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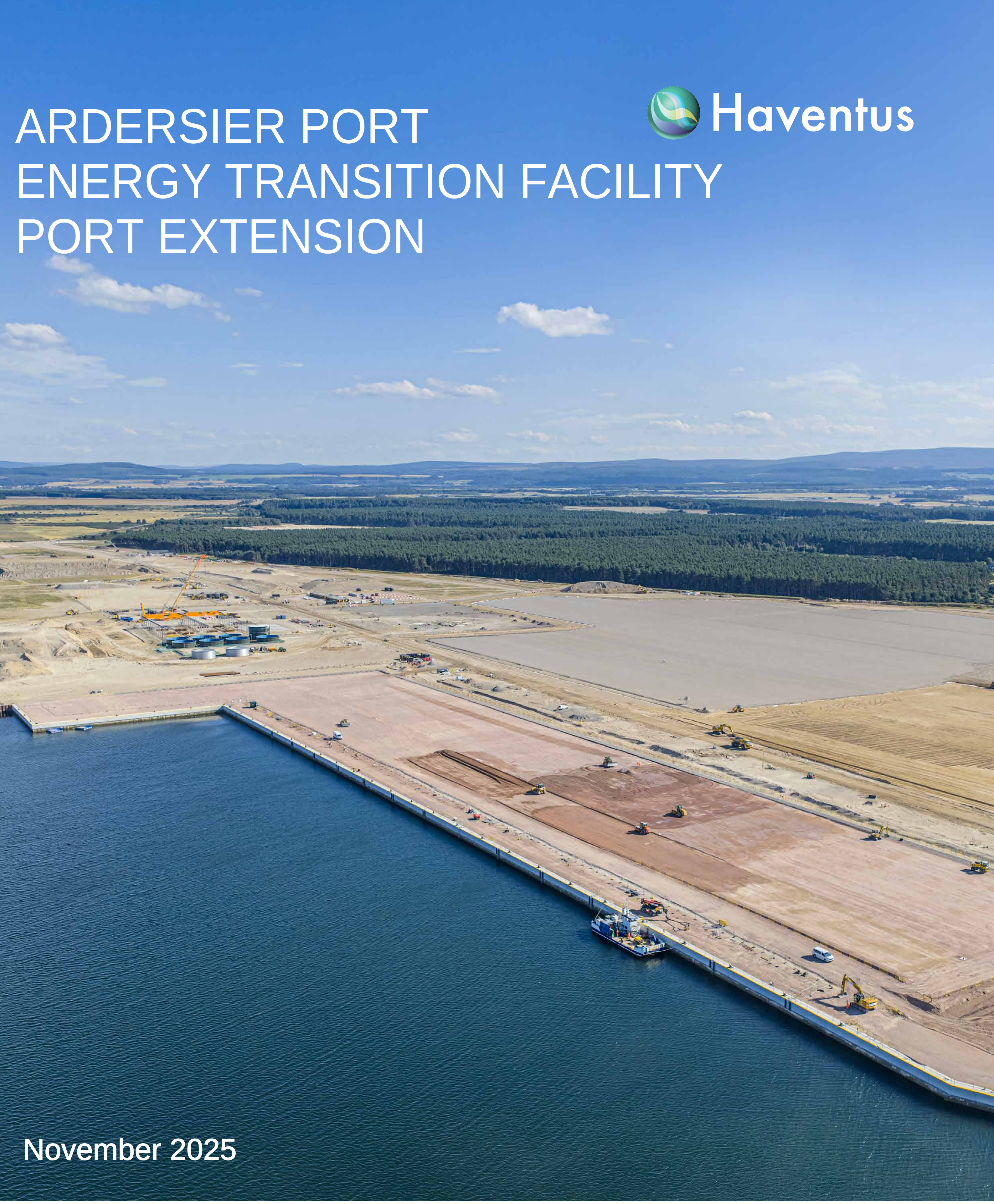

November 2025

Appendix 11.1: Legislation, Policy and Guidance

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Ardersier Port Extension

EIAR Appendix 11.1: Legislation, Policy and Guidance

Authors:	Jack Clarkson
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Contents

1 Legislation, Policy and Guidance

The preparation of the Marine Mammals chapter has been informed by the following policy, legislation and guidance.

1.1 Legislation

1.1.1 Habitats Regulations (The Conservation (Natural Habitats &c.) Regulations)

The Habitats Regulations includes a number of legislative items:

- The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019;
- The Conservation of Habitats and Species Regulations 2017 (covering inshore waters (<12nm)); and
- The Conservation (Natural Habitats &c.) Regulations 1994.

Under the Habitats Regulations, European Protected Species (EPS) are species listed in Annex IV of the Habitat Directive (and afforded protection under the Habitats Regulations). All cetacean species found in Scottish waters are EPS.

Annex V of the Habitats Directive as transposed into Scottish and UK legislation, defines seals as species of community interest, meaning that any take of these species in the wild is subject to management measures.

The inshore legislation makes it an offence to deliberately or recklessly capture, injure or kill a wild animal of an EPS. It should be noted that with respect to auditory injury, the current advice from NatureScot is that there is no requirement to fully mitigate modelled cumulative auditory injury (PTS) (based on the cumulative Sound Exposure Level (SEL_{cum}) metric) ranges, as it is acknowledged that they are over-precautionary given current modelling methods (see Appendix 11.2). NatureScot thus advise that best practice measures which could reduce the risk of cumulative PTS is welcomed but not required.

Further, it is also an offence to deliberately or recklessly disturb any cetacean (dolphin, porpoise or whale). In terms of the disturbance offence, this is assessed at the individual level. If such an offence is likely to occur, an EPS licence is required.

Should an EPS licence be required, for it to be granted the Habitats Regulations specify three tests which need to be met: (i) there must be a licensable purpose; (ii) there must be no satisfactory alternative; and (iii) the activity must not be detrimental to the maintenance of the population of the species concerned at favourable conservation status in their natural range. It should be noted that only a high-level EPS assessment is undertaken at the EIA stage. A full EPS risk assessment will be undertaken post-consent, as required.

1.1.2 Wildlife and Countryside Act 1981 (WCA)

Under this Act, it is illegal to intentionally or recklessly, disturb or harass dolphins, whales and porpoises (listed under Schedule 5). It is also an offence to deliberately kill, injure or take cetaceans.

1.1.3 Marine (Scotland) Act 2010

The Marine (Scotland) Act 2010 provides the legislative and management framework for the marine environment within Scottish Territorial Waters (from MHWS out to 12 nm). Under Section 21 of the Marine (Scotland) Act 2010, Caledonia North requires a Marine Licence for marine licensable activities below MHWS.

The Act replaces the Conservation of Seals Act 1970 in Scottish waters. The Natural Environment Research Council (NERC) has a duty to provide scientific advice to the Scottish Government on matters related to the management of seal populations. NERC has appointed the Special Committee on Seals (SCOS) to formulate this advice.

1.1.4 Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014 and Amendment Order 2017

This legislation designates seal haul-outs (coastal locations that seals use to breed, pup, moult and rest). At designated haul-out sites, it is an offence to intentionally or recklessly harass seals, and seals are protected from adverse anthropogenic impacts.

1.1.5 The Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention') (Council of Europe, 1979)

The Convention aims to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention). Cetaceans and seals are listed under Annex II and Annex III.

1.1.6 The Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention') (United Nations Environment Programme, 1983)

The Convention aims to conserve migratory species and their habitats by providing strict protection for endangered migratory species (Appendix I of the Convention) and lists migratory species which would benefit from multilateral agreements for conservation and management (Appendix II of the Convention). Marine mammal species included in the list and of relevance to this assessment bottlenose dolphin, harbour porpoise, harbour seal, grey seal, and minke whale.

1.2 Policy

1.2.1 The OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) will be implemented through OSPAR's North-East Atlantic Environment Strategy 2030. The OSPAR Convention contains a series of Annexes with five of them addressing land-based and offshore pollution, marine environment quality and protection of marine ecosystems and biodiversity. There is one marine mammal species listed under the OSPAR Convention that is relevant to this assessment (harbour porpoise).

1.2.2 Department for Environment, Food and Rural Affairs (DEFRA) Policy Paper: Reducing Marine Noise

The UK Government's marine noise policy[1] sets out a strategic approach to reducing human-generated underwater noise and its harmful impacts on marine ecosystems. Central to this strategy is the Marine Noise Registry, which collects data on loud impulsive activities (e.g. pile driving, sonar use, and explosive ordnance clearance) to support marine planning and meet the requirements of the UK Marine Strategy. The policy promotes a risk-based, evidence-led framework, encouraging developers—especially in the offshore wind sector—to adopt low-noise technologies and mitigation techniques as standard practice. Regulatory expectations are tightening, with planned consultations

[1] https://www.gov.uk/government/publications/reducing-marine-noise/reducing-marine-noise

on setting noise limits for offshore piling and an increasing preference for alternatives to high-noise explosive clearance of unexploded ordnance.

The policy is also aligned with broader marine conservation and decarbonisation goals. Strategic compensation measures, such as expanding Marine Protected Areas (MPAs) and establishing a Marine Recovery Fund, are being developed to facilitate responsible offshore wind development while enhancing biodiversity. Cross-sector collaboration is a core theme, involving government, regulators, industry, and NGOs to drive innovation and implement effective noise reduction. Overall, the policy aims to integrate noise management into marine licensing and spatial planning in a way that supports sustainable development and marine environmental protection

1.3 Guidance:

1.3.1 Priority Marine Features (PMFs), as described in NatureScot Commissioned Report 388; Strategy

Cetaceans and pinnipeds are amongst the most regularly occurring marine mammal species within Scottish waters designated as PMFs and are considered to be marine nature conservation priorities in Scottish waters (Tyler-Walters *et al.*, 2016; NatureScot, 2020).

1.3.2 Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects (Southall et al. 2019)

Provides updated marine mammal exposure criteria for auditory injury (PTS).

1.3.3 Scottish Marine Wildlife Watching Code

A code of conduct which aims to minimise disturbance to wildlife, help people enjoy watching marine wildlife, improve chances of seeing wildlife, provide a standard for the wildlife watching industry and help people stay within the law (SNH 2017a, b).

1.3.4 The Protection of Marine European Protected Species from injury and disturbance: Guidance for Inshore Waters (July 2020 Version)

This guidance provides advice for marine users who are planning to carry out an activity in the marine environment which has the potential to kill, injure or disturb a marine EPS. The guidance can also be used by regulators, nature conservation agencies, enforcement authorities and competent authorities when considering whether an activity will cause or has caused death, injury or disturbance to a marine EPS (Marine Scotland 2020).

1.3.5 Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise

This set of mitigation measures offers guidance on reducing risk of injury to marine mammals during pile driving. If followed, risk of injury is likely to be greatly reduced. The guidelines are split by survey planning, mitigation, and reporting, to increase ease of use (JNCC 2010).

1.3.6 Guidance on the Offence of Harassment at Seal Haul-out Sites

Provides guidance on seal harassment and how to avoid an offence (Marine Scotland 2014).

2 Glossary of Terms, Acronyms and Abbreviations

Term	Description
EPS	European Protected Species
EU	European Union
JNCC	Joint Nature Conservation Committee
MHWS	Mean High Water Spring
MPA	Marine Protected Area
NERC	Natural Environment Research Council
NGO	Non-Governmental Organisation
nm	Nautical Miles
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PMF	Priority Marine Features
PMF	Priority Marine Features
PTS	Permanent Threshold Shift
SCOS	Special Committee on Seals
SEL_{cum}	Cumulative Sound Exposure Level
SNH	Scottish Natural Heritage (now known as 'NatureScot')

3 Literature Cited

JNCC. 2010. Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

Marine Scotland. 2014. Guidance on the Offence of Harassment at Seal Haul-out Sites.

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SNH. 2017a. A Guide to Best Practice for Watching Marine Wildlife SMWWC - Part 2. Scottish Natural Heritage.

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Southall, B., J. J. Finneran, C. Reichmuth, P. E. Nachtigall, D. R. Ketten, A. E. Bowles, W. T. Ellison, D. Nowacek, and P. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals **45**:125-232.

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Appendix 11.2: Assessment Methodology

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Ardersier Port Extension

EIAR Appendix 11.2: Marine Mammal Assessment Methodology

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Contents

Figures

1 Introduction

This appendix outlines the approach to the Marine Mammal impact assessment to support the Ardersier Port Extension EIA.

The Ardersier Energy Transition Facility Extension EIA Scoping Report (SCOP-0062) (Haventus 2025) briefly outlined the assessment methodologies required to undertake a robust and complete assessment of the potential impacts to marine mammals which may occur during the construction, and operation and maintenance (O&M) phases of the proposed development.

The following assessment approaches have used in the marine mammal impact assessment for underwater noise:

- Auditory injury (PTS): quantitative assessment using Southall et al. (2019) dual thresholds;
- Disturbance from piling: quantitative assessment using dose-response functions:
  - Harbour porpoise dose-response function (Graham et al. 2017) (also applied to other cetacean species)
  - Harbour seal dose-response function (Whyte et al. 2020) (also applied to grey seals);
- Disturbance from dredging and soil disposal: quantitative assessment for dredging activities through the use of effective deterrence ranges (EDRs), and a qualitative assessment based on literature on vessel activity and the responses of marine mammals for spoil disposal activities.
- Disturbance to seal haul-out sites: qualitative assessment for disturbance to seals at their haul-out sites.
- Vessel collision and disturbance: qualitative assessment based on literature on vessel activity and the responses of marine mammals, particularly within the inner Moray Firth. Where possible, a quantitative impact assessment shall be provided for vessel disturbance.
- Indirect impacts on prey availability: qualitative assessment based on literature on marine mammal prey in the Moray Firth, and the potential risks of pollutant release and/or contamination impacts on marine mammal prey items.
- Cumulative impacts assessment for projects in the Moray Firth: quantitative assessment of the number of animals which may be impacted on any one day of piling, based on reported levels of impacts in published EIARs where available and, where not, on various assumptions relating to impact footprints (e.g., fixed EDRs) and animal densities (Carter et al. 2020, Gilles et al. 2023, Gilles et al. 2025).

Each assessment method is described in detail in Section 2: Assessment Methodology.

2 Assessment Methodology

2.1 Assessment of Auditory Injury (PTS)

The Southall et al. (2019) thresholds were used to assess the risk of auditory injury (PTS) using the dual criteria: cumulative sound exposure level (SEL_{cum}, accumulated sound energy over 24 hours) and peak sound pressure level (SPL_{peak}, sound pressure from a single noise pulse). The SEL_{cum} from multiple pulses was assessed using a fleeing animal model using indicative swim speeds. The SPL_{peak} criterion is for unweighted received sound level. The method used to calculate PTS-onset impact ranges for both 'instantaneous' PTS (SPL_{peak}), and 'cumulative' PTS (SEL_{cum}, over 24 hours) is detailed in EIAR Appendix 11.5.

For cumulative PTS, the calculated impact ranges represent the minimum safe starting distances from the piling location for fleeing animals to avoid a dose higher than the PTS threshold. In calculating the received noise level that animals are likely to receive during the whole piling sequence, constant animal swimming speeds were used:

- For harbour porpoise, NatureScot (Scottish Natural Heritage 2016) recommend that 1.4 m/s is used based on an average descent and ascent speed from tagged porpoise (Westgate et al. 1995).
- The swimming speed for bottlenose dolphins is based on Bailey and Thompson (2006) at 1.52 m/s.
- Scottish Natural Heritage (2016) also recommend a fleeing speed of 2.1 m/s for minke whales based on Williams (2009)
- Scottish Natural Heritage (2016) recommend a swimming speed of 1.8 m/s for harbour and grey seals, based on Thompson (2015) which estimated that typical swimming speeds were in the range of 1.8-2.0 m/s.

2.2 Assessment of Disturbance

2.2.1 Pile Driving

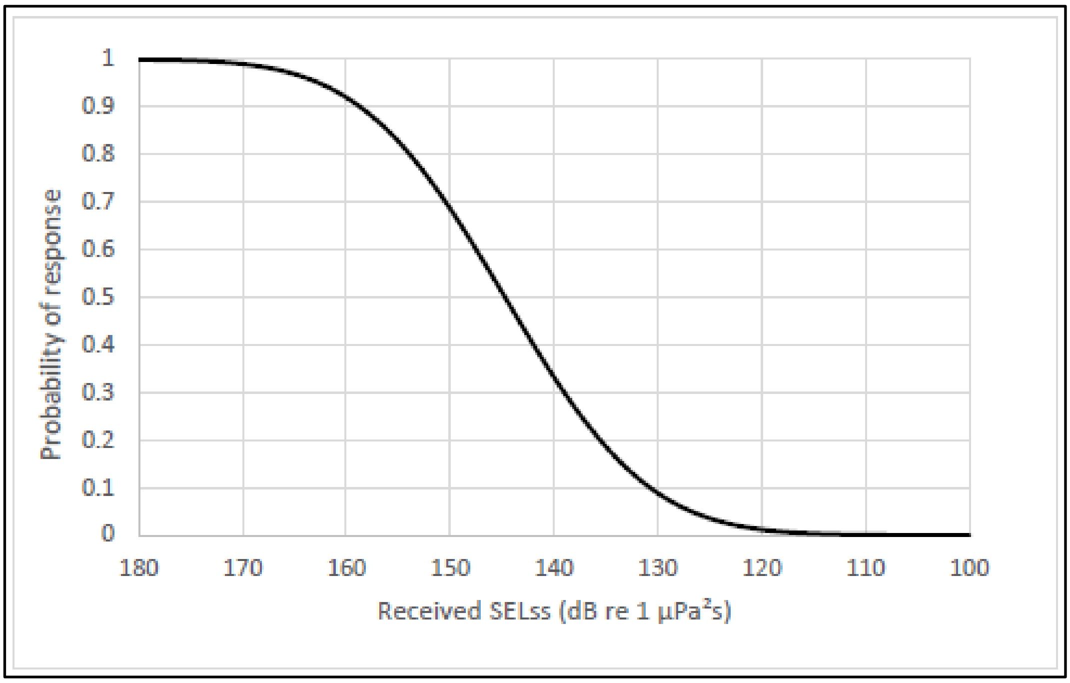
The assessment of disturbance from pile-driven foundations used the current best practice methodology, making use of the best available scientific evidence. This incorporated the application of a dose-response approach.

Noise contours were generated by underwater noise modelling and overlain on species density surfaces to predict the number of animals present within each modelled noise contour. The number of animals present was then multiplied by the proportion of animals that are expected to respond within each contour. The dose-response functions are outlined below.

2.2.1.1 Harbour porpoise dose-response function

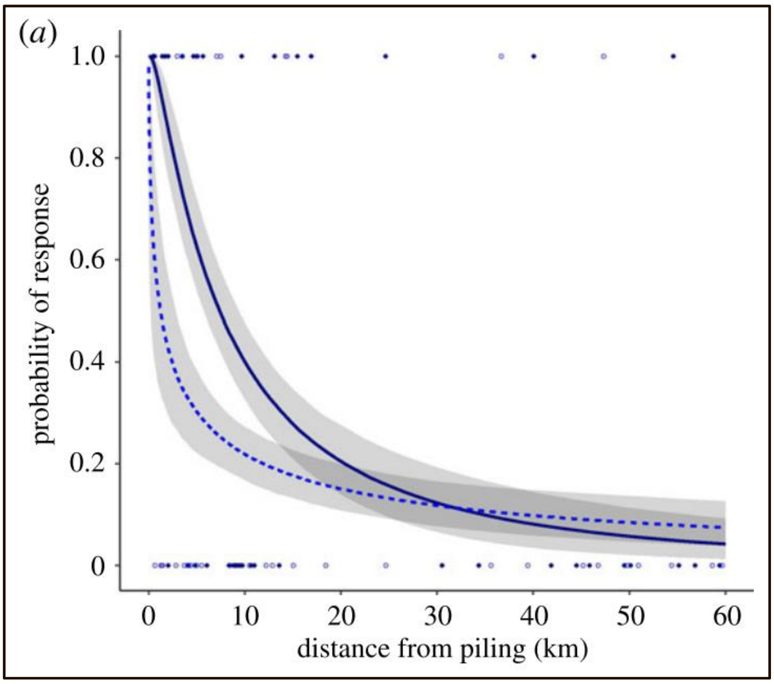
To estimate the number of porpoise predicted to be disturbed as a result of pile driving, the porpoise dose-response function from Graham et al. (2017) was applied.

Figure 1: Relationship between the proportion of porpoise responding and the received single strike SEL (SELss) (Graham et al. 2017)



The Graham et al. (2017) dose-response function was developed using data on harbour porpoise collected during the first six weeks of piling during Phase 1 of the Beatrice Offshore Wind Farm (OWF) monitoring program. Since the initial development of the dose-response function in 2017, additional data from the remaining pile driving events at Beatrice OWF have been processed and are presented in (Graham et al. 2019). The passive acoustic monitoring showed a 50% probability of porpoise response (a significant reduction in detection relative to baseline) within 7.4 km at the first location piled, with decreasing response levels over the construction period (excluding pre-construction surveys) to a 50% probability of response within 1.3 km by the final piling location (Figure 2) (Graham et al. 2019). Using the dose-response function derived from the initial piling events for all piling events in the impact assessment is precautionary, as evidence shows that porpoise response is likely to diminish over the construction period (excluding pre-construction surveys).

Figure 2: The probability of a harbour porpoise response (24 h) in relation to the partial contribution of distance from piling for the first location piled (solid navy line) and the final location piled (dashed blue line). Obtained from Graham et al. (2019)



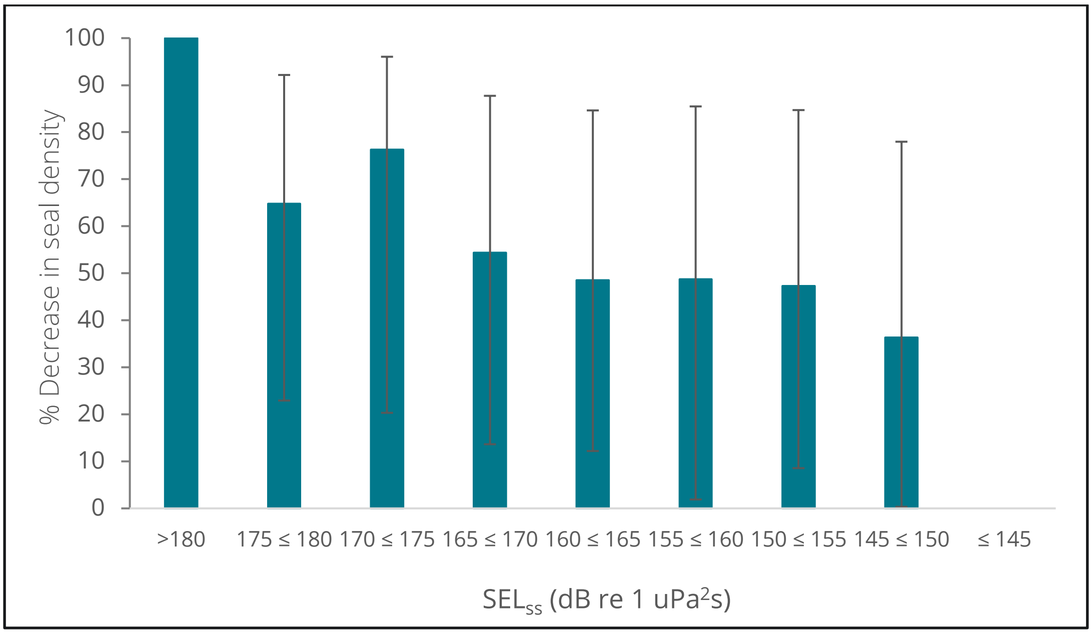
It is noted that Graham et al. (2019) presents an updated dose-response function for harbour porpoise, however this function is audiogram weighted specific to VHF-cetaceans and as such cannot be used as a proxy for other species. Therefore, the assessment uses the Graham et al. (2017) dose-response function as it is more precautionary (predicts higher responses) than the (Graham et al. 2019) dose-response function and can be used across other cetacean species since the curve is not audiogram weighted.

Although the Graham et al. (2017) dose-response function is specific to harbour porpoise, it is proposed that in the absence of species-specific data on dolphin species or minke whales, the Graham et al. (2017) dose-response function was adopted for all cetaceans. However, it should be noted that numerous studies have shown that other cetacean species show comparatively less of a disturbance response from underwater noise compared with harbour porpoise (Kastelein et al. 2006, Culloch et al. 2016, Stone et al. 2017, Fernandez-Betelu et al. 2021), meaning this approach is highly precautionary.

2.2.1.2 Seal dose-response function

For seals, the Whyte et al. (2020) harbour seal dose-response function was used (Figure 3). The Whyte et al. (2020) study used telemetry data from 25 harbour seals tagged in the Wash between 2003 and 2006 and 24 harbour seals tagged in 2012, to assess how seal usage changed in relation to the pile driving activities at the Lincs OWF in 2011-2012.

