ARRAY ENVIRONMENTAL IMPACT ASSESSMENT

ANNEX B: MARINE MAMMAL METHODOLOGY NOTE

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1. INTRODUCTION

1. This methodology note is submitted as a follow up to the pre-Scoping workshop, held on 11 November 2022, to provide further information to stakeholders to that included in the Ossian Scoping Report and gain agreement with the approach to the marine mammal assessment for Ossian.

2. The content of this methodology note does not duplicate information presented within the Ossian Scoping Report (Ossian OWFL, 2023), however, it is intended to be read alongside it. The focus here is on the topics within the Environmental Impact Assessment (EIA) that are of particular importance to the marine mammal impact assessment and therefore it is imperative to seek stakeholders' agreement on the approach to the assessment as early as possible in the pre-application process.

3. Specifically, this methodology note describes the methodology used to analyse the site-specific survey data as well as the methodology to be used to inform the marine mammal assessment for underwater noise and entanglement impacts associated with the Ossian Array which is the subject of this application (hereafter referred to as "the Array"). The Array will be located within the offshore site (hereafter referred to as "site boundary"). The marine mammal study area encompasses the site boundary plus an 8 km buffer, whilst the regional marine mammal study area encompasses a larger range due to the highly mobile and wide-ranging nature of marine mammal species (Figure 1.1).

