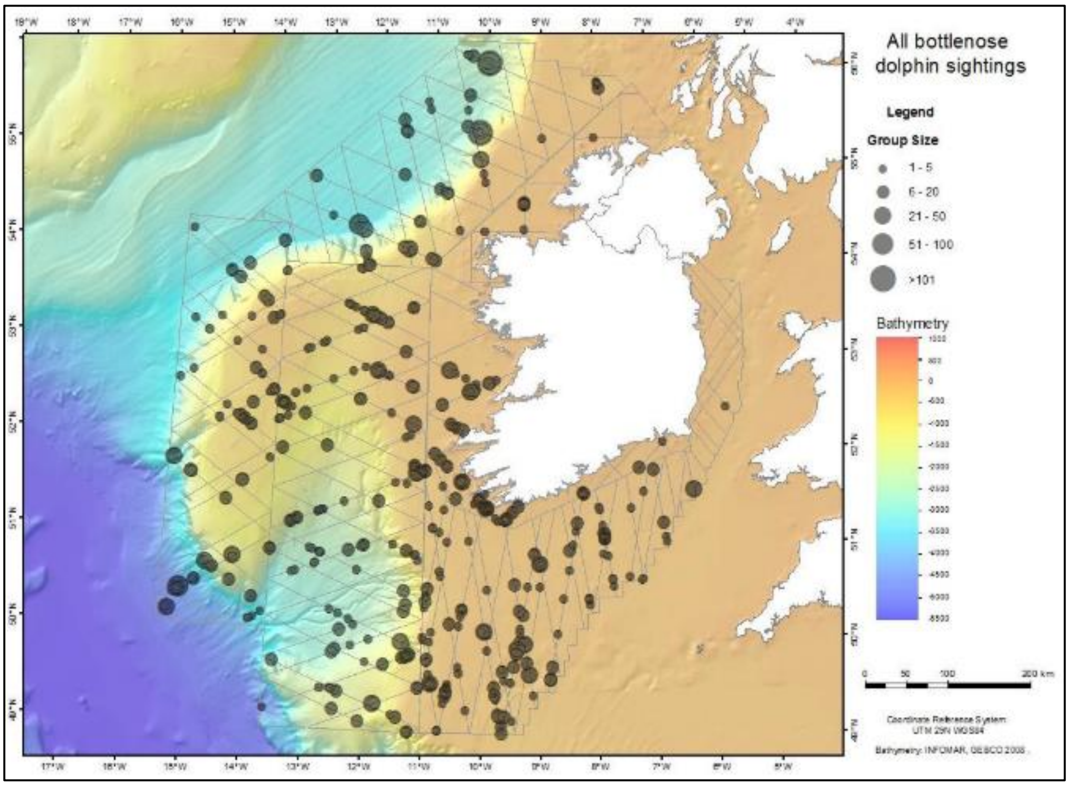


Figure 4-3 All bottlenose dolphin sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

4.4 SCANS

4.4.1 SCANS III

The SCANS III survey effort for the east coast of Ireland, assigned as block E, concluded an estimated abundance of 288 individuals in 2016, with lower and upper CIs of 0 – 664. The estimated density of bottlenose dolphins within this block was reported at 0.008 dolphins/km^2 (Hammond *et al.*, 2017, Hammond *et al.*, 2021).

The density surfaces obtained from the SCANS III data show the predicted bottlenose dolphin distribution across the MU is not uniform, with higher densities found in the southwest of the MU (Lacey *et al.*, 2022). Densities of bottlenose dolphin in the vicinity of CWP Project are relatively low with values below 0.05 bottlenose dolphin/km^2 in the array site and ECC (Figure 4-4).

While the SCANS III bottlenose dolphin density surface provides some information on bottlenose dolphin distribution within the Irish Sea (higher in the coastal waters of east Ireland), the density surface is incompatible with the Irish Sea MU population size estimate of 293 bottlenose dolphins (IAMMWG, 2023). If the grid cells within the Irish Sea MU are summed, then the number of bottlenose dolphins present in the Irish Sea MU according to the Lacey *et al.* (2022) density surface is 1,069 bottlenose dolphins. This is over three times higher than the MU abundance estimate advised by IAMMWG (2023). If the Lacey *et al.* (2022) density surface is to be used in a quantitative impact assessment to predict the number of bottlenose dolphins impacted, then the Irish Sea MU population has to be assumed to be 1,069 bottlenose dolphins, or else more dolphins could be predicted to be impacted than there are in the MU population if it is assumed to be 293.

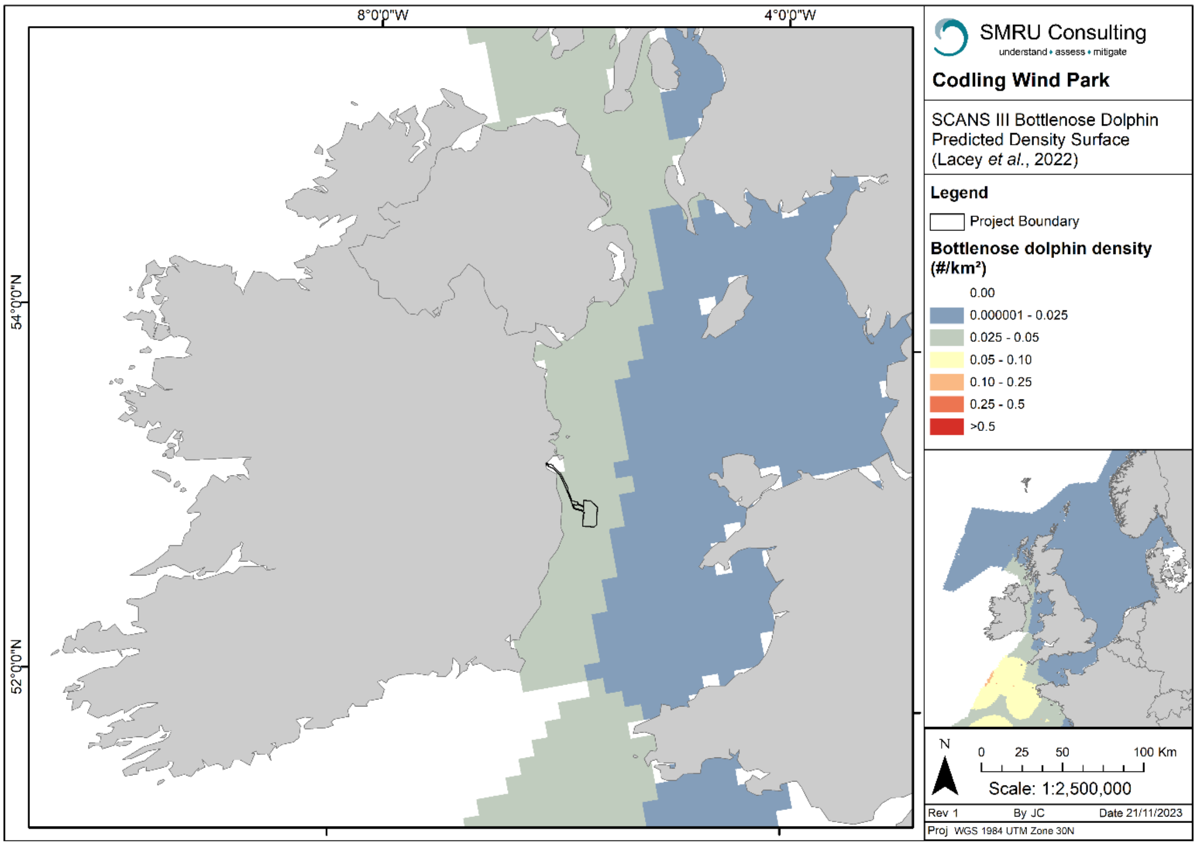


Figure 4-4 Predicted surface for bottlenose dolphin in SCANS III. Data from Lacey et al. (2022).

4.4.2 SCANS IV

The SCANS IV used different survey block names to SCANS III, and CWP Project is located within SCANS IV survey block CS-D (which covered the western Irish Sea). Bottlenose dolphins were sighted throughout SCANS IV survey block CS-D, resulting in a block wide abundance estimate of 8,199 (95% CI: 3,595 – 15,158) and a uniform density across the survey block of 0.2352 dolphins/km^2 (CV 0.353) (Gilles *et al.*, 2023).

It is important to highlight here the significant differences between the SCANS III and SCANS IV results for the abundance of bottlenose dolphins in the Irish Sea. SCANS III estimates there to be a total of 288 bottlenose dolphins in the Irish Sea, while SCANS IV estimates there to be 8,326 bottlenose dolphins in the Irish Sea (Table 11). The difference in bottlenose sightings between SCANS III and SCANS IV are shown in Figure 4-5, where there were significantly more bottlenose dolphin sightings throughout the Irish Sea in SCANS IV. The SCANS IV report states the following with regards to bottlenose dolphins: *"The bottlenose dolphin is a species for which European Atlantic waters are at the edge of a wider North Atlantic range. There is no information on abundance in the central North Atlantic but the differences in distribution and abundance estimates between 2005/07, 2016 and 2022 may reflect bottlenose dolphins responding to interannual spatial variation in prey availability across the wider range. Data from the 2022 ObSERVE2 survey, when available, will add to understanding of the variation in distribution and abundance of bottlenose dolphin in European Atlantic waters seen between SCANS-IV and previous surveys."* (Gilles *et al.*, 2023). The current recommended population estimate for the Irish Sea MU is 293 bottlenose dolphins (IAMMWG, 2023) based on data from SCANS III and ObSERVE. The abundance estimate of 8,326 bottlenose dolphins in the Irish Sea using the SCANS IV density estimates is therefore completely incompatible with the current Irish Sea MU population size estimate of 293. Therefore, it is not possible to use the SCANS IV density estimate in a quantitative impact assessment unless the Irish Sea MU abundance estimate is assumed to be 8,326 instead of 293.

Table 11 Number of bottlenose dolphins estimated to be in the Irish Sea using SCANS III (Hammond *et al.*, 2017, Hammond *et al.*, 2021) and SCANS IV estimates (Gilles *et al.*, 2023).

	SCANS III	SCANS IV
West Irish Sea block	E	CS-D
Area west Irish Sea block (km^2)	34,870	34,867
Density in west Irish Sea block (#/km^2)	0.0082	0.2352
Abundance in west Irish Sea block (95% CIs)	288 (0 – 664)	8,199 (3,595 - 15,158)
East Irish Sea block	F	CS-E
Area east Irish Sea block (km^2)	12,322	12,274
Density in east Irish Sea block (#/km^2)	0	0.0104
Abundance in east Irish Sea block (95% CIs)	0	127 (3 – 353)
Total bottlenose dolphins in Irish Sea	**288**	**8,326**

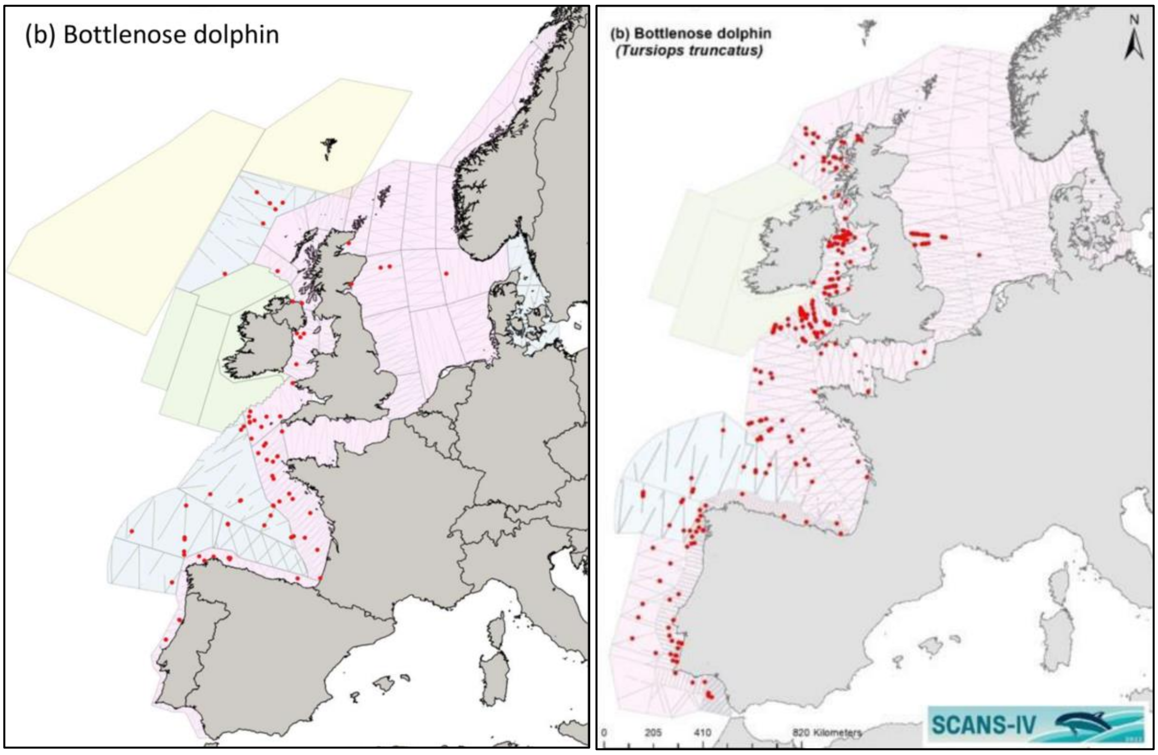


Figure 4-5 Distribution of bottlenose dolphin sightings in SCANS III (left) (Hammond *et al.*, 2017, Hammond *et al.*, 2021) and SCANS IV (right) (Gilles *et al.*, 2023)

4.5 Irish Sea distribution

In Evans and Waggitt (2023), bottlenose dolphins were modelled throughout the Irish Sea and Bristol Channel, with consistent distribution patterns across seasons (Figure 4-6). The modelled outputs indicate that the main areas of high density are inclusive of Cardigan Bay and west Anglesey, with some densities in a concentrated area on the southwest coast of England. The densities predicted for the east coast of the Republic of Ireland were comparatively very low. Using the maximum density per cell across all months, the estimated density in the CWP Project array site is at most 0.01 dolphins/km^2 (Figure 4-7).

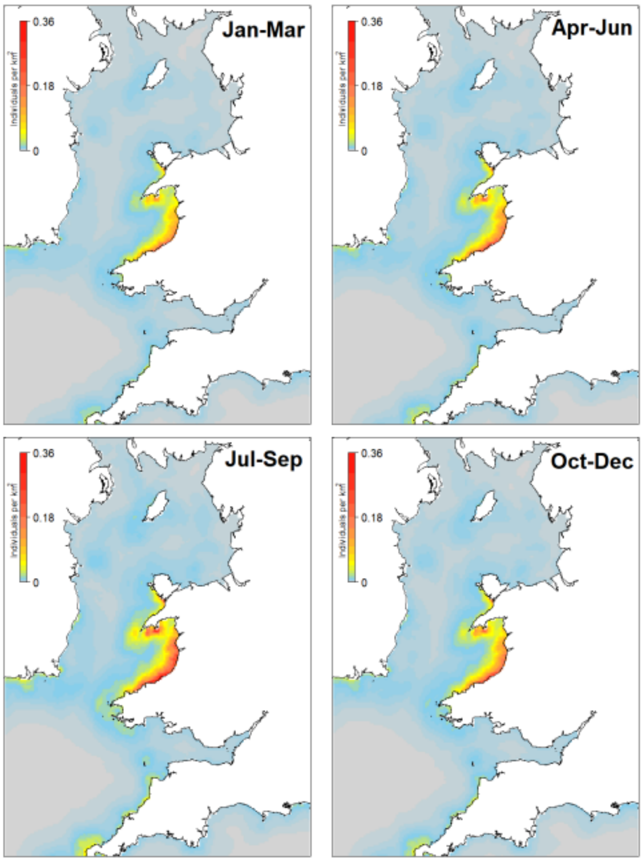


Figure 4-6 Bottlenose dolphin modelled densities by quarter (Evans and Waggitt, 2023).

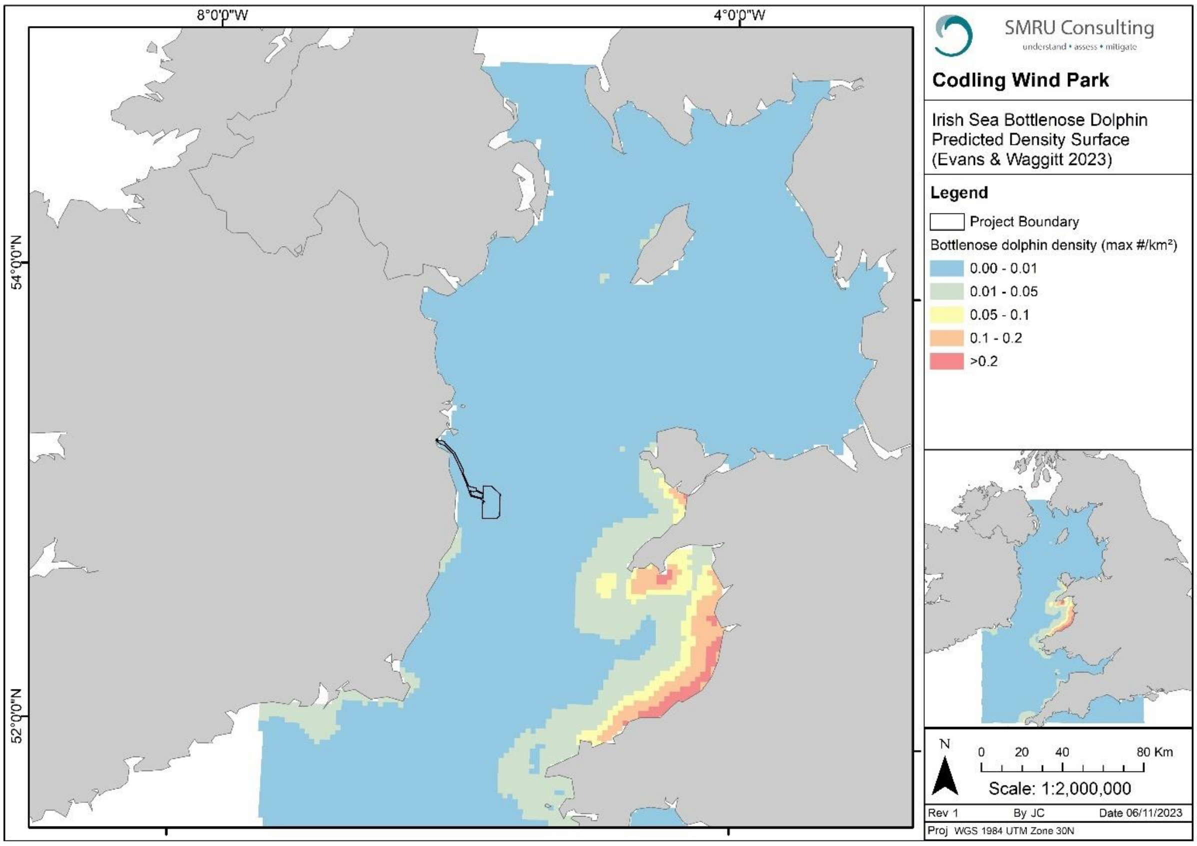


Figure 4-7 Bottlenose dolphin modelled densities (maximum density per cell across months) relative to the CWP Project (Evans and Waggitt, 2023).

As noted for the SCANS surveys, the Evans and Waggitt (2023) maximum density surface is not compatible with the Irish Sea MU population size estimate of 293 bottlenose dolphins (IAMMWG, 2023). If the grid cells within the Irish Sea MU are summed, then the number of bottlenose dolphins present in the Irish Sea MU according to the Evans and Waggitt (2023) maximum density surface is 496 bottlenose dolphins. This is over 1.5 times higher than the MU abundance estimate advised by IAMMWG (2023). If the Evans and Waggitt (2023) maximum density surface is to be used in a quantitative impact assessment to predict the number of bottlenose dolphins impacted, then the Irish Sea MU population has to be assumed to be 496 bottlenose dolphins, or else more dolphins could be predicted to be impacted than there are in the MU population if it is assumed to be 293.

4.6 IWDG surveys

For the majority of IWDG surveys, no bottlenose dolphin sightings were reported on the east coast of Ireland during the IWDG surveys considered in this baseline characterisation (O'Brien *et al.*, 2009, Berrow *et al.*, 2011, O'Brien and Berrow, 2016, Berrow *et al.*, 2021). For example, during inshore Irish Sea surveys conducted in 2011, bottlenose dolphins were not sighted in Blocks A or B, and were not acoustically detected (Berrow *et al.*, 2011). However, in Berrow *et al.* (2008) during a survey in North County Dublin, a group of 20 bottlenose dolphins was sighted on one occasion.

4.7 Other OWFs

NISA

Bottlenose dolphins were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial marine mammal site-specific surveys have been undertaken as part of the NISA project (ARUP, 2021), these data are yet to be published and site-specific density estimates are not yet available.

Dublin Array

Bottlenose dolphins were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although boat site-specific marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

Arklow Bay Wind Park

Bottlenose dolphins were not observed during site specific surveys for Arklow Phase 1 and 2.

4.8 Seasonality

No sightings of bottlenose dolphins were made during site-specific surveys at CWP Project and thus, inferences on seasonality could not be made.

Whilst other studies have shown that bottlenose dolphins have been sighted all year round in Irish waters (Berrow *et al.*, 2012), data from ObSERVE showed no real difference in the density of bottlenose dolphins between summer and winter in strata 5 (Rogan *et al.*, 2018). In addition, Evans and Waggitt (2023) demonstrated consistent distribution patterns and density estimations of bottlenose dolphins in the Irish Sea across all seasons. These data seem to confirm a year-round presence of bottlenose dolphins in the Irish Sea.

4.9 Summary

There are a few surveys that have recorded bottlenose dolphins in the vicinity of CWP Project, (the SCANS surveys, the ObSERVE surveys and surveys undertaken at other OWF sites). The density estimates from all surveys was fairly low, ranging between 0.00 to <0.5 dolphins/km^2 (Table 12). A range of density estimates will be taken forward to the quantitative impact assessment to reflect the uncertainty in bottlenose dolphin density in the CWP Project area and the wider Irish Sea. These will include the SCANS IV uniform density estimate, the SCANS III density surface and the Evans and Waggitt (2023) density surface.