Figure 3: Predicted decrease in seal density as a function of estimated sound exposure level, error bars show 95% CI (Whyte et al. 2020)



In the Whyte et al. (2020) dose-response function it has been assumed that all seals are displaced at sound exposure levels above 180 dB re 1 µPa^{2}s. This is a conservative assumption since there were no data presented in the study for harbour seal responses at this level. It is also important to note that the percentage decrease in response in the categories 170 ≤ 175 and 175 ≤ 180 dB re 1 µPa^{2}s is slightly anomalous (higher response at a lower sound exposure level) due to the small number of spatial cells included in the analysis for these categories (n = 2 and 3 respectively). Given the large confidence intervals on the data, this assessment presents the mean number of seals predicted to be disturbed alongside the 95% confidence intervals (CI), for context.

There are no corresponding data for grey seals and, as such, the harbour seal dose-response function is applied to the grey seal disturbance assessment. This is considered to be an appropriate proxy for grey seals, since both species are categorised within the same functional hearing group. However, it is likely that this over estimates the grey seal response, since grey seals are considered to be less sensitive to behavioural disturbance than harbour seals and could tolerate more days of disturbance before there is likely to be an effect on vital rates (Booth et al. 2019). Recent studies of tagged grey seals have shown that there is vast individual variation in responses to pile driving, with some animals not showing any evidence of a behavioural response (Aarts et al. 2018). Likewise, if the impacted area is considered to be a high quality foraging patch, it is likely that some grey seals may show no behavioural response at all, given their motivation to remain in the area for foraging (Hastie et al. 2021). Therefore, the adoption of the harbour seal dose-response function for grey seals is considered to be precautionary as it will likely over-estimate the potential for impact on grey seals.

2.2.2 Dredging and Spoil Disposal Activities

There is currently no guidance on the thresholds to be used to assess disturbance of marine mammals from construction activities such as dredging and spoil disposal activities. However, it has been reported harbour porpoise in the Moray Firth show broad-scale responses to construction vessel activities by up to 4 km (Benhemma-Le Gall 2021, Benhemma-Le Gall et al. 2021), whilst McQueen et al. (2020) predicted avoidance of harbour porpoise to dredging vessel up to 5 km. McQueen et al. (2020) also predicted avoidance of seals to dredging vessels between 400 m to 5 km from the dredging site. Further, Pirotta et al. (2015) have assumed that dredging activities exclude dolphins from a 1 km radius of the dredging site, based on a study undertaken at Aberdeen Harbour.

Based on the literature reviewed, the Project impact assessment for dredging activities provides a quantitative assessment on the number of individuals, and percentage of the MU, for each marine mammal receptor which may experience behavioural disturbance. For harbour porpoise and seals, a 5 km EDR is applied, whilst for bottlenose dolphins, a 1 km EDR is applied. As no studies have focussed specifically on the expected disturbance ranges on minke whales from dredging activities, a 5 km EDR is applied.

For spoil disposal (i.e., dredge material dumping activities) the assessment is qualitative and focusses on the impacts of vessel presence/activity (see Section 2.2.3).

2.2.3 Disturbance and Collision Risks from Vessel Activity

There is currently no guidance on the thresholds to be used to assess disturbance of marine mammals from vessel activity. Where possible, literature on vessel activity and the responses of marine mammals, particularly within the Moray Firth (e.g., Onoufriou et al. (2016), Jones et al. (2017), Benhemma-Le Gall et al. (2021)) were used to inform the assessment. In the absence of Moray Firth specific studies on the interactions of marine mammals with vessels, other studies were used to inform the assessment (e.g., Young et al. (2014), Cates and Acevedo-Gutierrez (2017), Sullivan and Torres (2018), Clarkson et al. (2020), Puszka et al. (2021)).

2.2.4 Disturbance to Seal Haul-Out Sites

There is currently no guidance on the thresholds to be used to assess disturbance of seals at their haul-out sites. Therefore, this impact assessment provides a qualitative assessment for disturbance to seals at their haul-out sites, using studies which focus on the reactions of seals at their haul-out sites to human activities (e.g., Henry and Hammill (2001), Bankhead et al. (2023)).

2.2.5 Indirect impacts on Marine Mammal Prey Availability

There is currently no guidance on the assessment methodologies to be undertaken for this impact pathway. Thus, this impact assessment provides a qualitative assessment for indirect impacts on prey availability, using studies which focus on marine mammal prey items in the Moray Firth, and the potential risks of pollutant release and/or contamination impacts on marine mammal prey items.

2.3 Cumulative Effects Assessment (CEA)

The approach to CEA shall follow the process outlined Section 5: Cumulative Effects of Appendix 11.4.

The most significant cumulative impact on marine mammal species is likely to be underwater noise associated with construction activities, and vessel disturbance during operations and maintenance. For marine mammals, the approach to CEA is holistic and combines all potential sources of underwater noise including unexploded ordnance (UXO) clearance and pile driving at other wind farms together with disturbance from vessels, seismic surveys and any other marine construction developments that are planned within the Moray Firth.

For each relevant project, an assessment will be made of the number of animals which may be impacted on any one day, based on reported levels of impacts in published EIARs where available and, where not, on various assumptions relating to impact footprints (e.g., fixed EDRs) and animal densities (Carter et al. 2020, Carter et al. 2022, Gilles et al. 2023, Carter et al. 2025). The quantitative approach to the CEA shall only consider projects located within the Moray Firth (e.g. OWFs, Nigg port, Invergordon/Cromarty port). Where there is a potential for temporal overlap with construction at the proposed development and other developments, the assessment will assume that there is a potential for projects to be piling within the same timeframe. As definitive timescales for which piling shall occur at the proposed development are unknown, assumptions shall be made on the likely piling year within the proposed development construction timeline to allow for a quantitative CEA to take place against years for which other projects within the Moray Firth may also be piling. The maximum cumulative number of animals impacted on any one day will be presented as a proportion of the relevant MU. The contribution of the proposed development to this proportion shall also be calculated and provided.

The CEA for marine mammals will consider the maximum design scenario for each of the projects, plans and activities in line with the methodology outlined in Chapter 2 (Methodology) of the EIAR. The impacts of fishing will not be considered in the CEA, since these activities will have occurred throughout the baseline and are therefore already accounted for in the existing marine mammal baseline characterisation abundance and density estimates. Where no EIA is available yet, indicative numbers of animals disturbed will be estimated (e.g. assuming a fixed EDR and using the most relevant density estimate (e.g., SCANS IV)).

As, once operational, the proposed development shall give rise to a significant increase in the number of vessel movements throughout the Inner Moray Firth, increased shipping traffic shall also be considered in this CEA. However, it is challenging to reliably quantify the level of increased disturbance to marine mammals resulting from increased vessel activity on a cumulative basis, given the large degree of temporal and spatial variation in vessel movements between projects and regions, coupled with the spatial and temporal variation in marine mammal movements across the region and thus, this assessment shall be qualitative.

3 Data Limitations & Assumptions

There are uncertainties relating to the underwater noise modelling and impact assessment for the proposed development. Broadly, these relate to predicting exposure of animals to underwater noise, predicting the response of animals to underwater noise.

3.1 PTS-onset Assumptions

There are no empirical data on the threshold for auditory injury in the form of Permanent Threshold Shift (PTS) -onset for marine mammals, as to test this would be inhumane. Therefore, PTS-onset thresholds are estimated based on extrapolating from Temporary Threshold Shift (TTS) -onset thresholds. For pulsed noise, such as piling, NOAA have set the onset of TTS at the lowest level that exceeds natural recorded variation in hearing sensitivity (6 dB), and assumes that PTS occurs from exposures resulting in 40 dB or more of TTS measured approximately four minutes after exposure (NMFS 2018). This assumption is used in the Southall et al. (2019) thresholds for PTS which are used in this assessment.

3.1.1 Instantaneous PTS

The predictions for instantaneous PTS-onset assume that all animals within the PTS-onset range are impacted, which is likely to overestimate the true number of impacted animals.

3.2 Density Assumptions

There are uncertainties relating to the ability to predict the responses of animals to underwater noise and the number of animals potentially exposed to levels of noise that may cause an impact is uncertain. Given the high spatial and temporal variation in marine mammal abundance and distribution in any particular area of the sea, it is difficult to predict how many animals may be present within the range of noise impacts. All methods for determining at sea abundance and distribution suffer from a range of biases and uncertainties. The density estimates selected for the quantitative impact assessment for the proposed development are the most recent and most robust density estimates available for each species, as detailed in EIAR Appendix 11.3.

3.3 Disturbance Assumptions

3.3.1 Dose-response function

In the absence of species-specific data on dolphin species or minke whales, the Graham et al. (2017) dose-response function has been adopted for all cetaceans. However, it should be noted that various studies have shown that other cetacean species show comparatively less of a disturbance response from underwater noise compared with harbour porpoise, meaning this approach is highly precautionary. Porpoise are considered to be particularly responsive to anthropogenic disturbance, with playback experiments showing avoidance reactions to very low levels of sound (Tyack 2009), and multiple studies showing that porpoise respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt et al. 2013, Thompson et al. 2013, Tougaard et al. 2013, Brandt et al. 2018, Sarnocinska et al. 2019, Thompson et al. 2020, Benhemma-Le Gall et al. 2021).

Evidence suggests that dolphin species are less sensitive to disturbance compared to harbour porpoise. A literature review of recent (post Southall et al. 2007) behavioural responses by harbour porpoises and bottlenose dolphins to noise was conducted by Moray Offshore Renewables Limited (2012). Several studies have reported a moderate to high level of behavioural response at a wide range of received SPLs (100 and 180 dB re 1µPa) (Lucke et al. 2009, Tougaard et al. 2009, Brandt et al. 2011). Conversely, a study by Niu et al. (2012) reported moderate level responses to non-pulsed noise by bottlenose dolphins at received SPLs of 140 dB re 1µPa. Another high frequency cetacean, Risso's dolphin, reported no behavioural response at received SPLs of 135 dB re 1µPa (Southall et al. 2010). Whilst both species showed a high degree of variability in responses and a general positive trend with higher responses at higher received levels, moderate level responses were observed above 80 dB re 1µPa in harbour porpoise and above 140 dB re 1µPa in bottlenose dolphins (Natural Power and SMRU Ltd 2012), indicating that moderate level responses by bottlenose dolphins will be exhibited at a higher received SPL and, therefore, they are likely to show a lesser response to disturbance. Likewise, other high-frequency cetacean species, such as striped and common dolphins, have been shown to display less of a response to underwater noise signals and construction-related activities compared with harbour porpoise (e.g. Kastelein et al. 2006, Culloch et al. 2016).

3.3.2 Exposure to noise

There are uncertainties relating to the ability to predict the exposure of animals to underwater noise, as well as in predicting the response to that exposure. These uncertainties relate to a number of factors: the ability to predict the level of noise that animals are exposed to, particularly over long periods of time; the ability to predict the numbers of animals affected, and the ability to predict the individual and ultimately population consequences of exposure to noise. These are explored in further detail in the paragraphs below.

The propagation of underwater noise is relatively well understood and modelled using standard methods. However, there are uncertainties regarding the amount of noise actually produced by each pulse at source and how the pulse characteristics change with range from the source. There are also uncertainties regarding the position of receptors in relation to received levels of noise, particularly over time, and understanding how position in the water column may affect received levels. Noise monitoring is not always carried out at distances relevant to the ranges predicted for effects on marine mammals, so effects at greater distances remain un-validated in terms of actual received levels. The extent to which ambient noise and other anthropogenic sources of noise may mask signals from the Project construction are not specifically addressed. The dose-response functions for porpoise include behavioural responses at noise levels down to 120 dB SEL_{ss} which may be indistinguishable from ambient noise at the ranges these levels are predicted.

3.3.3 Predicted Response

There are limited empirical data available to inform predictions of the extent to which animals may experience auditory damage or display responses to noise. The current methods for prediction of behavioural responses are based on received sound levels, but it is likely that factors other than noise levels alone will also influence the probability of response and the strength of response (e.g. previous experience, behavioural and physiological context, proximity to activities, characteristics of the sound other than level, such as duty cycle and pulse characteristics). However, at present, it is impossible to adequately take these factors into account in a predictive sense. This assessment makes use of the monitoring work that has been carried out during the construction of the Beatrice OWF and, therefore, uses the most recent and site-specific information on disturbance to harbour porpoise as a result of pile driving noise.

There is also a lack of information on how observed effects (e.g. short-term displacement around impact piling activities) manifest themselves in terms of effects on individual fitness, and ultimately population dynamics to attempt to quantify the amount of disturbance required before vital rates are impacted.

3.3.4 Duration of Impact

The duration of disturbance is another uncertainty. Studies at Horns Rev 2 demonstrated that porpoises returned to the area between one and three days (Brandt et al. 2011) and monitoring at the Dan Tysk Wind Farm as part of the Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS) project found return times of around 12 hours (van Beest et al. 2015). Two studies at Alpha Ventus demonstrated, using aerial surveys, that the return of porpoises was about 18 hours after piling (Dähne et al. 2013). A recent study of porpoise response at the Gemini wind farm in the Netherlands, also part of the DEPONS project, found that local population densities recovered between two and six hours after piling (Nabe-Nielsen et al. 2018). An analysis of data collected at the first seven OWFs in Germany has shown that harbour porpoise detections were reduced between one and two days after piling (Brandt et al. 2018).

Analysis of data from monitoring of marine mammal activity during piling of jacket pile foundations at Beatrice OWF (Graham et al. 2017, Graham et al. 2019) provides evidence that harbour porpoise were displaced during pile driving but return after cessation of piling, with a reduced extent of disturbance over the duration of the construction period. This suggests that the assumptions adopted in the current assessment are precautionary as animals are predicted to remain disturbed at the same level for the entire duration of the pile driving phase of construction.

4 Glossary of Terms, Acronyms and Abbreviations

Term	Description
µPa	Micropascals
CEA	Cumulative Effects Assessment

Term	Description
CI	Confidence Intervals
dB	Decibels
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
EDR	Effective Deterrence Ranges
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ETF	Energy Transition Facility
HF	High Frequency
km	Kilometres
LF	Low Frequency
m	Metres
m/s	Metres per second
MU	Management Units
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations and Maintenance
OWF	Offshore Wind Farm
PTS	Permanent Threshold Shifts
RaDIN	Range Dependent nature of Impulsive Noise
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Sound Exposure Level (Single Strike)
SPL_{peak}	Peak Sound Pressure Level
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
VHF	Very High Frequency

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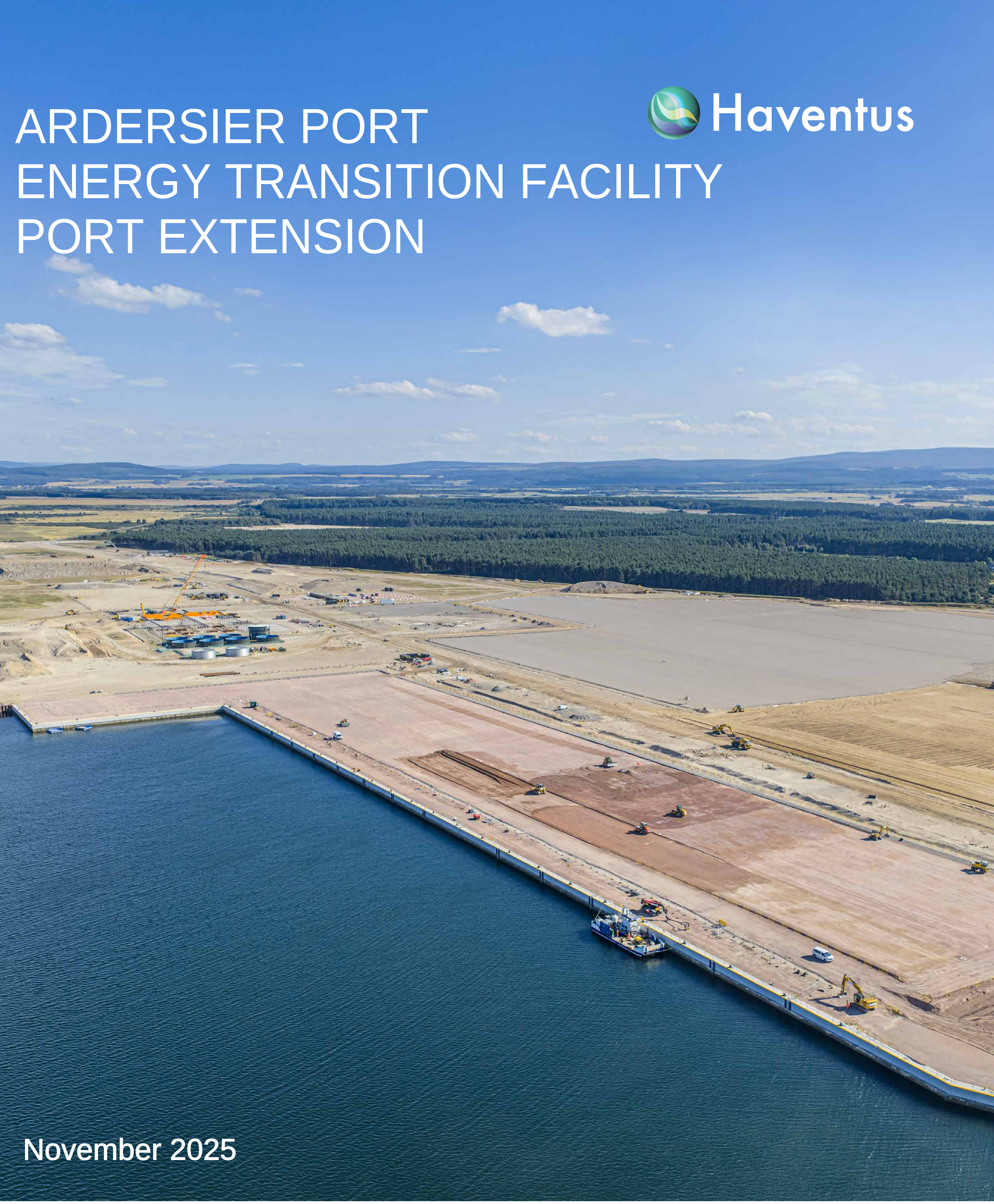

November 2025

Appendix 11.4: Ardersier ETF Expansion Technical Marine Mammal Impact Assessment

Ardersier Port Extension

EIAR Appendix 11.4: Marine Mammal Impact Assessment

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1	01/08/2025	First draft	EG, RC, JC	RRS	RRS	HAV
2	03/09/2025	Second draft – revised vessel numbers	JC	RRS	HAV	HAV
3	29/09/2025	Final draft – revised timelines	JC	RRS	SWECO	HAV

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1 Introduction

This Appendix, the Marine Mammal Impact Assessment, assesses the level and significance of the residual effects of the proposed development on marine mammal receptors during both construction and operation. This Appendix is supported by the following EIAR documents:

- EIAR Chapter 11: Marine Mammals;
- EIAR Appendix 11.1: Legislation, Policy and Guidance;
- EIAR Appendix 11.2: Marine Mammal Assessment Methodology;
- EIAR Appendix 11.3: Marine Mammal Baseline Characterisation;
- EIAR Appendix 11.5: Underwater Noise Modelling;
- EIAR Appendix 11.6: Report to Inform the Appropriate Assessment (RIAA) - Marine Mammals; and
- EIAR Appendix 11.7: Marine Mammal Mitigation Plan (MMMP).

The list of impacts proposed to be scoped into the EIAR Chapter 11 (Marine Mammals), and approach to the assessment, follows the approach set out in the EIA Scoping Report (SCOP-0062). The overarching legislation, policy and guidance relating to Marine Mammals in Scotland, and relevant to this assessment of the proposed development are presented in Appendix 11.1. The methodology used in the impact assessment is presented in Appendix 11.2 which includes the assumptions and limitations of the assessment. Appendix 11.3 includes the marine mammal study area and key data sources used in the marine mammal assessment, and EIAR Chapter 3 (Project Description) contains a detailed description of the proposed development for which impacts are assessed against.

A detailed description of the baseline marine mammal environment is provided in Appendix 11.3. The marine mammal species scoped into the assessment of impacts, and thus included in this appendix, are as follows:

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

There are a range of density estimates available from various surveys and data sources, as outlined in Appendix 11.3. The most robust and relevant density estimates are outlined in Table 1 and were taken forward to the quantitative impact assessment.

Table 1: Species, MU size and density estimate recommended for use in the quantitative impact assessment for the proposed development.

Species	MU	MU size (# of individuals)	UK MU Size (# of individuals)	MU Ref	Density (#/km^2)	Density Ref
Bottlenose dolphin	Coastal East Scotland	234		Arso Civil et al. (2025)	Density surface scaled from Thompson et al. (2015).	
Harbour seal	Moray Firth	1,365		SCOS (2024)	Grid cell specific	Carter et al. (2025)
Grey seal	Moray Firth	5,384		SCOS (2024)	Grid cell specific	Carter et al. (2025)
Harbour porpoise	North Sea	346,601	159,632	IAMMWG (2023)	0.2813	SCANS IV block CS-K (Gilles et al. 2023)
					0.186	Grid cell closest to the port (Gilles et al. 2025)
Minke whale	Celtic and Greater North Sea	20,118	10,288	IAMMWG (2023)	0.0116	SCANS IV block CS-K (Gilles et al. 2023)
					0.008	Grid cell closest to the port (Gilles et al. 2025)

For each of the scoped-in marine mammal receptors, the following impacts have been assessed within this appendix:

- Construction Phase:
    - Auditory injury (PTS) associated with piling (vibro and impact) for installation of mooring dolphins;
    - Auditory injury (PTS) associated with dredging and spoil disposal activities;
    - Disturbance associated with piling (vibro and impact) for installation of mooring dolphins;
    - Disturbance associated with dredging and spoil disposal activities;
    - Disturbance associated with increased vessel traffic;
    - Collision risks associated with increased vessel traffic; and

- Indirect impacts on prey availability.

- O&M Phase:
    - Collision risk impacts associated with increased vessel traffic;
    - Disturbance impacts associated with increased vessel traffic (including disturbance to seal haul-outs);
    - Indirect impacts on prey availability; and
    - Long term habitat changes, displacement and/or barrier effects.

The construction impacts scoped into this assessment are described in Section 3: Construction Phase, whilst operational impacts scoped into this assessment are described in Section 4: Operation & Maintenance Phase. The Cumulative Effects Assessment (CEA) for marine mammals is included in Section 5.

2 Assessment Methodology

Although full details on the assessment methodology employed for marine mammal impacts are described in Appendix 11.2, this section provides a summary of the assessment criteria used to determine the significance of impacts for marine mammals.

The criteria for determining the significance of effects is a two-stage process which involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors to the magnitude of potential impacts.

2.1 Sensitivity

The criteria for defining sensitivity for Marine Mammals receptors are provided below in Please note, the value of the receptor is not included in the definition of sensitivity as all marine mammals are considered to have a high value. It is considered that since marine mammals are either listed under Annex IV of the Habitats Directive as EPS of Community Interest and are in need of strict protection and/or are listed in the under Annex II of the Habitats Directive as species of Community Interest, the value of the receptor is inherently considered through various legislation. In addition to the EIA process, there is legislation and regulatory mechanisms (Habitat Regulations Appraisal (HRA)/European Protected Species (EPS) Licence) to ensure additional and comprehensive assessment to specific species because of their value/importance. Further, the sensitivity of marine mammal receptors should be defined by their potential vulnerability to an impact from the proposed development, their recoverability and their tolerance. This ensures that the potential risks to individuals and populations are based around evidence on the behavioural adaptability of marine mammals, and the likelihood of changes to vital, reproduction and survival rates of these species from specific impacts.Please note, the value of the receptor is not included in the definition of sensitivity as all marine mammals are considered to have a high value. It is considered that since marine mammals are either listed under Annex IV of the Habitats Directive as EPS of Community Interest and are in need of strict protection and/or are listed in the under Annex II of the Habitats Directive as species of Community Interest, the value of the receptor is inherently considered through various legislation. In addition to the EIA process, there is legislation and regulatory mechanisms (Habitat Regulations Appraisal (HRA)/European Protected Species (EPS) Licence) to ensure additional and comprehensive assessment to specific species because of their value/importance. Further, the sensitivity of marine mammal receptors should be defined by their potential vulnerability to an impact from the proposed development, their recoverability and their tolerance. This ensures that the potential risks to individuals and populations are based around evidence on the behavioural adaptability of marine mammals, and the likelihood of changes to vital, reproduction and survival rates of these species from specific impacts.

Table 2: Definition of Terms Relating to Receptor Sensitivity.