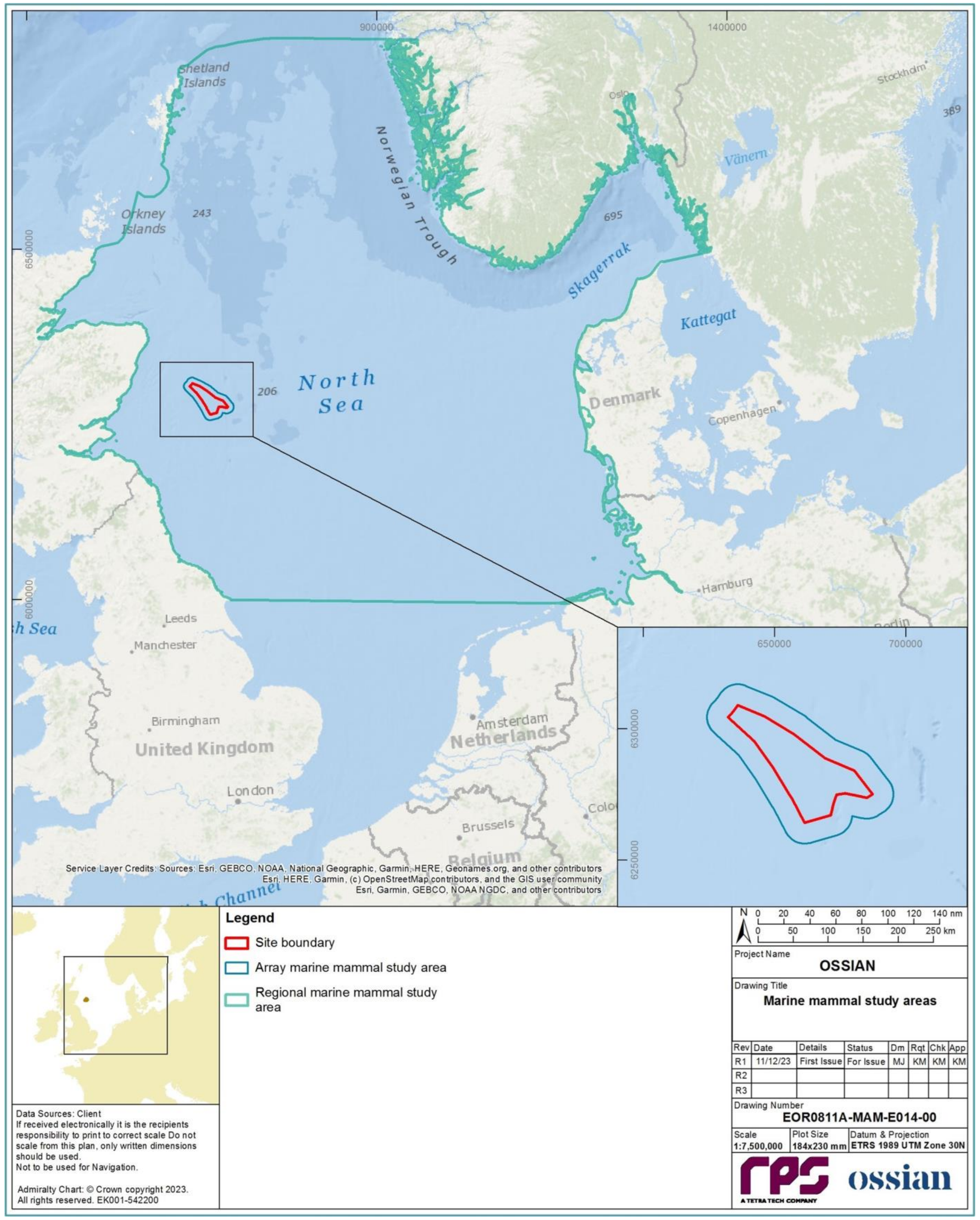

Figure 1.1 Marine Mammal Study Areas

2. SITE-SPECIFIC SURVEY DATA

2.1. DATA COLLECTION

4. Ossian Offshore Wind Farm Limited (OWFL) (hereafter referred to as "The Applicant") has commissioned HiDef Aerial Surveying Ltd (HiDef) to undertake aerial surveys of marine mammals across the marine mammal study area (Figure 1.1). The survey data has been collected monthly for 24-months between March 2021 and February 2023.

5. In the processing of aerial survey data, marine mammals identified in the images are categorised to the lowest taxonomic level possible and a comprehensive internal Quality Assurance (QA) process was conducted. Where a marine mammal sighting cannot be identified to species level with high confidence, sightings are given in their own non-species-specific categories (e.g. 'seal species', 'seal/small cetacean species' and 'cetacean species').

6. Full details of the survey methodology, data processing methods, data analyses, assumptions and limitations will be provided as part of the Array EIA Report. Sightings data from each category is presented and discussed further in the technical report (volume 3, appendix 10.2).

2.2. DATA ANALYSIS

7. Both design-based densities and modelled estimates are calculated from site-specific survey data. Where data is sufficient, model-based density estimates are calculated using the statistical software R v4.2.0 (R Core Team, 2023), and the MRSea package v1.3.1 (Scott-Hayward *et al*., 2013; see section 2.4). Covariates such as bathymetry, distance to coast, latitude and longitude and season are used within the modelling to predict species distribution. To ensure that bias is not introduced to the site-specific survey modelling results, data from broader non-species specific classifications were not assigned to species categories. As such, sightings classed as 'cetacean species', 'dolphin species', 'seal/small cetacean species' and 'seal species' are not considered in species-specific analyses.

2.3. AVAILABILITY BIAS

8. Aerial survey data represent a snapshot of marine mammal distribution and densities within a given survey per month and may not fully capture the natural variability of marine mammal distribution or densities over time. Therefore, it is important to correct for availability bias when using snapshot data such as site-specific surveys. In most cases, animals are noted and identified from digital images where the animal is under the sea surface. Changes in sightings rates may be influenced by environmental conditions. However, due to the short time frames (single day) of data collection, it is not possible to analyse this. Therefore, whilst differences in sightings rates between months may be due to seasonal changes, environmental conditions also have the potential to influence these results.

9. Relative density estimates can be corrected for availability bias using published correction factors based on the proportion of time individuals are likely to be at or near the surface and available for detection. Telemetry studies of the diving behaviour of different species can be useful in indicating the average proportion of time that individuals of a species may be on, or near, the surface and available for detection. Note that these are considered to be the best estimates of absolute densities, subject to limitations recognised in studies (e.g. potentially subject to geographic, seasonal, diurnal, and individual animal variation).

10. Within the impact assessment, both relative abundance and density are calculated from site-specific data, and then absolute values are calculated correcting for availability bias. In order to account for the availability bias and apply the most appropriate correction factors, a precautionary approach was taken by reviewing the literature to compare correction factors from different studies and different months (Table 2.1). Mannoconi *et al*. (2018) provides an equation to derive correction factors from the latest available literature per species; this is a standard approach used in offshore wind farm consenting studies and has been used to derive the correction factors presented in Table 2.1.