Table 12 Bottlenose dolphin density estimates (dolphins/km^2)

Data source	Reference	Density estimate
CWP Project site specific surveys	Natural Power (2023)	No estimation provided
ObSERVE summer stratum 5	Rogan *et al.* (2018)	No estimation provided
ObSERVE winter stratum 5	Rogan *et al.* (2018)	Season 2: No estimate provided Season 4: 0.02
SCANS IV block CS-D	Gilles *et al.* (2023)	0.2352
SCANS III density surface	Lacey *et al.* (2022)	Grid cell specific <0.05 in the CWP Project array site
SCANS III block E	Hammond *et al.* (2017)	0.008
Welsh and Irish Sea distribution	Evans and Waggitt (2023)	Grid cell specific Max 0.01 in the CWP Project array site

5 Common dolphin

Common dolphins are the most frequently recorded dolphin species in Irish waters, occurring in group sizes ranging from a few individuals to over a thousand individuals in the open sea (NPWS, 2019). They have a wide distribution and occur in both coastal and offshore waters off Ireland (Figure 5-1). The species has been assessed as having an overall Favourable conservation status in Irish waters (NPWS, 2019).

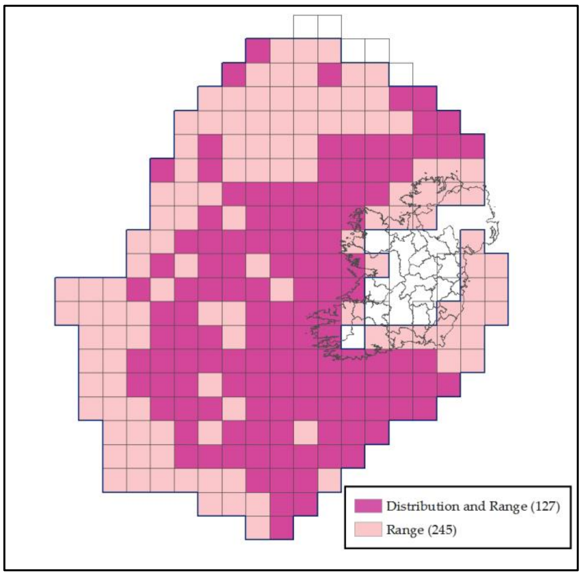


Figure 5-1 The range and distribution of short-beaked common dolphin in Irish waters (NPWS, 2019).

5.1 MU

The IAMMWG recommend that a single Celtic and Greater North Seas MU is appropriate for common dolphins (IAMMWG, 2023). The abundance estimate for the MU is 102,656 (CV: 0.29, 95% CI: 58,932 – 178,822) based on data collected during SCANS III and the ObSERVE surveys (Rogan *et al.*, 2018, Hammond *et al.*, 2021).

5.2 Site-specific surveys

Density estimations for common dolphin were derived by modelling both boat-based survey and aerial survey data (Natural Power, 2023) (Figure 5-5):

- During 2013-2014 boat-based surveys, no common dolphins were sighted.
- During the 2018-2020 boat-based surveys, 6 common dolphins were recorded. Assuming a strip width of 0.22 km and an assumed availability of 1, the density estimate was 0.0026 dolphins/km^2.
- During the 2020-2022 aerial surveys, 82 common dolphins were recorded. Assuming a strip width of 0.25 km and an assumed availability of 0.203 (Watwood *et al.*, 2020), the density estimate was 0.2810 dolphins/km^2. This is significantly higher than the SCANS IV density estimate for the eastern Irish Sea (0.0272 dolphins/km^2, see below).

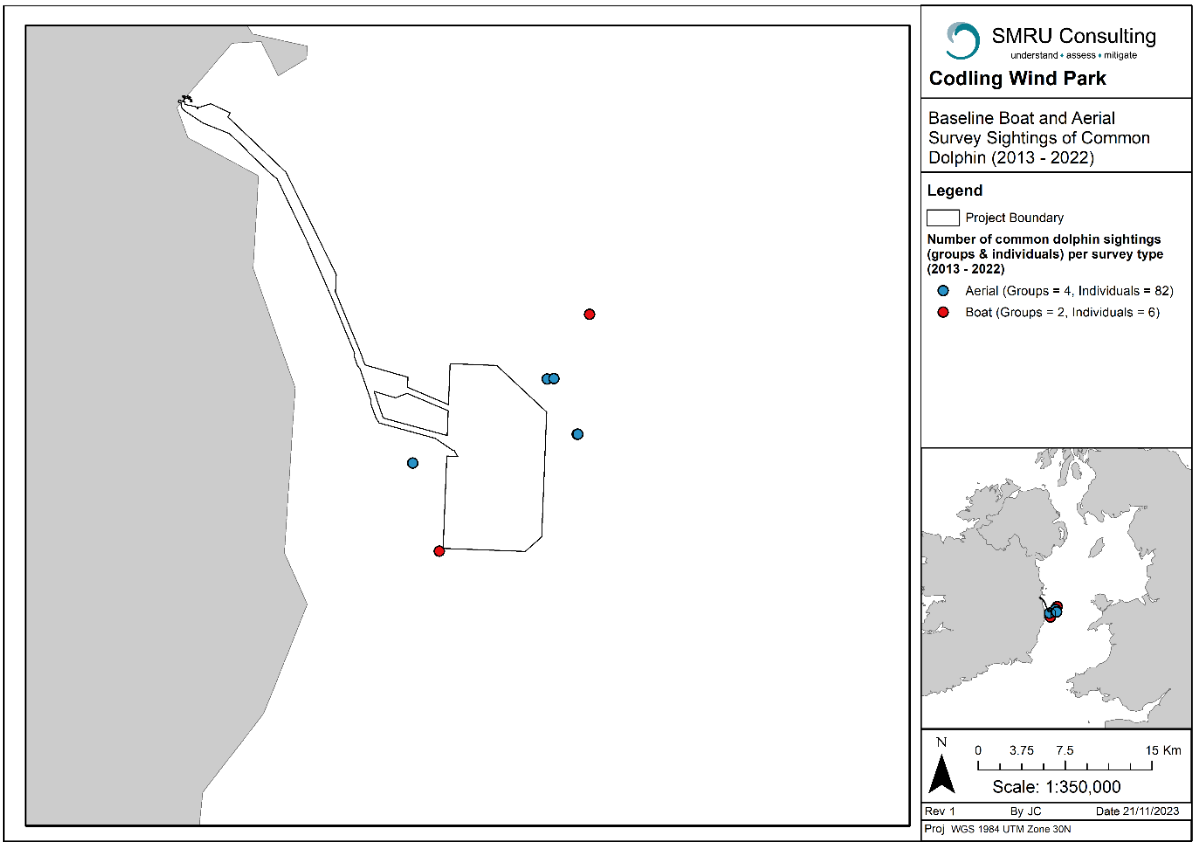


Figure 5-2 Number of common dolphin sightings within the project array site, ECC and surrounding area. All data were collated as part of baseline boat and aerial surveys.

5.3 ObSERVE

During the ObSERVE surveys, common dolphins were mainly sighted in deeper waters, to the west and south of Ireland. No common dolphins were sighted in stratum 5 in the Irish Sea during any of the ObSERVE surveys (Figure 5-3).

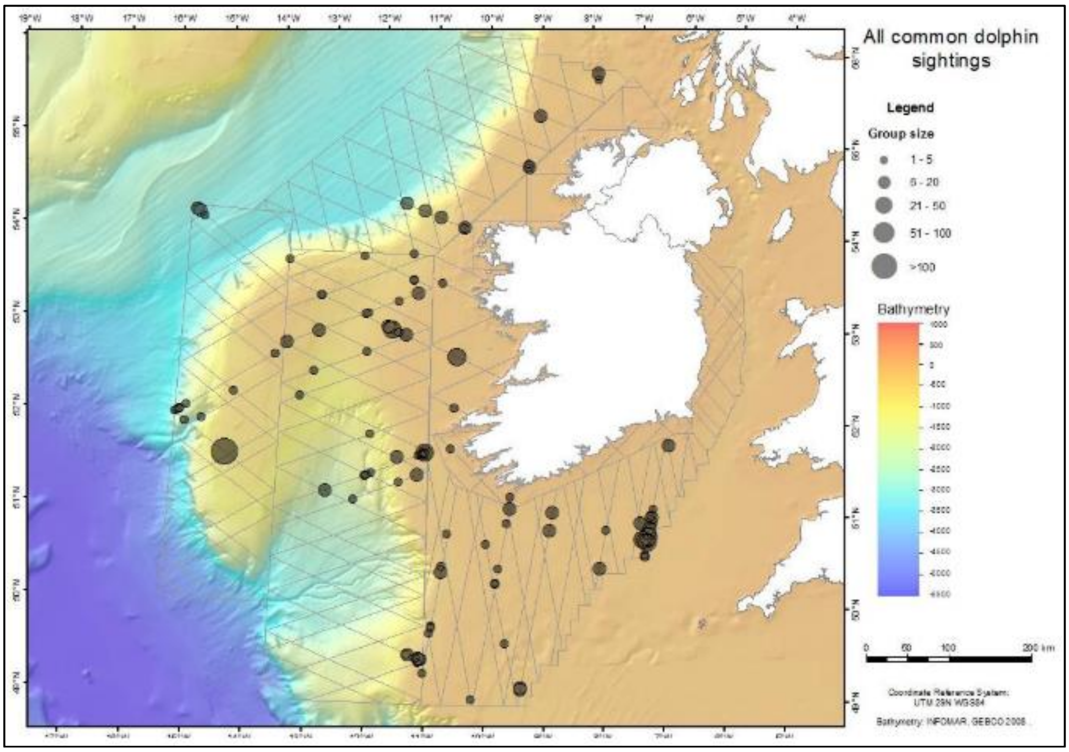


Figure 5-3 All common dolphin sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

5.4 SCANS

5.4.1 SCANS III

Although no common dolphins were sighted in SCANS III block E (Hammond et al. 2017), the SCANS III data shows that the predicted common dolphin distribution across the MU is not uniform, with higher densities found in the southwest of the MU, along the shelf edge in the northern Bay of Biscay and around the coasts of Spain and Portugal (Lacey *et al.*, 2022). Densities of common dolphin in the vicinity of the CWP Project are low with values below 0.07 common dolphin/km^2 (Figure 5-4).

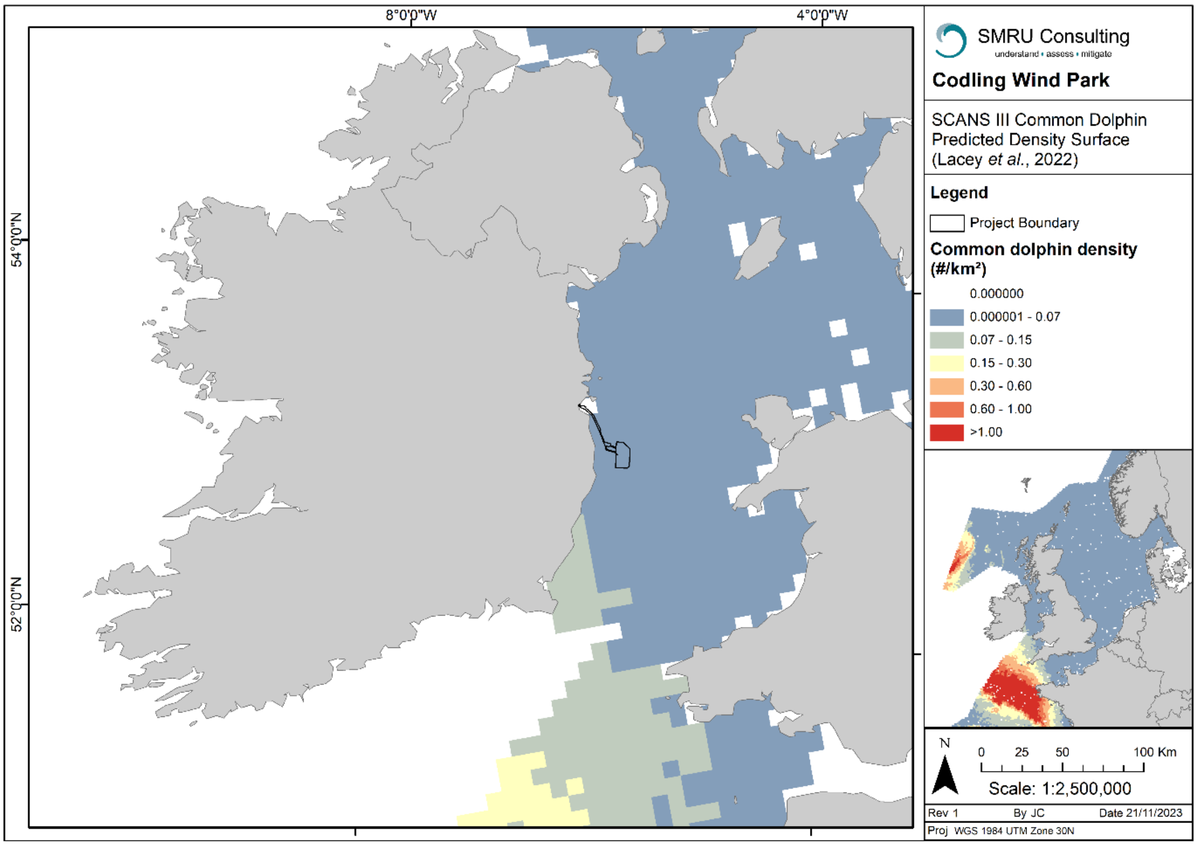


Figure 5-4 Predicted surfaces of estimated density for common dolphin in SCANS III. Data from Lacey *et al.* (2022).

5.4.2 SCANS IV

The SCANS IV used different survey block names to SCANS III, and Dublin Array is located within SCANS IV survey block CS-D (which covered the western Irish Sea). Common dolphin were sighted throughout SCANS IV survey block CS-D, resulting in a block wide abundance estimate of 949 (95% CI: 32 – 2,990) and a uniform density across the survey block of 0.0272 dolphins/km^2 (CV 0.814) (Gilles *et al.*, 2023). It is important to note that Gilles *et al.* (2023) highlight there are issues with species validation for common and striped dolphin sightings. SCANS IV therefore report on densities of 'common dolphins', 'striped dolphins' and 'Unidentified common or striped dolphins', In block CS-D, common dolphins were recorded, but there were no sightings of striped dolphins or 'unidentified common or striped dolphins'.

5.5 Irish Sea distribution

Evans and Waggitt (2023) modelled short-beaked common dolphin throughout the Irish Sea and Bristol Channel, with consistent distribution patterns across seasons (Figure 5-5). The third quarter, July – September, had peak densities. The modelled outputs below indicate that the main areas of high density are inclusive of the south coast of the Republic of Ireland, the southwest coast of England, and the southwest coast of Wales. Using the maximum density per cell across all months, the estimated density in the CWP Project is up to 0.01 dolphins/km^2 (Figure 5-6).

Evans and Waggitt (2023) note the following important information with regards to the common dolphin density surface: *"The maps need careful interpretation because survey effort is patchy and greater in the southern Irish Sea than elsewhere. Although the modelled density maps attempt to overcome potential biases including variation in effort, where effort is minimal there is obviously greater uncertainty"*.

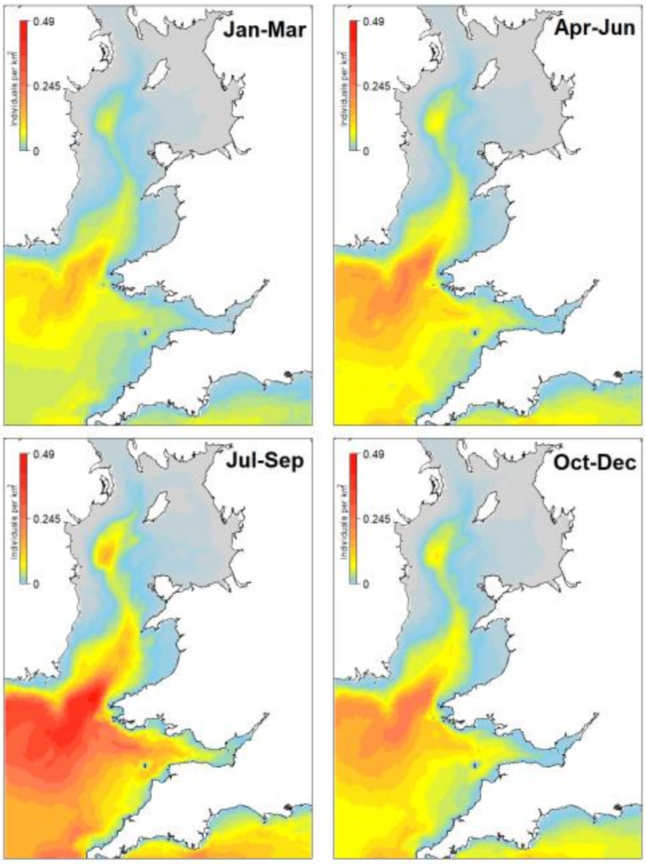


Figure 5-5 Common dolphin modelled densities by quarter (Evans and Waggitt, 2023).

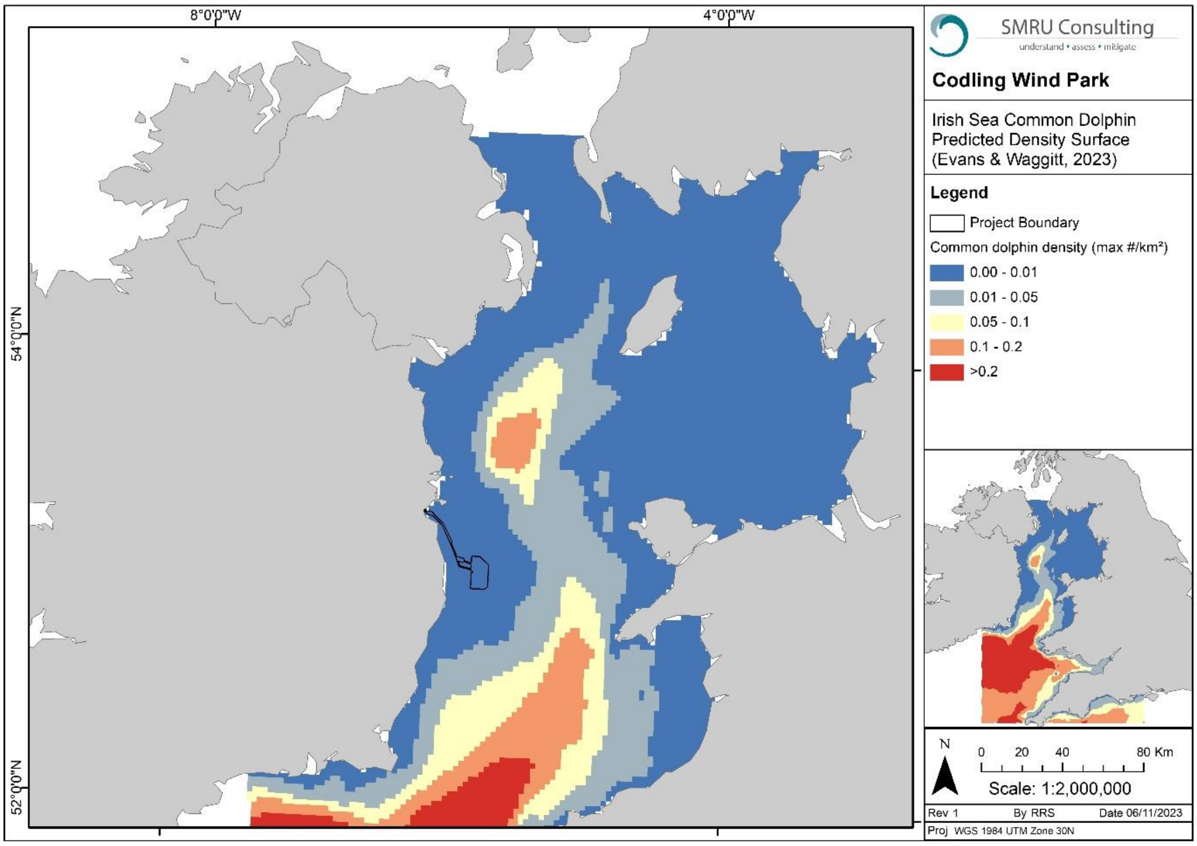


Figure 5-6 Common dolphin modelled densities (maximum density per cell across months) relative to the CWP Project (Evans and Waggitt, 2023).

5.6 IWDG surveys

For the majority of IWDG surveys, no common dolphin sightings were reported on the east coast of Ireland during the IWDG surveys considered in this baseline characterisation (Berrow *et al.*, 2008, O'Brien *et al.*, 2009, Berrow *et al.*, 2011, Berrow *et al.*, 2012, O'Brien and Berrow, 2016). However, in Berrow *et al.* (2021) during harbour porpoise surveys in the Rockabill and Dalkey Island SAC, common dolphin were recorded on two occasions.

5.7 Other OWFs

NISA

Common dolphins were not identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021).

Dublin Array

Common dolphins were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although boat site-specific marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

Arklow Bay Wind Park

Short-beaked common dolphins were not observed during site specific surveys for Arklow Phase 1 and 2.

5.8 Seasonality

Common dolphins were not sighted during every month or season during site-specific boat-based visual or aerial surveys. Based on site-specific survey data only, common dolphins were present within the CWP Project development area most frequently during spring and autumn months, although the greatest number of individuals observed was for the month of January (Table 13). However, other data sources analysed as part of this baseline characterisation report indicates the potential for common dolphin presence within the Irish Sea all year round and thus, inference on common dolphin seasonality within the CWP Project based on site-specific survey data only should be exercised with caution.

For example, short-beaked common dolphins have been reported in Irish waters year-round with the higher densities of these animals from late spring to autumn (specifically July – September (Evans and Waggitt, 2023)), and this species becoming largely absent during the winter (Wall *et al.*, 2013), contradicting the site-specific survey data. An increased density in the late spring to autumn would coincide with common dolphin breeding periods, where calves are typically born during the summer months, typically from May to August (Robinson *et al.*, 2010).