Sensitivity	Definition Used in this Chapter
High	Adaptability: No ability to avoid or adapt to an impact so that individual survival and reproduction rates are affected. Tolerance: No tolerance – Effect will cause a change in both individual reproduction and survival rates. Recoverability: No ability for the animal to recover from any impact on vital rates (reproduction and survival rates).
Medium	Adaptability: Limited ability to avoid or adapt to an impact so that individual survival and reproduction rates may be affected. Tolerance: Limited tolerance – Effect may cause a change in both individual reproduction and survival of individuals. Recoverability: Limited ability for the animal to recover from any impact on vital rates (reproduction and survival rates).
Low	Adaptability: Reasonable ability to avoid or adapt to an impact so that individual reproduction rates may be affected but survival rates not likely to be affected. Tolerance: Some tolerance – Effect unlikely to cause a change in both individual reproduction and survival rates. Recoverability: Ability for the animal to recover from any impact on vital rates (reproduction and survival rates).
Negligible	Adaptability: Receptor is able to avoid or adapt to an impact so that individual survival and reproduction rates are not affected. Tolerance: Receptor is able to tolerate the effect without any impact on individual reproduction and survival rates. Recoverability: Receptor is able to return to previous behavioural states/activities once the impact has ceased.

2.2 Magnitude

The magnitude of an impact is based on its duration and spatial extent. Data sources, feedback received from consultation, and expert judgement are used to inform the assessment of magnitude for impacts to Marine Mammal receptors. The criteria for defining magnitude are defined in Table 3**.**

Table 3: Definition of Terms Relating to Magnitude of an Impact.

Magnitude	Definition Used in this Chapter
High	Extent/Duration: The impact occurs over a large spatial extent and over long-term duration, with the potential to affect a large proportion of a receptor population. Probability/frequency: The effect is highly likely to occur and/or will occur at a high frequency. Consequence: The effect could affect a large enough proportion of the population to alter the long-term trajectory of the population in the long term.
Medium	Extent/Duration: The impact occurs over a medium spatial extent and over medium-term duration, with potential affect a moderate proportion of a receptor population. Probability/frequency: The effect is likely to occur and/or will occur at a moderate frequency. Consequence: The effect could affect a moderate proportion of the population although not large enough to alter the population trajectory in the long term.
Low	Extent/Duration: The impact is localised and temporary or short-term, with potential to result in a noticeable effect on a small proportion of a receptor population. Probability/frequency: The effect may occur but at low frequency. Consequence: The effect could affect a small proportion of the population, and the population trajectory would not be altered.
Negligible	Extent/Duration: The impact is highly localised and short-term, with potential to result in very slight or imperceptible changes to a receptor population. Probability/frequency: The effect is very unlikely to occur; if it does, it will occur at a very low frequency. Consequence: The effect will not alter the population trajectory.

2.3 Significance

The significance of the effect upon Marine Mammal receptors is determined by combining the sensitivity of the receptor and the magnitude of the impact. On this basis potential impacts as assessed as either negligible, minor, moderate or major significance. For the purposes of this assessment, any effects with a significance level of major and/or moderate are considered significant in EIA terms, while those of minor and/or negligible are deemed non-significant.

Where the potential for significant effects is identified, additional secondary mitigation measures are proposed and an assessment of residual effects carried out. It should be noted that significant residual effects need not be unacceptable or irreversible.

Table 4: Matrix Used for Assessment of the Significance of the Effect.

Significance of Effect		**Sensitivity of Receptor**			
		Negligible	*Low*	*Medium*	*High*
Magnitude of Effect	*Negligible*	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Minor	**Moderate**
	Medium	Negligible	Minor	**Modertate**	**Major**
	High	Negligible	**Moderate**	**Major**	**Major**

2.4 Proposed Development Design Parameters

Table 5 details the key Proposed Development Design Parameters of relevance to the assessment for marine mammal receptors.

Table 5: Proposed Development Design Parameters used to inform the impact assessment for marine mammal receptors.

Impact	**Project details**	**Timeline**
Construction		
Auditory injury and disturbance from pile driving of mooring dolphins	**Impact pile driving for 3 mooring dolphins:** • Pile diameter: 1.2 meters • Maximum hammer energy: 294 kJ • Total number of piles: 12 • Total number of piling days: 12 • Number of piles installed per day: 1 • Duration of each pile installation: 10 hours • Duration of soft start: 20 minutes • Initial soft start strike rate: 6 strikes per minute (spm) (20% of max) • Maximum strike rate: 30 spm	12 piling days between 2026 and 2028
Auditory injury and disturbance from dredging and soil disposal	• Cutter Suction Dredge (CSD) modelled and assessed under worst-case scenario for auditory injury • Disturbance assessment has considered CSD, Trailer-Suction Hopper Dredgers (TSHD) and Split Hopper Barges (SHB) • Expected soil disposal sites: Inverness, Sutors or Burghead	Dredging and soil disposal is expected to be taking place over a 10 week period between March and September (sometime between 2027 – 2029)
Vessel disturbance and collision	**Peak vessel activity:** • During spoil disposal operations (between Ardersier and Inverness, Sutors or Burghead) • Up to 13–23 barge movements per day may be required to transport dredged material offshore • Maximum of ~450 additional vessel movements within the Inner Moray Firth over a 10 week period when considering material delivery by barge, and spoil disposal operations	Construction activities are planned to take place between 2026 and 2028, with dredging activities (licensed separately) set to take place between 2027 – 2029

Operation		
Vessel disturbance and collision	• **Vessel movements:** Vessel traffic during the operational phase is anticipated to be 400 vessel calls per year as a maximum worst-case scenario (Haventus 2025). • **Vessel speed:** While some of the vessels expected to operate are capable of reaching speeds up to 13 knots, most are expected to transit at typical speeds around 10 knots. • **Vessel types primarily large vessels servicing offshore industries, including**: Heavy Load Carriers (>150 m): 7 different vessel types arriving on-site, in total, per year, Heavy Lift Vessels (>100 m): 4 different vessel types arriving on-site, in total, per year, Jack-up Barges (>80 m): 7 different vessel types in total, General Cargo Vessels (>140 m): 2 different vessel types arriving on-site, in total, per year, Bulk Carrier (150 m): 1 vessel type arriving on-site, in total, per year, Semi-submersible (137 m): 1 vessel type arriving on-site, in total, per year.	Vessel activity levels will be sustained over a long-term duration (50 years)

2.5 Primary Mitigation Measures

The primary mitigation measures relevant to marine mammals include:

- Piling MMMP (Marine Mammal Mitigation Protocol);
- Dredging MMMP;
- Port Environmental Management Plans (POEMP) and
- Navigational Safety Risk Assessment (NRA) for vessels.

3 Construction Phase

3.1 Auditory injury (PTS) from piling

Pile driving activity involves the installation of 12 piles over a 19-day period. One pile shall be installed per day. There shall be 12 days within the 19 day period, within which piling shall take place. It shall take ~10 hours to install each pile. The pile driving will be conducted using an impact hammer with a maximum energy of 294 kJ. The pile diameter is 1.2 meters. A soft-start procedure is implemented to minimise underwater noise impacts with the soft-start beginning at 20% of the maximum strike rate (6 strikes per minute) for the first 20 minutes, gradually increasing to the maximum rate of 30 strikes per minute thereafter. Table 6 provides a summary of the piling parameters used in underwater noise modelling.

As impact piling shall only be utilised for the installation of mooring dolphins, the representative location used in underwater noise modelling was the most seaward pile (i.e., the pile located furthest from the inner harbour area). This represents the worst-case scenario.

Table 6: Summary of piling parameters

Parameter	Value
Pile diameter	1.2 meters
Maximum hammer energy	294 kJ
Total number of piles	12
Total number of piling days	12
Number of piles installed per day	1
Duration of each pile installation	10 hours
Duration of soft start	20 minutes
Initial soft start strike rate	6 strikes per minute (spm) (20% of max)
Maximum strike rate	30 spm

3.1.1 Sensitivity

The ecological consequences of PTS for marine mammals are uncertain. At an expert elicitation workshop for the iPCoD framework several general discussion points were raised, including that PTS did not mean animals were deaf, that the limitations of the ambient noise environment should be considered and that the magnitude and frequency band in which PTS occurs are critical to assessing the effect on vital rates (Booth and Heinis 2018).

For piling noise, most energy is between approximately 30 – 500 Hz, with a peak usually between 100 – 300 Hz and energy extending above 2 kHz (Kastelein et al. 2015, Kastelein et al. 2016). Studies have shown that exposure to impulsive pile driving noise induces threshold shift in a relatively narrow frequency band (i.e. a 'notch') in marine mammals (reviewed in Finneran (2015)), with statistically significant threshold shift occurring at 4 and 8 kHz (Kastelein et al. 2016) and centred at 4 kHz (Kastelein et al. 2012a, Kastelein et al. 2012b, Kastelein et al. 2013, Kastelein et al. 2017). Therefore, it is expected that any threshold shifts that occur as a result of pile driving would manifest themselves somewhere between 2 to 10 kHz (Kastelein et al. 2017). This is considered to apply to all marine mammals. The expert elicitation found that a PTS 'notch' of 6 to 18 dB in a narrow frequency band in the 2 to 10 kHz region is highly unlikely to significantly affect the fitness of individuals (ability to survive and reproduce) of the species assessed (harbour porpoise, bottlenose dolphins and seals).

The frequency where the PTS is expected is below the region of greatest sensitivity for VHF cetaceans, including harbour porpoise (12 to 140 kHz). There is a small overlap with the 2 to 10 kHz range and region of greatest sensitivity for HF cetaceans such as bottlenose dolphin (8.8 to 110 kHz). Whilst there is a potential for overlap with the region of greatest hearing sensitivity for PCW species (1.9 to 30 kHz), expert elicitation process concluded that auditory injury (PTS) is unlikely to have a large impact on survival or fertility of both seal species (Booth and Heinis 2018).

Whilst PTS is a permanent effect which cannot be recovered from, the evidence does not suggest that PTS from piling will cause a material impact on either survival or reproductive rates for species included in the expert elicitation process (harbour porpoise, bottlenose dolphin, harbour seal, grey seal). As such, harbour porpoise, bottlenose dolphin, harbour seal and grey seal are assessed as having a **Low** sensitivity to auditory injury (PTS-onset) from piling.

There is an overlap with frequency at which PTS due to piling is expected to occur and the region of greatest sensitivity for LF cetaceans, including minke whale and humpback whale (200 Hz to 19 kHz) Although animals are not at risk of loss of hearing across the entire hearing band, they may have limited ability to adapt their behaviour and tolerance to the effect. As such, minke whale are assessed as having a **Medium** sensitivity to auditory injury (PTS-onset) from piling.

3.1.2 Magnitude

The following section provides the quantitative assessment of the impact of auditory injury (PTS) from pile driving on marine mammal species. The impact area and maximum impact ranges for each marine mammal hearing group are presented in Table 7 for instantaneous PTS (SPL_{peak}) and in Table 8 for cumulative PTS (SEL_{cum}) for impact piling, and Table 9 for cumulative PTS (SEL_{cum}) for vibropiling.

Impact ranges for cumulative PTS (SEL_{cum}) are calculated based on the effect over time of a moving receptor, and the maximum impact ranges were produced following bearings of transects which were not constrained by landmass or structures nearby to the noise source.

3.1.2.1 Instantaneous PTS

Using SPL_{peak} noise PTS-onset thresholds, the maximum estimated impact ranges were <10 m for minke whale, bottlenose dolphin, harbour seal and grey seal. Within this range, no animals are expected to be impacted by instantaneous PTS (SPL_{peak}). For harbour porpoise, the maximum estimated impact range was 60 m. Based on this worst-case impact range (corresponding to an area of 0.0013 km^2) and considering the worst-case harbour porpoise density estimate of 0.281 animals/$km^{2,}$ the estimated number of harbour porpoise impacted by instantaneous PTS will be <1 animal.

The extent of auditory injury from instantaneous PTS (SPL_{peak}) is expected to be extremely localised (maximum of 60 m). In addition, the project will adhere to a MMMP (see Appendix 11.7) outlining specific mitigation measures in accordance with the current guidance on minimising the risk of injury to marine mammals from piling noise. These measures include, but are not limited to, pre-piling marine mammal monitoring through the use of an marine mammal observer (MMO) or passive acoustic monitoring (PAM) equipment. As a result, it is anticipated that no animals will experience auditory injury. Therefore, the magnitude of instantaneous PTS from piling for marine mammals has been assessed as **Negligible**.

Table 7: Predicted auditory injury instantaneous PTS impact ranges for impact piling, using the Southall et al. (2019) SELpeak PTS criteria in marine mammals.

Hearing group	Species	Southall *et al.* (2019) criteria (PTS) (SEL_{peak})	Maximum estimated impact range (m)
LF Cetaceans	Minke whale	219 dB	<10
HF Cetaceans	Bottlenose dolphin	230 dB	No predicted exceedance
VHF Cetaceans	Harbour porpoise	202 dB	60

PCW Pinnipeds	Harbour seal Grey seal	218 dB	<10

3.1.2.2 Cumulative PTS

Using SEL_{cum} PTS-onset thresholds for impact piling (Table 8) and vibropiling (Table 9), the maximum estimated impact ranges were <10 m for all hearing groups. The extent of auditory injury from cumulative PTS (SEL_{cum}) is therefore expected to be extremely localised and as a result, no animals are expected to be impacted by cumulative PTS (SEL_{cum}) during impact piling or vibropiling. In addition, the project will adhere to a MMMP (see Appendix 11.7), which outlines specific mitigation measures in accordance with the current guidance on minimising the risk of injury to marine mammals from piling noise. These measures include, but are not limited to, pre-piling marine mammal monitoring through the use of MMOs and/or PAM. As a result, it is anticipated that no animals will experience auditory injury. Therefore, the magnitude of cumulative PTS from piling for marine mammals has been assessed as **Negligible**.

Table 8: Worst case scenario auditory injury cumulative PTS impact ranges for impact piling, using the Southall et al. (2019) SELcum PTS criteria in marine mammals, assuming a fleeing receptor

Hearing group	Species	Southall *et al*. (2019) criteria (PTS) (SEL_{cum})	Maximum estimated impact range (m)
LF Cetaceans	Minke whale	183 dB	<10
HF Cetaceans	Bottlenose dolphin	185 dB	<10
VHF Cetaceans	Harbour porpoise	155 dB	<10
PCW Pinnipeds	Harbour seal Grey seal	185 dB	<10

Table 9: Worst case scenario auditory injury cumulative PTS impact ranges for vibropiling, using the Southall et al. (2019) SELcum PTS criteria in marine mammals, assuming a fleeing receptor

Hearing group	Species	Southall *et al*. (2019) criteria (PTS) (SEL_{cum})	Maximum estimated impact range (m)
LF Cetaceans	Minke whale	199 dB	<10
HF Cetaceans	Bottlenose dolphin	198 dB	<10
VHF Cetaceans	Harbour porpoise	173 dB	<10
PCW Pinnipeds	Harbour seal Grey seal	201 dB	<10

3.1.3 Significance of Effect

For both instantaneous PTS (SPL_{peak}), and cumulative PTS (SEL_{cum}), the magnitude of the impact is deemed to be **Negligible** for all marine mammals. The sensitivity is deemed to be **Low** for porpoise, dolphins and seals and **Medium** for minke whales. The effect will therefore be of **Negligible** significance, which is not significant in EIA terms (Table 10).

Table 10: Summary of the impact assessment for auditory injury (PTS) from pile driving

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)
Harbour seal	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Low	Negligible (not significant)
Minke whale	Negligible	Medium	Negligible (not significant)

3.1.4 Secondary Mitigation

The embedded primary mitigation includes an MMMP.

No additional marine mammal mitigation is considered necessary because the likely effect is not significant in EIA terms.

3.1.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

3.2 Auditory injury (PTS) associated with dredging and spoil disposal activities

3.2.1 Sensitivity

Dredging is described as a continuous broadband sound source, with the main energy below 1 kHz. However, the frequency and sound pressure level can vary considerably depending on the equipment, activity, and environmental characteristics (Todd et al. 2015). The source level of dredging has been described to vary between SPL 172-190 dB re 1 µPa @ 1 m with a frequency range of 45 Hz to 7 kHz (Evans 1990, Thompson et al. 2009, Verboom 2014). This is in line with estimated source levels for dredging activities at the proposed development (181.4 dB RMS re 1 µPa) (see Appendix 11.5), where data was obtained from Subacoustech's measurement library and calculated directly from the recordings of Taurus II dredge vessel. It is expected that the underwater noise generated by dredging will be below the PTS-onset threshold (Todd et al. 2015) and thus the risk of injury is unlikely. For harbour porpoise, bottlenose dolphins and seals, the hearing sensitivity below 1 kHz is relatively poor and thus it is expected that a PTS at this frequency would result in little impact to vital rates. Therefore, the sensitivity of harbour porpoise, dolphins and seals to PTS from dredging is assessed as **Low.**

The low frequency noise produced during dredging may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whale. Minke whale communication signals have been demonstrated to be below 2 kHz (Edds-Walton 2000, Mellinger et al. 2000, Gedamke et al. 2001, Risch et al. 2013, Risch et al. 2014). Tubelli et al. (2012) estimated the most sensitive hearing range (the region with thresholds within 40 dB of best sensitivity) to extend from 30 to 100 Hz up to 7.5 to 25 kHz, depending on the specific model used. Therefore, the sensitivity of minke whales to PTS from dredging is precautionarily assessed as **Medium.**

3.2.2 Magnitude

The maximum impact ranges for each hearing group are presented in Table 11 for cumulative PTS (SEL_{cum}) for CSD as a worst-case scenario.

Using SEL_{cum} PTS-onset thresholds for CSD (Table 11) the maximum estimated impact ranges were <10 m for all hearing groups. The extent of auditory injury from cumulative PTS (SEL_{cum}) is therefore expected to be extremely localised and as a result, no animals are expected to be impacted by cumulative PTS (SEL_{cum}) during CSD.

In addition, the project will adhere to a MMMP (see Appendix 11.7), which outlines specific mitigation measures in accordance with the current guidance on minimising the risk of injury to marine mammals from dredging noise. These measures include, but are not limited to, pre-dredging marine mammal monitoring and the implementation of a soft-start procedure. As a result, it is anticipated that no animals will experience auditory injury. Therefore, the magnitude of cumulative PTS from CSD for marine mammals has been assessed as **Negligible**.

Table 11: Worst case scenario auditory injury cumulative PTS impact ranges for cutter suction dredging, using the Southall et al. (2019) SELcum PTS criteria in marine mammals, assuming a fleeing receptor

Hearing group	Species	Southall *et al.* (2019) criteria (PTS) (SEL_{cum})	Maximum estimated impact range (m)
LF Cetaceans	Minke whale	199 dB	<10
HF Cetaceans	Bottlenose dolphin	198 dB	<10
VHF Cetaceans	Harbour porpoise	173 dB	<10
PCW Pinnipeds	Harbour seal Grey seal	201 dB	<10

3.2.3 Significance of Effect

For cumulative PTS (SEL_{cum}), the magnitude of the impact is deemed to be **Negligible** for all marine mammals. The sensitivity is deemed to be **Low** for porpoise, dolphins and seals and **Medium** for minke whales. The effect will therefore be of **Negligible** significance, which is not significant in EIA terms (Table 12).

Table 12: Summary of the impact assessment for auditory injury (PTS) from dredging

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)

Harbour seal	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Low	Negligible (not significant)
Minke whale	Negligible	Medium	Negligible (not significant)

3.2.4 Secondary Mitigation

The embedded primary mitigation includes an MMMP and a NRA.

No additional marine mammal mitigation is considered necessary because the likely effect is not significant in EIA terms.

3.2.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

3.3 Disturbance from piling

The assessment of disturbance from pile-driven foundations was based on the current best practice methodology, making use of the best available scientific evidence. Results for all species are presented using dose-response functions (Graham et al. 2017a, Whyte et al. 2020).

In addition to the piling works for new mooring dolphins, the project will also involve extraction of old quay piles using vibro methods. These works will take place approximately 800 m to 1.8 km inside the harbour. In some locations, a temporary bund within the water may be required, while in others works will proceed without such a bund. Given the location of these activities within the enclosed harbour environment, and the very low likelihood of marine mammals—particularly cetaceans—occurring in this area, no specific impact assessment for vibro-extraction is presented.

The potential underwater noise effects of piling for the new mooring dolphins have been modelled. Both vibro piling and impact piling were considered, with impact piling representing the worst-case scenario. Accordingly, only the potential impacts associated with impact piling are assessed in this section. Piling activities shall only take place during daylight hours.

3.3.1 Sensitivity

3.3.1.1 Harbour porpoise

A study on harbour porpoise behavioural responses to the construction of the Nigg Energy Park port in the Cromarty Firth found that porpoises were not excluded from monitoring sites in the vicinity of either impact or vibration piling (Graham et al. 2017). However, there was a slight reduction in the probability of porpoise presence on days in which vibration piling occurred. Further, monitoring of harbour porpoise activity at the Beatrice Offshore Wind Farm within the Moray Firth during piling has indicated that harbour porpoises were displaced from the immediate vicinity of the pile driving activity with diminishing response over the construction period (Graham et al. 2019). In addition, the study indicated that harbour porpoise activity recovered between pile driving days. Benhemma-Le Gall et al. (2021) studied harbour porpoise response to pile driving at two OWFs within the Moray Firth and found that harbour porpoise were not completely displaced from the piling site: detections of clicks (echolocation) and buzzing (associated with prey capture) in the short-range (2 km) did not cease in response to pile driving. Detections of both clicks (echolocation) and buzzing (associated with prey capture) increased above baseline levels with increasing distance from the pile, which suggests that those harbour porpoise that are displaced from the near-field resume foraging at a greater distance from the modelling location. Therefore, harbour porpoise that experience displacement are expected to be able to compensate for the lost foraging opportunities.

The findings of the expert elicitation workshop suggest that first year calf survival (post-weaning) and fertility were the most likely vital rates to be affected by disturbance, but that juvenile and adult survival were unlikely to be significantly affected as these life-stages were considered to be more robust (Booth et al., 2019). Experts agreed that the final third of the year was the most critical for harbour porpoises as they reach the end of the current lactation period and the start of new pregnancies, therefore it was thought that significant impacts on fertility would only occur when animals received repeated exposure throughout the whole year. It was also concluded that it would likely take high levels of repeated disturbance to an individual before there was any effect on that individual's fertility, and that it was very unlikely an animal would terminate a pregnancy early. The experts agreed that calf survival could be reduced by only a few days of repeated disturbance to a mother/calf pair during early lactation; however, it is highly unlikely that the same mother-calf pair would repeatedly return to the area in order to receive these levels of repeated disturbance (Booth et al., 2019).

The observed responsiveness to piling and expected ability to compensate for lost foraging opportunities suggest that harbour porpoise have the ability go adapt behaviour in response to stressor. As such, harbour porpoises are anticipated to be able to recover from any impact on vital rates and have been assessed as having a **Low** sensitivity to disturbance from piling.

3.3.1.2 Bottlenose dolphin

There is evidence in published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by offshore construction activities; for example, avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities, piling and seismic surveys (Pirotta et al. 2013, Graham et al. 2017b, Fernandez-Betelu et al. 2021). However, a study on bottlenose dolphin during the construction of the Nigg Energy Park in the Cromarty Firth showed that dolphins were not excluded from the vicinity of the piling activities (Graham et al. 2017b). The vibration pile driving resulted in a slight reduction of encounter durations (though only by a few minutes) for dolphins within the Cromarty Firth. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities.

Furthermore, the relatively dynamic social structure of bottlenose dolphins (Connor et al. 2001) and the fact that they have no significant predation threats and do not appear to face excessive competition for food with other marine mammal species, have potentially resulted in a higher tolerance (compared to porpoise) to perceived threats or disturbances in their environment, which may make them less sensitive to disturbance. According to the opinions of the experts, disturbance would be most likely to affect bottlenose dolphin calf survival if "*it exceeded 30-50 days, because it could result in mothers becoming separated from their calves and this could affect the amount of milk transferred from the mother to her calf*" (Harwood et al. 2014). Note, bottlenose dolphins were not included in the second (most recent) expert elicitation in 2018.

Given that the Moray Firth has been identified as important area with calves being recorded throughout the Moray Firth SAC[1], there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs. However, a study on bottlenose dolphins within the Moray Firth suggests that bottlenose dolphins have the ability to compensate for behavioural responses as a result of increased commercial vessel activity, where longer term overall activity time budget remained the same despite the immediate behavioural response to disturbance (New et al. 2013). Therefore, while there remains the potential for disturbance and displacement to affect individual behaviour, it is not expected that this would result in an overall change in individual energy budget since animals have been shown to compensate for time lost due to disturbance. Therefore, bottlenose dolphins are considered to have a **Low** sensitivity to disturbance from piling.

3.3.1.3 Seals

3.3.1.3.1 Harbour seals

A study of tagged harbour seals in the Wash has shown that they are displaced from the vicinity of piles during impact piling activities in the short-term, and that seals returned to non-piling distributions within two hours after the end of a piling event (Russell et al. 2016). Harbour seals store energy in a thick layer of blubber, which means that they are tolerant of periods of fasting when hauled out and resting between foraging trips, and when hauled out during the breeding and moulting periods. Therefore, they are unlikely to be particularly sensitive to short-term displacement from foraging grounds during periods of active piling.