11. Precautionary correction factors taken forward to the assessment were derived from studies in both the North Sea and other regions, e.g. harbour porpoise diving behaviour in the Baltic and North Seas (42.5%), white-beaked dolphin diving behaviour in Iceland (18%), and grey seal diving behaviour in the North Sea (15.6%).

Table 2.1: Summary of Estimated Correction Factors from Relevant Studies

Species	Correction Factor	Description	Reference
Harbour porpoise *Phocoena phocoena*	42.5%	Tagging study in Baltic/North Sea looking at proportion of time surfacing in top 0 m to 2 m. Most conservative correction factor based on winter months, where surfacing lower.	Teilman *et al*. (2013)
	42.4%	Tagging study of fine scale movements of harbour porpoise in the Danish North Sea. Estimated a mean dive duration of 53 seconds and a mean surfacing time of 39 seconds.	van Beest *et al*. (2018)
White-beaked dolphin *Lagenorhynchus albirostris*	18.0%	Bio-logging study of two individual free ranging white-beaked dolphin in Iceland. Spent on average 18% of time close to the surface (0 m to 2m deep) and 82% of the time diving.	Rasmussen *et al*. (2013)
Minke whale *Balaenoptera acutorostrata*	44.0%	Visual tracking study in Iceland recorded surfacing duration between short and long dive sequences. Surfacing estimated at 58 seconds, dive mean 73 seconds.	McGarry *et al*. (2017)
Grey seal *Halichoerus grypus*	15.7% to 16.6%	Tagging study of three male grey seal in the Farne Islands (north-east England). Average proportion of time animals were submerged as they travelled was 84.3%, slightly lower during short duration trips (83.4%).	Thompson *et al*., (1991)
	15.6%	Tagging (deployed by Sea Mammal Research Unit (SMRU)) on grey seal in North Sea. 60% of surfacing periods were between 15 and 45 seconds, with an average of 40 seconds and dive durations varied between 20 and 496 seconds with an average of 216 seconds.	Ørsted (2018)

2.4. MODELLING

12. Species distribution modelling is carried out using the MRSea package 3 (Scott-Hayward *et al*., 2013) to predict the density of marine mammals within aerial survey areas. MRSea generates spatial maps of density of marine mammals within the survey areas. Previous consenting applications have modelled relative abundance and density by month, or bio-season (such as those for harbour porpoise defined in Heinänen and Skov (2015)).

3. INJURY AND DISTURBANCE FROM ELEVATED UNDERWATER NOISE – PILING

3.1. UNDERWATER NOISE MODELLING

13. Pile driving during the construction phase of the Array has the potential to result in elevated levels of underwater noise that are detectable by marine mammals above background levels, and could result in injury or behavioural effects. A detailed underwater noise modelling assessment will be carried out to investigate the potential for injury and behavioural effects on marine mammals as a result of piling (impulsive sounds), using the latest assessment criteria. The criteria proposed by Southall *et al*. (2019) will be used for modelling of auditory injury. For disturbance, the assessment adopts a conservative approach and uses the National Marine Fisheries Service (NMFS) (2005) Level B harassment threshold of 160 dB re 1 μPa (root mean square (rms)) for impulsive sound, excluding piling which is assessed based on Sound Exposure Level (SEL). For continuous noise, level B harassment threshold at 120 dB re 1 μPa (rms) is used (NMFS, 2005).

14. The underwater noise modelling will assume that an animal would swim away from the sound source at the onset of activity in a straight line and at a constant rate (fleeing animal model) and subsequently, conservative species-specific swim speeds will be incorporated into the model. Indicative swim speeds are given in Table 3.1.

Table 3.1: Indicative Assessment Swim Speeds of Marine Mammals

Species	Hearing Group	Swim Speed (m/s)	Reference
Harbour porpoise	Very High Frequency (VHF)	1.5	Otani *et al.* (2000)
Bottlenose dolphin *Tursiops truncatus*	High Frequency (HF)	1.52	Bailey *et al.* (2010)
White-beaked dolphin	HF	1.52	Bailey *et al.* (2010)
Minke whale	Low Frequency (LF)	2.3	Boisseau *et al.* (2021)
Harbour seal *Phoca vitulina*	Phocid Carnivores in Water (PCW)	1.8	Thompson *et al.* (2015)
Grey seal	PCW	1.8	Thompson *et al.* (2015)
	Very High Frequency (VHF)	1.5	Otani *et al.* (2000)

15. Maximum Design Scenarios (MDS) will be defined on the basis of the range of metrics in the Project Design Envelope (PDE). For example, to assess the impact of pile driving, a range of pin piles with different diameters will be modelled with the maximum required hammer energy to determine the spatial scenario likely to result in the largest ranges for injury and disturbance for the key species. The maximum temporal scenario will also be determined on the basis of the longest duration of piling (leading to the maximum number of piling days) over the construction phase for the Array.