Table 13 Number of individual common dolphins sighted per month during site-specific surveys

Month	Season	Surveys Conducted	Number of Individuals Observed
January	Winter	Boat-based visual, aerial-based	71
February	Winter	Boat-based visual, aerial-based	0
March	Spring	Boat-based visual, aerial-based	10
April	Spring	Boat-based visual, aerial-based	0
May	Spring	Boat-based visual, aerial-based	1
June	Summer	Boat-based visual, aerial-based	0
July	Summer	Boat-based visual, aerial-based	0
August	Summer	Boat-based visual, aerial-based	0
September	Autumn	Boat-based visual, aerial-based	0
October	Autumn	Boat-based visual, aerial-based	2
November	Autumn	Boat-based visual, aerial-based	4
December	Winter	Boat-based visual, aerial-based	0

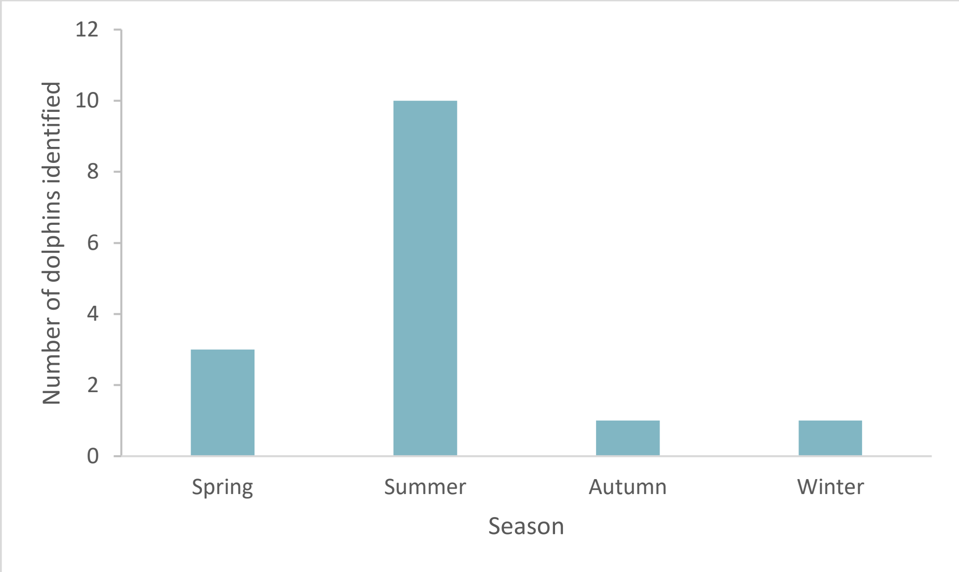


Figure 5-7 Seasonal differences in common dolphin sightings across the site-specific surveys.

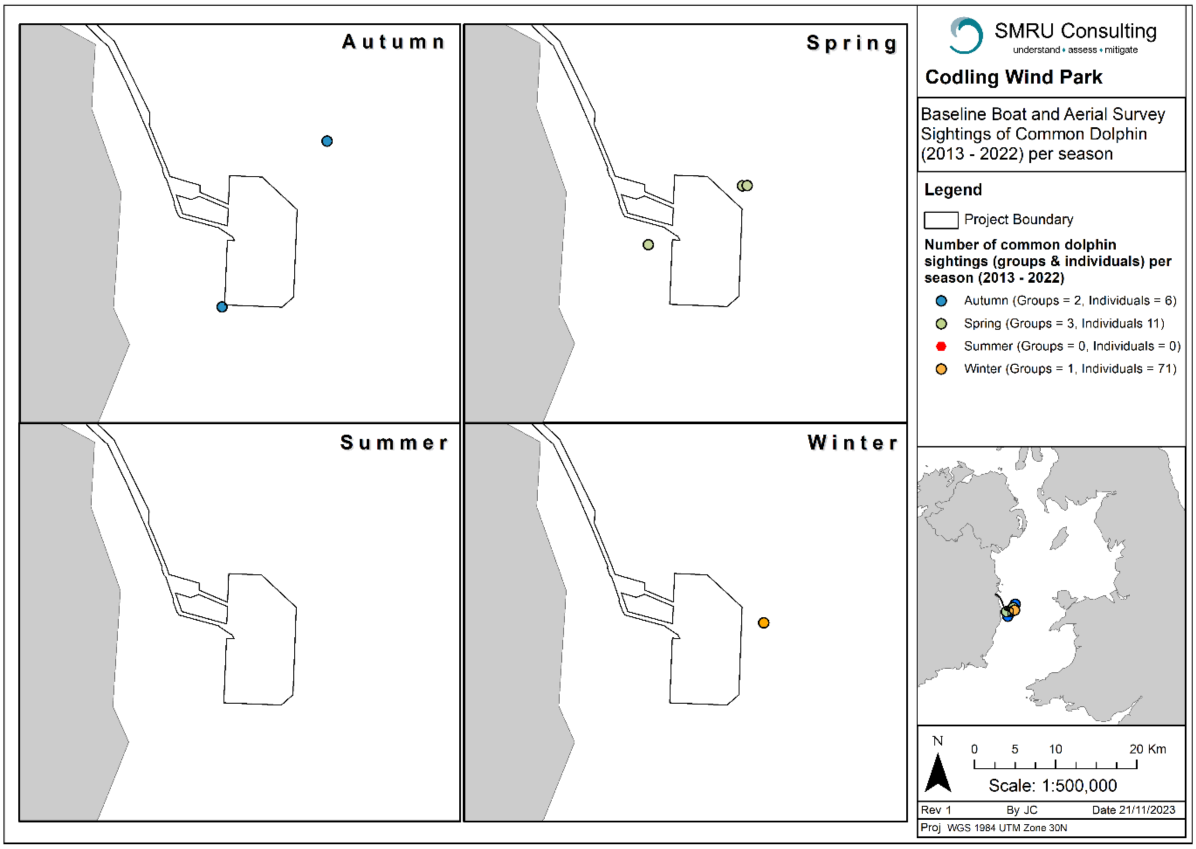


Figure 5-8 Seasonal differences in the number of common dolphin sightings made during site-specific surveys.

5.9 Summary

There are a few surveys that present common dolphins in the vicinity of CWP Project (including the site-specific aerial surveys, the SCANS surveys, the ObSERVE surveys and surveys undertaken at other OWF sites), with density estimates ranging between 0.00 and 0.2810 dolphins/km^2 (Table 14). It is important to consider not only the site-specific survey data, but also density estimates for much wider areas that are more suited to potential larger scale disturbance impacts. Therefore, a range of density estimates will be taken forward to the quantitative impact assessment. These include the CWP Project site-specific survey estimate, SCANS IV uniform density estimate, the SCANS III density surface and the Evans and Waggitt (2023) density surface.

While a range of density estimates shall be taken forward for the quantitative impact assessment, it is acknowledged that the CWP Project site-specific survey density estimate is an order of magnitude greater than the more recent SCANS-IV density for block CS-D. This will lead to large discrepancies in the predicted number of individuals impacted as a result of pile driving activities. Other site-specific surveys for renewable energy projects in the Celtic & Irish Seas have also demonstrated the same trends. For example, the results of site-specific surveys at Erebus (Floating) Offshore Wind Farm resulted in density estimates for common dolphins of 1.61 dolphins/km^2 (Darias-O'Hara and Sinclair, 2021, Blue Gem Wind, 2022) which is much greater than the SCANS IV density estimate for the relevant block (0.8410 dolphins/km^2, CS-C). While there is no evidence to suggest the higher densities of common dolphins persists beyond the site-specific survey area at the CWP Project, this density estimate will be used when assessing the potential for disturbance from pile driving to acknowledge that common dolphin density in the Irish Sea may be higher than was predicted in the SCANS surveys. This is considered to be a highly precautionary approach.

Table 14 Common dolphin density estimates (dolphins/km^2)

Data source	Reference	Density estimate
CWP Project site specific surveys	Natural Power (2023)	0.2810
ObSERVE summer stratum 5	Rogan *et al.* (2018)	No estimate provided
ObSERVE winter stratum 5	Rogan *et al.* (2018)	No estimate provided
SCANS IV block CS-D	Gilles *et al.* (2023)	0.0272
SCANS III density surface	Lacey *et al.* (2022)	Grid cell specific Max 0.07 in the CWP Project array site
SCANS III block E	Hammond *et al.* (2017)	No estimate provided
Welsh and Irish Sea distribution	Evans and Waggitt (2023)	Grid cell specific Max 0.01 in the CWP Project array site

6 Risso's dolphin

Risso's dolphin occurrence is described as *"wide and frequent… throughout Irish waters"*, sighted in both the continental shelf and slope as well as the margins of deeper ocean basins (NPWS, 2019) (Figure 6-1). The species has been assessed as having a Favourable overall conservation status in Irish waters (NPWS, 2019).

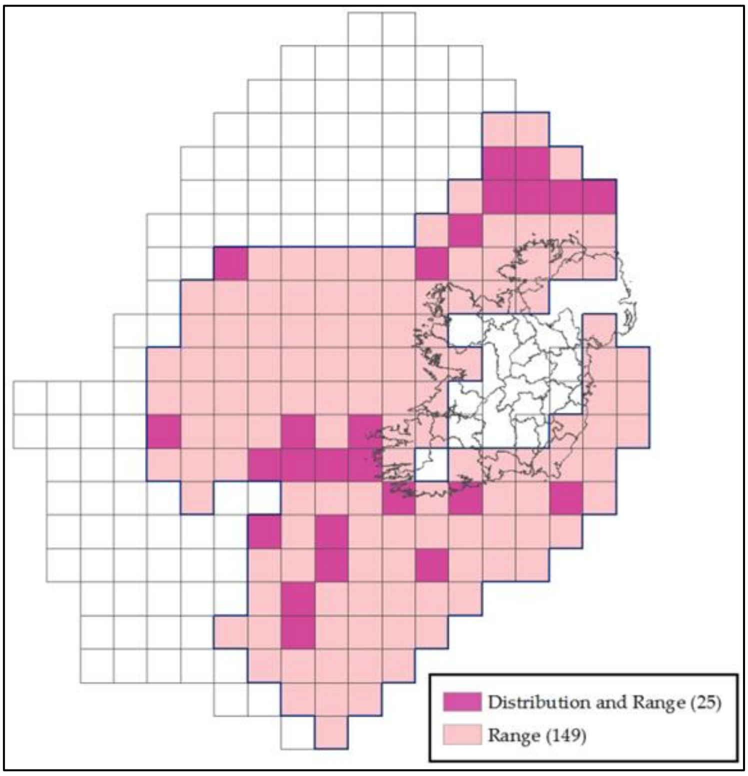


Figure 6-1 The range and distribution of Risso's dolphins in Irish waters (NPWS, 2019).

Risso's dolphins were reported around the entire Irish coast, with highest relative abundances reported to be off the southwest and southeast coasts (Figure 6-2) (Wall *et al.*, 2013). These individuals were sighted in Irish waters from April – November, with a peak in sightings during the summer months. Sightings of young calves in some groups suggested that calving may also be occurring in Irish waters. This species was largely absent in Irish shelf waters from December – March.

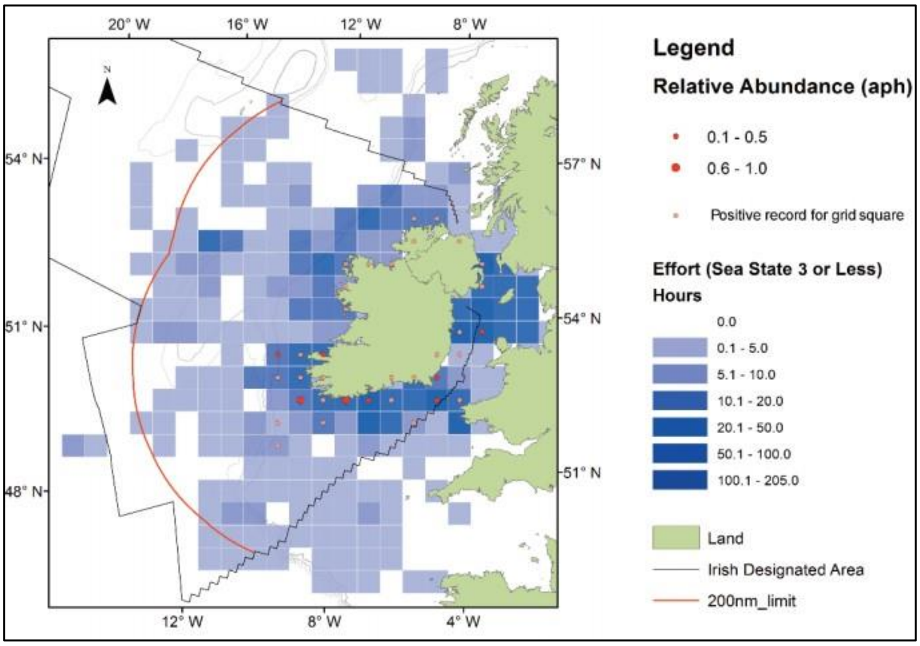


Figure 6-2 Relative abundance of Risso's dolphins from the Irish marine mammal atlas (Wall *et al.*, 2013).

6.1 MU

The IAMMWG recommend a single Celtic and Greater North Seas MU for Risso's dolphin where the estimate of abundance is 12,262 (CV: 0.46, 95% CI: 5,227 – 28,764) (IAMMWG, 2023) based on data collected during SCANS III and the ObSERVE surveys (Rogan *et al.*, 2018, Hammond *et al.*, 2021).

6.2 Site-specific surveys

No Risso's dolphins were recorded during any of the aerial CWP Project site-specific baseline surveys, although two sightings of Risso's dolphin were observed in the 2013-2014 boat-based surveys (May & July 2013). Assuming a strip width of 0.302 km and an assumed availability of 1, the (point) density estimate is 0.0023 dolphins/km^2. The density surface estimate was calculated as 0.0008 dolphins/km^2 (Natural Power, 2023).

6.3 ObSERVE

Risso's dolphin sightings during the ObSERVE surveys were low across all surveys and strata (Figure 6-3). Risso's dolphins were only sighted in the ObSERVE stratum 5 during the season 1 survey (summer 2015) which resulted in a design-based density estimate of 0.003 dolphins/km^2.

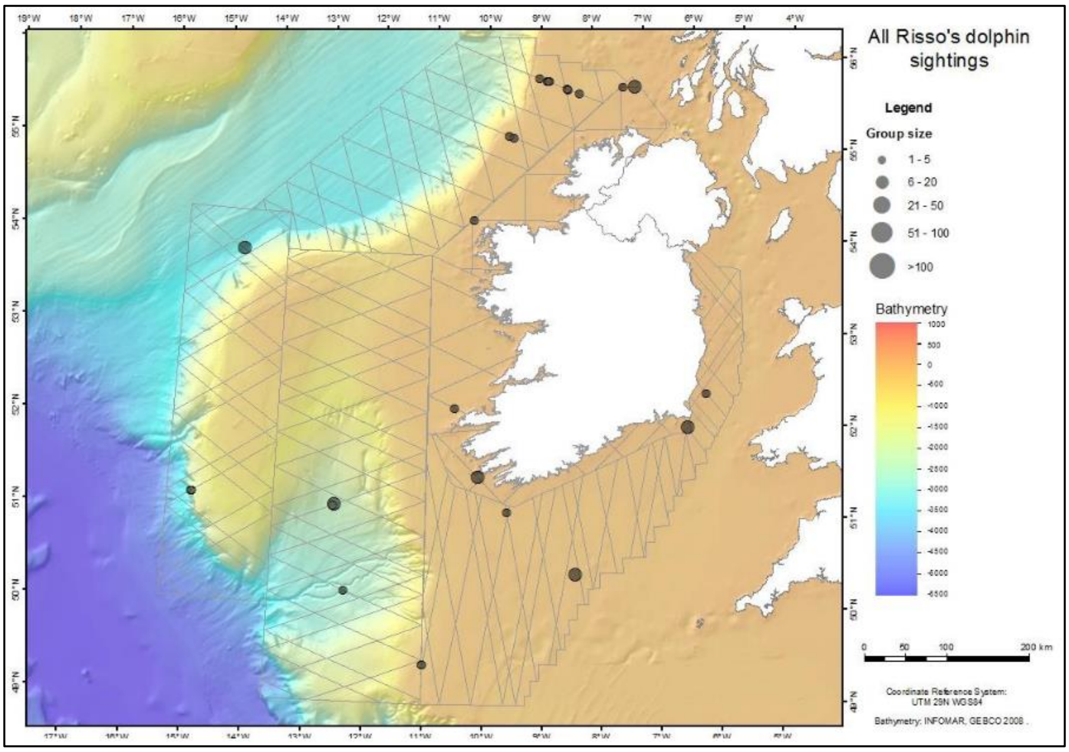


Figure 6-3 All Risso's dolphin sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

6.4 SCANS

6.4.1 SCANS III

The Risso's dolphin estimated abundance for block E, the East coast of Ireland, was reported to be 1,090 individuals during the SCANS III surveys in 2016, with lower and upper CIs of 0 and 2,843 respectively. Density estimates for this species within block E was reported at 0.031 animals/km^2 (Hammond *et al.*, 2017, Hammond *et al.*, 2021). Risso's dolphins were not included in the SCANS III predicted density surface modelling.

6.4.2 SCANS IV

The SCANS IV used different survey block names to SCANS III, and Dublin Array is located within SCANS IV survey block CS-D (which covered the western Irish Sea). Risso's dolphin were sighted throughout SCANS IV survey block CS-D, resulting in a block wide abundance estimate of 75 (95% CI: 2 – 259) and a uniform density across the survey block of 0.0022 dolphins/km^2 (CV 1.012) (Gilles *et al.*, 2023).

6.5 Irish Sea distribution

In Evans and Waggitt (2023), Risso's dolphin were modelled throughout the Irish Sea and Bristol Channel, with seasonally varying distribution patterns (Figure 6-4). The third quarter, July – September, had peak densities. The modelled outputs below indicate that the main areas of higher density are inclusive of the Irish Sea from July – September, particularly the southeast coast of the Republic of Ireland and the deeper waters in the central Irish Sea. Using the maximum density per cell across all months, the estimated density in the CWP Project is up to 0.025 dolphins/km^2 (Figure 6-5).

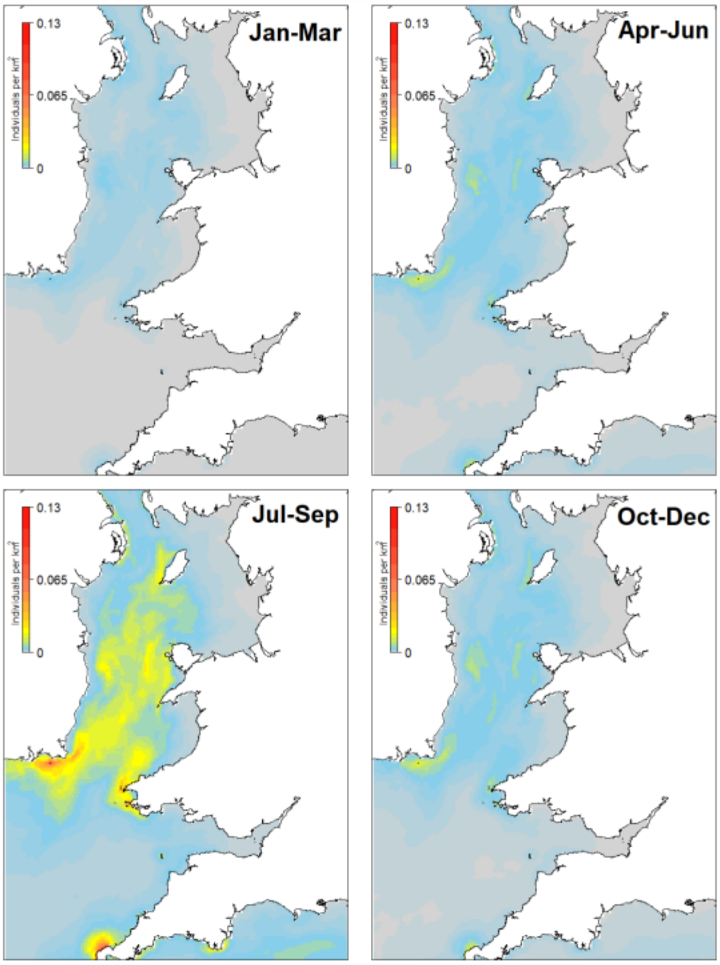


Figure 6-4 Risso's dolphin modelled densities by quarter (Evans and Waggitt, 2023).