At the expert elicitation workshop (Booth et al., 2019), experts agreed that harbour seals were considered to have a reasonable ability to compensate for lost foraging opportunities due to their generalist diet, mobility, life history and adequate fat stores. The survival of 'weaned of the year' animals and fertility were determined to be the most sensitive life history parameters to disturbance (i.e., leading to reduced energy intake). Juvenile harbour seals are typically considered to be coastal foragers (Booth et al., 2019) and so less likely to be exposed to disturbances and similarly pups were thought to be unlikely to be exposed to disturbance due to their proximity to land. There was no DEB model available to simulate the effects of disturbance on seal energy intake and reserves; therefore, the opinions of the experts were less certain. Experts considered that the location of the disturbance would influence the effect of the disturbance, with a greater effect if animals were disturbed at a foraging ground as opposed to when animals were transiting through an area (note: the modelling does not show impacts to high density foraging areas). The experts agreed that for an animal in bad condition, moderate levels of repeated disturbance might be sufficient to reduce fertility; however, there was a large amount of uncertainty in this estimate.

Two controlled playback experiments further quantified harbour seal responses to impulsive pile-driving sounds recorded in the North Sea and played back in a quiet pool. Behavioural responses were observed at SEL_{ss} levels of 131–137 dB re 1 μPa²s and were pronounced at ≥143 dB re 1 μPa²s. The strongest responses were elicited by high-frequency components, highlighting the value of frequency-weighted SEL_{ss} in predicting disturbance effects and informing mitigation measures (Kastelein et al. 2025).

1 Although it should be noted that studies show that bottlenose dolphin from the Moray Firth SAC extended their distributional range southwards along the east coast of Scotland and into northeast England (Arso Civil et al., 2019; Cheney et al., 2024).

Due to their observed responsiveness to piling the sensitivity of harbour seals within the Moray Firth SMU has been assessed as **Low**.

3.3.1.3.2 Grey seals

There are still limited data on grey seal behavioural responses to pile driving. The key dataset on this topic is presented in Aarts et al. (2018) where 20 grey seals were tagged in the Wadden Sea to record their responses to pile driving at two OWFs: Luchterduinen in 2014 and Gemini in 2015. The grey seals showed varying responses to the pile driving, including no response, altered surfacing and diving behaviour, and changes in swimming direction. The most common reaction was a decline in descent speed and a reduction in bottom time, which suggests a change in behaviour from foraging to horizontal movement. The distances at which seals responded varied significantly; in one instance a grey seal showed responses at 45 km from the pile location, while other grey seals showed no response when within 12 km. Differences in responses could be attributed to differences in hearing sensitivity between individuals and in sound transmission with environmental conditions or the behaviour and motivation for the seal to be in the area. The telemetry data also showed that seals returned to the pile driving area after pile driving ceased. While this evidence base is from studies of grey seals tagged in the Wadden Sea, it is expected that grey seals in waters east of Scotland would respond in a similar way, and therefore the data are considered to be applicable. Hastie et al. (2021) found that grey seal avoidance rates in response to pile driving sounds were dependent on the quality of the prey patch, with grey seals continuing to forage at high density prey patches when exposed to pile driving sounds but showing reduced foraging success at low density prey patches when exposed to pile driving sounds. Additionally, the seals showed an initial aversive response to the pile driving playbacks (lower proportion of dives spent foraging) but this diminished during each trial. Therefore, the likelihood of grey seal response is expected to be linked to the quality of the prey patch and their previous exposure history.

Based on the expert elicitation workshop, Booth et al. (2019) concluded that grey seals were considered to have a reasonable ability to compensate for lost foraging opportunities due to their generalist diet, mobility, life history and adequate fat stores and that the survival of ‘weaned of the year’ animals and fertility were determined to be the most sensitive parameters to disturbance (i.e., reduced energy intake). However, in general, experts agreed that grey seals would be much more robust than harbour seals to the effects of disturbance due to their larger energy stores and more generalist and adaptable foraging strategies. It was agreed that grey seals would require moderate-high levels of repeated disturbance before there was any effect on fertility rates. The ‘weaned of the year’ were considered to be most vulnerable following the post-weaning fast, and that during this time it might take ~60 days of repeated disturbance before there was expected to be any effect on weaned-of-the-year survival, however there was a lot of uncertainty surrounding this estimate.

Grey seals are capital breeders and store energy in a thick layer of blubber, which means that, in combination with their large body size, they are tolerant of periods of fasting as part of their normal life history. Grey seals are also highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (Beck et al. 2003, Sparling et al. 2006). Grey seals are also very wide ranging and are capable of moving large distances between different haul out and foraging regions (Russell et al. 2013). Therefore, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active piling.

The observed responsiveness to piling suggest that grey seal have the ability to adapt behaviour in response to a stressor and their life-history implies that they have a high tolerance to the stressor. Grey seals are expected to be able to return to previous behavioural activities once the impact has ceased and therefore and have been assessed as having a **Negligible** sensitivity to disturbance from piling.

3.3.1.4 Minke whale

There is little information available on the behavioural responses of minke whales to underwater noise, specifically, piling noise. Minke whales have been shown to change their diving patterns and behavioural state in response to disturbance from whale watching vessels; and it was suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success in this capital breeding species (Christiansen et al. 2013). Sivle et al. (2016) reported minke whale reactions to sonar signals with behavioural response severity scores above 4 (the stage at which avoidance to a sound source first occurs) for a received SPL of 146 dB re 1 µPa (score 72)[2] and a received SPL of 158 dB re 1 µPa (score 83)[3]. There is a study detailing minke whale responses to a Lofitech Acoustic Deterrent Device (ADD) which has a source level of 204 dB re 1 µPa @ 1m, which showed minke whales within 500 m and 1,000 m of the source exhibiting a behavioural response. The estimated received level at 1,000 m was 136.1 dB re 1 µPa (McGarry et al. 2017). Durbach et al. (2021) showed that minke whale's movements became faster and more directed during sonar exposure than in baseline phases and that the mean direction of movement differed during sonar exposure. However, not all whales changed their movement patterns. Whales remaining in a slow movement state during sonar exposure were more likely to stop calling than in other exposure phases (Durbach et al., 2021). There are no equivalent such studies of responses to piling noise.

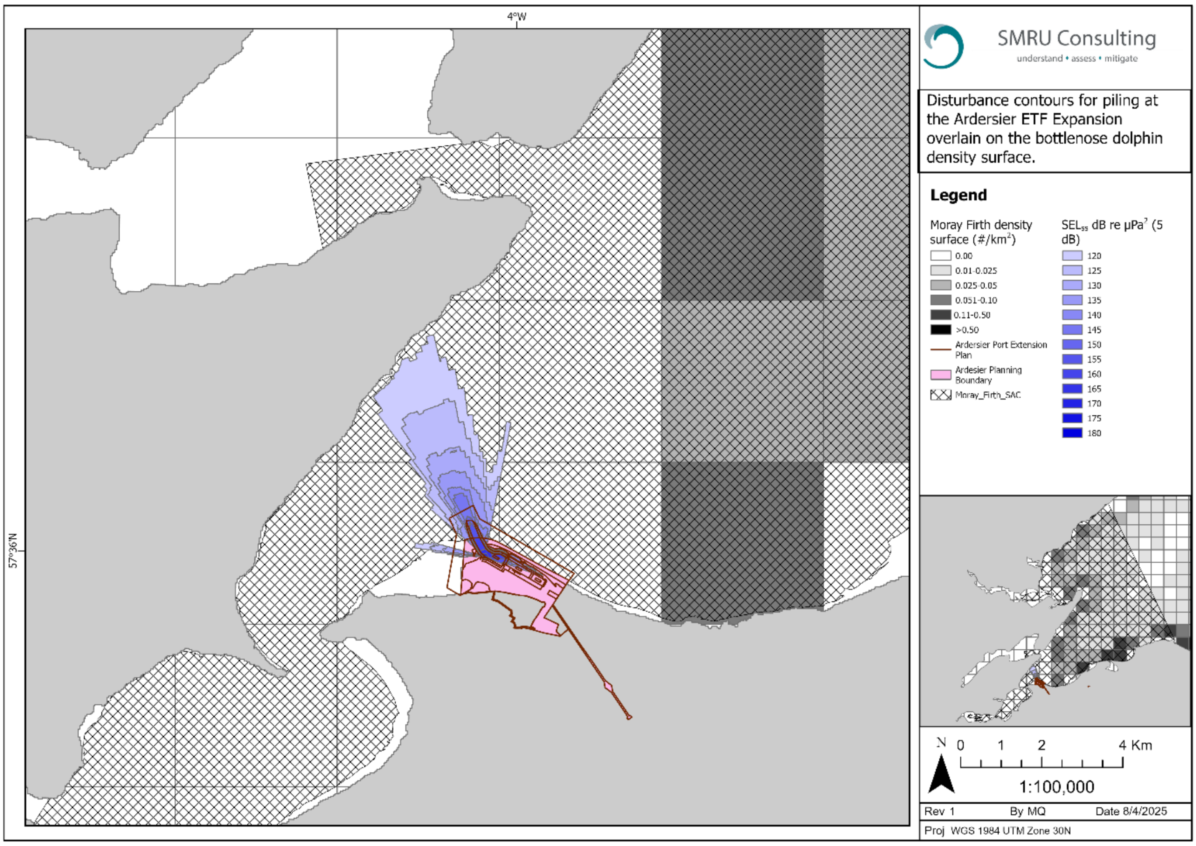
Since minke whales are known to forage in UK waters in the summer months, there is the potential for displacement to impact on reproductive rates. However, due to their large size and capacity for energy storage, it is expected that minke whales will be able to tolerate temporary displacement from foraging areas much better than harbour porpoise and individuals are expected to be able to recover from any impact on vital rates. Therefore, minke whales have been assessed as having a **Low** sensitivity to disturbance from pile driving.

3.3.2 Magnitude

The number of marine mammals predicted to be disturbed by piling activities has been estimated using species-specific density data and dose-response functions. The results are summarised in Table 13. Figure 1: Disturbance contours for piling of mooring dolphins at the proposed development , overlain on the scaled Thompson et al. (2015) bottlenose dolphin density surface

2 Defined in Sivle et al. (2015) as: Prolonged avoidance – The animal increased speed and swam directly away from the sound source throughout the rest of the exposure. Opportunistic visual observations of skim feeding at the surface before the start of the sonar exposure indicated that this response might also have involved a cessation of feeding.

3 Defined in Sivle et al. (2015) as: Obvious progressive aversion (and sensitization) – The animal continued to increase its speed as the exposure progressed, swimming at such a high speed that the distance to the source ship remained constant. About halfway through the exposure, the dive pattern changed to shallower diving, which may be a way to move more effectively away from the source.



Error! Reference source not found. show the disturbance contours for bottlenose dolphins (Figure 1) and seals (Figure 2 & Figure 3) respectively, overlain on grid cell density surfaces where applicable. The extent of the disturbance contours for bottlenose dolphins are the same as those for harbour porpoise and minke whales.

Table 13: Predicted Number of Marine Mammals Disturbed by Piling Activities

Species	Density source	Number of Individuals Impacted	% MU	% UK MU
Harbour porpoise	0.2813/km² (SCANS IV Block CS-K)(Gilles et al. 2023)	<1	<0.001	<0.001
	0.186/km² (Grid cell closest to port (Gilles et al. 2025))	<1	<0.001	<0.001

Bottlenose dolphin	Moray Firth density surface (scaled from Thompson et al. 2015)	<1	<0.001	N/A
	Data on presence and group size (Benhemma-Le Gall and Cheney 2025)	Mean group size: 8 Max group size: 56	Mean group size: 3.4% Max group size: 24%	N/A
Harbour seal	Grid cell specific (Carter et al. 2025)	<1	<0.001	N/A
Grey seal	Grid cell specific (Carter et al. 2025)	<1	<0.001	N/A
Minke whale	0.0116/km^2 (SCANS IV Block CS-K) (Gilles et al. 2023)	<1	<0.001	<0.001
	0.008/km^2 (Grid cell closest to port (Gilles et al. 2025))	<1	<0.001	<0.001

Figure 1: Disturbance contours for piling of mooring dolphins at the proposed development , overlain on the scaled Thompson et al. (2015) bottlenose dolphin density surface

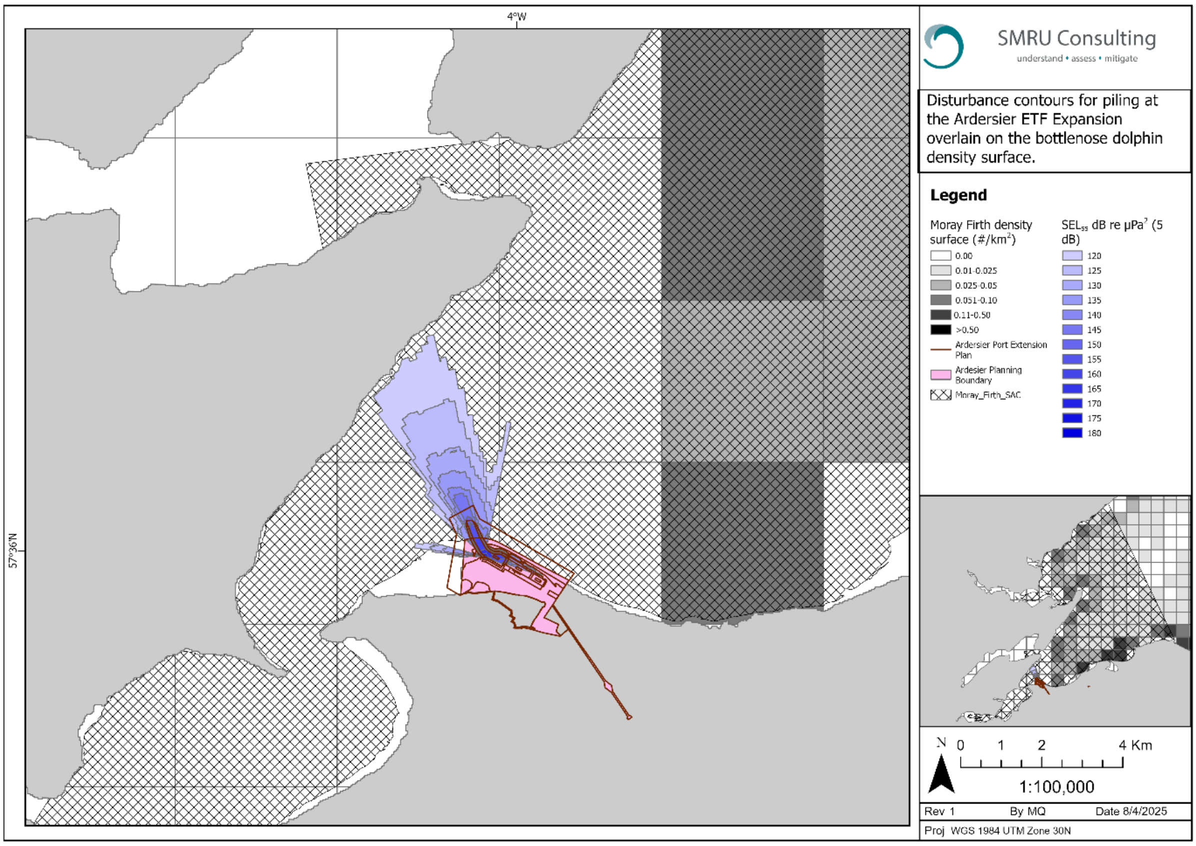


Figure 2: Disturbance contours for piling of mooring dolphins at the proposed development, overlain on the Carter et al. (2025) harbour seal density surface

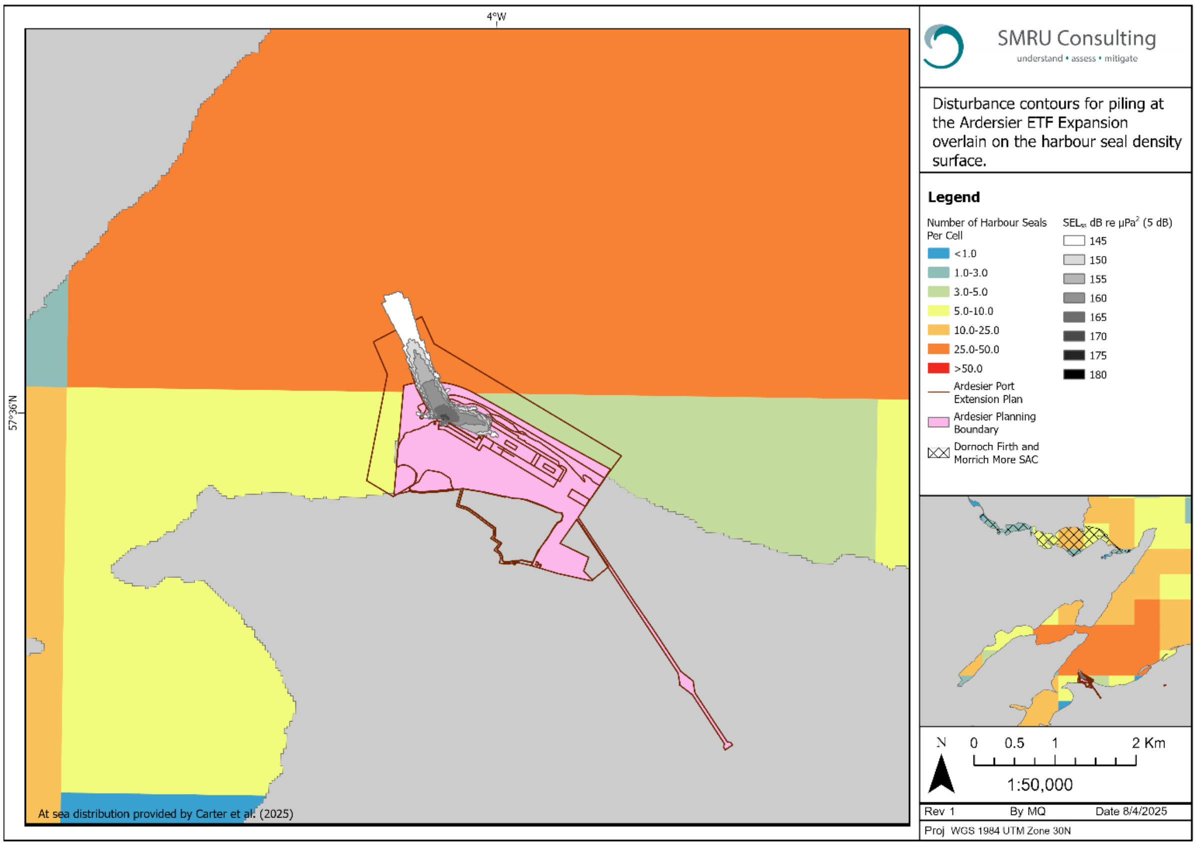
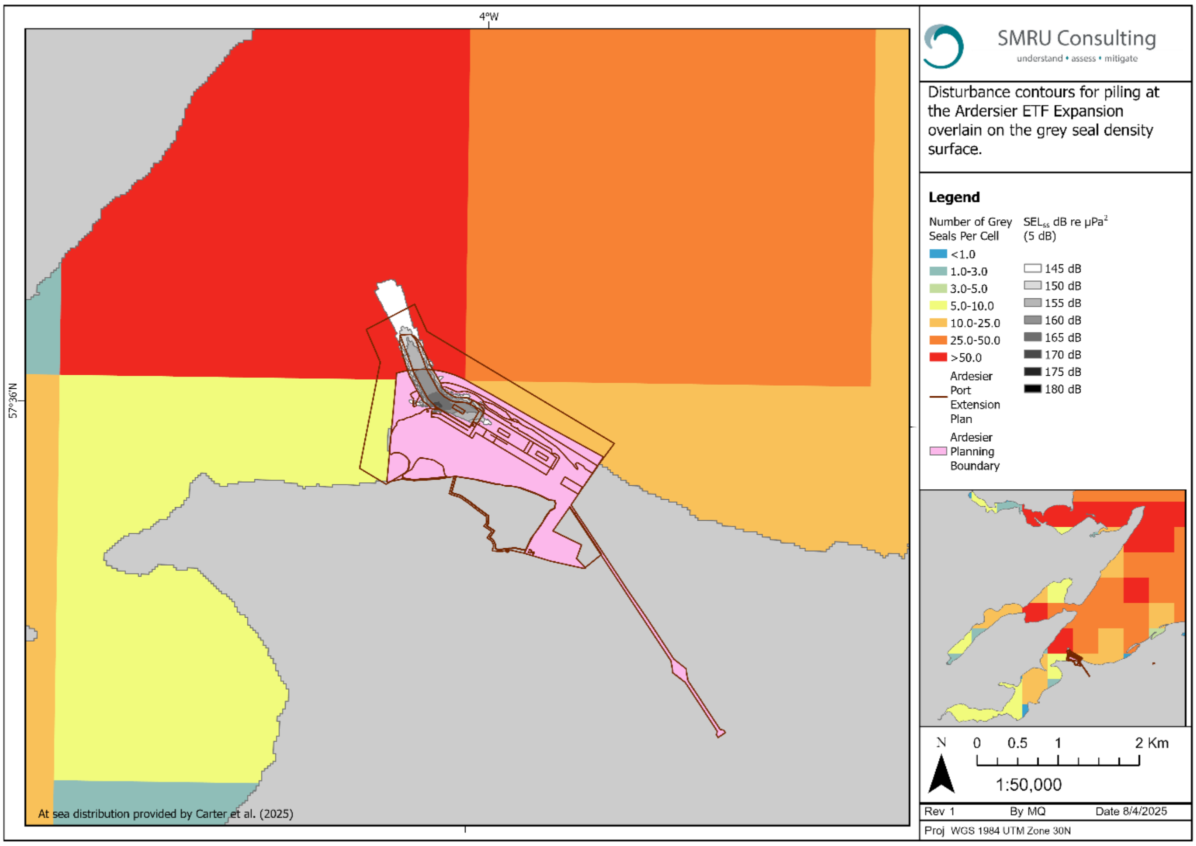


Figure 3: Disturbance contours for piling of mooring dolphins at the proposed development , overlain on the Carter et al. (2025) grey seal density surface



For all marine mammal species assessed, except for bottlenose dolphins, the predicted number of individuals exposed to noise levels sufficient to cause disturbance is <1. This translates to less than <0.001% of the MU population and, where applicable, the UK MU population. For bottlenose dolphins, 8 – 56 individuals could be impacted by pile driving events at the proposed development, translating to 3.4 – 24.0% of the MU, based on presence and group size data Benhemma-Le Gall and Cheney (2025).

In the case of harbour porpoise and minke whale, both broad-scale (SCANS IV) and fine-scale (grid cell-specific) density estimates were used to reflect potential variation in distribution. The SCANS IV data provide a conservative, spatially uniform estimate across offshore waters, while the grid-cell densities offer insight into potential nearshore habitat use near the Port of Ardersier. Though SCANS IV data are limited to summer and may be conservative, they are considered robust for regional assessments. The use of localised density values ensures that the analysis captures both offshore and inshore habitat use.

While acoustic and visual data on bottlenose dolphins and harbour porpoise in the Moray Firth, as provided by the University of Aberdeen (Benhemma-Le Gall and Cheney 2025), have not been directly incorporated into the quantitative modelling, they provide important context suggesting that both species may use the area with moderate regularity during the piling window. Given that bottlenose dolphins were detected for a median of 3.5 (year-round) DPH per day around the Port of Ardersier, and harbour porpoise were detected for a median of 0.000 (July, September, November) – 4.008 (May) DPH per day (Benhemma-Le Gall and Cheney 2025), they imply a non-zero probability that individual harbour porpoises or bottlenose dolphins could be present during piling activities.

Thus, with respect to bottlenose dolphins, there is a high likelihood that bottlenose dolphins will be present on piling days due to their year-round presence at the Port of Ardersier. This, coupled with the fact that during boat based surveys, the mean dolphin group size at Ardersier was 8 individuals (maximum group size was 56) leads to the possibility that bottlenose dolphins could be disturbed by piling events. For harbour porpoise, DPH per day fluctuates throughout the year. This variability suggests that while there is a non-zero probability of harbour porpoise presence during piling activities, their occurrence is likely to be intermittent. As such, piling events may coincide with periods of higher porpoise activity, but may also occur during periods when the species is largely absent from the area. Therefore, while there is some potential for disturbance, the likelihood and frequency of harbour porpoise exposure to piling noise is considerably lower and less predictable compared to bottlenose dolphins.

However, even when considering this potential for presence, the likelihood of individuals being exposed to disturbance levels sufficient to elicit a behavioural response remains low. This is due to the fact that there is limited spatial footprint of the piling operations and a short duration of the works (12 piles installed over 12 non-consecutive days, with a maximum of 10 hours of activity per pile).

Taken together, these factors suggest that while marine mammal individuals may occasionally be present near the piling location, the probability of any one individual being within the disturbance range during active piling is extremely low. Overall, the duration of the piling events are far below the number of days expected before population level effects may occur (e.g., 60 days for grey seals, and 30 – 50 days for harbour porpoise). Based on the limited spatial and temporal extent of piling activity and the very low number or proportion of individuals predicted to be exposed, the magnitude of impact is assessed as **Negligible** for all marine mammal species except bottlenose dolphins, for which the impact is considered **Low** due to the higher likelihood of presence, larger group sizes, and greater proportion of the Management Unit potentially affected.