16. Full detail of the underwater noise methodology are presented in the Underwater Noise Modelling Methodology Note (volume 3, appendix 5.1, annex C).

3.2. ASSESSMENT OF IMPACTS

17. Injury and disturbance from elevated underwater noise during impacts such as piling is important to consider in impact assessments. Marine mammals, in particular cetaceans, are capable of generating and detecting sound (Bailey *et al*., 2010) and are dependent on sound for many aspects of their lives (i.e. prey identification; predator avoidance, communication and navigation). Increases in anthropogenic sound may consequently lead to a potential masking effect within the marine environment (Parsons *et al*., 2008; Bailey *et al*., 2010), and subsequent ecological effects on marine mammals.

3.2.1. INJURY

18. In the assessment of injury as a result of piling, potential auditory injury will focus on Permanent Threshold Shift (PTS), where there is no hearing threshold recovery in the animal after the cessation of piling. Temporary threshold shift (TTS) will be modelled, however, this is reversible and likely to induce a temporary moving away response from the ensonified area. For TTS, the derived thresholds are based on the smallest measurable shift in hearing (i.e. the lowest level that exceeds recorded variation and leads to onset of TTS) (NMFS, 2016) and as such are likely to result in overestimates of the effect ranges. Therefore, TTS is not considered a useful predictor of the injury to marine mammals and will not be included in the assessment of injury for piling.

Dual metric approach

19. For marine mammals, injury thresholds can be presented using:

- unweighted peak sound pressure levels (i.e. peak SPL, commonly referred to as SPL_{pk}); and
- marine mammal hearing-weighted SEL as per the latest guidance from Southall *et al.* (2019).

20. The two metrics are applied under the condition that exceeding either threshold by the specified level is sufficient to result in predicted PTS (or TTS) onset. The different exposure metrics account for different aspects of exposure level and duration. SPL_{pk} characterises the amplitude of the sound and in marine mammal assessments is measured as the zero-to-peak pressure of the sound wave to determine the potential for an instantaneous injury at a point in time. SEL is a measure of sound energy of exposure accumulated over time taking into account the received level and duration of exposure as an animal moves across a sound field (Southall *et al*., 2019). To assess injury, cumulative SEL is computed for multiple pulses over a 24-hour period (SEL_{cum}) and assumes an animal moves away from the sound source in a directional movement based on conservative swim speeds (Table 3.1). SEL_{cum} is considered a precautionary metric for determining injury due to the conservative assumptions in the model (e.g. assumptions that an animal would be exposed over the entire duration of the piling sequence with no sound pressure release during pauses in piling or when an animal breaks the surface) which may lead to overestimates of the effect. Another key point to note is that there is currently no agreed approach to modelling the cross-over point from impulsive to continuous sound and this is an ongoing active area of research.

21. The underwater noise modelling will investigate a range of different scenarios (including concurrent piling if applicable) to determine the scenario likely to lead to the largest potential impact range for each species.

22. With respect to the SPL_{pk} metric, the soft-start initiation is the most relevant noise source and period, as this is the range at which animals may potentially experience injury from the initial strike of the hammer, after which point it is assumed that they will move away from the noise source. As such, although the assessment of significance will be based on the MDS (maximum hammer energy, as mentioned in paragraph 15), the injury ranges associated with initial hammer energy will be presented in the assessment to provide a comprehensive overview of potential impacts. The assessment will also present injury ranges predicted for marine mammals exposed to impulsive noise from multiple hammer strikes over a prolonged period (i.e. using the SEL_{cum} metric); the assumption being that a marine mammal exposed to lower noise levels over a prolonged period (as it moves away from the source) could experience auditory injury.