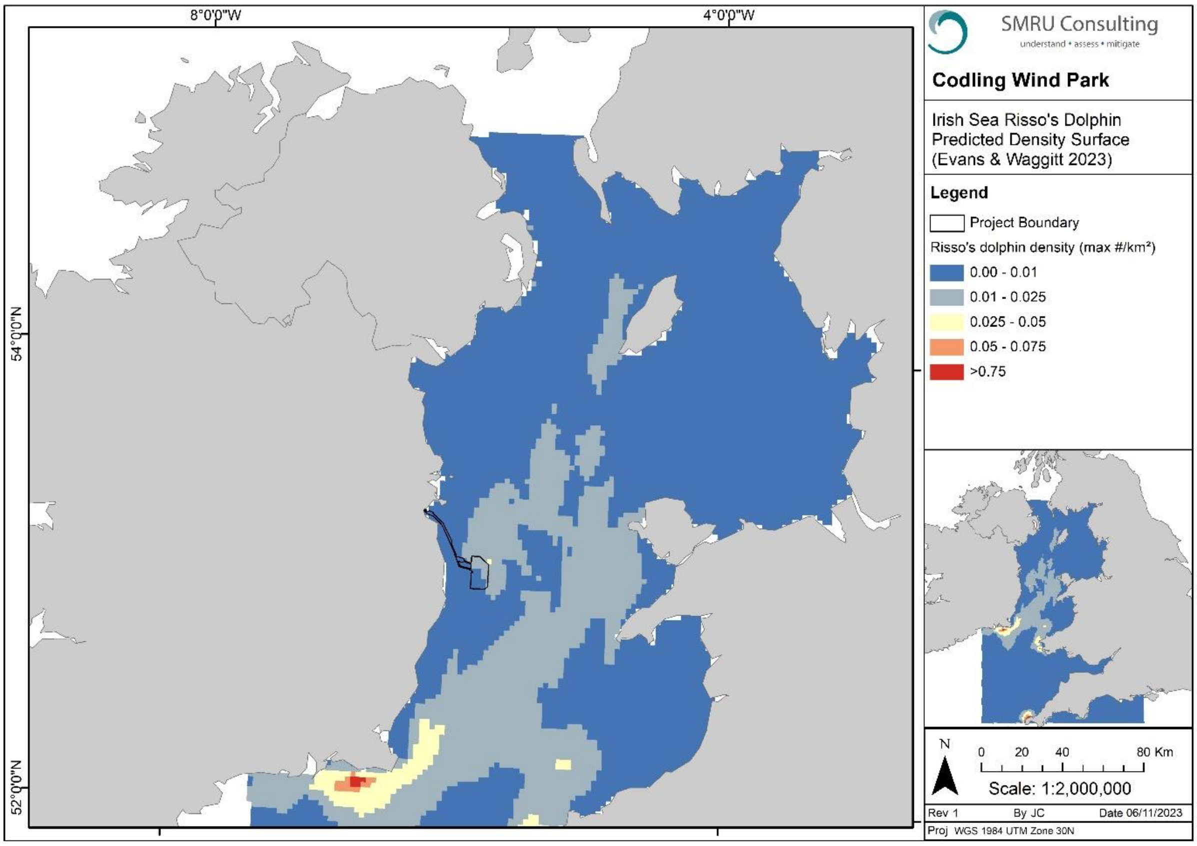


Figure 6-5 Risso's dolphin modelled densities (maximum density per cell across months) relative to the CWP Project (Evans and Waggitt, 2023).

6.6 IWDG surveys

No Risso's dolphin sightings were reported during the IWDG surveys on the east coast of Ireland considered in this baseline characterisation (Berrow *et al.*, 2008, O'Brien *et al.*, 2009, Berrow *et al.*, 2011, Berrow *et al.*, 2012, O'Brien and Berrow, 2016, Berrow *et al.*, 2021).

6.7 Other OWFs

NISA

Risso's dolphins were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial site-specific marine mammal surveys have been undertaken as part of the NISA project (ARUP, 2021), these data are yet to be published and site-specific density estimates are not yet available.

Dublin Array

Risso's dolphins were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although boat site-specific marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

Arklow Bay Wind Park

Although Risso's dolphin were observed during the nearby Arklow Bank Phase 1 and 2 surveys (RPS 2020), no density estimation was provided.

6.8 Seasonality

Although the data sources and surveys examined have not indicated Risso's dolphin are likely to be present in the vicinity of the CWP Project, they would be most vulnerable to disturbance during the breeding season. The knowledge of the reproduction and breeding of Risso's dolphins is still limited, although studies in other regions have indicated it is typically during the summer and autumn months (Chen *et al.*, 2011).

6.9 Summary

There are a few surveys that present Risso's dolphins in the vicinity of CWP Project (including the site-specific surveys, the SCANS IV surveys and the ObSERVE surveys). It is important to consider not only the site-specific survey data, but also density estimates for much wider areas that are more suited to potential larger scale disturbance impacts. Therefore, a range of density estimates will be taken forward to the quantitative impact assessment. These include the CWP Project site-specific survey estimate, SCANS IV uniform density estimate, and the Evans and Waggitt (2023) density surface.

Table 15 Risso's dolphin density estimates (dolphins/km^2)

Data source	Reference	Density estimate
CWP Project site specific surveys	Natural Power (2023)	0.0008
ObSERVE summer stratum 5	Rogan *et al.* (2018)	0.003
SCANS IV block CS-D	Gilles *et al.* (2023)	0.0022
Welsh and Irish Sea distribution	Evans and Waggitt (2023)	Grid cell specific Max 0.025 in the CWP Project array site

7 Minke whale

Minke whales are observed throughout Irelands coastal and offshore waters, and both the continental slope and shelf (Figure 7-1). The species has been assessed as having an overall Favourable conservation status in Irish waters (NPWS, 2019).

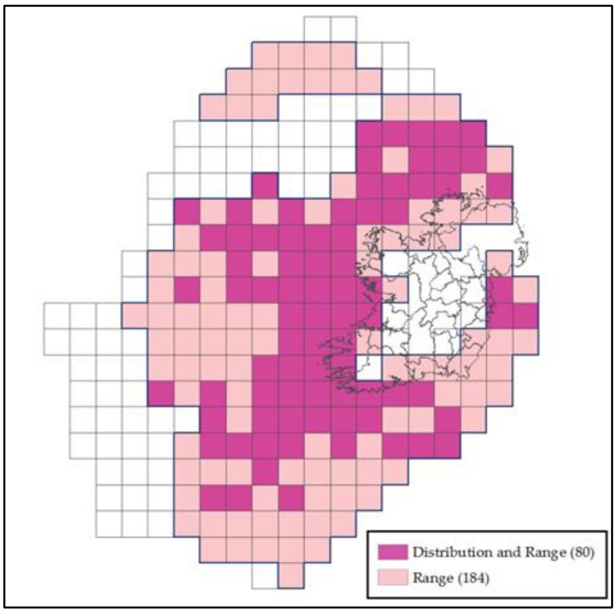


Figure 7-1 The range and distribution of minke whales in Irish waters (NPWS, 2019).

Minke whales were reported off all Irish coasts, with the majority of sightings occurring in shallow waters (<200 m) over the Irish shelf (Figure 7-2). Relative abundances were concluded to be relatively low for this species, reflective of the fact that the vast majority of sightings involved single animals rather than groups. During active foraging, minke whales were infrequently seen in groups of 2/3 and loose feeding aggregations of up to 7 individuals (Wall *et al.*, 2013).

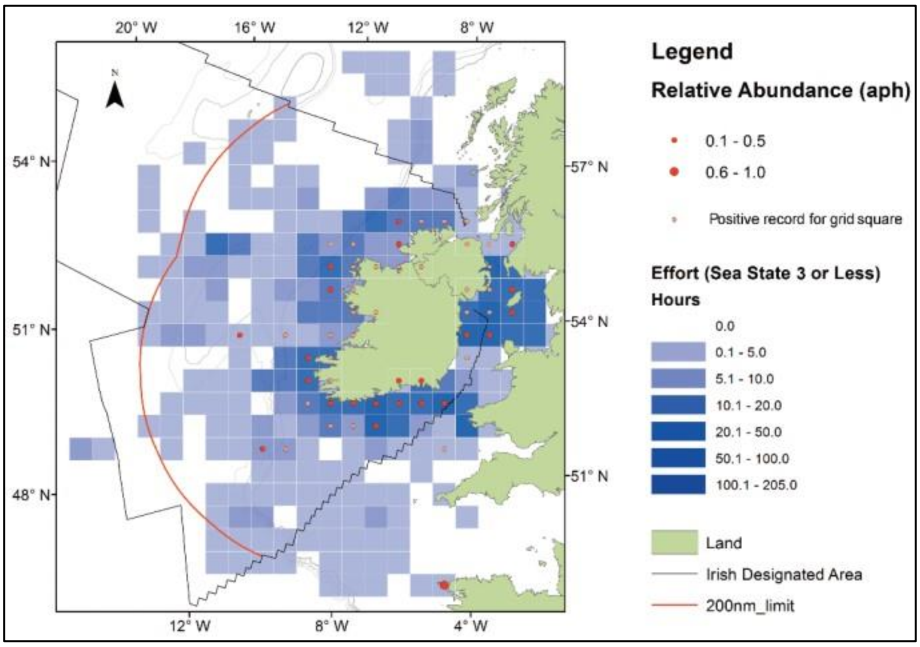


Figure 7-2 Relative abundance of minke whales from the Irish marine mammal atlas (Wall *et al.*, 2013).

7.1 MU

The IAMMWG recommend that a single Celtic and Greater North Seas MU is appropriate for minke whales, for which the abundance estimate is 20,118 minke whales (CV: 0.18, 95% CI: 14,061 –

28,786) (IAMMWG, 2023) based on data collected during SCANS III and the ObSERVE surveys (Rogan *et al.*, 2018, Hammond *et al.*, 2021).

7.2 Site-specific surveys

Density estimations for minke whales were derived by modelling the boat-based survey data only (Natural Power, 2023) (Figure 7-3):

- During 2013-2014 boat-based surveys, 2 minke whales dolphins were sighted. Assuming a strip width of 0.416 km and an assumed availability of 1, the density estimate was 0.0017 whales/km^2.
- During the 2018-2020 boat-based surveys, 3 minke whales were recorded. Assuming a strip width of 0.416 km and an assumed availability of 1, the density estimate was 0.0020 whales/km^2.

Based on these 5 observations, the density estimate was calculated as 0.0019 whales/km^2.

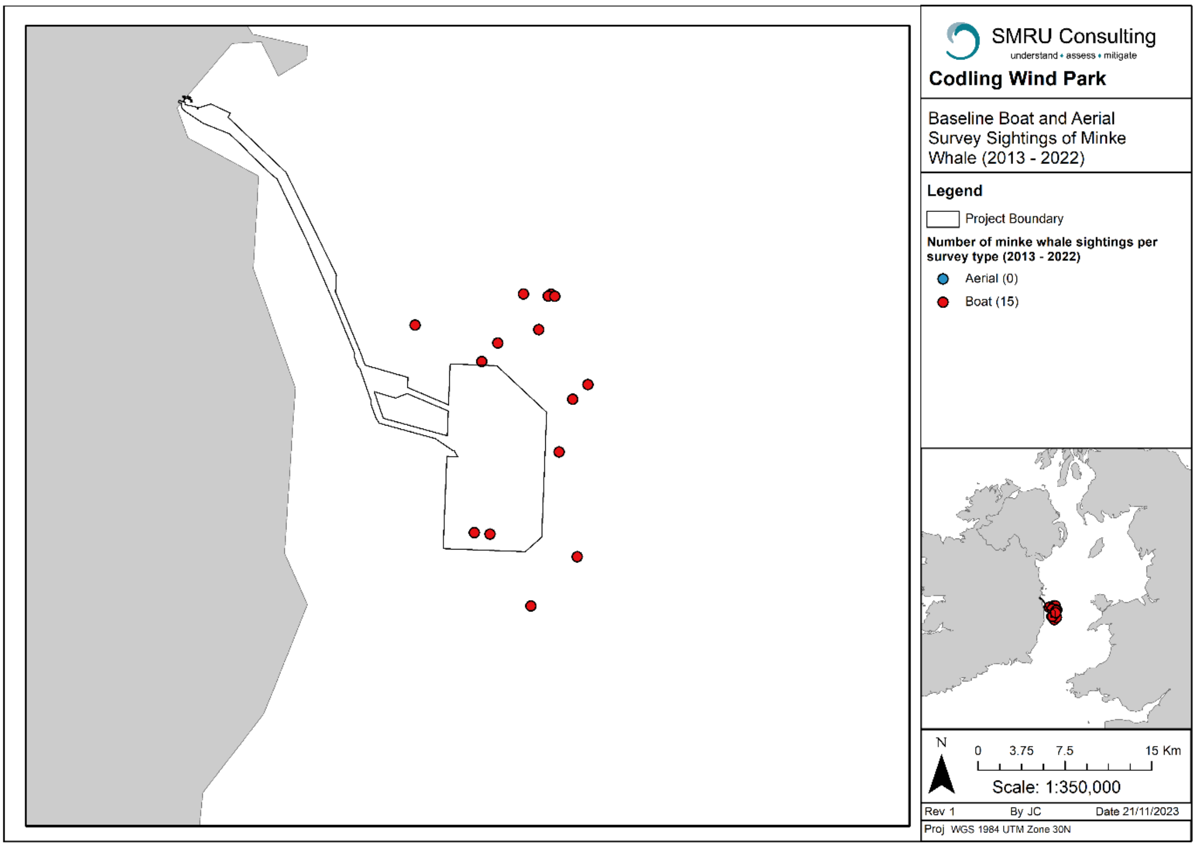


Figure 7-3 Number of minke whale sightings within the project array site, ECC and surrounding area. All data were collated as part of baseline boat and aerial surveys.

7.3 ObSERVE

Minke whales were the most frequently sighted mysticete species during the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018). Almost all sightings were single individuals, with one sighting of a mother-calf pair of minke whales. These individuals were sighted in neritic waters, in all strata and in the Irish Sea (Figure 7-4). Observations from these surveys concluded that there was inter-seasonal variation present for minke whales in the survey area, with coastal distributions of these individuals increasing during the summer in comparison to winter months, suggesting that a seasonal inshore to offshore movement pattern may be occurring for minke whales in the survey area (Figure 7-5). There was a high use of coastal waters by minke whales in the summer months, however findings suggest that the Irish Sea appears to be *"unsuitable for minke whales in the winter period"* (Rogan *et al.*, 2018) (Figure 7-5).

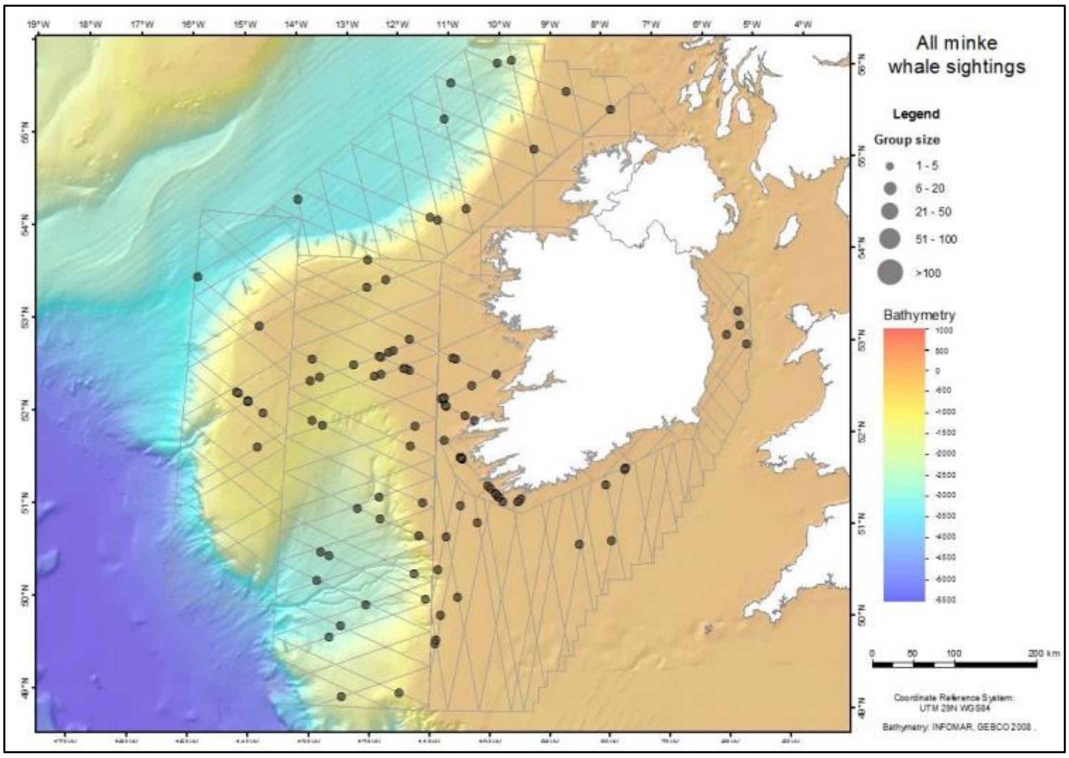


Figure 7-4 All minke whale sightings from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

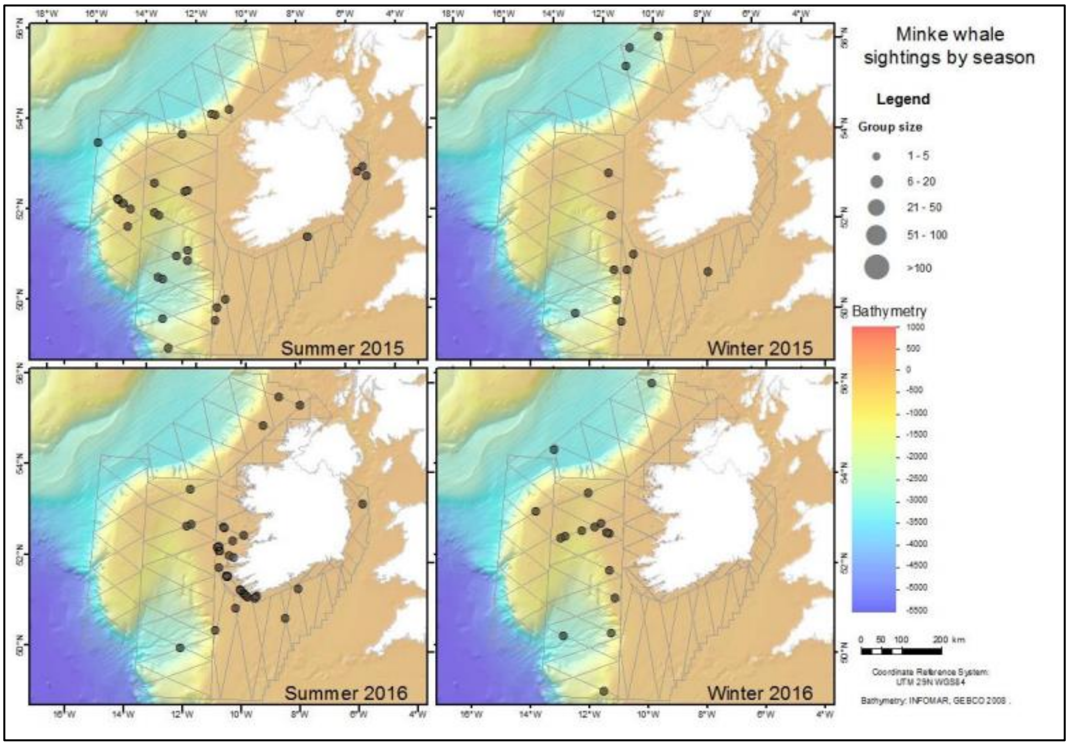


Figure 7-5 Seasonal sightings of minke whales from the ObSERVE surveys from 2015-2016 (Rogan *et al.*, 2018).

Across the survey area, estimated abundances for minke whales was higher in the summer months (seasons 1 and 3), with estimates 3.4 times higher than in the winter months (seasons 2 and 4) in 2015, and 1.6 times higher in the summer months than the winter months in 2016-17. Within strata 5, in which the CWP Project is located, minke whales were only sighted in the summer surveys, resulting in corrected density estimates between 0.016 and 0.045 whales/km^2.

7.4 SCANS

7.4.1 SCANS III

Minke whales were sighted during the SCANS III surveys on the East coast of Ireland, assigned block E, during the 2016 aerial surveys (Hammond *et al.*, 2017, Hammond *et al.*, 2021). The abundance estimate for these individuals was concluded at 603 individuals, with lower and upper CIs of 134 and 1,753 respectively. Density estimates for minke whales within this block was reported to be 0.017 animals/km^2.

The density surfaces obtained from the SCANS III data show the predicted minke whale distribution across the MU is not uniform, with higher densities generally found in the northeast of the northern North Sea (Lacey *et al.*, 2022). Densities of minke whale in the vicinity of the CWP Project are relatively low with values up to 0.02 minke whale/km^2 (Figure 7-6).

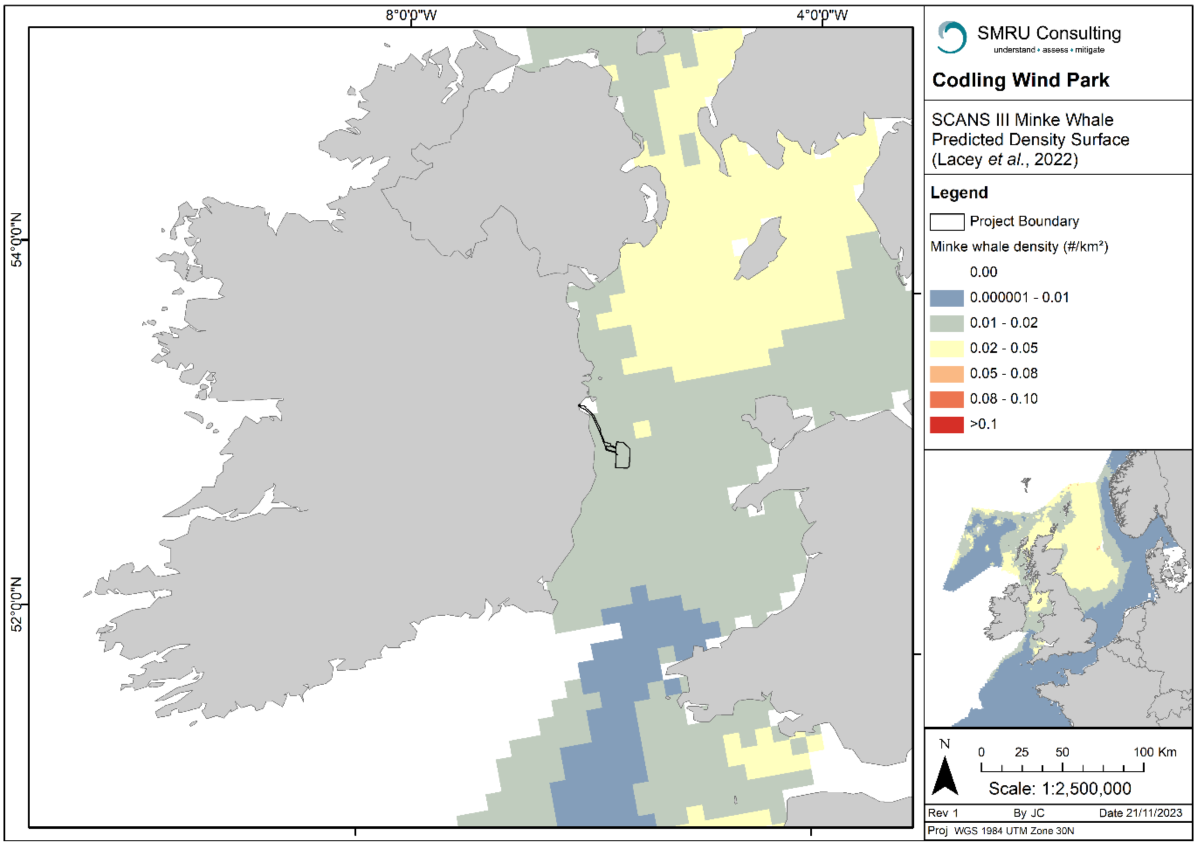


Figure 7-6 Minke whale predicted density surface using SCANS III data (Lacey et al., 2022).