3.3.3 Significance of Effect

The sensitivity of marine mammals to disturbance from piling has been assessed as Low for all species except grey seals, which were assessed as having Negligible sensitivity. The magnitude of impact is assessed as Negligible for all species considered except for bottlenose dolphins, which were assessed as Low. The effect will therefore be of **Negligible** significance for all marine mammals, which is **Not Significant** in EIA terms.

Table 14: Summary of the impact assessment for disturbance from piling

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Low	Low	Negligible (not significant)
Harbour seal	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Negligible	Negligible (not significant)
Minke whale	Negligible	Low	Negligible (not significant)

3.3.4 Secondary Mitigation

The embedded primary mitigation includes an MMMP.

No additional marine mammal mitigation is considered necessary because the likely effect is not significant in EIA terms.

3.3.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Not Significant** in EIA terms.

3.4 Disturbance associated with dredging and spoil disposal activities

3.4.1 Sensitivity

3.4.1.1 Harbour porpoise

Source levels for dredging activities at the proposed development are estimated to be 181.4 dB RMS re 1 µPa (see Appendix 11.5). Dredging at a source level of 184 dB re 1 µPa at 1 m resulted in harbour porpoise avoidance up to 5 km from the dredging site (Verboom 2014). Conversely, Diederichs et al. (2010) found much more localised impacts; using Passive Acoustic Monitoring there was short term avoidance (~3 hours) at distances of up to 600 m from the dredging vessel, but no significant long-term effects. Modelling potential impacts of dredging using a case study of the Maasvlatke port expansion (assuming maximum source levels of 192 dB re 1 µPa) predicted a disturbance range of 400 m, while a more conservative approach predicted avoidance of harbour porpoise up to 5 km (McQueen et al. 2020).

NOTE: Awaiting full UWN modelling report to see what source level was modelled to incorporate into this section Based on the literature reviewed, harbour porpoise sensitivity to dredging activities is assessed as **Low.**

3.4.1.2 Bottlenose dolphins

Increased dredging activity at Aberdeen Harbour was associated with a reduction in bottlenose dolphin presence and, during the initial dredge operations, bottlenose dolphins were absent for five weeks (Pirotta et al. 2013). Based on the results of this study, Pirotta et al. (2015a) have assumed that dredging activities exclude dolphins from a 1 km radius of the dredging site. However, a study on bottlenose dolphin during the construction of the Nigg Energy Park in the Cromarty Firth showed that dolphins were not excluded from the vicinity of the piling activities (Graham et al. 2017b), which demonstrates the potential tolerance of bottlenose dolphins in the Moray Firth to noisy activities. Based on the literature examined, it is concluded that localised, temporary avoidance of dredging activities by bottlenose dolphins could take place.

Bottlenose dolphin sensitivity to dredging activities is therefore assessed as **Low.**

3.4.1.3 Seals

Source levels for dredging activities at the proposed development are estimated to be 181.4 dB RMS re 1 µPa. Based on the generic threshold of behavioural avoidance of pinnipeds (140 dB re 1 µPa SPL) (Southall et al. 2007), acoustic modelling of dredging demonstrated that disturbance could be caused to individuals between 400 m to 5 km from site (McQueen et al. 2020).

Based on the literature reviewed, harbour and grey seal sensitivity to dredging activities is assessed as **Low.**

3.4.1.4 Seal haul-out sites

Due to proximity of the proposed dredge area to the Ardersier designated seal haul-out site, the sensitivity of hauled-out seals to dredging activities is also considered.

The results of a study where Bankhead et al. (2023) compared harbour seal responses to in-air noise at two haul-out sites with different levels of human activities showed that seals may become tolerant to in-air noise levels at sites where human activities are high. It corroborated the findings of Cates and Acevedo-Gutiérrez (2017) who found that harbour seals at haul-out sites with low vessel activity flush more readily in response to boats than those at high-activity sites. Although vessel disturbance could be most detrimental during pupping season, there is evidence that seals are more reluctant to enter the water during the annual moult (Henry and Hammill 2001).

It should be noted that potential impacts of seals may be different depending on type of the year. Harbour seal breeding season occurs in June and July, followed by the moulting period in August During these periods, there is typically a greater number of harbour seals hauled-out during low tide periods than at other times of year. Grey seal breeding season occurs from August to December, followed by the annual moult occurs between December and April. During the breeding and moulting season, they will spend longer hauled-out compared to other times of year.

The sensitivity of grey seals to disturbance to haul-outs, is classified as **Low** outside of the breeding season and **Medium** during the breeding season. Due to declines in several regional harbour seal populations, this species is considered more vulnerable to pressures, including physical disturbance (SCOS 2022). Therefore, the sensitivity of harbour seal to disturbance during and outside the breeding and moult seasons at haul-outs has been assessed as **Medium**.

3.4.1.5 Minke whale

In northwest Ireland, construction-related activity (including dredging) has been linked to reduced minke whale presence (Culloch et al. 2016). Minke whale distance to construction site increased and relative abundance decreased during dredging activities in Newfoundland (Borggaard et al. 1999). No studies have focussed specifically on the expected disturbance ranges of dredging activity on minke whales, however.

Based on the literature reviewed, minke whale sensitivity to dredging activities is assessed as **Low.**

3.4.2 Magnitude

Although the presence of vessels and associated noise in the vicinity of the proposed development is not a novel impact for marine mammals in the area, additional vessel movements and the duration for which vessels are active during the dredging and spoil disposal phase could introduce additional disturbance events to marine mammals above existing baseline levels.

A combination of hydraulic and mechanical dredging will be carried out during the construction phase of the proposed development . The primary dredging activity will be conducted using a cutter suction dredger (CSD), supported by a combination of self-propelled split hopper barges (SHB) and trailer suction hopper dredgers (TSHD), which will transit between the dredge area and disposal sites. Up to six dredging and spoil disposal vessels may be present on site at one time; however, these vessels are expected to operate in continuous rotation, each transiting between the port and the disposal sites. Once operational, the CSD is expected to run with minimal interruptions or shut-down events, enabling efficient and near-continuous dredging to ensure timely completion. As a result, the repetition of disturbance events is expected to be short-term and infrequent, as the limited number of pauses in activity reduces opportunities for animals to move into active areas and subsequently be disturbed upon resuming operations.

Under the most likely scenario, spoil disposal operations are projected to take place over a ten-week period between March and September (sometime between 2027 – 2029). During this phase, up to 13 – 23 barge movements may be required per day to transport dredged material offshore. Assuming each barge has the capacity to transport on average ~4,500m^3 of material, this results in approximately 450 additional vessel movements taking place within the inner Moray Firth over the ten-week period.

The intensity of movement is short-term but represents a significant temporary increase in marine traffic local to the Ardersier site and spoil disposal areas, as well as along the transit routes between these. The anticipated increase in vessel movements for dredging and spoil disposal may lead to short-term localised impacts, particularly relating to underwater noise, and a higher risk of disturbance to marine mammals.

This assessment presents results for the following behavioural disturbance thresholds:

- 1 km effective deterrence range (EDR): Bottlenose dolphin; and
- 5 km EDR: Harbour porpoise, minke whale, harbour seal and grey seal.

It is important to note that all EDRs were created around a point that represents the most seaward extent of all dredging activity proposed to take place. However, this location is very close to landmass (i.e., Whiteness Point) which will likely create a strong barrier effect for any noise propagation and thus, estimates of impacts may be highly conservative.

Table 15: Summary of the densities, number of individuals and the proportion of the respective MUs impacted based on the impact ranges for dredging and spoil disposal using a 5 km and 1 km EDR.

Species	Density source	Impact	5 km EDR	1 km EDR
Harbour porpoise	0.2813/km^2 (SCANS IV Block CS-K) (Gilles et al. 2023)	# animals	22	-
		% NS MU	< 0.01	-
		% UK MU	0.01	-
	0.186/km^2 (Grid cell closest to port (Gilles et al. 2025))	# animals	15	-
		% NS MU	< 0.01	-
		% UK MU	0.01	-
Bottlenose dolphin	Moray Firth density surface (scaled from Thompson et al. 2015)	# animals	-	0.00
		% CES MU	-	0.00

	Data on presence and group size (Benhemma-Le Gall and Cheney 2025)	# animals	Mean group size: 8 Max group size: 56	
		% CES MU	Mean group size: 3% Max group size: 24%	
Harbour seal	Grid cell specific (Carter et al. 2025)	# animals	23	-
		% MF SMU	1.71	-
Grey seal	Grid cell specific (Carter et al. 2025)	# animals	37	-
		% MF SMU	0.69	-
Minke whale	0.0116/km^2 (SCANS IV Block CS-K) (Gilles et al. 2023)	# animals	<1	-
		% CGNS MU	<0.001	-
		% UK MU	<0.001	-
	0.008/km^2 (Grid cell closest to port (Gilles et al. 2025))	# animals	<1	-
		% CGNS MU	<0.001	-
		% UK MU	<0.001	-

3.4.2.1 Harbour porpoise

Based on literature discussed in 3.4.1, it has been shown that harbour porpoises are predicted to exhibit avoidance of dredging vessels up to 5 km. As such, a 5 km EDR (methodology discussed in Appendix 11.2) has been used to determine the magnitude of impact from dredging vessels (Table 15).

Predicted numbers of individuals disturbed were calculated using both the SCANS IV uniform density estimate and the density estimate for the cell closest to the port. While limited to summer months and likely overly conservative, the SCANS IV uniform estimate provides a robust absolute density estimate that is more representative of harbour porpoise in offshore waters. Density cell estimates from the cell closest to the port are used to ensure the consideration of species habitat use in coastal environments.

Using the 5 km EDR, up to 22 (SCANS IV) and 15 (closest grid cell) harbour porpoise individuals are anticipated to be disturbed by dredging vessels, which equates to <0.01% of the NS MU and/or 0.01% UK MU. While the associated disturbance from dredging vessel presence and movement is expected to be short-term, it represents a temporary but notable increase in marine traffic in the vicinity of the proposed development and disposal sites and routes. While the number of interactions between spoil disposal vessel movements and harbour porpoise in the waters, acoustic data from Benhemma-Le Gall and Cheney (2025) indicate that harbour porpoise presence, measured by DPH per day varies significantly by month—ranging from 0.0 DPH in July and September, to a peak of 4.008 DPH in May, with intermediate levels in April (1.992), June (1.992), and August (1.008). Spoil disposal is scheduled to occur over a 10-week period between March and September, with approximately 13–23 barge movements per day, resulting in a total of around 450 vessel movements across this period. Due to the uncertainty in the exact timing of disposal operations, vessel activity may coincide with months of higher porpoise activity or with periods of near absence. Assuming continuous spoil disposal operations (24 hours/day for 70 days), and using an average daily presence estimate of 1.5 DPH across the March–September period, this equates to approximately 105 hours of porpoise presence during the 1,680-hour operational window (70 days × 24 hours). This represents ~6.3% of the total spoil disposal timeframe. Applying this to the estimated 450 vessel movements suggests that roughly 28 movements (450 × 0.063) may occur during periods when harbour porpoises are present.

Given that porpoise detections tend to reflect solitary or small-group behaviour, the number of individuals potentially disturbed per interaction is expected to be low. Further, the very small proportion of the population predicted to be impacted indicates that disturbance effects will be biologically insignificant at the population level. Further, embedded mitigation measures including a MMMP covering both dredging and spoil disposal activities, and a NRA will be in place for all construction-phase vessel operations. These protocols are coordinated to minimise disturbance, reduce overlap in vessel activity and avoid unnecessary transits.

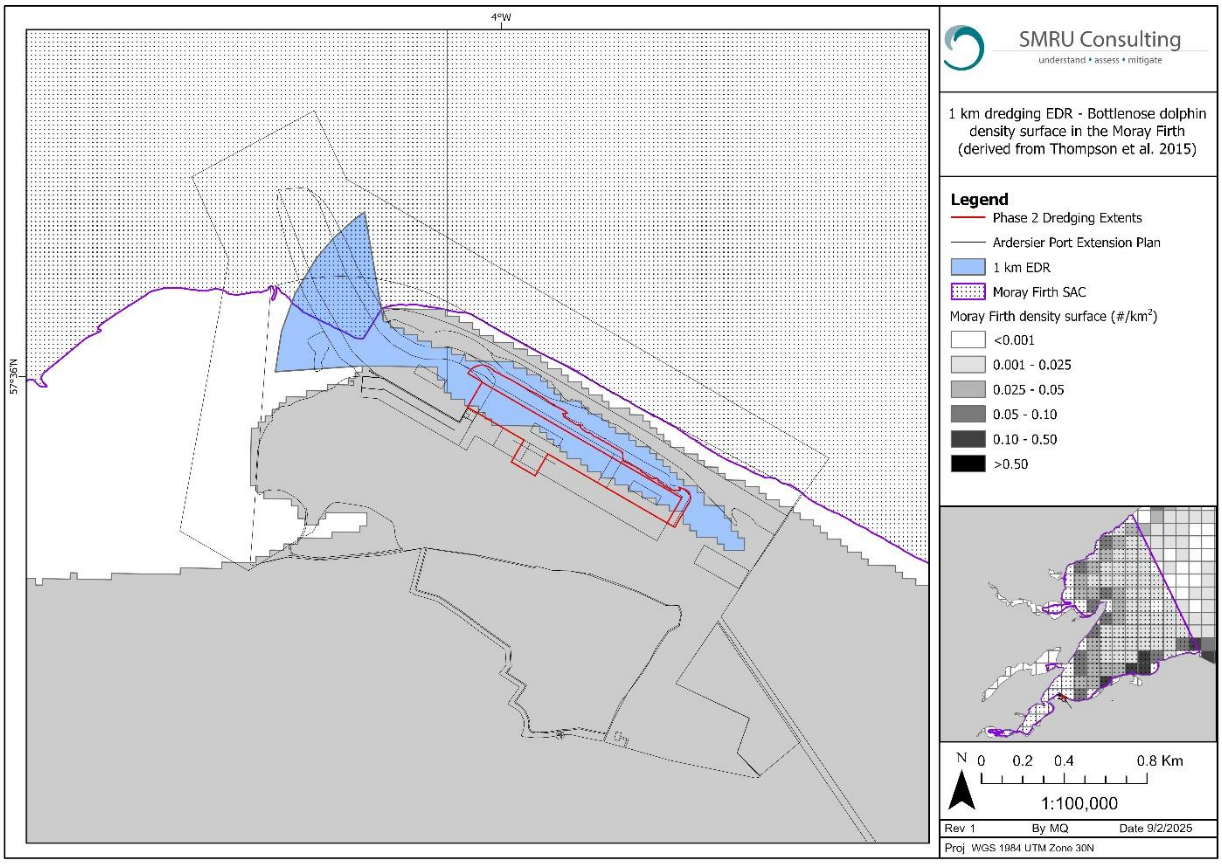
As such, the magnitude of disturbance from dredging vessel activity from the proposed development can be assessed as **Negligible**.

3.4.2.2 Bottlenose dolphin

As discussed in Section 3.4.1, Pirotta et al. (2015a) assumed a 1 km exclusion distance radius (EDR) around dredging operations for bottlenose dolphins, based on observational data from Aberdeen Harbour. Accordingly, a 1 km EDR has been applied in this assessment to evaluate potential disturbance from dredging vessels (refer to Appendix 11.2; and Table 15The EDR has been clipped to account for barrier effects from land masses, preventing propagation of underwater noise from dredging activities.

Under a worst-case scenario, the potential disturbance to bottlenose dolphins during dredging is at the most seaward location of the dredge footprint (see Figure 4). Predicted numbers of individuals disturbed were calculated using the Moray Firth density surface scaled from predicted probabilities of bottlenose dolphin occurrence Thompson et al. (2015). Based on this and using a 1 km EDR, no bottlenose dolphins were predicted to be disturbed by dredging vessel activity within this range (Table 15). The activity will also be short-term (few days to one week) as it will involve the removal of only small volumes of material to create the dredge channel slope.

Figure 4: Bottlenose dolphin density surface for the Moray Firth derived from Thompson et al. (2015). Blue polygon represents a 1 km EDR for disturbance associated with dredging activity from the most seaward dredging location. The EDR has been clipped to account for barrier effects from land masses, preventing propagation of underwater noise from dredging activities.



However, reliable density estimates for bottlenose dolphins within the CES MU and Moray Firth SAC are absent and thus, the application of a 1 km EDR and the Moray Firth density surface may not realistically predict the number of bottlenose dolphin individuals, and the probability of bottlenose dolphins, from being disturbed by dredging activities.

The University of Aberdeen LHFS identified the waters adjacent to the Port of Ardersier as a hotspot for bottlenose dolphin activity within the Moray Firth SAC. Over the 2006 to 2024 monitoring period, 161 individual dolphins (56.3% of the total identified within the Moray Firth SAC) were recorded around the Port of Ardersier, and encounter rates around the Port of Ardersier regularly reached ~1 encounter per hour (of survey effort). During boat based surveys, the mean dolphin group size at Ardersier was 8 individuals (maximum group size was 56), whilst using acoustic survey methods, bottlenose dolphins were detected for a median of 3.5 DPH per day around the Port of Ardersier (Benhemma-Le Gall and Cheney 2025).

The number of interactions between the dredging vessel itself and bottlenose dolphin groups utilising waters surrounding the Port of Ardersier shall be minimal, as dredging activity shall largely take place, over the medium-term (~6 months), deeper within the inner harbour away from where encounter rates are highest around the Port of Ardersier. However, when considering spoil disposal events, up to 13 – 23 barge movements may be required per day to transport dredged material offshore (to the Inverness, Sutors or Burghead disposal sites), resulting in approximately 450 additional vessel movements within the inner Moray Firth (medium extent) over the ten-week period. To estimate the number of individual bottlenose dolphin exposures to vessel movements during the 70-day spoil disposal period, a conservative approach was adopted based on the temporal overlap between vessel activity and dolphin presence. A total of 450 vessel movements are expected over the 70-day period, equating to 1,680 operational hours (70 days × 24 hours) assuming spoil disposals shall take place 24 hours a day, 7 days a week. Bottlenose dolphin presence in the area is estimated at an average of 3.5 hours per day, resulting in 245 hours of dolphin activity across the same period. This represents approximately 14.6% of the total operational time. Applying this proportion to the total number of vessel movements, an estimated 66 movements are likely to coincide with periods when dolphins are present (450 × 0.146). Using a mean group size of 8 individuals (Benhemma-Le Gall and Cheney, 2025), there is expected to be disturbance to an average of 8 individuals (maximum 56) over each of these 66 vessel movements.

Overall, the dredging works will be medium-term but spatially restricted to the inner harbour, where overlap with high dolphin use is limited. While spoil disposal activities are expected to involve a higher frequency of vessel movements (approximately 450 over 10 weeks), these will be temporary and transient in nature. It is expected (based on data on dolphin presence and group size) that there will be disturbance to an average of 8 individuals (maximum 56) over 66 vessel movements. Consequently, risk of repeated behavioural disturbance to a small portion of the local population is high but is unlikely to alter its long-term trajectory. The impact will occur over a medium spatial extent, but for a short-term duration. Further, embedded mitigation measures including a MMMP for dredging and spoil disposal activities. These plans will ensure that vessel routes, speeds, and scheduling are coordinated to minimise disturbance, minimise overlap in vessel activity and reduce unnecessary transits. Therefore, magnitude of impact for both dredging and spoil disposal activities combined is considered to be **Medium**.

3.4.2.3 Seals

Based on literature discussed in 3.4.1, it has been shown that seals are predicted to exhibit avoidance of dredging vessels between 400 m to 5 km (McQueen et al. 2020). As such, and to remain conservative, a 5 km EDR (methodology discussed in Appendix 11.2) has been used to determine the magnitude of impact from dredging vessels (Table 15). The EDR has been clipped to account for barrier effects from land masses, preventing propagation of underwater noise from dredging activities.

Predicted numbers of individuals disturbed were calculated using grid-cell specific density estimates from the Carter et al. (2025) habitat preference maps. Using the 5 km EDR, up to 23 harbour seal individuals (Figure 5) (1.71% of the MF SMU) and 37 grey seal individuals (Figure 6) (0.69% of the MF SMU) are anticipated to be disturbed by dredging vessels (Table 15). While the associated disturbance from dredging vessel presence and movement is expected to be short-term, it represents a temporary but notable increase in marine traffic in the vicinity of the proposed development and disposal sites and routes. However, the small proportion of the population predicted to be impacted indicates that disturbance effects will be biologically insignificant at the population level. Further, embedded mitigation measures including a MMMP covering both dredging and spoil disposal activities, and a NRA will be in place for all construction-phase vessel operations. These protocols are coordinated to minimise disturbance, reduce overlap in vessel activity and avoid unnecessary transits.

As such, the magnitude of disturbance from dredging vessel activity from the proposed development can be assessed as **Negligible**.

Figure 5: Harbour seal distribution during autumn-winter-spring from haul out sites in Scotland only. Data from Carter et al. (2025). Blue outline represents a 5 km EDR for disturbance associated with dredging activity from the most seaward dredging location. The EDR has been clipped to account for barrier effects from land masses, preventing propagation of underwater noise from dredging activities.

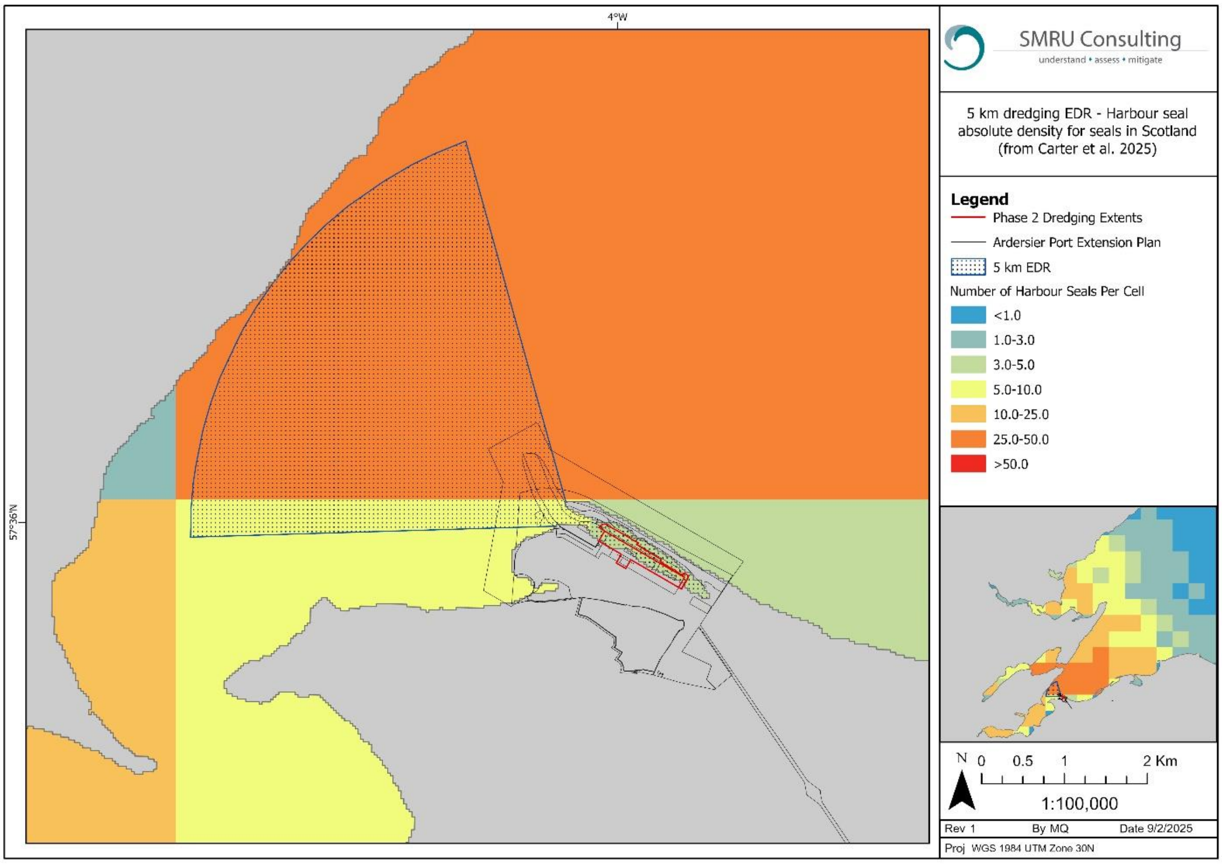
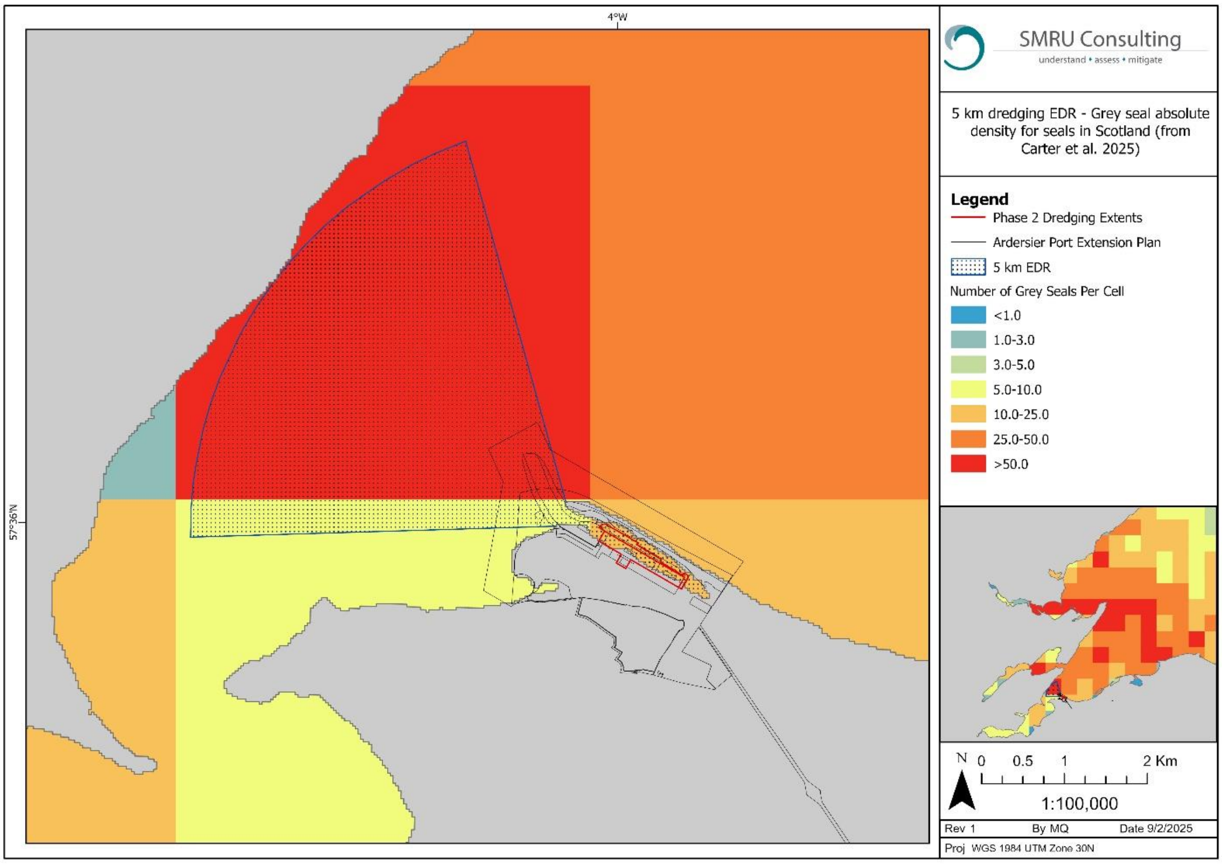


Figure 6: Grey seal at-sea habitat preference map in Summer (May – August). Data from Carter et al. (2025). Blue outline represents a 5 km EDR for disturbance associated with dredging activity from the most seaward dredging location. The EDR has been clipped to account for barrier effects from land masses, preventing propagation of underwater noise from dredging activities.