23. Suitable conservative densities derived from baseline characterisation will be used in-combination with the MDS injury ranges from underwater noise modelling to give an area of effect and the number of animals impacted. Population effects will be assessed against relevant Management Units (MUs). The quantitative assessment will be interpreted subject to the caveats highlighted above and considering the environmental context (Southall *et al*., 2021).

24. The dual metric approach is recommended by Southall *et al*. (2019) for assessment of injury. However, as recommended by stakeholders during the pre-Scoping workshop, only the SPL_{pk} will be used to inform the injury (PTS) assessment and appropriate Mitigation Zone (MZ), although both metrics (SPL_{pk} and SEL_{cum}) will be presented in the assessment of PTS for the Array.

Threshold for mitigation ranges

25. The SPL_{pk} metric will be used to determine the MZ, by using the SPL_{pk} predicted range. The MZ is defined as the maximum potential instantaneous PTS-onset impact ranges and is the radius around the sound source over which mitigation should be focused. It is a prescribed area within which no marine mammals should be present before noisy activity begins and is applied to reduce the potential for injury (PTS) to negligible levels.

26. Designed in measures will be implemented as follows:

- primary mitigation will include the use of a low hammer energy initiation, soft-start to piling before ramping up to full hammer energy; and
- tertiary mitigation (standard industry measures) will include the use of Marine Mammal Observers (MMO[2]) and Passive Acoustic Monitoring (PAM) to monitor the MZ prior to hammer initiation as well as the use of an Acoustic Deterrent Device (ADD), if required, to deter animals from the MZ.

27. ADDs are considered a tertiary mitigation as the application of these devices is recommended in statutory guidelines (JNCC, 2010) and form a part of the standard industry practices during piling at offshore wind developments. This approach is in line with- the Institute of Environmental Management and Assessment (IEMA) Guidance (2016) where tertiary mitigation measures are defined as "*Actions that would occur with or without input from the EIA feeding into the design process. These include actions that will be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects*."

28. With respect to deterrence using an ADD, swim speeds (see Table 3.1) will be used to estimate whether an animal can swim beyond the modelled PTS (injury) threshold distances for each species over a set deployment duration of the ADD. If the swim distance is larger than the injury range, it will be deemed there is no residual risk of injury. In order to balance the risk of additional noise introduced into the marine environment, the ADD will be applied for a minimum possible duration that will ensure that the animals are deterred beyond the injury zone.

29. The designed in measures will evolve over the development process as the EIA progresses. The marine mammal assessment will consider the potential for any residual risk of injury after implementation of primary and tertiary mitigation. Requirements to include secondary mitigation (e.g. noise abatement systems) for reducing the risk of injury from piling will be dependent on the significance of the effects, which are determined in part due to injury ranges determining magnitude of impact.

30. It needs to be noted that caution should be used in interpreting predicted injury ranges based upon sound level thresholds defined for impulsive sounds to signals that are no longer impulsive, as they are likely to be lower than predicted. The NMFS (2018) guidance suggested an estimate of 3 km for transition from impulsive to continuous (although this was not subsequently presented in the later peer-reviewed paper, Southall *et al*., 2019). Hastie *et al*. (2019) suggest that some measures of impulsiveness (for seismic airguns and pile driving) change markedly within approximately 10 km of the source. As mentioned in paragraph 20, there is currently no agreed approach to modelling the cross-over point from impulsive to continuous sound and this is an ongoing active area of research, with Southall *et al.* (2019) noting specific methods to estimate the transition from impulsive sound to non-impulsive sound are being developed. Therefore, caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres that have used impulsive sound thresholds for the whole contour range, as the injury (PTS) ranges are likely to be significantly lower than predicted.

3.2.2. DISTURBANCE

31. Beyond the zone of injury, sound levels are such that auditory injury is less likely to occur but can result in change to marine mammal behaviour. This response will depend on the individual and the context; previous experience and acclimatisation will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities, as will an animal's incentive to remain in an area, due to prime foraging grounds for example. Typically, a threshold approach has been adopted in offshore wind farm assessments in the UK to quantify the scale of the effects.