7.4.2 SCANS IV

The SCANS IV used different survey block names to SCANS III, and Dublin Array is located within SCANS IV survey block CS-D (which covered the whole Irish Sea). Minke whale were sighted throughout SCANS IV survey block CS-D, resulting in a block wide abundance estimate of 477 (95%

CI: 85 – 1,425) and a uniform density across the survey block of 0.0137 minke whale/km^2 (CV 0.632) (Gilles *et al.*, 2023).

7.5 Irish Sea distribution

In Evans and Waggitt (2023), minke whales were modelled throughout the Irish Sea and Bristol Channel, with varying distribution patterns across seasons (Figure 7-7). Minke whale densities are highly seasonal. The third quarter, July – September, had peak densities, whilst the first quarter, January – March, had scarce densities. The modelled outputs below indicate that the main areas of high density are inclusive of the Irish Sea (St George's Channel westwards from Pembrokeshire across the Celtic Deep to Co. Wexford, and Co. Dublin), Isle of Man, Bristol Channel, and the Celtic Sea. Using the maximum density per cell across all months, the estimated density in the CWP Project array site is up to 0.015 whales/km^2 (Figure 7-7).

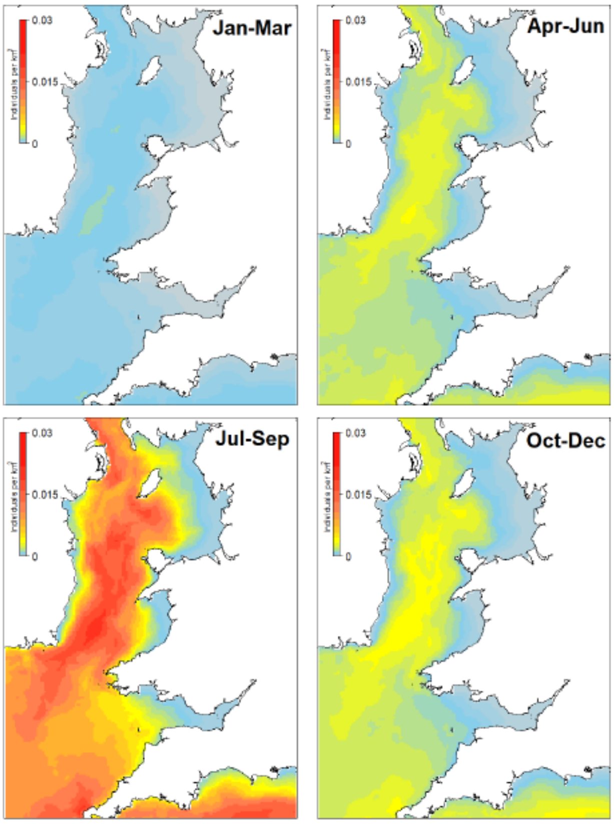


Figure 7-7 Minke whale modelled densities by quarter (Evans and Waggitt, 2023).

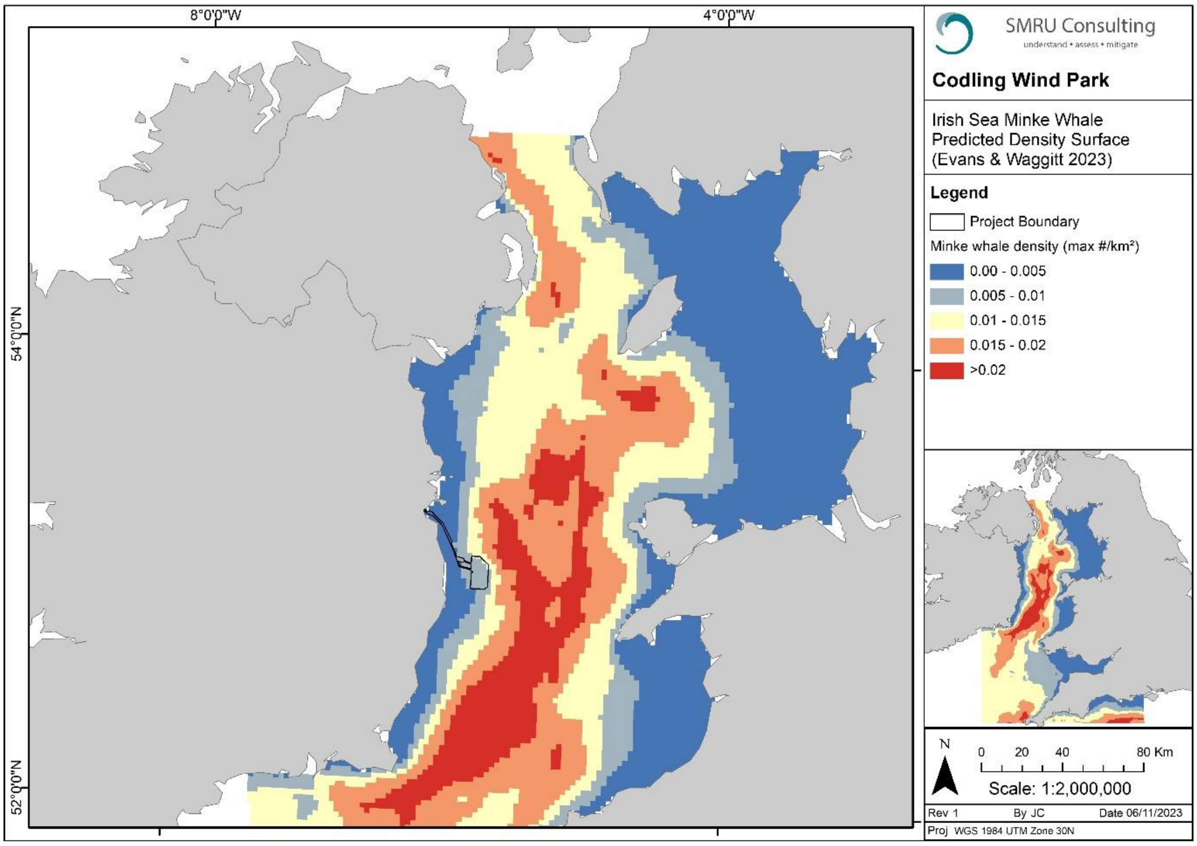


Figure 7-8 Minke whale modelled densities (maximum density per cell across months) relative to the CWP Project (Evans and Waggitt, 2023).

7.6 IWDG surveys

During the Greater Dublin Drainage Project IWDG vessel-based marine mammal surveys (Meade *et al.*, 2017) a total of two minke whales were sighted, one in June 2015 and one in August 2016. No minke whales were recorded during the land-based surveys at Howth Head.

During the IWDG Inshore Irish Sea surveys, minke whales were reported in both block A (Dublin area) and B (south coast) (Berrow *et al.*, 2011). For block A, the estimated relative abundance of minke whales was estimated at 0.03 individuals/km (Figure 7-9). For block B, the estimated relative abundance of minke whales was reported at 0.149 individuals/km.

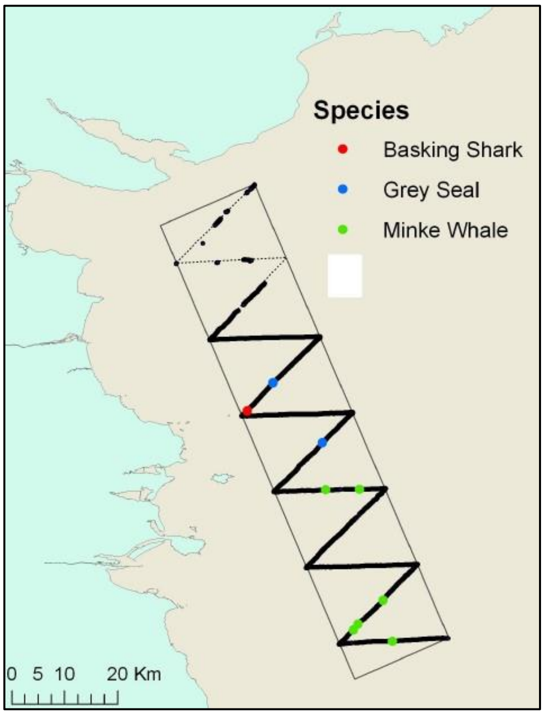


Figure 7-9 Sighting records of minke whale, grey seal and basking shark in block A (Berrow *et al.*, 2011).

7.7 Other OWFs

7.7.1 NISA

Minke whales were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial site-specific marine mammal surveys have been undertaken as part of the NISA project (ARUP, 2021), these data are yet to be published and site-specific density estimates are not yet available.

7.7.2 Dublin Array

Minke whale were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although boat marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

7.7.3 Arklow Bay Wind Park

Minke whales were not observed during site specific surveys for Arklow Phase 1 and 2.

7.8 Seasonality

Minke whales are known to exhibit a high degree of seasonal variation in their presence in the Irish Sea, with sightings occurring more frequently during the summer months (Rogan *et al.*, 2018). Minke whales are known to perform seasonal migrations between high latitude feeding grounds in the summer and low latitude area for breeding and calving in the winter months (Risch *et al.*, 2014) and their increased presence in the summer months supports this migration pattern

Wall *et al.* (2013) reported some seasonal variation in the presence of minke whales, with highest relative abundances of this species recorded in the western Irish Sea in Spring. This peak in relative abundance was concluded to be due to foraging, with concentrations of pelagic schooling fish present in the area. Based on the site-specific data obtained during boat-based and aerial surveys, minke whale presence within the CWP Project was greatest during summer (months of June and July) (Table 16, Figure 7-10, Figure 7-11). Therefore, minke whale present in the vicinity of the CWP Project will most likely be undertaking feeding behaviour in this region.

Table 16 Number of individual minke whale sighted per month during site-specific surveys

Month	Season	Surveys Conducted	Number of Individuals Observed
January	Winter	Boat-based visual, aerial-based	0
February	Winter	Boat-based visual, aerial-based	0
March	Spring	Boat-based visual, aerial-based	0
April	Spring	Boat-based visual, aerial-based	2
May	Spring	Boat-based visual, aerial-based	1
June	Summer	Boat-based visual, aerial-based	5
July	Summer	Boat-based visual, aerial-based	4
August	Summer	Boat-based visual, aerial-based	1
September	Autumn	Boat-based visual, aerial-based	1
October	Autumn	Boat-based visual, aerial-based	0
November	Autumn	Boat-based visual, aerial-based	0
December	Winter	Boat-based visual, aerial-based	1

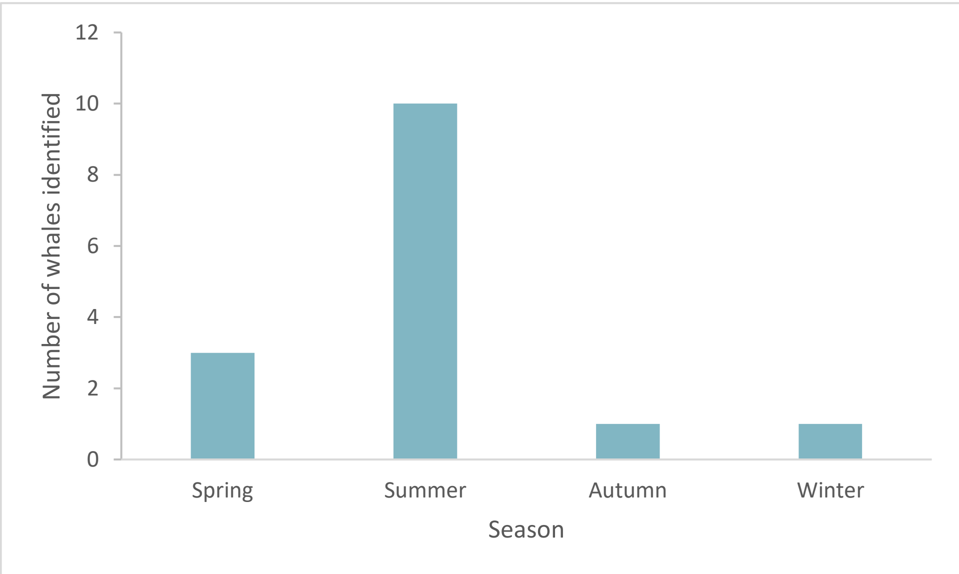


Figure 7-10 Seasonal differences in minke whale sightings across the site-specific surveys.

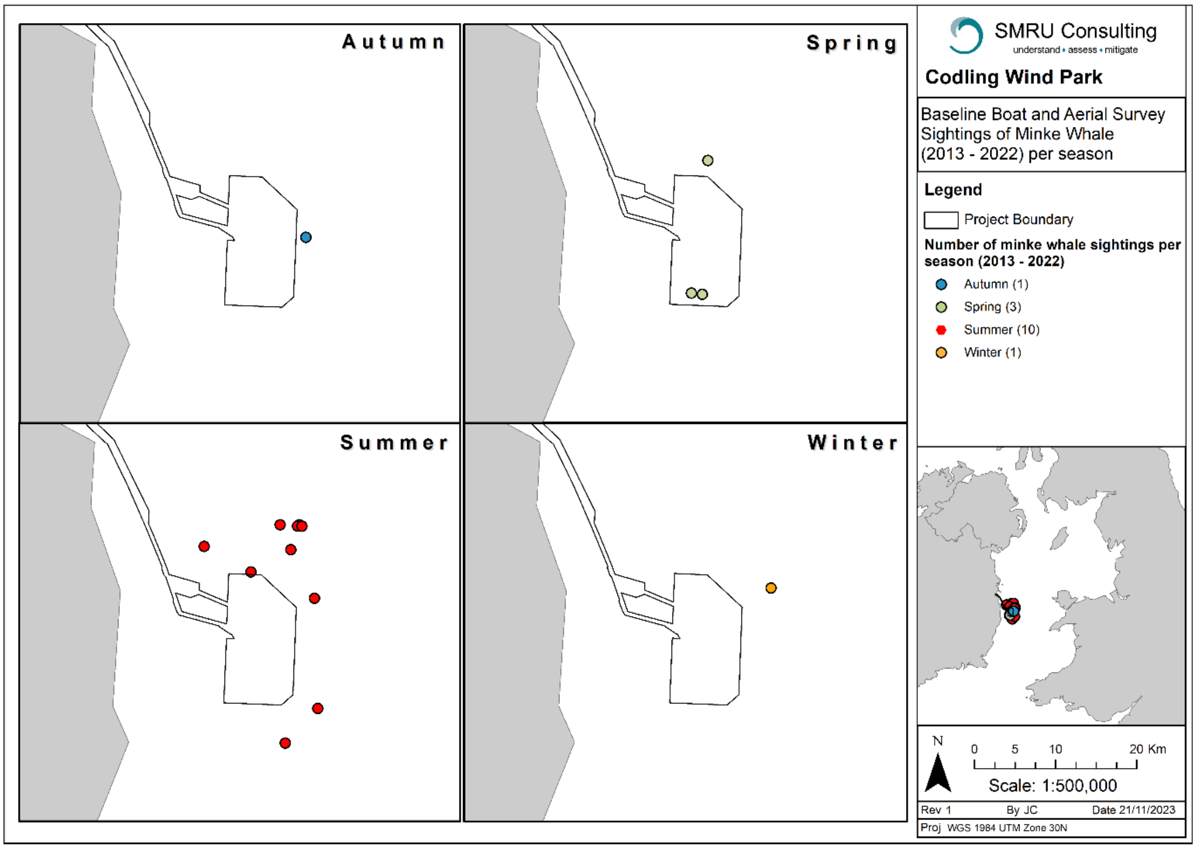


Figure 7-11 Seasonal differences in the number of minke whale sightings made during site-specific surveys.

7.9 Summary

In summary, there have been a few studies of minke whales in the Irish Sea and in the vicinity of the CWP Project. While there are a range of density estimates available (Table 17), all data sources have shown that minke whales are present in significantly higher densities in the summer months. It is important to consider not only the site-specific survey data, but also density estimates for much wider areas that are more suited to potential larger scale disturbance impacts. Therefore, a range of density estimates will be taken forward to the quantitative impact assessment. These include the CWP Project site-specific survey estimate, SCANS IV uniform density estimate, the SCANS III density surface and the Evans and Waggitt (2023) density surface.

Table 17 Minke whale density estimates (whales/km^2)

Data source	Reference	Density estimate
CWP Project site specific surveys	Natural Power (2023)	0.0019
ObSERVE summer stratum 5	Rogan *et al.* (2018)	Season 1: 0.045 Season 3: 0.016
SCANS IV block CS-D	Gilles *et al.* (2023)	0.0137
SCANS III density surface	Lacey *et al.* (2022)	Grid cell specific Max 0.02 in the CWP Project array site

SCANS III block E	Hammond *et al.* (2017)	0.017
Welsh and Irish Sea distribution	Evans and Waggitt (2023)	Grid cell specific Max 0.015 in the CWP Project array site

8 Harbour seal

Harbour seals occur throughout Irish waters in estuarine, coastal, and fully marine areas (Figure 8-1). They have been assessed as having a Favourable conservation status in Irish waters (NPWS, 2019).

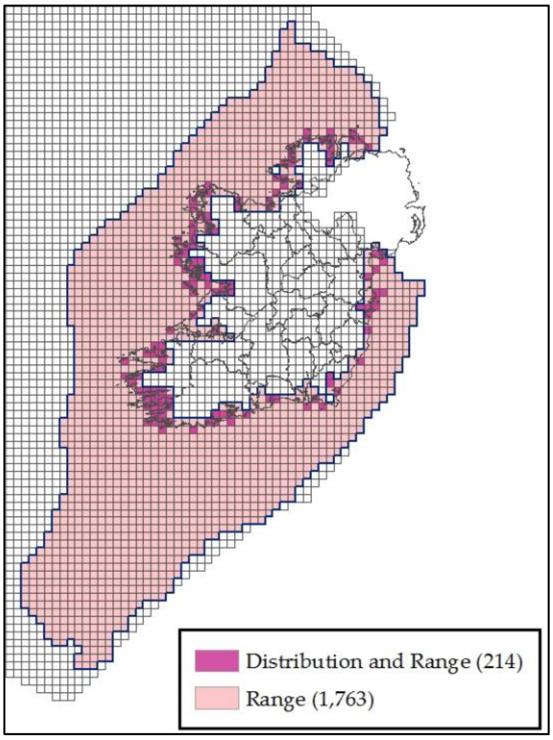


Figure 8-1 The range and distribution of grey seals in Irish waters (NPWS, 2019).

In Wall *et al.* (2013), harbour seal sightings recorded during vessel surveys were rare, with just two sightings reported during the survey period of 2005-2011 (Figure 8-2). This is reflective of the fact that harbour seals tend to forage in close proximity to their haul-out site, not undertaking offshore movements (Tollit *et al.*, 1998). In terms of seasonal variation, there was insufficient data available to assess both temporal changes in distribution and relative abundance, with both sightings of harbour seals being reported in May.

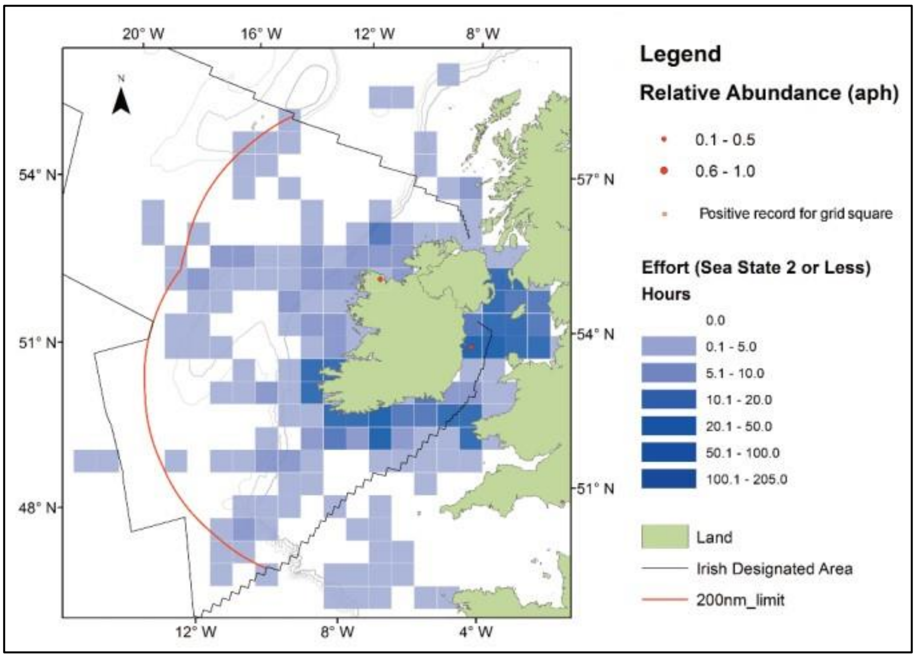


Figure 8-2 Relative abundance of harbour seals from the Irish marine mammal atlas (Wall *et al.*, 2013).

8.1 Site-specific surveys

Aerial and boat-based survey data were not used to obtain information on seals and thus, no density estimates from site-specific surveys have been derived for harbour seals.

8.2 Seal counts

The CWP Project is located within the East region of the RoI but is close to the Northern Ireland MU. The relevant reference population against which to assess the impacts of CWP Project is thus a combination of the east regions of RoI and the Northern Ireland MU.

Morris and Duck (2019) reported on the number (Table 18) and distribution of hauled-out harbour seals in RoI (Figure 8-3). A total of 131 seals were counted in the East region and 34 in the south-east region. The most recent 2021 August counts for harbour seals in the Northern Ireland MU is 818 individuals, which was 23% lower than the 2018 count (SCOS, 2023). It was noted that concerningly, counts of harbour seals in Northern Ireland surveyed in 2021 were substantially lower than counts in recent years (Table 19).