3.4.2.4 Seal haul-outs

Under a worst-case scenario, the potential disturbance to seals hauled-out involves dredging at the most seaward location of the dredge footprint. This will be short-term (few days to one week) and will involve the removal of only small volumes of material to create the dredge channel slope. Most dredging activity will take place deeper within the inner harbour, where extensive port infrastructure - including harbour walls and built structures - provides substantial acoustic masking of vessel activity, thereby minimising the risk of flushing seals into the water.

As such, the magnitude of disturbance to seal haul-outs from dredging vessel activity from the proposed development can be assessed as **Negligible**.

3.4.2.5 Minke whale

As discussed in 3.4.1, there are no studies that have focussed specifically on the expected disturbance ranges on minke whales. As such, to remain conservative, a 5 km EDR (methodology discussed in Appendix 11.2) has been used to determine the magnitude of impact from dredging vessels (Table 15

Predicted numbers of individuals disturbed were calculated using both the SCANS IV uniform density estimate and the density estimate for the cell closest to the port. While limited to summer months and likely overly conservative, the SCANS IV uniform estimate provides a robust absolute density estimate that is more representative of harbour porpoise in offshore waters. Density cell estimates from the cell closest to the port are used to ensure the consideration of species habitat use in coastal environments.

Using the 5 km EDR, 0.058 (SCANS IV) and 0.040 (closest grid cell) minke whale individuals are anticipated to be disturbed by dredging vessels, which equates to <0.001% of the CGNS MU and/or <0.001% UK MU. While the associated disturbance from dredging vessel presence and movement is expected to be short-term, it represents a temporary but notable increase in marine traffic in the vicinity of the proposed development and disposal sites and routes. However, the very small proportion of the population predicted to be impacted indicates that disturbance effects will be biologically insignificant at the population level. Further, embedded mitigation measures including a MMMP covering both dredging and spoil disposal activities, and a NRA will be in place for all construction-phase vessel operations. These protocols are coordinated to minimise disturbance, reduce overlap in vessel activity and avoid unnecessary transits.

As such, the magnitude of disturbance from dredging vessel activity from the proposed development can be assessed as **Negligible**.

3.4.3 Significance of Effect

The sensitivity of the receptor is **Low** for all marine mammals, including seals at-sea. For seals at their haul-out sites, grey seal sensitivity is classified as Low outside of the breeding/moult seasons and Medium during the breeding/moult seasons. For hauled-out harbour seals, sensitivity is classified as Medium year-round.

The magnitude of impact is deemed Medium for bottlenose dolphins. For all other marine mammals including seals at their haul-out sites, the magnitude of impact is deemed to be Negligible.

The significance of effect is therefore assessed as **Negligible** and **Not Significant** for all marine mammals except for bottlenose dolphins, where the significance of effect is assessed as **Minor** and **Not Significant** (Table 16).

Table 16: Summary of the impact assessment for disturbance from dredging and soil disposal

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Medium	Low	Minor (not significant)
Seals at-sea	Negligible	Low	Negligible (not significant)
Seals hauled-out	Negligible	Medium (Harbour seals) Low (Grey seals, non-breeding) Medium (Grey seals, breeding)	Negligible (not significant)
Minke whale	Negligible	Low	Negligible (not significant)

3.4.4 Secondary Mitigation

The embedded primary mitigation includes and MMMP and a NRA.

No additional marine mammal mitigation is considered necessary because the likely effect in not significant in EIA terms.

3.4.5 Residual Effect

No additional mitigation commitments are required; the residual effect remains **Non-Significant** in EIA terms.

3.5 Disturbance associated with increased vessel traffic

Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (e.g. Pirotta et al. 2015b, Pirotta et al. 2015c). It is not simple to disentangle these drivers and thus disturbance from vessels is assessed here in general terms, covering disturbance driven by both vessel presence and underwater noise.

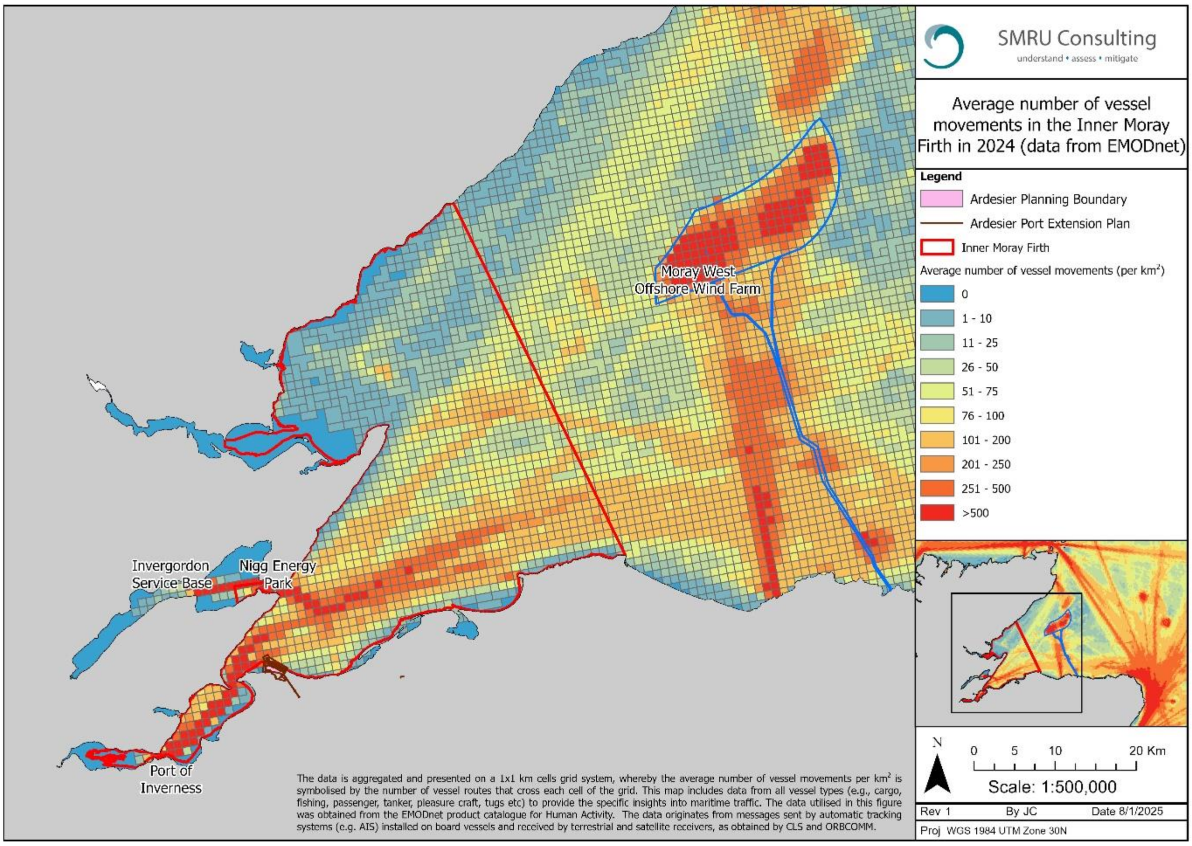
Noise levels from construction vessels will result in an increase in non-impulsive, continuous sound in the vicinity of the proposed development , typically in the range of 10 to 100 Hz (although higher frequencies will also be produced) (Erbe et al. 2019) with an estimated L_p source level of ~161 and ~168 dB re 1 µPa@1m for medium and large construction vessels respectively, travelling at a speed of 10 knots. Vessel noise is continuous, and is dominated by sounds from propellers, thrusters and various rotating machinery (e.g., power generation, pumps) (OSPAR 2009). In general, small boats and ships are expected to have broadband source levels in the range 160 to 180 dB re 1µPa (rms), with the majority of energy below 1 kHz (OSPAR 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below 200 Hz (Gotz et al. 2009, OSPAR 2009).

3.5.1 Baseline vessel activities

Data obtained from the European Marine Observation and Data Network (EMODnet) provides a baseline characterisation of existing vessel traffic within the Inner Moray Firth in 2024. Both vessel movement data and vessel 'density' data show the distribution and movement patterns of vessels within the Inner Moray Firth. These data, created by EMODnet, use a grid system of 1x1 km cells to represent vessel density. The data is derived from Automatic Identification System (AIS) data, which tracks vessel positions and includes data from various vessel types (fishing, service, dredging or underwater ops, sailing, pleasure craft, high speed craft, tug and towing, passenger, cargo, tanker, military and law enforcement, and unknown and other) to provide the specific insights into maritime traffic.

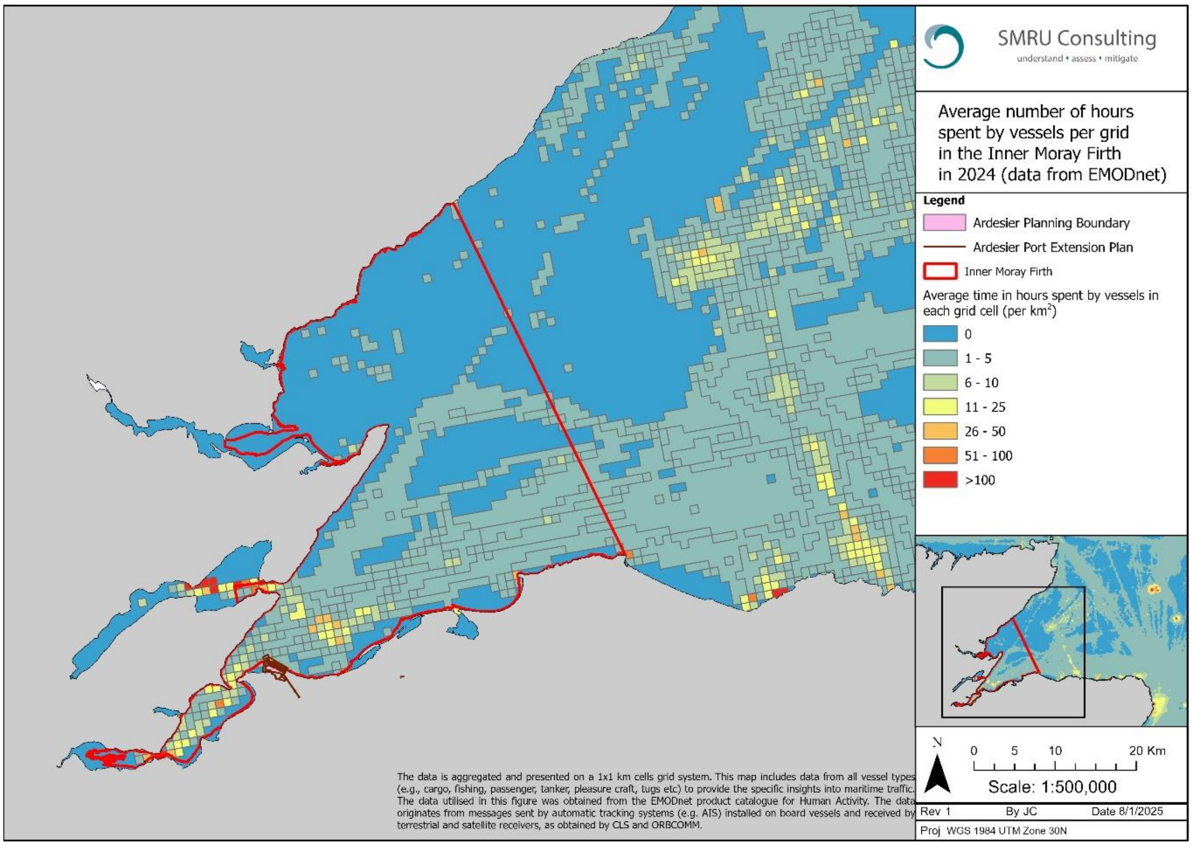
The highest concentrations of vessel movements, exceeding 500 movements/km² throughout 2024, are primarily located in and around the Ardersier Port and along the main southern (Inverness and Beauly Firths) and western navigational corridors (Cromarty Firth). Overall annual traffic volume that can approach or exceed 1,000 vessel movements per year (Affric 2025). These zones, displayed in dark red in Figure 7, suggest significant year-round vessel traffic, likely associated with port operations, industrial activities, and established shipping lanes. For the Port of Ardersier itself, it has been reported that there are currently ~340 vessel movements per year (Haventus 2025), whilst the Invergordon Service Base, Nigg Energy Park and Deephaven (all located in the Cromarty Firth) collectively reported a yearly average of 882 vessels from 2019 – 2023 (Affric 2025). Surrounding these hotspots are zones of high to moderate activity, with movement densities ranging from 101 to 500 movements/km² throughout 2024. These areas extend along the broader southern channel and northeast toward the outer Moray Firth, highlighting key transit routes for commercial and possibly recreational vessels. Moderate vessel movements, shown in yellow to light green, span large portions of the central and eastern regions of the Inner Moray Firth, with densities between 26 and 100 movements/km² throughout 2024. These areas likely represent regular passage routes with less frequent or concentrated use. Peripheral and more offshore regions generally exhibit lower activity, with many areas recording fewer than 25 movements/km² or none at all. This spatial pattern of vessel movement aligns closely with the spatial patterns observed temporally (see Figure 9 for spatial patterns of vessels observed temporally) and reinforces the strategic importance of the Ardersier Port and adjacent corridors as the focal points of maritime activity in the Inner Moray Firth. However, the 'density' of vessels (i.e., how much time vessels spend in each grid cell) remains low throughout the Inner Moray Firth (see Figure 8).

Figure 7: Average number of vessel movements in the Inner Moray, per km2, throughout 2024.



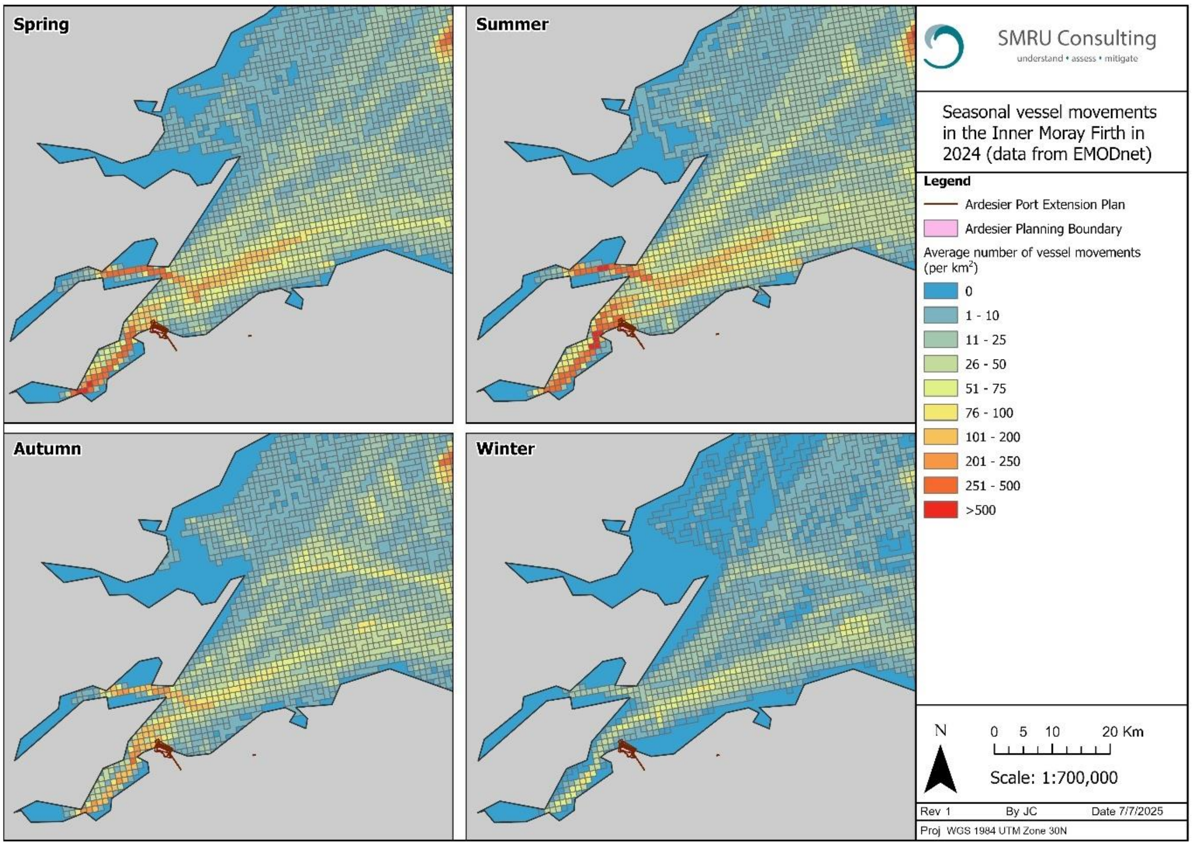
Areas with the highest vessel density (those with over 100 hours/km^2) are concentrated around the channels leading to the Invergordon Service Base, Nigg Energy Park, and the Port of Inverness. Increased levels of vessel density are also present within the Moray West OWF, likely associated with construction activities. These zones, shown in red in Figure 8, indicate areas where vessels either remained stationary for extended periods, such as at anchor or while berthed, or were engaged in slow manoeuvring. Moderate-density areas, with vessels spending between 26 and 100 hours per square kilometre, are observed along major navigational routes east of the Ardersier Planning Boundary. These zones likely represent areas of consistent but transient traffic associated with port approaches and departures. Broader central and eastern sections of the Inner Moray Firth exhibit low to moderate vessel presence, with vessels spending between 6 and 25 hours/km^2. This suggests regular passage but minimal loitering, characteristic of navigational transit corridors. Peripheral and offshore areas show minimal vessel presence, with only 1 to 5 hours/km^2, while several outer regions register restricted vessel activity. These patterns highlight the core areas of maritime activity and may reflect both physical navigational constraints and operational practices.

Figure 8: Average number of hours per month that vessels were present within each grid cell (1 km2) in the Inner Moray Firth in 2024.



Seasonal variations for vessel movements throughout 2024 (**Error! Reference source not found.**) demonstrate that during Spring, vessel activity is generally moderate throughout the Inner Moray Firth. Notable hotspots, with densities ranging from 101 to over 500 movements/km², are concentrated near the Port of Ardersier, along the main northeastern channel and within the Cromarty Firth and to the Port of Inverness. Summer sees the highest level of vessel activity across all seasons. Areas with high densities of vessel movements, ranging from 101 to over 500 movements/km², expand significantly compared to Spring. These high-traffic areas are particularly prominent around Port of Ardersier and stretch along the primary shipping routes from the Cromarty Firth, the Port of Inverness and towards the Outer Moray Firth. During Autumn, there is a noticeable decline in vessel movement compared to Summer. Despite this reduction, some moderately high-density zones persist near the port and along key navigation channels. Much of the area returns to moderate usage, with movement densities between 26 and 100 movements/km². In Winter, vessel activity is at its lowest. Most of the region experiences minimal movement, with densities ranging from 0 to 25 movements/km². The only areas with slightly elevated activity are those immediately surrounding the Port of Ardersier, the Cromarty Firth and the Inverness and Beauly Firths.

Figure 9: Average number of vessel movements, seasonally, in the Inner Moray, per km2, throughout 2024. Winter (December – February); Spring (March – May); Summer (June – August); Autumn (September – November).



3.5.2 Sensitivity

3.5.2.1 Harbour porpoise

During the construction of the offshore windfarms within the Moray Firth, harbour porpoise occurrence decreased with increasing vessel presence, with the magnitude of decrease depending on the distance to the vessel (Benhemma-Le Gall et al. 2021). Additional studies conducted during offshore windfarm construction demonstrated that harbour porpoise detections in the vicinity of the pile driving location decline prior to a piling event, likely due to vessel activity (Brandt et al. 2018, Benhemma-Le Gall et al. 2021, Benhemma-Le Gall et al. 2023). Further, a study in the North Sea by Pigeault et al. (2024) highlighted that harbour porpoises avoid areas with high maritime traffic, where porpoise were significantly less likely to be present within 9 km of areas frequently used by ships, with the average number of ships and the average closest approach distance over time being the most effective predictors of disturbance. Specifically, areas that experienced repeated or prolonged close-range ship traffic, i.e., when vessels approached on average closer than 2.1 km for more than 30 minutes, porpoise sightings dropped by 50%. Overall, the proximity and frequency of ship presence had a stronger correlation with porpoise absence than predicted sound levels (Pigeault et al. 2024).

Data examining the surfacing behaviour of harbour porpoise in relation to vessel traffic in Swansea Bay from land-based surveys found a significant correlation between harbour porpoise sightings and the number of vessels present (Oakley et al. 2017). When vessels were up to 1 km away, 26% of the interactions observed were considered to be negative (animal moving away or prolonged diving). The proximity of the vessel being an important factor, with the greatest reaction occurring just 200 m from the vessel. The type of vessel was also relevant, as smaller motorised boats (e.g. jet-ski, speed boat, small fishing vessels), were associated with more negative behaviours than larger cargo ships, although this type of vessel was a less common occurrence (Oakley et al. 2017). Vessels associated with offshore wind farm construction are typically larger than these types of small, motorised vessels, and, therefore, it would be anticipated that the behavioural response would not be as severe. Telemetry data can also be used to identify fine-scale changes in behaviour. Between 2012-2016, seven harbour porpoises were tagged in a region of high shipping density in the inner Danish waters and Belt seas (Wisniewska et al. 2018). Periods of high vessel noise coincided with erratic behaviour including 'vigorous fluking', bottom diving, interrupted foraging, and the cessation of vocalisations. Four out of six of the animals that were exposed to noise levels above 96 dB re 1 µPa (16 kHz third octave levels) produced significantly fewer buzzes with high quantities of vessel noise. In one case, the proximity of a single vessel resulted in a 15 minute cessation in foraging (Wisniewska et al. 2018). In a more recent study by Frankish et al. (2023), harbour porpoises were fitted with GPS-Acoustic Tagging devices that recorded fine-scale movement (location, depth, orientation) and broadband noise levels, to understand how broadband ship noise (10 Hz–20 kHz) affects the behaviour of harbour porpoises by analysing GPS and acoustic data from tagged individuals as they navigate near vessels. Frankish et al. (2023) observed clear and consistent changes in swimming and diving patterns when porpoises were exposed to broadband ship noise including abrupt changes in swimming direction, increased dive depth and delays in surfacing. Porpoises reacted more strongly when vessels passed within 1–2 kilometres of an individual and behavioural shifts often began several minutes before the ship was visible, indicating acoustic cues as the trigger (Frankish et al. 2023).