32. For example, the NMFS (2018) define strong disturbance in all marine mammals as Level B harassment and for impulsive noise suggests a threshold of 160 dB re 1µPa (rms). This threshold meets the criteria defined by JNCC (2010) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al*. (2008) severity score of 5 or more on the behavioural response scale. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al*., 2008)). The assessment will adopt the NMFS criteria of non-trivial (strong) disturbance (160 dB rms) for all impulsive sound sources, other than for piling which will use a dose-response approach as described in paragraph 36 *et seq*. To note, for continuous sound sources, the NMFS criteria of 120 dB re 1 µPa (rms) will be adopted for the onset of a strong behavioural reaction.

Contours

33. To obtain the numbers of animals disturbed, contours from underwater noise modelling are plotted in Geographical Information System (GIS) for all modelled locations. Contours are plotted by 5 dB isopleths, to allow additional context for each species with respect to the thresholds of strong disturbance and mild disturbance at 160 dB re 1 µPa (rms) as per NMFS (2005).

34. The areas within each isopleth will be calculated from the spatial GIS map and a proportional expected response (derived from the dose-response curve for each isopleth area, discussed further in in paragraph 36 *et seq*.) used to calculate the number of animals potentially disturbed. These numbers will be subsequently summed across all isopleths to estimate the total number of animals disturbed during piling at any given time. The number of animals predicted to respond will be based on species-specific densities derived from site-specific surveys and desktop data.

35. For each species, the modelled location of piling taken forward for assessment will be that which results in the greatest number of animals affected for that species, thereby representing the maximum design scenario.

Dose response

36. Empirical evidence from monitoring at offshore wind farms during the construction phase suggests that pile driving is unlikely to lead to 100% disturbance of all individuals exposed to sound above a specific sound level, and that there will be a proportional decrease in the duration of response at greater distances from the pile driving source (Brandt *et al*., 2011; Graham *et al*., 2019; Russell *et al*., 2016). As such, dose-response is an accepted approach to understanding the behavioural effects from piling and has been applied in other recent UK offshore wind farms EIAs (for example Awel y Môr (RWE, 2023), Seagreen (Seagreen Wind Energy Ltd, 2012), Hornsea Project Three (Ørsted, 2018) and Berwick Bank (SSE, 2022)).

37. The marine mammals assessment for Ossian proposes to use a dose-response curve derived from Graham *et al*. (2019) for all cetaceans (study assessed probability of response based on harbour porpoise behaviour as a result of pile driving; applied to the assessment for all cetaceans in the absence of species-specific data for other species) and dose-response curve derived from Whyte *et al*. (2020) for pinnipeds.

3.2.3. DENSITIES

38. In line with the Scoping Opinion, densities based on both site-specific surveys and publicly available sources were considered. Table 3.2 presents an overview of cetacean densities and indicates the densities to be taken forward to the assessment in the EIA. For harbour porpoise, densities based on site-specific data are considered to be more robust as collected monthly and over area of interest (Array marine mammal study area). This is also most recent set of data and the density values lie between Hammond *et al*. (2021), Waggitt *et al.* (2020) and Lacey *et al.* (2022) estimates. For bottlenose dolphin, Lacey *et al.* (2022) maps reflect coastal distribution of Coastal East Scotland bottlenose dolphin population. Given higher resolution of Lacey *et al*. (2022) maps over Hammond *et al*. (2021), this data is considered more appropriate to use to reflect densities of bottlenose dolphins in offshore waters where the site boundary is located. For minke whale, due to higher resolution of Lacey *et al.* (2022) maps (10 km) over Hammond *et al.* (2021) (survey blocks), this density is considered to be more representative to use for densities of minke whale over the Array marine mammal study area.

39. Table 3.3 presents an overview of pinniped densities and indicates the densities to be taken forward to the assessment in the EIA. It should be noted that the magnitude of effect with respect to behavioural disturbance during pilling will be calculated by overlaying the noise contours on the spatial at-sea density map provided by Carter *et al*. (2022) and summing the values for all cells where more than 50% of the cell lay within a contour. As such, densities presented in Table 3.3 will be taken forward to the assessment of other impacts, except behavioural disturbance due to piling.