The total August counts for the East region (131), South-east region (34) and the Northern Ireland MU (818) can be scaled by the estimated proportion of animals hauled-out at the time of the survey (0.72, 95% CI 0.54 – 0.88) (Lonergan et al. 2013). The combined count totals 983 harbour seals with a resulting population estimate of 1,365 harbour seals in the reference population (95% CI: 1,117 – 1,820).

Table 18 Harbour seal counts in the Republic of Ireland from 2003 – 2018 (Morris and Duck, 2019).

Region	Area	Harbour seal counts		
		2003	2011/12	2017/18
East	1	89	61	61
East	2	34	29	70

East	3	0	0	0
South-east	1	17	49	33
South-east	2	0	0	0
South-east	3	1	4	1

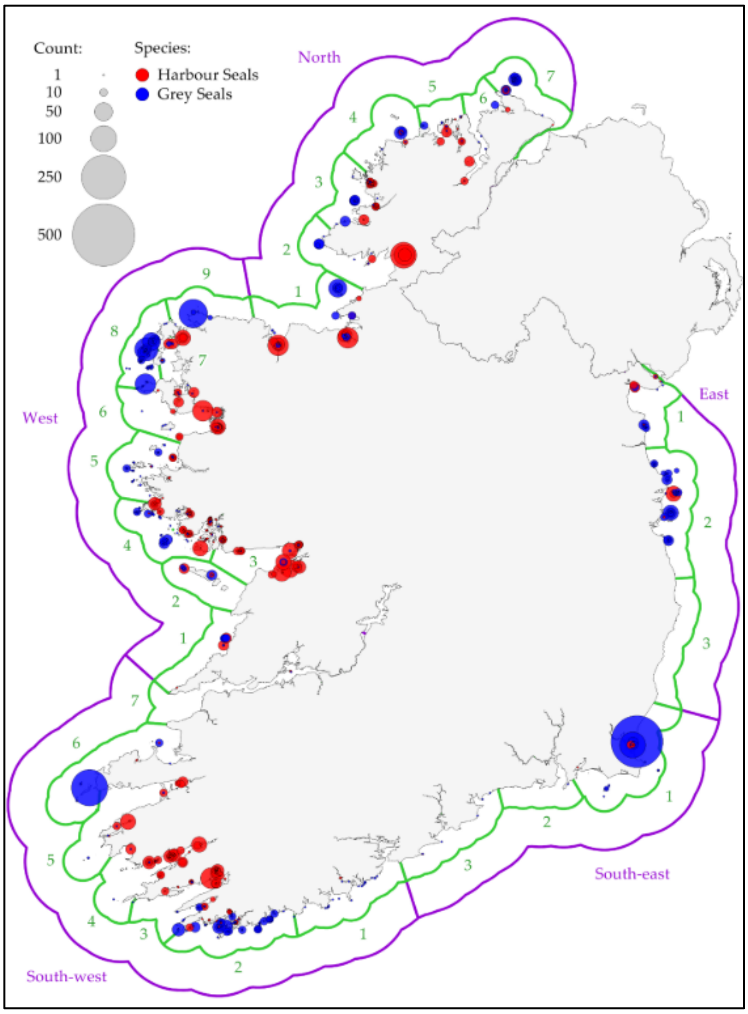


Figure 8-3 Numbers and distribution of Harbour Seals (red circles) and Grey Seals (blue circles) in Ireland in August 2017 and August 2018. The displayed symbol size represents the recorded group size with count guides given in the Legend (top left).

Table 19 Harbour seal August haul-out counts in the Northern Ireland MU (SCOS, 2023)

	2000-2006	2007-2009	2011-2015	2016-2019	2021
Northern Ireland	1,176	1,101	948	1,062	818

8.3 Seal telemetry

There have been no harbour seal tagging studies conducted in the RoI to date. However, there have been several tagging events in Strangford Lough in Northern Ireland (12 in 2006, 10 in 2008 and 12 in 2010) which were included in the dataset used for the seal habitat preference maps (Figure 8-4).

The track data from these seals showed limited movement into the wider Irish Sea, with most tracks remaining in the vicinity of Strangford Lough as well as out into the UK part of the Irish Sea, both north and south of the Isle of Man.

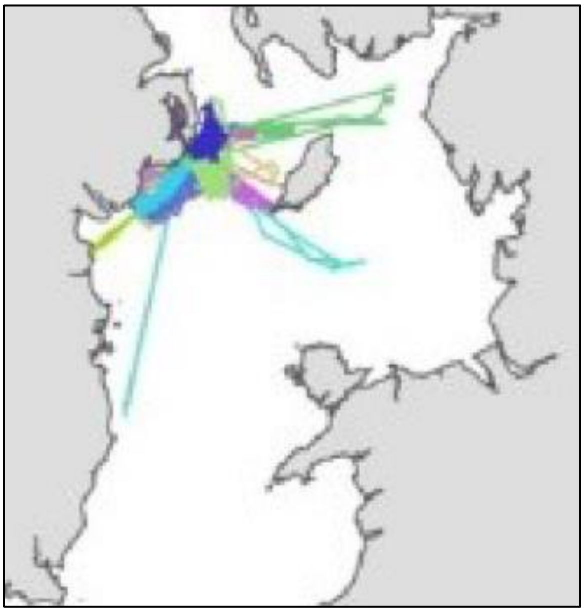


Figure 8-4 Harbour seal telemetry data for seals tagged at Strangford Lough in 2006, 2008 and 2010 (taken from Carter et al 2022).

8.4 Seal at-sea density

Harbour seal density in the Irish Sea is generally low, with higher densities associated with the SACs: Strangford Lough, Murlough, Lambay Island and Slaney River Valley (Figure 8-5). Given the proximity of the CWP Project to the Lambay Island SAC and the Murlough SAC, densities in the vicinity of the project are lower compared to areas within the vicinity of the SACs. Density estimates for the cells adjacent to the Lambay Island SAC reach up to 0.25 harbour seals/km^2 (extracted from Carter *et al.*, 2020), whilst those within the CWP Project array site and ECC average 0.0075 seals/km^2. (Figure 8-5).

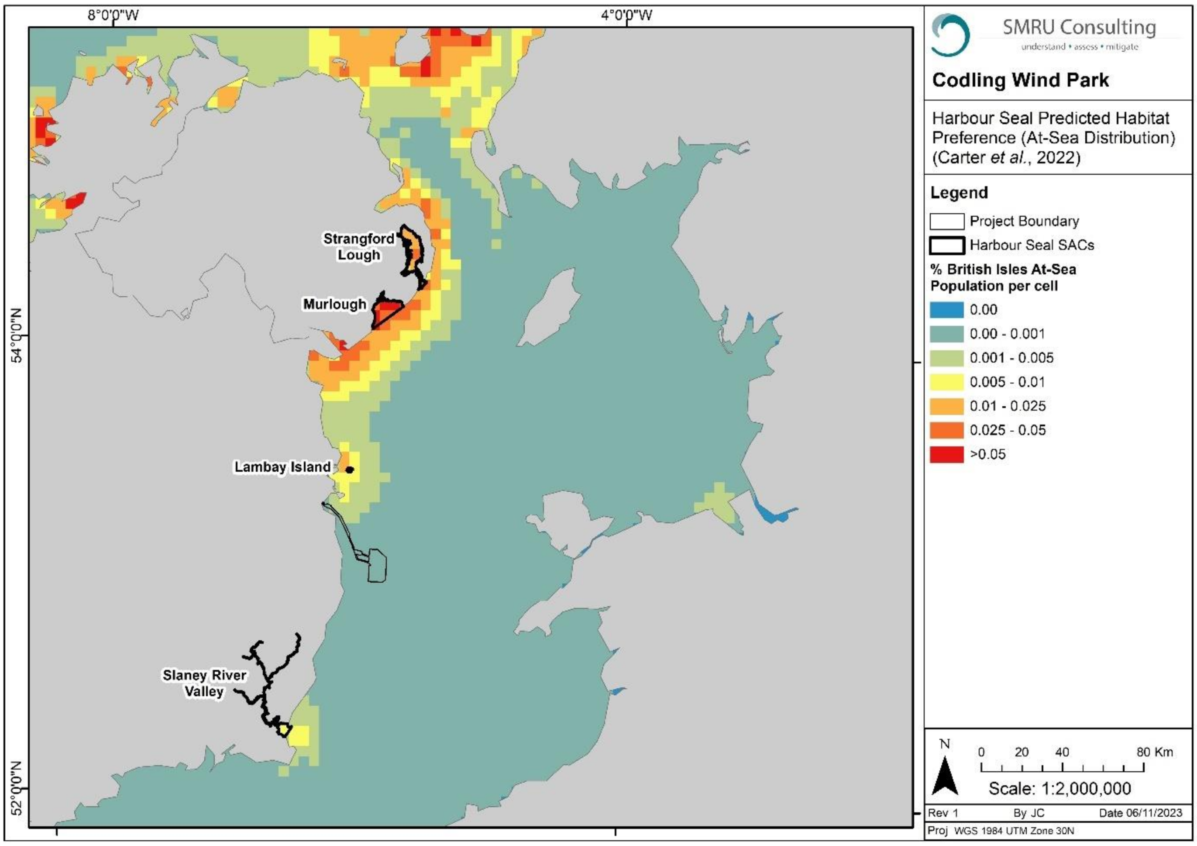


Figure 8-5 At-sea distribution of harbour seals from haul-outs in the British Isles in 2018 (Carter *et al.*, 2020).

8.5 Irish Sea distribution

8.6 IWDG Surveys

The vessel-based marine mammal surveys carried out by Meade *et al.* (2017) for the Greater Dublin Drainage Project recorded a total of two harbour seals, one in April 2015 and one in August 2015. No harbour seals were recorded during the land-based surveys at Howth Head. During the IWDG Inshore Irish Sea surveys (Berrow *et al.*, 2011), a single harbour seal was reported in block B (south coast, where the CWP Project is located), resulting in an estimate of 0.007 seals/km. No harbour seals were sighted in Block A with which the CWP Project also overlaps.

8.7 Other OWFs

8.7.1 NISA

Harbour seals were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial marine mammal surveys have been undertaken as part of NISA (ARUP, 2021), these data are yet to be published and the derivation of site-specific density estimates are not yet available.

8.7.2 Dublin Array

Harbour seals were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although both boat and aerial marine mammal surveys have been undertaken as part of the Dublin Array (SLR *et al.*, 2020), these data are yet to be published and the derivation of site-specific density estimates are not yet available.

8.7.3 Arklow Bay Wind Park

Unidentified seals were observed during the nearby Arklow Bank Phase 1 and 2 surveys. However, it was considered most likely that these were grey seals rather than harbour seals (RPS, 2020).

8.8 Seasonality

Harbour seal pupping occurs during the summer months, primarily in June and July (Arso Civil *et al.*, 2018, SCOS, 2023). Moulting most frequently occurs during August (SCOS, 2023) following pupping, although seals in active moult have been observed in southwest Ireland from June to November (Cronin *et al.*, 2013a). During the breeding season and whilst moulting, grey seals spend longer periods of times hauled out on land (SCOS, 2023), resulting in a higher density of seals on land. They may, therefore, be more vulnerable to activity being conducted close to haul out sites during these months. Outside of the breeding season, seals will exhibit a wider spatial variation.

8.9 Summary

There have been several studies on harbour seal abundance and distribution at haul-outs around Ireland, however there is uncertainty in at-sea density estimates as there is both a lack of telemetry data in Irish waters. Given that there is no alternative, it is recommended that the at-sea density estimates obtained from the habitat preference maps (i.e., Carter *et al.* (2020)) are taken forward for impact assessment for NISA.

9 Grey seal

Grey seals occur throughout Irish waters (Figure 9-1), and those in Ireland are considered to be part of a meta-population that also inhabits adjacent jurisdictions (NPWS, 2019). They have a Favourable conservation status with an increasing trend in Irish waters (NPWS, 2019).

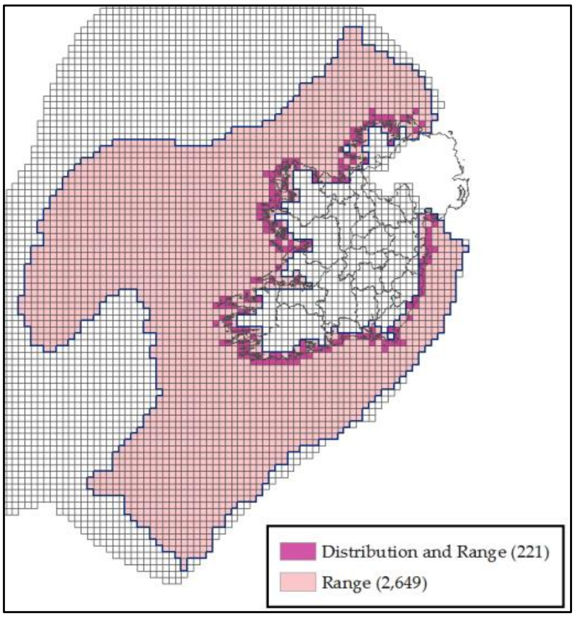


Figure 9-1 The range and distribution of grey seals in Irish waters (NPWS, 2019).

In Wall *et al.* (2013), grey seals were present off all Irish coasts and were reported at low relative abundances throughout the Irish sea, with these individuals being predominantly sighted in inshore waters (Figure 9-2). In terms of seasonal variation, grey seals were reported year-round in Irish waters.

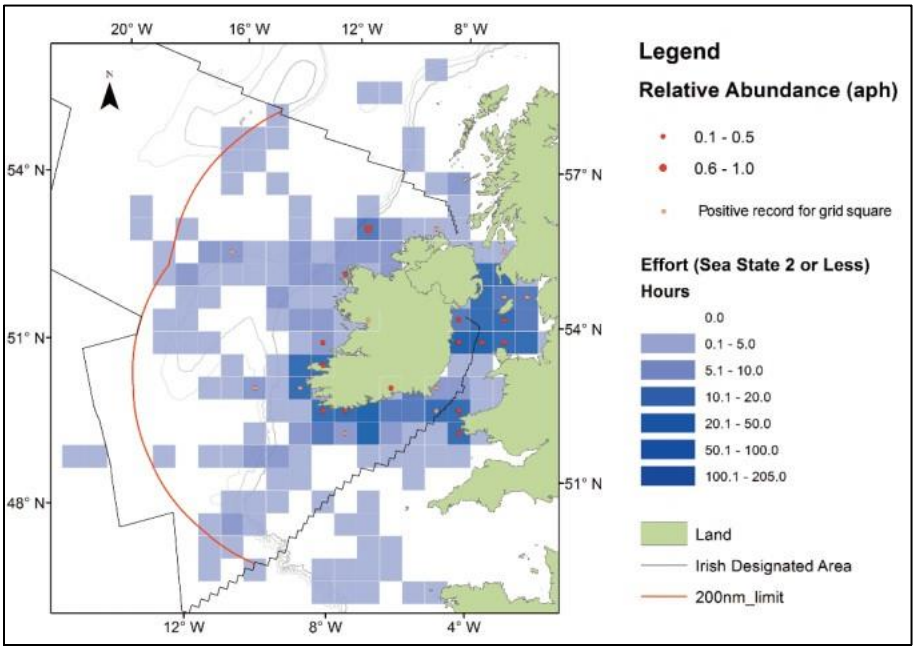


Figure 9-2 Relative abundance of grey seals from the Irish marine mammal atlas (Wall *et al.*, 2013).

9.1 Site-specific surveys

Aerial and boat-based survey data were not used to obtain information on seals and thus, no density estimates from site-specific surveys have been derived for grey seals.

9.2 Seal counts

9.2.1 August haul-out counts

The CWP Project is located within the East region of the RoI. Given the wide scale movement of grey seals, the relevant reference population against which to assess the impacts of the CWP Project is a combination of the east regions of RoI and the Northern Ireland MU.

Morris and Duck (2019) reported on the number (Table 20) and distribution of hauled-out grey seals in RoI (Figure 8-3). A total of 418 grey seals were counted in the East region and 556 in the south-east region. The most recent 2021 August haul-out counts (Table 20) for grey seals in the Northern Ireland MU is 549 individuals (Table 21) (SCOS, 2023). The total August counts for the East region (418), South-east region (556) and the Northern Ireland MU (549) can be scaled by the estimated proportion of animals hauled-out at the time of the survey (25.15%, 95% CI 21.45% - 29.07%) (SCOS, 2022) to provide an estimate of the total population (hauled-out and at-sea at the time of the count). The combined count totals 1,523 grey seals with a resulting population estimate of 6,056 grey seals in the reference population (95% CI: 5,239 – 7,100).

Table 20 Grey seal counts in the Republic of Ireland from 2003 – 2018 (Morris and Duck, 2019).

Region	Area	Grey seal counts		
		2003	2011/12	2017/18
East	1	39	48	83
East	2	211	172	335
East	3	12	03	0

South-east	1	189	239	550
South-east	2	0	0	1
South-east	3	0	4	5

Table 21 Grey seal August haul-out counts in the Northern Ireland MU (SCOS, 2023)

	2000-2006	2007-2009	2011-2015	2016-2019	2021
Northern Ireland	272	243	468	505	549

9.2.2 Pup counts

Ó Cadhla *et al.* (2007) estimated a total of 1,574 grey seal pups to have been born in the RoI during the 2005 breeding season. Ground survey results from Lambay Island & Ireland's Eye concluded a minimum pup production of 58 pups and an all-age population size of 203-261. Pup production for these islands was also concluded to have occurred primarily on Lambay Island, with only 4 pups reported to have been born on Ireland's Eye in 2005. The distribution of pup counts on Lambay Island was strongly aggregated amongst three bays on the south coast of the island. Certain cave sites which have been previously documented by other studies were not included in this study due to safety restrictions, as a result, Ó Cadhla *et al.* (2005) concluded that the pup production estimates reported for both of these islands are likely to be lower than the true figure.

Grey seal pup production estimate in 2019 was approximately 250 pups for Northern Ireland, equating to a total population estimate of 500 individuals at the start of the 2022 breeding season (SCOS, 2023). This shows an increase in pup production counts in the Northern Ireland MU, from 150 in 2016 to 250 in 2019. There are no more recent data available for this MU.

9.3 Seal telemetry

Between 2017 and 2019, a total of 32 grey seals were tagged in the northern Irish Sea and the Celtic Sea and Irish Sea regions (Carter *et al.*, 2020):

- In June/July 2017, 15 grey seals were tagged at the Dee Estuary in North Wales, though two of these transmitted <5 days of data,
- In May 2018, 10 grey seals were tagged at Bardsey Island off the Llŷn Peninsula in Wales, and
- In April 2019, 7 grey seals were tagged at Ramsey and Skomer Islands (Figure 9-3).

In addition, Cronin *et al.* (2016) tagged 19 grey seals at Raven Point, County Wexford in April 2013 and April 2014, although only 11 of the tags transmitted data. Both the data from Carter *et al.* (2020) (Figure 9-3) and Cronin *et al.* (2016) (Figure 9-4) show wide movement of grey seals throughout the Irish Sea, with Carter *et al.* (2020) also displaying evidence of grey seals tagged in Wales, hauling out in the RoI.

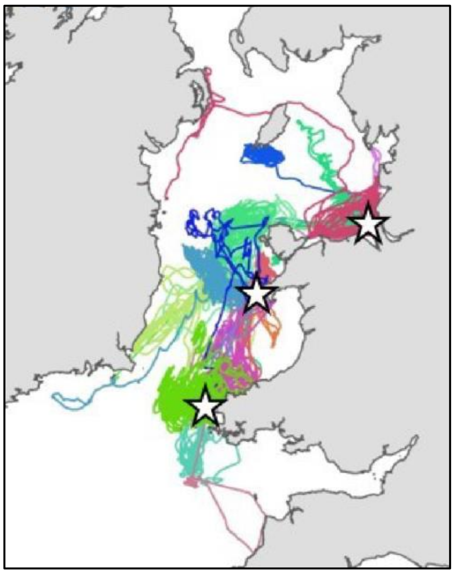


Figure 9-3 Grey seal GPS telemetry data (taken from Carter et al 2022). White stars denote tagging locations (Ramsey & Skomer Islands (n=7), Bardsey Island (n=10) and Dee Estuary (n=15)).