Although the aforementioned studies have observed short-term changes in harbour porpoise presence and behaviour in the vicinity of vessels, Owen et al. (2024) demonstrated that – through use of two years of continuous passive acoustic monitoring data – rerouting of a high-vessel traffic shipping lane in the Kattegat, Sweden & Denmark, did not change patterns of presence and foraging in harbour porpoise. For example, areas that experienced increased ship noise and vessel traffic after the rerouting did not show declines in porpoise detection or feeding buzzes. Likewise, areas where ship activity decreased did not see increases in porpoise presence (Owen et al. 2024). The lack of shift in porpoise behaviour suggests that porpoises strongly prefer certain habitats, possibly due to prey availability or other ecological factors, even when these areas are exposed to more disturbance. This implies that short-term avoidance seen in other studies doesn't necessarily translate to long-term displacement (Owen et al. 2024). While porpoises stayed in the area, ship noise did intermittently reach levels known to cause short-term behavioural changes in individuals. However, these levels were rare (<1% of the time). Thus, subtle physiological or behavioural impacts (e.g., stress or reduced echolocation range) may still be present but not detectable through acoustic presence data alone and cumulative impacts like chronic stress, acoustic masking, or reduced communication range could still affect individual fitness and long-term population health (Owen et al. 2024).

Behaviour-based modelling has indicated the potential for vessel disturbance to have population-level effects under certain circumstances. Nabe-Nielsen et al. (2014) simulated harbour porpoise response to vessels did not result in further population decline when prey sources recovered fast (after two days), but if prey availability remained low then vessels were estimated to have a significant negative impact on the population. However, whilst this negative trend was estimated, when comparing the theoretical impact of vessel presence versus bycatch, the latter was found to have a greater effect on population size as it causes direct mortality and, therefore, Nabe-Nielsen et al. (2014) suggest that conservation efforts should instead focus more closely on this issue.

In conclusion, harbour porpoise show a reasonable ability to adapt to vessel disturbance. Although short-term avoidance and behavioural responses (e.g., altered diving, movement away) are well documented, individuals continue to use areas with regular vessel activity, including construction zones and high-traffic areas. Long-term data (e.g., Owen et al. 2024) suggest site fidelity and persistence, even when noise exposure increases — indicating that porpoises can adapt to recurring vessel presence under certain ecological conditions. Further, harbour porpoise exhibit some tolerance to vessel noise and presence. While close-range encounters (particularly within 1–2 km) can elicit behavioural responses, these are generally short-term and not linked to reduced survival or reproduction. Lastly, porpoise typically return to previous activity patterns and locations once vessels have passed, and there is no clear evidence of displacement or long-term reduction in habitat use following vessel exposure The sensitivity of harbour porpoise to disturbance from vessel activity is therefore classified as **Low.**

3.5.2.2 Bottlenose dolphins

Visual observations have demonstrated that vessels within 400 m of a dolphin group have been found to result in short-term changes to bottlenose dolphin behaviour through both targeted, and non-targeted approaches (Clarkson et al. 2020, Puszka et al. 2021, Mills et al. 2023). For example, Mills et al. (2023) demonstrated that bottlenose dolphin foraging and socialising behaviours decreased near vessels (e.g., tugboat, cargo ship, recreational boat) and showed more milling and resting behaviours when vessels were absent or at greater distances. Larger vessels, especially those moving at higher speeds, had a more pronounced effect on dolphin behaviour, whilst tugboats and cargo ships were associated with stronger avoidance responses compared to slower or smaller recreational boats (Mills et al. 2023).

Studies using passive acoustic monitoring have also suggested that vessel disturbance (from large dredging vessels) has been shown to negatively affect bottlenose dolphin foraging activity as the results indicated a short-term 49% reduction in foraging activity (though this did not vary with noise level) (Pirotta et al. 2013). However, animals resumed foraging after the vessel had ceased operations. The susceptibility to disturbance was variable depending on the location and year, suggesting circumstantial impacts of vessel noise on bottlenose dolphins. The physical presence of vessels, and not just the noise created, plays a large role in disturbance responses (Pirotta et al. 2015b). Changes in behaviour as a result of vessel presence may also include increased swimming speeds (when resting or socialising), increased travelling time (less time resting, socialising and foraging) as well as characteristics of whistles (Constantine et al. 2004, La Manna et al. 2013, Marley et al. 2017b, Piwetz 2019).

It is hypothesised that the quality of the habitat impacts the behavioural response to disturbance (Marley et al. 2017a). In Italy, bottlenose dolphins would tolerate vessel presence within certain levels and were more likely to leave an area if disturbance was persistent (La Manna et al. 2013). Similarly, high levels of tolerance to vessel disturbance were observed in Aberdeen harbour where vessel traffic is consistently high (Pirotta et al. 2013). Therefore, the degree to which an animal will be disturbed is likely linked to their baseline level of tolerance (Bejder et al. 2009).

New et al. (2013) developed a mathematical model simulating the complex interactions of the coastal bottlenose dolphin population in the Moray Firth to determine if an increased rate of disturbance resulting from vessel traffic was biologically significant. The scenario modelled increased vessel traffic from 70 to 470 vessels a year to simulate the potential increase from the proposed offshore development. An increase in commercial vessel traffic only is not anticipated to result in a biologically significant increase in disturbance because the dolphins have the ability to compensate for their immediate behavioural response and, therefore, their health and vital rates are unaffected (New et al. 2013).

In conclusion, vessel disturbance can elicit a variety of responses in bottlenose dolphins (Constantine et al. 2004, La Manna et al. 2013, Pirotta et al. 2015b, Marley et al. 2017a, Marley et al. 2017b). However, bottlenose dolphins have been observed to display tolerance to vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta et al. 2013). Furthermore, behavioural changes in bottlenose dolphins are not always considered biologically significant (New et al. 2013), and the coastal bottlenose dolphin population in east Scotland (Moray Firth) has continued to expand despite high baseline vessel traffic levels, indicating resilience and effective adaptation to current disturbance regimes. This suggests that while individual dolphins show short-term behavioural responses, the population is not currently limited or negatively affected by vessel presence within the observed range of disturbance. The sensitivity of bottlenose dolphins to disturbance from vessel activity is therefore classified as **Low.**

3.5.2.3 Seals at sea

A telemetry study that included the tagging of 28 harbour seals (at both Ardersier and the Dornoch Firth) in the Inner Moray Firth found high exposure levels of harbour seals to shipping noise (Jones et al. 2017a). The overlap between seals and vessel activity most frequently occurred within 50 km of the coast, and in proximity to seal haul outs. Despite the distributional overlap and high cumulative sound levels, there was no evidence of reduced harbour seal presence as a result of vessel traffic (Jones et al. 2017a). Similarly, Mathews et al. (2016) reported that higher vessel counts in the study area were not associated with reduced seal counts, noting that the total counts included seals in the water, and therefore they were less sensitive to vessel disturbance. Further, Onoufriou et al. (2016) demonstrated that tracks of tagged individual seals overlapped with AIS ship track data and thus, showing that some seals repeatedly used discrete, small areas close to areas of relatively high shipping activity, suggesting that seals are not exhibiting overt avoidance of areas associated with high levels of shipping activity in the Moray Firth.

Although studies concerning grey seal interactions with vessels in the Moray Firth do not exist, a combined study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (as a proxy for disturbance, using Southall et al. (2019) criteria) (Trigg et al. 2020). On the northwest coast of Ireland, a study of vessel traffic and marine mammal presence found grey seals sightings decreased with increased vessel activity in the surrounding area, though the effect size was small (Anderwald et al. 2013); and the authors noted that relationships between sightings and vessel numbers were weaker than those with environmental variables such as sea state.

Despite high exposure to vessel noise and traffic in areas like the Moray Firth, harbour and grey seals continue to use affected habitats. Behavioural responses are limited, and there is no evidence of impacts on survival or reproduction. Based on observed adaptability, tolerance, and recoverability, both seal species are assessed as having **Low** sensitivity to vessel traffic.

3.5.2.4 Seals hauled-out

Vessel disturbance studies on seals have demonstrated disturbance of seals from haul-outs in response to vessels up to 1 km (Henry and Hammill 2001, Andersen et al. 2012, Young et al. 2014, Cates and Acevedo-Gutierrez 2017). For example, Henry and Hammill (2001) reported that the distance at which at >50% of seals (in Canada) first detected boats (alert distance) occurred when the boats were up to 800 m away from the animals, however, on average seals became more alert when the vessel approached to approximately 300 m and seals were observed to enter the water (flushing distance)when boats were at distances of >200 m. Similarly, Andersen et al. (2012) reported that for harbour seals in Denmark, alertness increased when vessel approaches were between 560 m to 850 m, and flight responses were initiated at distances between 510 – 830 m. In the same study animals exhibited weaker and shorter-lasting responses during the breeding season. They were more reluctant to flee and returned to the haul-out site immediately after being disturbed, in some cases even during the disturbance. The authors attributed this seasonal tolerance to a trade-off between fleeing and nursing during the breeding season (Andersen et al. 2012).

Published literature reported that the number of vessel-caused disturbances (e.g., harbour seals flushing from the haul-out site into the water) is a function of the number of vessels, the type of vessels, how they are distributed and the distance from a haul-out site (Mathews et al. 2016, Cates and Acevedo-Gutierrez 2017, Carpenter 2021). Paterson et al. (2019) studied post-disturbance haul-out behaviour of harbour seals and found that following the disturbance by boat located at a distance of 300 m from the haul-out site. Seals displayed a high degree of haul-out site fidelity and there was no significant effect on the probability of seals moving to a different haul-out site. Although distances at which behavioural response may occur vary, due to strong dependence on the distance of the vessel from the haul-out site, Cates and Acevedo-Gutierrez (2017) highlighted the importance of developing and enforcing buffer zones relative to the level of human activity.

Marine Scotland (2014) acknowledge this, stating that *“the distance at which seals show such signs of agitation varies tremendously, depending on their location, how they are approached, whether the animals are used to the presence of humans and the time of year; [and] in particular, whether or not they have pups with them”*. It should be noted that potential impacts of seals may be different depending on type of the year. Harbour seal breeding season occurs in June and July, followed by the moulting period in August During these periods, there is typically a greater number of harbour seals hauled-out during low tide periods than at other times of year. Grey seal breeding season occurs from August to December, followed by the annual moult occurs between December and April. During the breeding and moulting season, they will spend longer hauled-out compared to other times of year. Although vessel disturbance could be most detrimental during pupping season, there is evidence that seals are more reluctant to enter the water during the annual moult (Henry and Hammill 2001).

In conclusion, grey and harbour seals hauled out in the Inner Moray Firth, including near the Port of Ardersier, Nigg Energy Park and the Port of Inverness, could be sensitive to vessel disturbance at close range. Alert and flushing behaviours occur when vessels approach within 200–850 m, with flushing more likely below 300 m. However, seals show strong site fidelity and typically return shortly after disturbance, even during vessel activity. Further, seals are less responsive during breeding and moulting, likely due to energy or nursing trade-offs. While disturbance can affect short-term behaviour, there is no evidence of long-term displacement, and responses are highly dependent on distance, vessel type, and time of year. Therefore, the sensitivity of grey seals to disturbance to haul-outs, is classified as **Low** outside of the breeding season and **Medium** during the breeding season. Due to declines in several regional harbour seal populations, this species is considered more vulnerable to pressures, including physical disturbance (SCOS 2022). Therefore, the sensitivity of harbour seal to disturbance during and outside the breeding and moult seasons at haul-outs has been assessed as **Medium.**

3.5.2.5 Minke whale

There are currently limited studies available regarding the effects of vessel disturbance on minke whale. Of the few studies available, minke whale foraging activity has been found to decrease with increased vessel interactions (Christiansen et al. 2013, Sullivan and Torres 2018), exemplified by shorter dives and changes in movement patterns (Christiansen et al. 2013). In addition, by analysing the respiration rate of minke whales, energy expenditure was estimated to be 28% higher during boat interactions, regardless of swim speed. Swim speed was also found to increase with vessel presence and these combined physiological and behavioural changes are thought to represent a stress response. As noise levels were not measured within the study, behavioural responses were therefore related to vessel presence. In addition, when considering the temporal and spatial rates of individuals' exposure over an entire season, there appeared to be no potential for a population-level effect of these acute disturbances (Christiansen et al. 2015). Further study by Christiansen and Lusseau (2015) developed a mechanistic model for minke whales to examine the bioenergetic effects of disturbance from whale watching vessels, specifically on foetal growth. The presence of whale watching vessels resulted in an immediate 63.5% reduction in net energy intake. However, the impact of disturbance was considered to be below the threshold value at which whale watching would have a significant impact on foetal growth as the number of interactions with vessels was low during the feeding season and was, therefore, of negligible impact.

When considering the impacts of whale watching vessels to those likely to occur from construction vessel activities, they cannot be directly transposed, as disturbance effects from whale watching are direct impacts, whilst those from construction activities are indirect, and the vessel types and underwater noise produced are very different. Nevertheless, minke whale are capital breeders and therefore their reproductive success could be affected by disrupted feeding activities (Stephens et al. 2009, Christiansen et al. 2013). Therefore, the sensitivity of minke whales to disturbance from vessel activity is assessed as **Medium.**

3.5.3 Magnitude

Although the presence of vessels and associated noise in the vicinity of the proposed development is not a novel impact for marine mammals in the area, additional vessel movements, and the duration for which vessels are active during construction of the ETF could introduce additional disturbance events to marine mammals above existing baseline levels.

During the construction phase of the proposed development, vessel activity will increase temporarily due to construction activities including dredging, spoil disposal, and the delivery of construction materials. Under a typical construction phase scenario, a maximum of up to eleven vessels may be present at any one time, comprising six vessels for dredging and spoil disposal and up to five barges for material deliveries. However, this represents a conservative estimate assuming complete overlap of activities. In practice, due to construction phasing and scheduling, dredging and spoil disposal are not expected to coincide consistently with barge deliveries, and not all vessels will be active or in transit simultaneously. Under a worst-case scenario it is assumed that peak vessel activity shall occur during spoil disposal operations, which are projected to occur over a 10-week period (70 days) between March and September (sometime between 2027 – 2029). During this phase, up to 13–23 barge movements per day may be required to transport 2,000,000m^3 of dredged material offshore. This results in a maximum of ~450 additional vessel movements within the Inner Moray Firth over a ten-week period, assuming spoil disposal vessels have the capacity to transport and dispose of a maximum 4,500m^3 of material during each movement.

This intensity of movement is short-term but represents a significant temporary increase in marine traffic local to the Ardersier site and spoil disposal areas. The anticipated increase in vessel movements may lead to short-term, localised impacts, particularly relating to increased underwater noise, and a higher risk of disturbance to marine mammals.

3.5.3.1 Harbour porpoise

Based on the literature discussed in 3.5.2.1, it has been shown that short-term avoidance and behavioural responses of harbour porpoise to vessels are significant at distances up to 2 km. As such, a 2 km disturbance range has been used to determine the magnitude of impact (Table 17).

Table 17: Estimated number of animals and the percentage of the MU predicted to be disturbed at any one time by construction vessels

Density (animals/km^2)	Number Impacted	% MU	% UK MU
0.2813	4	<0.001%	<0.001%
0.186	2	<0.001%	<0.001%

Using the 2 km disturbance radii, up to 4 harbour porpoise individuals are anticipated to be disturbed by construction vessels, which equates to <0.001% of the MU and/or UK MU. When considering the impact of disturbance from vessel presence and movement, it is short-term but represents a significant temporary increase in marine traffic local to the proposed development and spoil disposal areas.

Under typical construction conditions, a maximum of five vessels (primarily barges for material delivery) may operate within the area at any one time. These vessel movements are expected to be dispersed and intermittent and are not anticipated to result in significant spatial overlap with areas of highest dolphin activity. Given the low frequency, localised nature, and short-term duration of these transits, the likelihood and extent of interaction with harbour porpoise is low.

As stated in Section 3.4.2.1, during peak construction activity associated with dredging and spoil disposal, up to 11 vessels may be present at any one time, comprising six active in dredging/disposal and five associated with barge operations. While this represents a conservative, worst-case overlap, spoil disposal is anticipated to be the primary driver of vessel activity. Assuming continuous spoil disposal operations (24 hours/day for 70 days) and using an average daily presence estimate of 1.5 DPH across the March–September period, this equates to approximately 105 hours of porpoise presence during the 1,680-hour operational window (70 days × 24 hours). This represents ~6.3% of the total spoil disposal timeframe. Applying this to the estimated 450 vessel movements suggests that roughly 28 movements (450 × 0.063) may occur during periods when harbour porpoises are present.

Given that porpoise detections tend to reflect solitary or small-group behaviour, the number of individuals potentially disturbed per interaction is expected to be low. Further, given the percentage of the MU predicted to be impacted, disturbance effects shall only impact a very small proportion of the population. Further, embedded mitigation measures including a MMMP for dredging and spoil disposal activities, in addition to a NRA, will be in place for all construction-phase vessel activity. These plans will ensure that vessel routes, speeds, and scheduling are coordinated to minimise disturbance, minimise overlap in vessel activity and reduce unnecessary transits.

As such, the magnitude of disturbance from construction vessel activity from the proposed development can be assessed as **Negligible.**

3.5.3.2 Bottlenose dolphins

As stated in Section 3.4.2.2, waters adjacent to the Port of Ardersier are a well-established hotspot for bottlenose dolphin activity within the Moray Firth SAC and wider inner Moray Firth areas.

Under typical construction conditions, a maximum of five vessels (primarily barges for material delivery) may operate within the area at any one time. These vessel movements are expected to be dispersed and intermittent and are not anticipated to result in significant spatial overlap with areas of highest dolphin activity. Given the low frequency, localised nature, and short-term duration of these transits, the likelihood and extent of interaction with bottlenose dolphins is low. As such, potential disturbance is expected to be minimal and unlikely to affect the trajectory of the SAC population. Therefore, the magnitude of impact from vessel disturbance during non-dredging phases of construction is considered to be **Low**.

By contrast, during peak construction activity associated with dredging and spoil disposal, up to 11 vessels may be present at any one time, comprising six active in dredging/disposal and five associated with barge operations. While this represents a conservative, worst-case overlap, spoil disposal is anticipated to be the primary driver of vessel activity. Disposal operations are projected to occur over a 10-week period between March and September (sometime between 2027 – 2029), requiring up to 13–23 barge movements per day and resulting in approximately 450 additional vessel transits across the Inner Moray Firth. This represents a significant, temporary increase in vessel activity within an area known to support consistently high dolphin encounter rates. As stated in Section 3.4.2.2, using a mean group size of 8 individuals (Benhemma-Le Gall and Cheney, 2025), there is expected to be disturbance to an average of 8 individuals (maximum 56) over 66 vessel movements. from spoil disposal activities only. When considering the inclusion of barges for material delivery, this value is likely to increase under the worst-case scenario, indicating the possibility that a moderate number of interactions between vessels and dolphins are likely during this phase.

Although there shall be a predictable and repetitive nature to vessel routing during spoil disposal and material deliveries, the strong spatial and temporal overlap with core dolphin habitat leads to moderate risks of repeated behavioural disturbance to a small portion of the local population, however, it is unlikely to alter its long-term trajectory. The impact will occur over a medium spatial extent, but for a short-term duration. Further, embedded mitigation measures including a MMMP or dredging and spoil disposal activities, in addition to a NRA will be in place for all construction-phase vessel activity. These plans will ensure that vessel routes, speeds, and scheduling are coordinated to minimise disturbance, minimise overlap in vessel activity and reduce unnecessary transits. Therefore, the magnitude of impact vessel disturbance during the dredging phase is considered to be **Medium**.

3.5.3.3 Seals at sea

Although, under a worst-case scenario, material deliveries by barge coinciding with the spoil disposal phase will result in a temporary increase in vessel traffic—up to approximately >450 additional movements over a 10-week period—this increase is short-term, highly localised, and within an area already subject to regular vessel activity. To remain precautionary, the largest observed range of disturbance. Using the 1km disturbance radii, 2 harbour seal (0.18% MU) and 4 grey seal individuals (0.07% MU) are predicted to be disturbed by vessel presence.

When considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews et al. 2016, Onoufriou et al. 2016, Jones et al. 2017a, Jones et al. 2017b). While there is limited local data for grey seals, wider evidence suggests similarly low responsiveness to typical vessel disturbance levels (Trigg et al. 2020). Both species continue to use areas in close proximity to ports and shipping lanes despite frequent exposure to underwater noise and vessel presence. Given the low sensitivity of seals to vessel traffic, the short duration and spatial confinement of the construction-related vessel activity, and the absence of expected impacts on population trajectory, the overall magnitude of effect is considered to be **Negligible**.

3.5.3.4 Seals hauled-out

Based on the literature discussed in 3.5.2.4, it has been shown that alert and flushing behaviours of seals occur when vessels approach within 200–850 m, with flushing more likely below 300 m.

Regular site-specific count data have been used to identify monthly and seasonal patterns in haul-out use (see Appendix 11.3). These counts represent the most recent and consistent monitoring effort available for the area and provide a robust basis for understanding seasonal seal presence and evaluating potential impacts. Therefore, for the quantitative assessment of potential disturbance to seals at the Ardersier designated haul-out site, the maximum number of seals recorded hauled-out on any one survey day, during each season, has been used as the primary metric. This approach has been adopted as density data is not typically recorded for seals using haul-out sites. Using maximum seasonal counts allows the assessment to reflect periods of peak site usage, which is particularly relevant for evaluating worst-case disturbance scenarios during sensitive periods such as breeding or moulting. A conservative estimate on the number of seals predicted to be impacted each season, and the percentage MU, is provided in Table 18. As the proportion of each seal species recorded at the Ardersier haul-out site could not be provided, an assumption has been made that all seals counted are classified as either grey or harbour seals. The percentages of the MUs predicted to be impacted reflect this.

Table 18: Estimated number of animals and the percentage of the MU predicted to be disturbed at any one time by construction vessels

Season	Number Impacted	% harbour seal SMU	% grey seal SMU
Spring	196	14.36%	3.64%
Summer	131	9.60%	2.43%
Autumn	50	3.66%	0.93%
Winter	126	9.23%	2.34%

Whilst the estimated number of seals predicted to be disturbed by construction vessels has been based on peak seasonal haul-out counts, representing a conservative, worst-case scenario, it is important to note that these counts were obtained during periods when dredging and port-related construction activities were already occurring within 500 m to 1 km of the haul-out site. This suggests that, to some degree, seals using the Ardersier designated haul-out site are habituated to vessel presence and associated disturbance occurring during the monitoring period. Therefore, the values used in the assessment – assuming all animals respond to the disturbance pathway – likely overestimate the actual number that would be impacted. Furthermore, mitigation measures such as the MMMP and NRA are expected to reduce both the frequency and severity of disturbance events. In combination, these factors support a Low magnitude assessment, reflecting the limited likelihood of significant behavioural disruption.

Taking into account the conservative nature of the input data, the effectiveness of embedded mitigation measures, and the likely habituation of seals to vessel traffic and construction activity—given the haul-out site's close proximity to an operational port—the magnitude of impact on both grey and harbour seals is assessed as **Low** across all seasons, including during breeding and moulting periods.

3.5.3.5 Minke whale

In baleen whales, observed changes in foraging behaviour were apparent when whale-watching vessels were within ~250 m of an animal (Sullivan and Torres 2018). This value has been used as a proxy for behavioural responses of minke whales to vessel presence, in the absence of species-specific distances. As such, a 0.25 km disturbance range has been used to determine the magnitude of impact (Table 19).

Table 19: Estimated number of animals and the percentage of the MU predicted to be disturbed at any one time by construction vessels

Density (animals/km^2)	Number Impacted	% MU	% UK MU
0.0116	<1	0.00%	0.00%
0.008	<1	0.00%	0.00%

Using the 2 km disturbance radii, <1 minke whale individuals are anticipated to be disturbed by construction vessels, which equates to <0.001% of the MU and/or UK MU. When considering the impact of disturbance from vessel presence and movement, it is short-term but represents a significant temporary increase in marine traffic local to the proposed development and spoil disposal areas. Given the percentage of the MU predicted to be impacted, disturbance effects shall only impact a very small proportion of the population. Further, embedded mitigation measures including a MMMP for dredging and spoil disposal activities, in addition to a NRA will be in place for all construction-phase vessel activity. These plans will ensure that vessel routes, speeds, and scheduling are coordinated to minimise disturbance, minimise overlap in vessel activity and reduce unnecessary transits.