Table 3.2: Summary of Densities for Cetaceans (Densities are Presented as Animals per km²; Densities in BOLD will be Taken Forward to the Assessment in the EIA. For Site-Specific Surveys, "-" Indicates That There Were Not Enough Sightings to Allow for Density Estimates

Species	SCANS III		Mean Value from Distribution Estimated for the Array Marine Mammal Study Area from Waggitt *et al.* (2020)	Site Specific (24Months of Digital Aerial Surveys)	
	Mean Design-based Estimate for SCANS III Block R from Hammond *et al.* (2021)	Mean Value from Surface Densities for the Array Marine Mammal Study Area from Lacey *et al.* (2022)		Design-based (Absolute)	Model-based (Absolute)
Harbour porpoise	0.599	0.763	0.512	**0.650 (summer bio-season)**	0.648 (summer bio-season)
Bottlenose dolphin	0.0298	**0.00303**	0.00213	-	-
White-beaked dolphin	0.243	0.120	0.130	**0.175 (summer)**	-
Minke whale	0.0387	**0.0284**	0.0116	-	-
Humpback whale *Megaptera novaeangliae*	0.599	0.763	0.512	**0.650 (summer bio-season)**	0.648 (summer bio-season)

Table 3.3: Summary of Densities for Pinnipeds (Densities are Presented as Animals per km²; Densities in BOLD will be Taken Forward to the Assessment in the EIA. For Site-Specific Surveys, "-" Indicates That There Were Not Enough Sightings to Allow for Density Estimates

Species	Mean at Sea Densities based on Carter *et al.* (2022)		Site Specific (24Months of Digital Aerial Surveys)	
			Design-based (Absolute)	Model-based (Absolute)
Harbour seal	0.599	0.763	**0.650 (summer bio-season)**	0.648 (summer bio-season)
Grey seal	0.0298	**0.00303**	-	-

3.2.4. HARBOUR SEAL

40. In line with the Scoping Opinion, harbour seal was scoped in to the assessment in the EIA, however, this section presents further evidence to support the assumption that there is no risk of the Array resulting in a likely significant effect (LSE[1]) on harbour seal receptors. Based on Carter *et al*. (2022) maps, harbour seal density across the Array marine mammal study area is very low and equal to 0.00000064 animals per km^2. Of the 50 tagged harbour seals that entered the East Scotland and North East England seal MUs, only four had telemetry tracks recorded within the Array marine mammal study area (Stevens, 2023). Additionally, during 24 months of site-specific surveys across the Array marine mammal study area, only two harbour seals (one individual per occasion, April 2021 and May 2022) were identified.

3.3. POPULATION LEVEL EFFECTS

41. There is limited understanding of how behavioural disturbance and auditory injury affect survival and reproduction in individual marine mammals and consequently how this translates into effects at the population level. As such, long term population effects from piling will be investigated using the interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al*., 2014). The iPCoD model uses a process of expert elicitation to determine how physiological and behavioural changes affect individual vital rates (i.e. the components of individual fitness that affect the probability of survival, production of offspring, growth rate and offspring survival). Species available for iPCoD modelling are:

- harbour seal;
- grey seal;
- bottlenose dolphin;
- harbour porpoise; and
- minke whale.

42. For UK populations of marine mammals, there is no published evidence for density dependence and therefore, density dependence assumptions will not be included within the iPCoD model.

43. The iPCoD model has been updated in light of additional work undertaken since it was originally launched in February 2014 (Version 1) and the most recent version of iPCoD will be used (currently iPCoD Version 5.2).

3.3.1. DEMOGRAPHICS OVERVIEW

44. To enable the iPCoD model to be run, the following data will be put into the model:

- demographic parameters for the key species (Sinclair *et al*., 2020);
- user specified input parameters including vulnerable subpopulations (i.e. assumes that only a proportion of the population are disturbed by piling) and number of residual days of disturbance (i.e. number of days when animals continue to experience disturbance after piling has ceased);
- number of animals predicted to experience PTS and/or disturbance during piling; and
- estimated piling schedule during the proposed construction programme.

45. Demographic parameters chosen will be based upon Sinclair *et al*. (2020) for the most relevant area to the site boundary (Table 3.4).