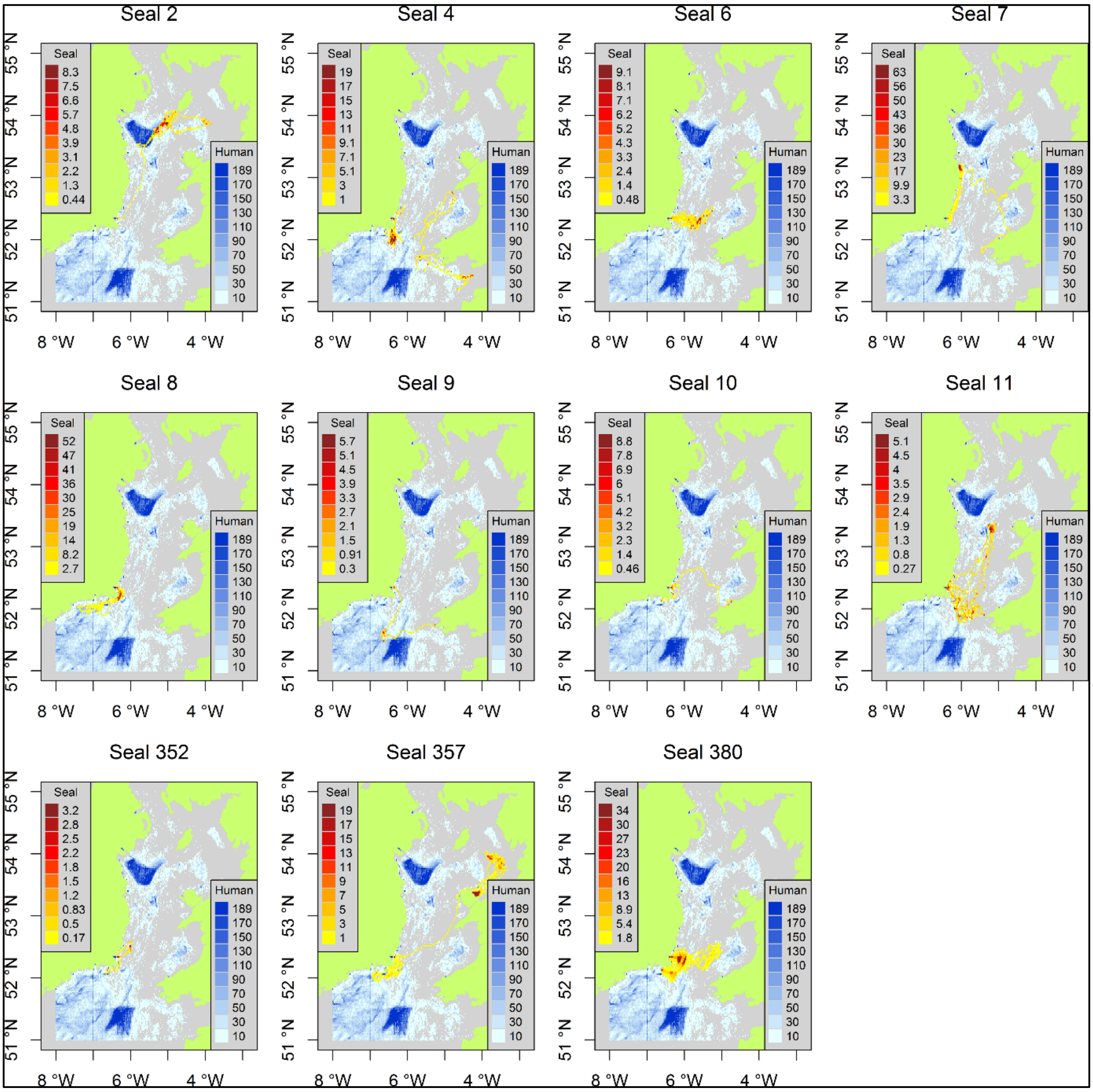


Figure 9-4 Spatial distribution of individual grey seals (yellow-red) (n = 11) and fishing effort (blue) of fishing vessels >12m during 2013 and 2014 (Cronin *et al.*, 2016).

One female grey seal tagged at Bardsey in 2018 showed telemetry tracks that crossed into the CWP Project array site. This seal also showed connectivity with the Lleyn Peninsula and the Sarnau, the Cardigan Bay and the Pembrokeshire Marine SACs in Wales, and travelled as far south as Wexford in the RoI (just north of the Saltee island SAC) (Figure 9-5).

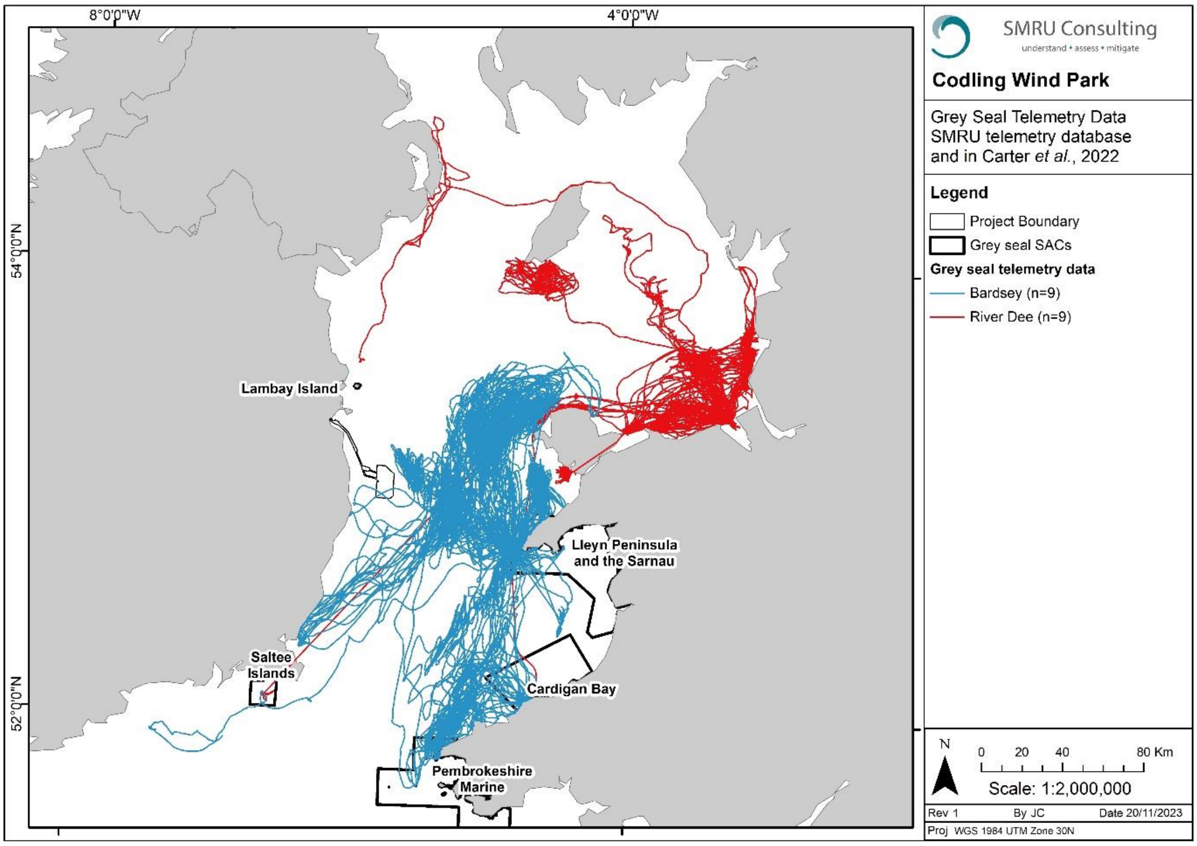


Figure 9-5 Grey seal telemetry data from the SMRU seal telemetry database for seals tagged at Bardsey Island and the River Dee, showing connectivity between the CWP Project array site and grey seal SACs.

Telemetry data from 8 grey seals tagged on the Great Blasket Island have shown movement along the west coast of the RoI, Northern Ireland and the Inner and Outer Hebrides in Scotland (Figure 9-6) (Cronin *et al.*, 2011, Cronin *et al.*, 2013b). These telemetry data do not show any movement between the west and east coast of RoI, however with such a small sample size it is not possible to conclude no connectivity.

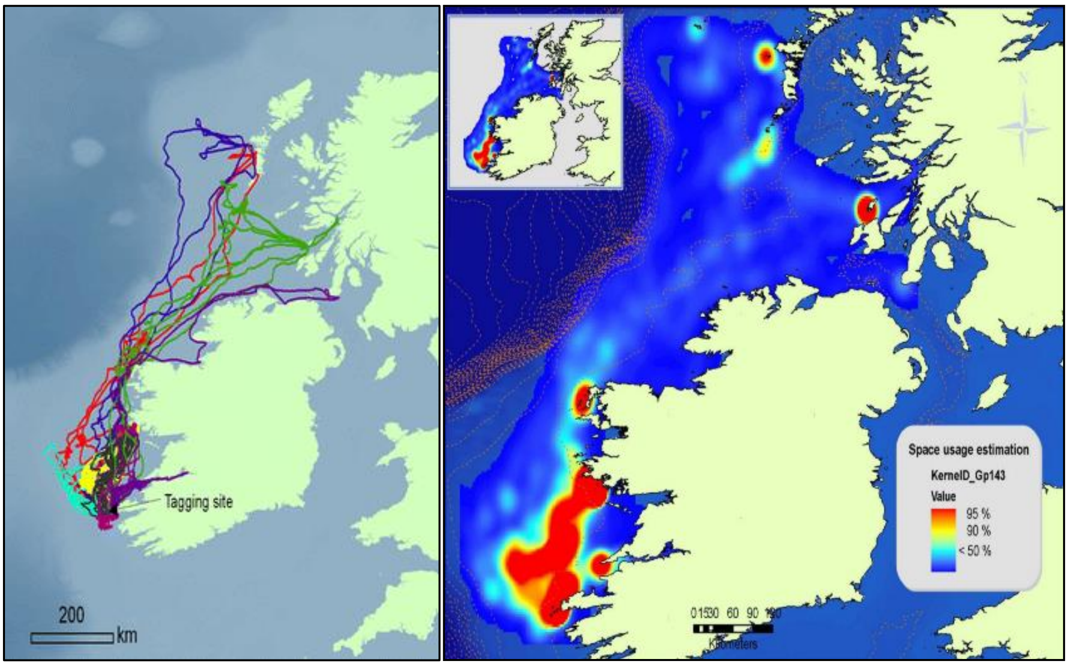


Figure 9-6 Left: Tracks of 8 female grey seals tagged with GPS/GSM tags between February and December 2009 (Cronin *et al.*, 2013b). Right: Space use of all 8 tagged grey seals (Cronin *et al.*, 2011).

9.4 Seal at-sea density

Grey seals in the Irish Sea are widespread, with higher densities in the vicinity of key haul-out sites and SACs (Figure 9-7). Densities in the vicinity of the project are lower compared to the Irish Sea in general. Density estimates for the cells adjacent to the Lambay Island SAC reach up to 1.25 grey seals/km^2 (extracted from Carter et al. 2020), whilst grey seal at-sea density estimates are relatively low in the project area (average 0.1536 seals/km^2 for both the windfarm area and export cable corridor) (Figure 9-7).

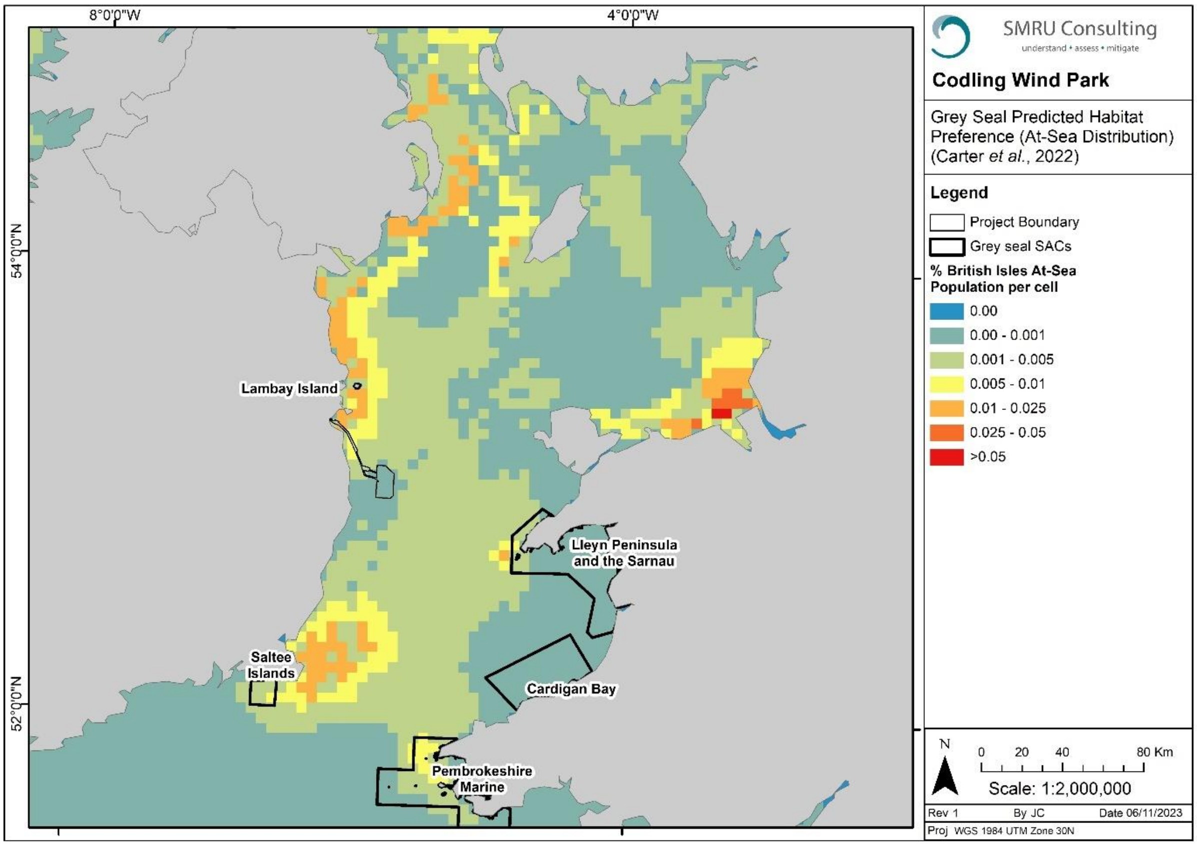


Figure 9-7 At-sea distribution of grey seals from haul-outs in the British Isles in 2018 (Carter *et al.*, 2020)

9.5 IWDG Surveys

During the Greater Dublin Drainage Project IWDG land-based marine mammal surveys (Meade *et al.*, 2017), a total of 325 grey seals were recorded, with 323 of these individuals recorded to be adults and 2 of them juveniles. Overall, the sightings had an average group size of one individual. The sighting rate for grey seals was highest in April 2015, with high numbers of grey seals also reported in September 2015, January 2016, and October 2016. Grey seal distributions were shown to be more westerly in the survey area, with peaks in foraging activity recorded in close proximity to the northern cliffs of Howth Head (Figure 9-8).

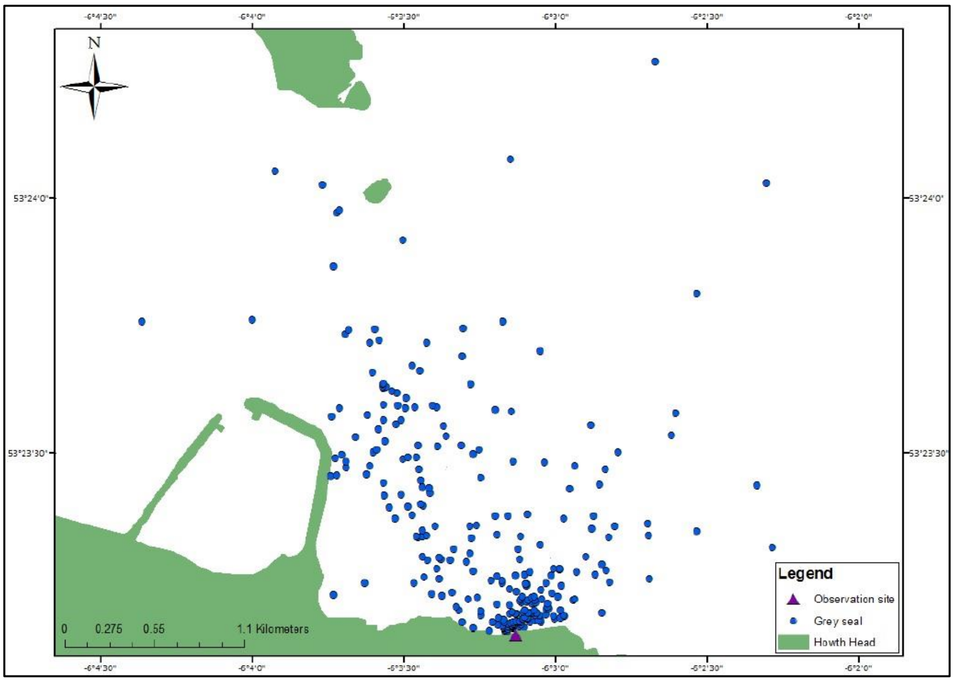


Figure 9-8 Distribution of grey seal sightings off Howth Head (Meade *et al.*, 2017).

In addition, the vessel-based marine mammal surveys carried out by Meade *et al.* (2017) for the Greater Dublin Drainage Project recorded a total of 25 grey seals between April 2015 and January 2017.

During the IWDG Inshore Irish Sea surveys (Berrow *et al.*, 2011), grey seals were reported in both block A (Dublin area) and B (south coast), with 2 grey seals reported in block A and 2 in block B. For both blocks, the mean group size was 1. For block A, the estimated relative abundance of grey seals was estimated at 0.01 individuals/km^2 (Figure 7-9). For block B, the estimated relative abundance of grey seals was reported at 0.014 individuals/km^2. The CWP Project overlaps with both block A and B.

9.6 Other OWFs

9.6.1 NISA

Grey seals were identified as one of the main species of interest within the NISA EIA Scoping Report (ARUP, 2021). Although both boat and aerial marine mammal site-specific surveys have been undertaken as part of the NISA project (ARUP, 2021), these data are yet to be published and site-specific density estimates are not yet available.

9.6.2 Dublin Array

Grey seals were identified as one of the main species of interest within the Dublin Array EIA Scoping Report (SLR *et al.*, 2020). Although both boat and aerial marine mammal surveys have been undertaken as part of the Dublin Array project (SLR *et al.*, 2020), these data are yet to be published and site-specific density estimates are not yet available.

9.6.3 Arklow Bay Wind Park

Unidentified seals were also observed during the nearby Arklow Bank Phase 1 and 2 surveys and were considered most likely to be grey seals (RPS, 2020).

9.7 Seasonality

Grey seal pups are typically born between August and December. Following pupping, the pups will suckle for 17 to 23 days and once weaned, will remain in the breeding colony for a further two to three weeks. Once the adult females have finished lactation, mating will then occur, before heading back out to sea (SCOS, 2023). Grey seals also undertake an annual moult between December and April (SCOS, 2023). During the breeding season and whilst moulting, grey seals spend longer periods of times hauled out on land, resulting in a higher density of seals on land and typically forage within 100 km of haul out sites (SCOS, 2023). They may, therefore, be more vulnerable to activity being conducted close to haul out sites during these months. Outside of the breeding season, seals will exhibit a much wider spatial variation.

9.8 Summary

There have been several studies on grey seal abundance and distribution at haul-outs around Ireland, however there is a lack of at-sea density estimates due to a lack of telemetry data in Irish waters. Given that there is no alternative, it is recommended that the at-sea density estimates obtained from the habitat preference maps (i.e., Carter *et al.* (2020)) are taken forward for impact assessment for the CWP Project.

10 Future receiving environment

It is challenging to predict the future trajectories of marine mammal populations. There is no appropriate monitoring at the right temporal or spatial scales to really understand the baseline dynamics of some marine mammal populations, including all cetacean species included in this assessment. The data available suggests that, apart from harbour porpoise, all other marine mammal populations included in this assessment are relatively stable. This is reflected in the most recent species conservation assessments where all marine mammal species included in this baseline characterisation were classified as having a Favourable overall conservation status (Table 22), with grey seals noted as having an increasing trend (NPWS, 2019).

While harbour porpoise were assessed as having a Favourable conservation status in Irish waters (NPWS, 2019), large scale surveys (SCANS III and ObSERVE combined) have estimated a decline in harbour porpoise abundance in the Celtic and Irish Seas MU, from an estimate of 98,807 (CV: 0.3, 95% CI: 57,315 – 170,336) in 2005 to 62,517 (CV: 0.1395% CI: 48,316 – 80,864) in 2016 (IAMMWG, 2021). The 2016 abundance estimate is therefore only 63% of the 2005 estimate, which represents a significant decline in abundance for this MU. The reason for this decline is not specified or speculated about in IAMMWG (2021). However, the IAMMWG is yet to incorporate the SCANS IV data into these trend estimations, as the ObSERVE surveys (i.e., ObSERVE2) are also scheduled to be updated. The SCANS IV report will also be updated to include results from ObSERVE2, and both reports shall be used to update the IAMMWG MU abundance estimates.

Table 22 Marine mammal conservation assessments (NPWS, 2019).

Species	Conservation Status
Harbour porpoise	The Overall Status of harbour porpoise in Ireland remains Favourable. This overall result is the same as the previous two NPWS assessments.
Bottlenose dolphin	The Overall Status of bottlenose dolphin in Ireland remains Favourable. This overall result is the same as the previous two NPWS assessments.
Common dolphin	The Overall Status of harbour porpoise in Ireland remains Favourable.

	This overall result is the same as the previous two NPWS assessments.
Risso's dolphin	The Overall Status of Risso's dolphin in Ireland is assessed as Favourable, given current knowledge of the species' population size, distribution, ecology, and prevailing pressures on the species. This overall result is different from the previous two assessments, in which the status was assessed as Unknown, and it represents a significant improvement in knowledge of the conservation status of the species.
Minke whale	The Overall Status of minke whale in Ireland remains Favourable, given current knowledge of the species' population size, distribution, ecology, and prevailing pressures on the species. This overall result is the same as in the previous two NPWS assessments.
Harbour seal	The Overall Status of the harbour seal in Ireland is considered to be Favourable, given the current knowledge of the species' population size, distribution, ecology, and prevailing pressures on the species.
Grey seal	Given the current state of knowledge of the species' distribution, population, ecology and prevailing pressures, the Overall Status is Favourable with an increasing trend.

The baseline environment is expected to continue to change as a result of global trends such as climate change. The potential impacts of climate change on marine mammals has previously been reviewed and synthesised by Evans and Bjørge (2013), but they concluded that this topic remains poorly understood.

Since then, numerous studies have, and are being undertaken to understand the potential impacts of climate change on marine mammals. Building upon the work by Evans and Bjørge (2013), Martin *et al.* (2023) provided a further review on climate change impacts on marine mammals around the UK and Ireland, highlighting for marine mammals, impacts are likely to present themselves in the form of geographic range shifts (Kaschner *et al.*, 2011, Nøttestad *et al.*, 2015, Ramp *et al.*, 2015, Williamson *et al.*, 2021) resulting from a reduction of suitable habitats; changes to predator-prey dynamics and thus, food-web alterations (Nøttestad *et al.*, 2015, Ramp *et al.*, 2015); and increased potential for prevalence of disease amongst marine mammal populations through the introduction of novel diseases (Blanchet *et al.*, 2021, SCOS, 2022). Whilst Martin *et al.* (2023) provides an overview of what is, and what could happen to marine mammal populations arounds the UK and Ireland, the review does not into the specifics for each of the species discussed in this baseline report and thus there still remains some uncertainty around the potential impacts of climate change.

To address species-specific impacts of climate change however, van Beest *et al.* (2022) assessed spatiotemporal changes in habitat suitability and inter-specific overlap among grey seals, harbour seals and harbour porpoise co-occurring in the southwestern Baltic Sea, including the Danish Straits. The study model estimated changes in total area size and overlap of habitat suitability for each species between 1997–2020 and 2091–2100. Overall, the model output suggested that habitat suitability of Baltic Sea grey seals will decline over space and time, driven by changes in sea surface salinity and a loss of currently available haul-out sites following sea-level rise in the future (van Beest *et al.*, 2022). A similar, although weaker, effect was observed for harbour seals, while suitability of habitat for harbour porpoises was predicted to increase slightly over space and time (van Beest *et al.*, 2022). Although this study was specific to the Baltic Sea and not UK and Irish waters, it suggested that there is the potential for species to respond differently the climate change, and that there may be divergent shifts in habitat suitability and thus a redistribution of species which influence food-web dynamics (Nøttestad *et al.*, 2015, Ramp *et al.*, 2015) and ecosystem functioning (Blanchet *et al.*, 2021, van Beest *et al.*, 2022).

Whilst species specific studies arising from the UK are lacking, the annual SCOS Advice on Matters Related to the Management of Seal Populations reports have recently reviewed the latest scientific information available on current environmental impacts seals face due to climate change in the UK. The reports concluded that whilst distributions of currently preferred prey are shifting northwards, there is little information on the relationships between environmental drivers and seal population dynamics and it is therefore unlikely that cause and effect will be reliably assigned to specific aspects of climate change with respect to changes in seal population dynamics (SCOS, 2022). In addition, one PhD student at the Sea Mammal Research Unit (SMRU) is exploring the effects of climate change on seals in the UK. Specifically, this exploration investigates how changes in sea surface temperatures and sea levels may potentially impact the distribution of grey seals in the North Sea. This research is ongoing however, and unfortunately no results are available to be shared at this time.

11 Summary

Specific limitations of each data source are outlined in Section 2. These include limitations such as the lack of fine spatial and temporal scales surveyed and the fact that many of the areas surveyed did not directly overlap with the CWP Project survey area. However, they do provide a good indication of the species present in the vicinity of the CWP Project and are complimented by the site-specific surveys which provide a more contemporary estimate at both fine temporal and spatial scale.

The key data limitations with the baseline data are the high spatial and temporal variation in marine mammal abundance and distribution in any particular area of the sea. For this reason, a precautionary approach has been taken, where the higher of the density estimates is recommended to be used in the CWP Project impact assessment.

Table 23 Summary of MU and density estimates taken forward to the quantitatve impact assessment.

Species	MU	Density estimate (#/km^2)
Harbour porpoise	Celtic and Irish Seas MU 62,517 porpoise (IAMMWG, 2023)	0.1225 (CWP Project site-specific surveys) *Not suitable for wide scale disturbance impacts that extend significantly beyond the survey area (ie: pile driving disturbance)*
		Grid cell specific (SCANS III density surface, Lacey *et al.* (2022))
		0.2803 (SCANS IV block CS-D, Gilles *et al.* (2023))
		Grid cell specific (Irish Sea density surface, Evans and Waggitt (2023))
Bottlenose dolphin	Irish Sea MU 1,069 dolphins[2]	Grid cell specific (SCANS III density surface, Lacey *et al.* (2022))
	Irish Sea MU	Grid cell specific (Irish Sea density surface, Evans and

[2] Given the high density estimates for bottlenose dolphins in the Irish Sea using the Lacey *et al.* (2022) density surface, they are incompatible with the current Irish Sea MU population size of 293 dolphins (IAMMWG, 2023).

	496 dolphins[3]	Waggitt (2023))
	Irish Sea MU 8,326 dolphins[4]	0.2352 (SCANS IV block CS-D, Gilles *et al.* (2023))
Common dolphin	Celtic and Greater North Seas MU 102,656 dolphins (IAMMWG, 2023)	0.2810 (CWP Project site-specific surveys) *Used in the presentation for wide scale disturbance impacts that extend beyond the survey area (i.e.: pile driving disturbance) but the results are likely to be highly precautionary*
		Grid cell specific (SCANS III density surface, Lacey *et al.* (2022))
		0.0272 (SCANS IV block CS-D, Gilles *et al.* (2023))
		Grid cell specific (Irish Sea density surface, Evans and Waggitt (2023))
Risso's dolphin	Celtic and Greater North Seas MU 12,262 dolphins (IAMMWG, 2023)	0.0008 (CWP Project site-specific surveys) *Not suitable for wide scale disturbance impacts that extend significantly beyond the survey area (ie: pile driving disturbance)*
		0.0022 (SCANS IV block CS-D, Gilles *et al.* (2023))
		Grid cell specific (Irish Sea density surface, Evans and Waggitt (2023))
Minke whale	Celtic and Greater North Seas MU 20,118 whales (IAMMWG, 2023)	0.0019 (CWP Project site-specific surveys) *Not suitable for wide scale disturbance impacts that extend significantly beyond the survey area (ie: pile driving disturbance)*
		Grid cell specific (SCANS III density surface, Lacey *et al.* (2022))
		0.0137 (SCANS IV block CS-D, Gilles *et al.* (2023))
		Grid cell specific (Irish Sea density surface, Evans and Waggitt (2023))
Harbour seal	East regions of RoI and Northern Ireland MU 1,365 harbour seals	Grid cell specific densities (average 0.0075 seals/km^2 in array site & ECC) (Carter *et al.*, 2020, Carter *et al.*, 2022)
Grey seal	East regions of RoI and Northern Ireland MU 6,056 grey seals	Grid cell specific densities (average 0.1563 seals/km^2 in array site & ECC)(Carter *et al.*, 2020, Carter *et al.*, 2022)

[3] Given the high density estimates for bottlenose dolphins in the Irish Sea using the Evans and Waggitt (2023) maximum density surface, they are incompatible with the current Irish Sea MU population size of 293 dolphins (IAMMWG, 2023).

[4] Given the high SCANS IV density estimates for bottlenose dolphins in the Irish Sea, they are incompatible with the current Irish Sea MU population size of 293 dolphins (IAMMWG, 2023).

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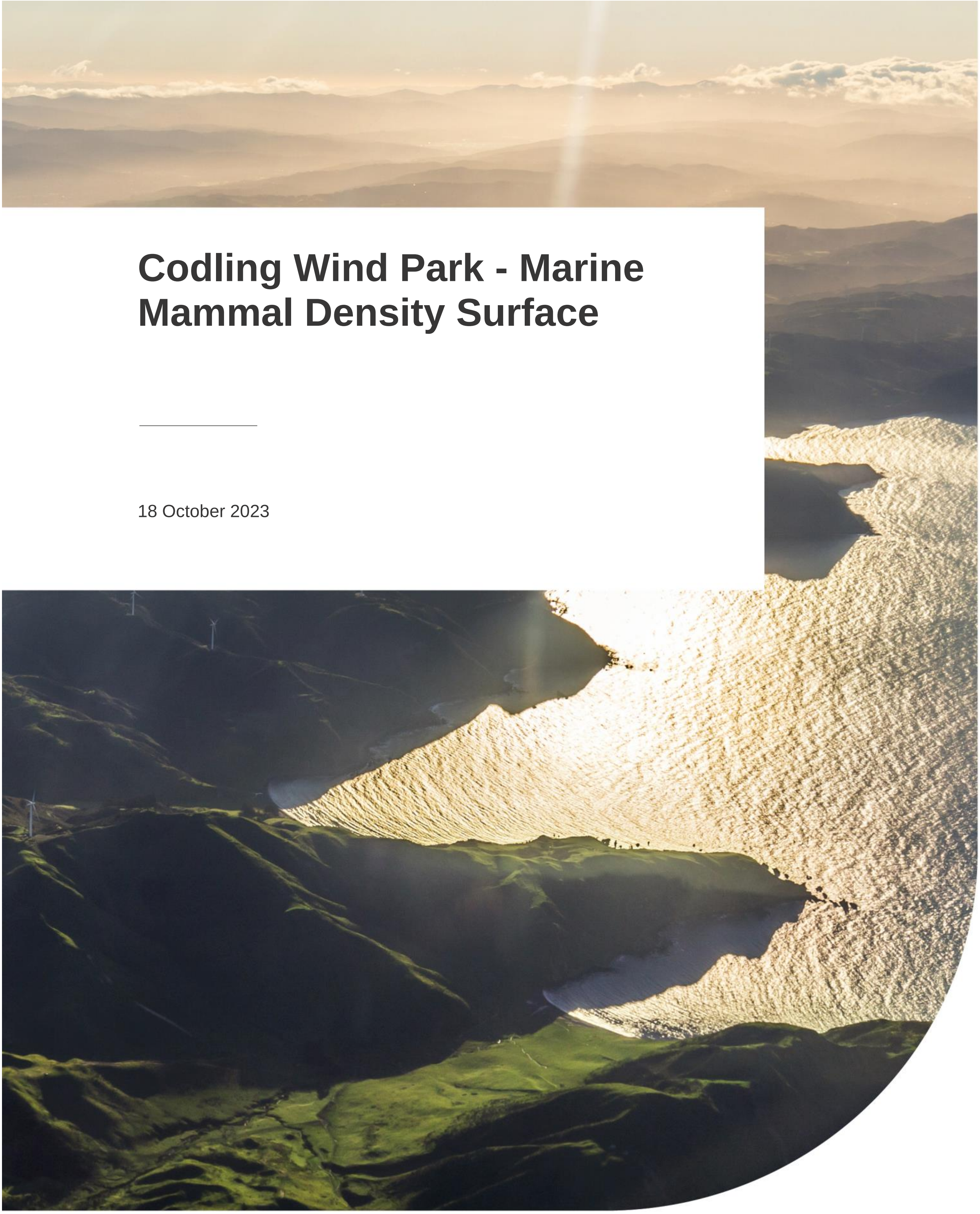
Codling Wind Park - Marine Mammal Density Surface

18 October 2023



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Contents

1. Spatial distribution of marine mammals

Density estimates are provided from survey data collected during boat-based and/or aerial surveys conducted over the Codling proposed wind farm development site and a 4 km buffer surrounding it. Where survey data were used, only those observations observed on effort and by a marine mammal observer were used in density estimation.

1.1. Harbour porpoise

For harbour porpoise, the distribution of animals for the proposed Codling Wind Park development site and 4 km buffer was derived by modelling data collected during the 2013 - 2014, and 2018 - 2020 boat-based survey campaigns and the 2020 - 2022 aerial survey campaign.

Accounting for a decline in detectability with distance – boat-based data

Boat-based surveys were carried out according to line transect methodology in which observers record all animals detected, along with their perpendicular distance from the transect line. In order to convert distance sampled data into densities, a detection function representing the decline in detectability of the target species with distance from the trackline must be constructed and used to account for individuals that were missed by the observers (Buckland *et al*., 2001).

Harbour porpoise observation data were right truncated at 900 m prior to construction of detection curves. This left 296 (of 304 total) observations with which to fit the detection function. Half-normal and hazard-rate functions were fit to the data, with sea state and group (cluster) size included as candidate covariates. The final model was selected by minimising AIC. It comprised a hazard rate function with sea state retained as a covariate. Goodness-of-fit was checked using QQ-plots and chi-squared tests. The final function, shown in Figure 1.1, was used to scale boat-based observations prior to density surface modelling based on the probability of animals being detected according to the following equation.

$$\widehat{N} = \frac{N}{P_{det}}$$

Where N is the raw observation and P_{det} is the detection probability for that observation.

Source: Natural Power

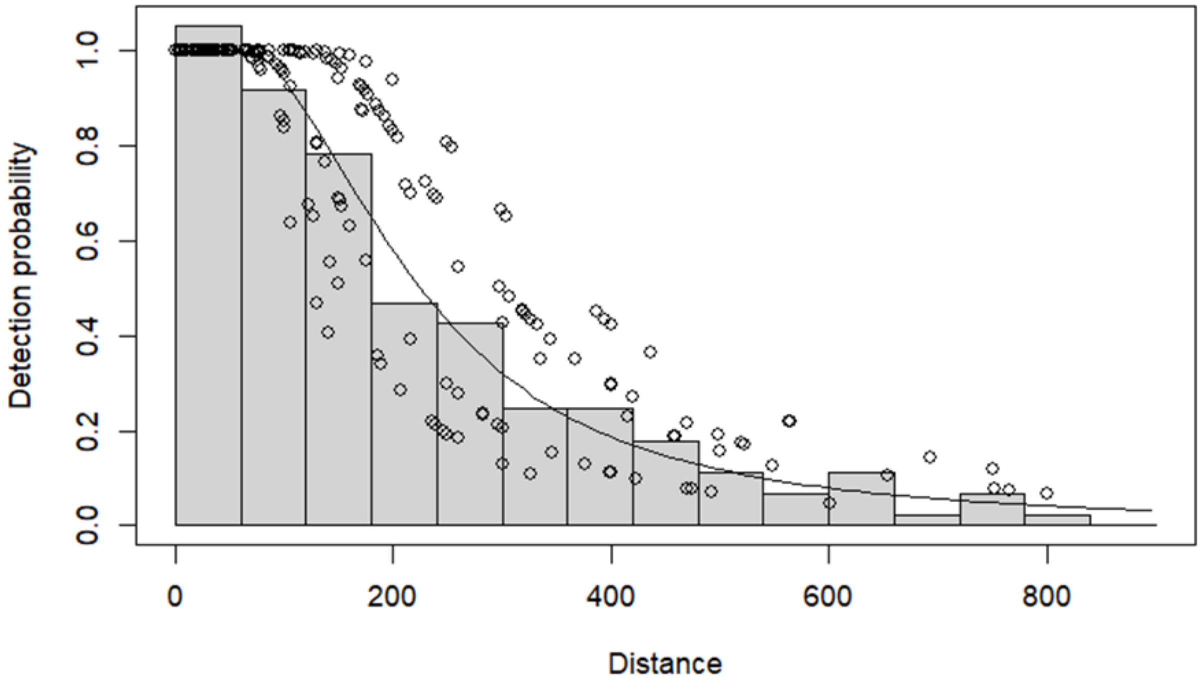

Figure 1.1: Detection probability with increasing perpendicular distance from the trackline for harbour porpoise

Accounting for availability bias – aerial surveys

Aerial surveys were carried out according to a strip transect methodology in which digital video captured by the plane when flying the transect route was analysed to identify all animals captured within the surveys. Since the plane moves rapidly, animals will not be detected if they are deep under the water when the plane flies over. This is known as availability bias. Observations from digital arial surveys were corrected for availability bias using monthly correction factors presented within Teilmann *et al*., 2013 (Table 1.1), using the same equation as above, where P_{det} is the availability bias correction.

Table 1.1: Aerial survey availability bias corrections for harbour porpoise (proportion of time spent in the top 2 metres of the water column and therefore likely visible during aerial surveys)

Month	Correction
January	0.492
February	0.425
March	0.525
April	0.615
May	0.573
June	0.553
July	0.570
August	0.517

Month	Correction
September	0.450
October	0.453
November	0.463
December	0.499

Source: Teilmann et al., 2013

Density surface modelling

Scaled observations were combined and used to construct a density surface model using the MRSea package in R (Scott-Hayward *et al*., 2013). The MRSea package facilitates model construction using one-dimensional and two-dimensional non-linear covariates and can do so within a GEE (Generalised Estimating Equation) framework to allow for correlated errors.

Transects were segmented into 1000 m lengths (with one smaller segment where transect lengths were not an exact multiple of 1000 m), used as the unit of replication for the modelling. Candidate covariates were month, depth and distance to coast included as one-dimensional smooths and x and y position included as a two-dimensional smooth. Smooths were modelled using Complex Region Spatial Smoother (CReSS) methods with flexibility determined by the Spatially Adaptive Local Smoothing Algorithm (SALSA) within MRSea, allowing flexibility of the smooth to vary across the surface. The model was fit within a GEE framework with transect as a blocking factor in order to account for spatial autocorrelation when estimating coefficients.

The final model was selected based on minimising Quasi Information Criterion (QIC), a measure of relative quality of a model for a given set of data based on balancing model fit and model complexity. The model was used to predict harbour porpoise density onto a 1km^2 grid covering the site and buffer area.

1.2. Minke whale

For minke whale, a design-based estimate derived from data collected during the 2013 – 2014, and 2018 – 2020 boat-based survey campaigns was used to represent density of animals within the proposed Codling Wind Park development site and 4 km buffer. Data collected during aerial surveys were not used for density estimation as no minke whale were recorded during aerial surveys and because minke whale are known to be extremely difficult to detect from aerial surveys (Webb *et al.*, 2018). It was therefore considered that including aerial survey effort could lead to under-estimating the true density of minke whale at the site.

Density was calculated as:

$$D = \frac{N}{S \times (L \times (2 \times ESW))}$$

where N is the number of individuals recorded within a 900 m truncation distance of the transect line, S is the number of surveys, L is the length of the surveyed transects, and ESW is the effective half-strip width. The effective half-strip width is derived from detection curves (see section 1.1 – Accounting for a decline in detectability with distance) and provides another method of correcting for the drop-off in detectability of targets with increasing distance from the observer. The effective strip width represents the strip width that would generate the same number of observations as were actually observed during surveys under the hypothetical scenario that all animals available for detection were detected with certainty. A minimum of 60 observations should be used to fit a robust detection curve (Buckland *et al.*, 2001), and only 5 minke whale were observed during the boat-based surveys. Effective strips widths used were therefore taken from the SCANS-III study (Hammond *et al*., 2021; Table 1.2). Whilst these may not be entirely representative of detection probability at Codling, use of this proxy was considered to be more appropriate than assuming that all individuals were detected, which would almost certainly result in significant underestimation of density within the site. Final densities are presented in Table 1.3.

Table 1.2: SCANS-III effective strip-widths used to correct for drop-off in detectability with distance for site-specific design-based estimates

Species	Effective half-strip width (ESW) (m)
Common dolphin	110
Risso's dolphin	151
Minke whale	208

Source: Hammond et al., 2021

Table 1.3: Minke whale point density estimate for the Codling Wind Park footprint and 4km buffer

Surveys	Animals observed	Single survey transect length (km)	Number of surveys	Total un-surveyed transect length (km)	Strip width (km)	Assumed availability	Effective effort acounting for availability	Density
2013-2014 boat-based	2	239.6	12	0.0	0.416	1	1195.9	0.0017
2018-2020 boat-based	3	239.6	15	26.0	0.416	1	1468.9	0.0020
Total	5						2664.8	0.0019

Source: Natural Power

1.3. Bottlenose dolphin

No density estimated.

1.4. Common dolphin

For common dolphin, a design-based estimate derived from data collected during the 2013 – 2014, and 2018 – 2020 boat-based survey campaigns, and the 2020 – 2022 aerial survey campaign was used to represent density of animals within the proposed Codling Wind Park development site including a 4 km buffer.

Prior to the analysis, boat-based effort was corrected using the effective half-strip width calculated for common dolphin for the SCANS-III study (see section 1.2 - Density within the Codling Wind Park Footprint and Buffer for an explanation of effective strip width). SCANS-based effective half-strip widths used for deriving density estimates are presented in Table 1.2. For the aerial survey data, no appropriate common dolphin availability bias estimates (i.e. the number of animals undetectable during surveys due to being below the surface of the water – see Section 1.1 - Accounting for availability bias – aerial surveys) were available so the estimate for the amount of time pan-tropical dolphin is present within the top 2 m of the water column from Watwood *et al.*, 2020 (0.203) was used instead. This was used to adjust aerial survey observations prior to density calculation. Pan-tropical dolphin was selected as the proxy for common dolphin due to being members of the same sub-family and sharing similar behavioural characteristics, following Watwood *et al*.

Density was calculated by dividing the total number of observations (adjusted as described above) by the total effort (adjusted as described above) and was assumed to be uniform across the site and buffer area. Final densities are presented in Table 1.4.

Table 1.4: Common dolphin point density estimate for the Codling Wind Park footprint and 4km buffer

Surveys	Animals observed	Single survey transect length (km)	Number of surveys	Total un-surveyed transect length (km)	Strip width (km)	Assumed availability	Effective effort accounting for availability	Density
2020-2022 Aerial	82	239.6	24	0.0	0.25	0.203	291.8	0.2810
2013-2014 boat-based	0	239.6	12	0.0	0.22	1.000	632.5	0.0000
2018-2020 boat-based	2	239.6	15	26.0	0.22	1.000	764.5	0.0026
Total	84						1688.8	0.0497

Source: Natural Power

1.5. Risso's dolphin

For Risso's dolphin, a design-based estimate derived from data collected during the 2013 – 2014, and 2018 – 2020 boat-based survey campaigns, and the 2020 – 2022 aerial survey campaign was used to represent density of animals within the proposed Codling Wind Park development site including a 4 km buffer.

Prior to the analysis, boat-based effort was corrected using the effective half-strip width calculated for common dolphin for the SCANS-III study (see section 1.2 - Density within the Codling Wind Park Footprint and Buffer for an explanation of effective strip width). SCANS-based effective half-strip widths used for deriving density estimates are presented in Table 1.2. For aerial surveys, availability bias for Risso's dolphin was assumed to be that presented in Watwood *et al*., 2020. Since no Risso's dolphin were observed during aerial surveys, Risso's dolphin availability bias estimates (i.e. the number of animals undetectable during surveys due to being below the surface of the water – see Section 1.1 - Accounting for availability bias – aerial surveys) was used to correct the effort data for the aerial surveys by dividing the effort by the availability bias prior to calculating densities.

Density was calculated by dividing the total number of observations by the total effort (adjusted as described above) and was assumed to be uniform across the site and buffer area. Final densities are presented in Table 1.5.

Table 1.5: Risso's dolphin point density estimate for the Codling Wind Park footprint and 4km buffer

Surveys	Animals observed	Single survey transect length (km)	Number of surveys	Total un-surveyed transect length (km)	Strip width (km)	Assumed availability	Effective effort accounting for availability	Density
2020-2022 Aerial	0	239.6	24	0.0	0.250	0.383	550.5	0.0000
2013-2014 boat-based	2	239.6	12	0.0	0.302	1.000	868.2	0.0023
2018-2020 boat-based	0	239.6	15	26.0	0.302	1.000	1059.2	0.0000
Total	2						2477.9	0.0008

Source: Natural Power

1.6. Harbour seal and grey seal

No density estimated.

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