Table 3.4: Summary of Recommended Parameters for iPCoD Relevant Species and MUs

Species	MU/SMA	Age Calf Becomes Independent	Age of First Birth	Calf/Pup Survival	Juvenile Survival	Adult Survival	Fertility	Growth Rate
Harbour porpoise	North Sea	1	5	0.8455	0.85	0.925	0.34	1
Bottlenose dolphin	All other MUs	2	9	0.8	0.94	0.94	0.25	1
Minke whale	European waters	1	9	0.7	0.77	0.96	0.91	1
Harbour seal	East Coast	1	4	0.4	0.78	0.92	0.85	1
Grey seal	All UK	1	6	0.222	0.94	0.94	0.84	1.01

3.4. CUMULATIVE MODELLING APPROACH

46. The cumulative assessment will use information from the MDS for other offshore wind projects within the regional marine mammal study area. Given that parameters included in each MDS for respective project is hihgly conservative, it is considered that an additional layer of precaution has been incorporated into our assessment further to the precaution already built into the assessments for other projects. It should be noted therefore, that this approach is likely to result in an overestimate of the likely impacts.

47. Where quantitative assessments are provided in the EIA Reports of projects located within the regional marine mammal study area, the numbers of animals experiencing PTS and disturbance will be modelled in a cumulative impact assessment using iPCoD. Where a project has received consent and a final piling strategy agreed with Marine Directorate – Licensing Operations Team (MD-LOT), the numbers of animals potentially disturbed presented in the final piling strategy for a project will be carried forward to the cumulative assessment for Ossian. However, where a final piling strategy is not available or has not been approved/agreed with MD-LOT[1], the numbers of animals potentially disturbed will be based on the Environmental Statement or the most up-to-date variations to consented design for that project.

48. Indicative piling schedules will be put into the model to assess temporal overlap between projects. Where actual piling schedules are unknown, the piling days will be spread evenly throughout the offshore construction phases in the model. Population level effects will be measured against the relevant MUs for which an overlap with cumulative projects has been identified and the demographic parameters will apply as per the Ossian alone iPCoD values (Table 3.4).

4. OPERATIONAL NOISE

49. Underwater noise may be generated during the operation phase of the Array by the re-tension in mooring lines following a period of slackness resulting from large amplitude and/or high-frequency surface motions (Liu, 1973). Noise monitoring on mooring lines has been conducted at the Hywind test site in Norway (Martin *et al*., 2011; Stephenson, 2015) and the completed Hywind site in Scotland (Burns *et al*., 2022).

[1] [1] Published on the https://marine.gov.scot/ website.

50. A qualitative approach will be applied to the assessment of operational noise based on modelling of data collected at the Hywind Project (Martin *et al*., 2011; Stephenson, 2015; Burns *et al*., 2022), as this is the only project to date where noise from mooring lines has been measured and analysed.

5. ENTANGLEMENT

51. There is potential for entanglement of marine mammals between mooring lines of floating wind turbines located within the Array. Entanglement can be defined as the accidental capture or restraint of marine animals by strong, flexible materials of anthropogenic origin (Benjamins *et al*., 2014; Garavelii, 2020).

52. The marine mammal assessment for Ossian will consider the risk of primary entanglement which is the occurrence of marine mammal directly becoming entangled with a mooring line or inter-array cable, as well as secondary entanglement where marine mammals become entangled with marine debris, including derelict fishing gear, that is snagged on a mooring line or inter-array cable (U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER), 2022).

53. A qualitative approach will be followed during the assessment using best scientific evidence. In line with approaches applied in Benjamins *et al*. (2014) and Harnois *et al*. (2015), biological as well as physical parameters will be considered. Biological parameters will include, amongst others, vulnerability of entanglement based on the body size and history of strandings. Physical parameters of the mooring system configurations will be considered within maximum design scenario and include tension characteristics, spread radius within water column and diameter of individual mooring lines/inter-array cables.

6. QUESTIONS TO STAKEHOLDERS

1. Are you content with the approach to the analysis of aerial data presented in section 2?
2. Are you content with the criteria and metrics suggested for the assessment of injury and disturbance to marine mammals in section 3?
3. Are you content with marine mammal densities presented in section 3?
4. Are you content with the approach to the IPCoD modelling (for project alone as well as cumulative) presented in section 3.3?
5. Are you content with approach to the assessment of operational noise presented in section 4?
6. Are you content with approach to the assessment of entanglement impacts presented in section 5?

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