As such, the magnitude of disturbance from construction vessel activity from the proposed development can be assessed as **Negligible.**

3.5.4 Significance of Effect

The magnitude of the impact is deemed to be Low for all marine mammals except for bottlenose dolphins during the dredging phase, which were assessed as Medium.

The sensitivity of the receptor is Low for all marine mammals except for minke whales which are assessed as Medium sensitivity. For seals at their haul-out sites, the sensitivity is classified as Low outside of the breeding/moult seasons and Medium during the breeding/moult seasons.

It should be noted however, that evidence on specific behavioural responses of marine mammals to construction-phase vessel activity is limited, particularly in relation to repeated barge movements and dredging support vessels. However, existing data suggest responses are typically short-term and context-dependent, with no long-term displacement expected under the proposed scenario.

Taking into account the localised extent and short-term duration of the increased vessel activity (primarily during a 10-week spoil disposal window), alongside the already high baseline vessel traffic in the Inner Moray Firth and embedded mitigation measures (MMMP and NRA), the probability of marine mammal disturbance is high, but the frequency of effect is low due to phasing and non-overlapping activities. The effect will therefore be **Negligible** for all marine mammals except for minke whales, and for bottlenose during the dredging phase, where the impact shall be **Minor.** For seals at their haul-out sites, the significance of the impacts shall be **Negligible** outside of the breeding/moult seasons and **Minor** during the breeding/moult seasons. Each of which are **Non-Significant** in EIA terms.

Table 20: Summary of the impact assessment for disturbance from construction vessels

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Low (Non-dredging phase)	Low	Negligible during non-dredging phase (not significant)
	Medium (Dredging phase)		Minor during dredging phase (not significant)
Seals at sea	Negligible	Low	Negligible (not significant)
Seals hauled-out	Low	Low outside breeding/moult	Outside breeding/moult: Negligible (not significant)
		Medium during breeding/moult	During breeding/moult: Minor (not significant)
Minke whale	Low	Medium	Minor (not significant)

3.5.5 Secondary Mitigation

The embedded primary mitigation includes an MMMP and a NRA.

No additional marine mammal mitigation is considered necessary because the likely effect is not significant in EIA terms.

3.5.6 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

3.6 Collision risks associated with increased vessel traffic

3.6.1 Sensitivity

Vessel movements during construction of the proposed development have the potential to cause injury and/or mortality to marine mammals. This includes vessels involved in all stages of dredging, including movements of spoil disposal vessels from the extraction site to spoil disposal grounds also present collision risks for marine mammals.

Harbour porpoise, bottlenose dolphin, grey seal and harbour seal are highly mobile and agile and have been observed to respond to vessel noise (e.g. propellors, thrusters, geophysical survey equipment) (Erbe et al. 2019). These species are therefore likely to be able to detect nearby vessels and move out of the 'zone of influence' and the path of the vessel, thus avoiding collision, although this is dependent on the vessel movement being predictable (Nowacek et al. 2001, Lusseau et al. 2009). In a study in the Moray Firth seals were shown to utilise the same areas as vessels when moving between foraging sites and haul-outs but tended to remain beyond 20 m from vessels with only three instances of seals coming within 20 m of vessels over 2,241 days (Onoufriou et al. 2016).

Larger and less agile species, such as minke whales, may be less able to avoid moving vessels. Vessel strikes are a documented source of injury and mortality for baleen whales, and the risks of collision and likelihood of severe injury or mortality are highest with vessel speeds over 11 knots (Vanderlaan & Taggart 2007). Baleen whales are particularly vulnerable to vessel strike when resting or feeding, and studies have reported seasonal changes in collision rates with increased collision risk during months with high foraging activity (Laist et al. 2001, Panigada et al. 2006). Calves and juvenile animals are more vulnerable to collision compared to adult whales (Lammers et al. 2013), however, areas within the Inner Moray Firth and surrounding the Port of Ardersier are not known for their prevalence of minke whale juveniles or calves.

If collision occurs, it may result in serious injury to marine mammal (beyond recovery) or sudden death. Therefore, the sensitivity of marine mammals to vessel collisions is considered to be **High.**

3.6.2 Magnitude

Given the proximity of the Port of Ardersier to other active ports (e.g. Port of Cromarty Firth and the Invergordon Service Base, and the Nigg Energy Park) within the Inner Moray Firth, the area within and surrounding the Port of Ardersier already experiences a high density of commercial vessel traffic (see Section 3.5).

During construction of the proposed development, there is a risk that increased vessel activity could result in physical trauma from collision with a construction vessel. These injuries include blunt trauma to the body, or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed with which it is travelling (Laist et al. 2001), and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality, and there is little evidence from marine mammals stranded in the UK and Ireland that injury from vessels is an important source of mortality. The Scottish Marine Animal Stranding Scheme documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. The SMASS data shows that very few strandings have been attributed to vessel collisions ((SMASS 2018, 2019, 2020, 2021, 2022, 2023), therefore while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post-mortem examinations.

Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic. The embedded mitigation of a NRA will ensure that vessel traffic moves along predictable routes, set recommended speed and define how vessels should behave in the presence of marine mammals.

During the dredging period between March and September (sometime between 2027 – 2029), it is estimated that a maximum of one of either a cutter suction dredger (CSD) or trailer suction hopper dredgers (TSHD) will be actively dredging on site at any given time. In addition, up to four disposal vessels will be on site, transiting between the dredging site and the spoil disposal site (at Burgheaddisposal area). Disposal vessels shall comprise of a combination of self-propelled split hopper barges (SHB) and TSHD. The majority of construction vessels will be large, with typical lengths ranging from 101.5 – 138.5 m for the CSD, and between 80 – 99.5 m and 89 – 97.5 m for the SHB and TSHD, respectively.

During the construction phase of the proposed development, and in addition to the temporary increase in vessels during dredging and spoil disposal, up to five additional barges are expected for construction material deliveries. In practice, full overlap of these activities is not expected due to phasing and scheduling. However, under a worst-case scenario, peak vessel activity is expected to occur during spoil disposal operations between April and September (sometime between 2027 – 2029), with up to 13-23 barge movements per day, resulting in a maximum of approximately 450 additional vessel movements within the inner Moray Firth over a ten-week period.

The likelihood of a vessel strike involving marine mammals can be influenced by vessel-specific factors such as size, draft, and speed (Schoeman et al. 2020). Larger vessels are considered to pose a greater risk due to their deeper drafts, which increase the potential strike zone. However, vessel speed may be a more significant factor in influencing the probability and severity of a collision (Todd et al. 2015). While dredging operations themselves will typically involve stationary or very slow-moving vessels (1 – 3 knots), the vessels associated with this project are capable of reaching speeds of up to 12 knots when in transit, with typical transit speeds of around 10 knots during spoil disposal. Due to the already high-volume vessel traffic within the inner Moray Firth (with vessel movements in some areas exceeding 500 movements/km^2 in 2024 Figure 7), the introduction of additional construction vessels during the port exptension is not a novel impact for marine mammals present in the area. Further, during spoil disposal, there is a potential risk of spoil material being deposited on top of a marine mammal at a disposal site, which could result in serious physical harm or fatality. However, this risk is considered negligible due to embedded mitigation measures outlined in the MMMP and NRA, such a marine mammal search period prior to spoil disposal.

Although vessel movements will occur across a medium extent, the potential impact will be localised to the immediate vicinity of the moving vessels. This potential impact may occur throughout the construction period for a short-term duration. The adoption of a NRA during construction will minimise the likelihood of vessel collisions with marine mammals. As such, the overall risk of a collision occurring is highly unlikely; if it were to occur, it would be at low frequency, and it is not expected to impact enough individuals to alter the population trajectory. As such, the magnitude of the risk of vessel collisions is **Negligible**.

3.6.3 Significance of Effect

Taking the **Negligible** magnitude of impact and **High** sensitivity of marine mammals, the overall effect of risk associate with vessel collisions during the construction is considered to be **Negligible** and **Not Significant** in EIA terms.

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Non-significant)
Bottlenose dolphin	Negligible	High	Negligible (Non-significant)
Harbour seal	Negligible	High	Negligible (Non-significant)
Grey seal	Negligible	High	Negligible (Non-significant)
Minke whale	Negligible	High	Negligible (Non-significant)

3.6.4 Secondary Mitigation

The embedded mitigation includes the commitment to NRA, which describes current guidance such as the Scottish Marine Wildlife Watching Code, that vessels need to adhere to in order to minimise the risk of collision.

Following application of this embedded measure, the effect of risk of vessel collisions is considered to be **Not Significant** in EIA terms. Therefore, no secondary mitigation is required.

3.6.5 Residual Effect

The overall effect of vessel collisions during construction is **Minor** and **Not Significant** in EIA terms.

3.7 Indirect impacts on prey availability

The activities associated with construction which could give rise to indirect impacts by affecting prey availability are: increases in underwater noise associated with piling, impacts of contaminants and sediment suspension as a result of dredging, and pollution events from the accidental release of hydraulic fluids and oils from the construction plant into the marine environment. Suspended sediments resulting from dredging activity can impact prey availability by reducing the ability of fish to feed and altering fish habitat preferences (Wenger et al. 2013, Wenger and McCormick 2013, as referenced in Todd et al. 2015). The suspended sediment can also cause gill damage in fish (Herbert and Merkens 1961, Lake and Hinch 1999, Au et al. 2004, Wong et al. 2013, as referenced in Todd et al. 2015). Any change in sediment structure can cause non-mobile organisms to be smothered by sediment, potentially reducing prey for certain fish species and having a cascading trophic effect whereby prey availability is reduced for marine mammals (Todd et al. 2015). Additionally, fish and cephalopods are vulnerable to chemical contaminants which may be released by dredging and other construction activities, and may exhibit behavioural and physiological changes in response to noise exposure associated with construction (Todd et al. 2015).

A summary of the marine mammal prey species is provided in Table 20, with key species that make up the majority of the diet in bold. Sandeels are of particular importance to harbour porpoise, grey seal, harbour seal and minke whales, and cod, saithe and whiting are the main prey items eaten by bottlenose dolphins in Scottish waters (Santos et al. 2001, Pierce et al. 2004, Santos et al. 2004, Wilson and Hammond 2019). Salmon are also a seasonally important component of the bottlenose dolphin diet, with the presence of bottlenose dolphins in the summer months coinciding with seasonal migrations of Atlantic salmon and sea trout through the Moray Firth (NatureScot 2025). The Nairn District Salmon Fisheries Board advise that the Port of Ardersier lies in close proximity to the River Nairn, which is an important river for migratory salmonids (salmon and sea trout), and as such it is likely that migratory fish travel close to the proposed works location while seeking their natal river (MD-LOT 2025). The Moray Firth is also an important habitat for sandeels, sprat and herring (NatureScot 2025), where sandeels are found in coarse sand with low silt content between 20-60 m depth (Wright et al. 2000, Macleod et al. 2004, Holland et al. 2005, NatureScot 2025) and herring lay eggs directly onto the seabed with a preference for coarse sand, gravel, shells and small stones (NatureScot 2025). As a result of the importance of seabed habitat for these species, both are vulnerable to impacts resulting from dredging activities.

Table 21: Prey species of the marine mammals present in the Moray Firth. Key species which make up the majority of the diet are in bold.

Receptor	Site	Key Prey Species	Reference
Harbour porpoise	Scotland	**Whiting**, **sandeel**, small cod (*Trisopterus* spp.), blue whiting, cod, haddock, saithe, rocklings, gobies, herring, sprat, mackerel, scad, cephalopods, molluscs, brown shrimp, crabs, isopods, amphipods, other crustaceans	Santos et al. (2004)
Bottlenose dolphin	British Isles & Ireland	Sandeel, **cod**, **saithe**, **whiting**, catsharks, sprat, scad, conger eel, Atlantic salmon, blue whiting, haddock, Norway pout, pout, small cod, silvery cod, ling, hake, Atlantic horse mackerel, Atlantic mackerel, gobies, sand smelt, lanternfish, flounder, plaice, dab, brill, sole, various squid, and octopus sp.	Santos et al. (2001), Hernandez-Milian et al. (2015)
Grey seal	Scotland	Saithe, whiting, cod, haddock, rockling, ling, blue whiting, hake, pollock, Norway pout, small cod, plaice, lemon sole, **sandeel**, dover sole, dab, herring, sprat, mackerel, salmonid, wrasse, catfish	Hammond and Wilson (2016), Wilson and Hammond (2019)

Harbour seal	British Isles	Lamprey, eels, herring, salmonids, haddock, pollock, saithe, whiting, blue whiting, Norway pout, poor cod, bib, rockling, ling, hake, perch, scad, wrasse, **sandeel**, goby, mackerel, flounder, dab, sole, witch, halibut, and squid sp.	Gosch et al. (2014), (Wilson and Hammond 2019)
Minke whale	British Isles	**Sandeel**, herring, sprat, mackerel, goby, Norway pout / poor cod	Pierce et al. (2004)

3.7.1 Sensitivity

Marine mammals are highly mobile and wide-ranging, and therefore if any interruption to prey availability occurs, it is expected that marine mammals will have a high level of adaptability in terms of being able to switch to an alternate prey source or foraging location, a high level of tolerance in terms of being able to tolerate short periods without access to prey, and a high level of recoverability in terms of replenishing lost energy by increasing foraging. However, there can still be some energetic cost, particularly if the increased time spent searching for alternate prey sources and foraging reduces the time available for activities such as resting or reproduction (Ransijn 2023).

In the Moray Firth, sandeels are a key prey species in the diet of harbour porpoise, bottlenose dolphin, seals, and minke whales (Hammond et al. 1994, Thompson et al. 1996, Brown and Pierce 1998, Santos et al. 2001, Pierce et al. 2004, Santos et al. 2004, Wilson and Hammond 2019). In a study on harbour porpoise stranded in Scottish waters, Santos et al. (2004) found that whiting and sandeels comprised approximately 80% of the diet. Similarly, a diet study on the stomach contents of stranded minke whales in Scottish waters showed sandeels were the most important prey species and contributed two-thirds of the diet (Pierce et al. 2004). Sandeels dominate the autumn and winter diet of grey seals in Scottish waters and are dominant in harbour seal scrats across all seasons (Wilson and Hammond 2019, Scottish Government 2023). The Moray Firth SAC Conservation and Management Advice report (NatureScot 2025) recommends that developers should *“reduce or limit pressures (loss of prey) that have the potential to damage, reduce, or loss habitat of key prey species (particularly sandeel).”* Although most of the marine mammals assessed here are likely able to supplement their diet with other species when required, studies in the southern outer Moray Firth found that minke whale distribution was positively correlated with areas of sandy-gravel sediments which represent suitable sandeel habitat (Robinson et al. 2009). As large, migratory baleens, minke whales are therefore more vulnerable to having to move to different areas in search of prey which may impact their energy stores required during migration, and are expected to be more sensitive to prey disruption in key foraging areas such as the Southern Trench MPA. However, the inner Moray Firth, including the dredging and dump sites, are not considered key minke foraging areas and as a result overall sensitivity is low in this area. Therefore, the sensitivity of marine mammals to indirect impacts on prey availability is assessed as **Low.**

3.7.2 Magnitude

Activities relating to the construction of the proposed development may influence water quality as a result of sediment disturbance and the accidental release of fuels, oils and/or hydraulic fluids. Sediment disturbance could also lead to the release of chemical contaminants and organic hydrocarbons into the marine environment. Each impact could have indirect implications on marine mammal prey availability. Additionally, the underwater noise associated with construction activities, particularly piling, has the potential to disturb prey populations and may result in temporary changes in prey behaviour or distribution.

3.7.2.1 Accidental release of fuels, oils and/or hydraulic fluids

With regards to the accidental release of fuels, oils and/or hydraulic fluids, the impact of pollution is associated with the construction of infrastructure and use of supply/service vessels, which may lead to a reduction in prey availability affecting marine mammal survival rates. However, with implementation of an appropriate POEMP and Port Oil Spill Contingency Plans (see EIAR Chapter 11 (Marine Mammals)), a major incident that may impact any fish species at a population level is considered very unlikely, as these impacts are expected to be localised and short-lived. The impact of the accidental release of fuels, oils and/or hydraulic fluids is therefore considered not significant in EIA terms when considering its impact on marine mammal prey items and was **scoped out** of the marine mammal assessment within the EIA Scoping Report (SCOP-0062).

3.7.2.2 Sediment disturbance and fish habitat loss

When considering sediment disturbance, dredging and dumping works are the most likely contributor to sediment disturbance and thus, increased turbidity. The risks of sediment disturbance and fish habitat loss are particularly relevant to demersal spawning species present in the Moray Firth, such as herring and sandeels. Sandeels are highly substrate-specific spawners and spend a large amount of time buried in the sediment, with specific requirements in terms of the silt content of the sediment. They are absent in substrates with a silt content greater than 10% (Wright et al. 2000, Holland et al. 2005). Their eggs remain attached to the seabed during development. However, sandeel eggs are expected to be tolerant to increased sediment deposition and smothering, due to the common resuspension and deposition events which occur in their natural high energy environment. Herring are a mobile species with the capacity to avoid unfavourable areas, but nonetheless rely on the substrate for spawning and sediment deposition could potentially smother herring eggs and disrupt the development of larvae. When considering the material to be dredged as part of the proposed development, it is expected to be predominantly composed of undisturbed sands and gravels (EnviroCentre Limited 2024). The sand component is expected to remain suspended for a longer time than the gravel component, but the effects are expected to be temporary and localised due to the short duration of dredging activity (~4 months). As a result of the short duration of dredging activity and the minimal impacts of increased sediment deposition on fish prey species present in the area, marine mammals are not expected to have reduced access to prey. The impact magnitude of sediment suspension impacting prey availability is therefore assessed as **Negligible.**

3.7.2.3 Release of contaminants from the sediment

As part of historic capital and maintenance dredging campaigns, sediment samples of the material to be dredged have previously been collected and tested against the Revised Action Levels (RAL) criteria as adopted by Marine Scotland. These tests assess the presence of metals, tributyl tin (TBT), polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and total hydrocarbons (THC content) to evaluate the chemical quality of dredged material and its potential impact on the marine environment when considering sea disposal options. Overall, there has been low levels of chemical contaminants and organic hydrocarbons present in the dredged sediments and they have previously been identified as suitable for disposal (EnviroCentre Limited 2024). Whilst a BPEO has not yet been concluded for the dredging activities as part of the proposed development, any future BPEO that is authored for the proposed development shall take the appropriate measures to ensure that dredged materials meet acceptable environmental standards. Thus, the impact magnitude of the accidental release of chemical contaminants and/or organic hydrocarbons impacting prey availability is expected to be **Negligible**.

3.7.2.4 Underwater noise

Fish species are generally sensitive to lower frequency sounds, such as the frequency profile which may be produced by dredging (Popper et al. 2003, Popper and Fay 2011, as referenced in Todd et al. 2015) and some species, such as cod, avoid low-frequency vessel noise and/or vessels themselves (Mitson 1995, Mitson and Knudsen 2003, De Robertis and Wilson 2011, as referenced in De Robertis and Handegard 2013) (Handegard et al. 2003, as referenced in Todd et al. 2015). Cephalopods may respond to the particle motion of low-frequency sound with altered breathing rhythms and movement or induced acoustic trauma and damage to sensory organs (Packard et al. 1990, Mooney et al. 2010, Solé et al. 2013, as referenced in Todd et al. 2015).

In addition, fish in close proximity to pile driving can suffer physical injuries such as swim bladder rupture or internal bleeding due to rapid pressure changes (Popper et al. 2014). For example, intense impulsive noise from pile driving can lead to Temporary Threshold Shift (TTS**)** or PTS in fish, and salmonids, such as Atlantic salmon (*Salmo salar*), present in the North Sea, are particularly sensitive to low-frequency impulsive sounds and may be vulnerable during migration period (Gillson et al. 2022). Fish may also exhibit avoidance behaviour, moving away from pile driving activity, potentially leading to disruption of migration, spawning, or feeding (Slabbekoorn et al. 2010), however, environmental assessments conducted for offshore wind developments in the North Sea have predicted that while localised impacts on fish may occur during piling, population-level effects are unlikely due to mitigation (e.g., soft-start procedures) and spatial avoidance (MMO 2014).

Although the temporary and localised exposures to noise associated with construction activity at the proposed development are unlikely to have any long-lasting effects on the fitness and survival of fish and cephalopods, the noise associated with construction activity may cause temporary relocation, communication making, and changes in behaviour of marine mammal prey species (Todd et al. 2015). The impact magnitude of the underwater noise associated with construction impacting prey availability is therefore expected to be **Negligible.**

3.7.2.5 Summary

It is expected that there would be no significant impact on the distribution or quality of marine mammal prey species as a result of the construction activities. As such it is highly likely that impacts to prey species would result in only very slight or imperceptible changes to marine mammal receptors, and it is expected that this will not result in any population level change. Therefore, indirect impacts on marine mammals via changes in prey availability during construction are most likely to be of **Negligible** magnitude.

3.7.3 Significance of Effect

The magnitude of impact is assessed as negligible for all marine mammal receptors and the sensitivity is assessed as **Low** for all receptors. The effect is therefore of **Negligible** significance, and the impact is **Non-significant** in EIA terms (Table 21.

Table 22: Summary of indirect impacts on prey availability to marine mammals during the construction phase.

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Low	Negligible (not significant)
Harbour seal	Negligible	Low	Negligible (not significant)
Minke whale	Negligible	Low	Negligible (not significant)

3.7.4 Secondary Mitigation

No additional marine mammal mitigation is considered necessary because the likely effect in the absence of further mitigation is not significant in EIA terms.

3.7.5 Residual Effect

The overall effect of indirect impacts to prey species during construction is **Negligible** and **Not Significant** in EIA terms.

4 Operations & Maintenance Phase

4.1 Collision risks associated with increased vessel traffic

4.1.1 Sensitivity

The sensitivity of marine mammals to vessel collision risks is considered to be the same as that presented for construction (see Section 3.6.1). Therefore, the sensitivity of marine mammals from vessel collisions is classified as **High** for all marine mammals.

4.1.2 Magnitude

As discussed in Section 3.6.1 for construction, vessel activity during the operational phase could result in physical trauma on marine mammals from collisions with vessels. The risk of vessel collisions is influenced by the vessel type of speed (Laist et al. 2001) and indirectly by ambient noise levels underwater and marine mammal behaviour. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic, as it allows marine mammals to better anticipate and avoid vessels (Nowacek et al. 2001, Lusseau 2006, New et al. 2020). The adoption of a NRA based on best practice vessel handling protocols (e.g., following the Scottish Marine Wildlife Watching Code) will minimise the potential for any impact by ensuring that vessel traffic moves along predictable routes, setting recommended speed and defining how vessels should behave in the presence of marine mammals.

Vessel traffic during the operational phase is anticipated to be 400 vessel calls per year as a maximum worst-case scenario (Haventus 2025), which is an increase of ~60 vessels per year compared to current levels. The types of vessels expected to operate from the Port of Ardersier are primarily large vessels servicing offshore industries, including:

- Heavy Load Carriers (>150 m): 7 different vessel types arriving on-site, in total, per year; number of movements unknown
- Heavy Lift Vessels (>100 m): 4 different vessel types arriving on-site, in total, per year; number of movements unknown
- Jack-up Barges (>80 m): 7 different vessel types in total, number of movements unknown
- General Cargo Vessels (>140 m): 2 different vessel types arriving on-site, in total, per year; number of movements unknown
- Bulk Carrier (150 m): 1 vessel type arriving on-site, in total, per year; number of movements unknown
- Semi-submersible (137 m): 1 vessel type arriving on-site, in total, per year; number of movements unknown

While some of the vessels expected to operate are capable of reaching speeds up to 13 knots, most are expected to transit at typical speeds around 10 knots. Vessel activity levels will be sustained over a long-term duration (50 years), however, the increase in traffic is not considered a novel impact due to the already high volumes of vessel movements in the inner Moray Firth (see Figure 7 & Figure 9).

Although vessels may transit over a broad geographical area (e.g., from the port to offshore wind farm sites), the physical risk of collision is localised to the immediate vicinity of the moving vessel. The implementation of a NRA during the O&M phase will further minimise the potential for the collisions to take place. Following the application of embedded mitigation, the risk of a collision occurring is unlikely and if it occurs, it would be at a very low frequency, and it is not expected to impact enough individuals to alter the population trajectory. The magnitude of vessel collisions during O&M is assessed as **Negligible.**

4.1.3 Significance of Effect

Taking the **High** sensitivity and the **Low** magnitude of impact, the overall effect of risk associated with vessel collisions during O&M is considered to be **Minor** and **Not Significant** in EIA terms.

Table 23: Summary of the impact assessment for collision risk from O&M vessels

Species	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Non-significant)
Bottlenose dolphin	Negligible	High	Negligible (Non-significant)
Harbour seal	Negligible	High	Negligible (Non-significant)

Grey seal	Negligible	High	Negligible (Non-significant)
Minke whale	Negligible	High	Negligible (Non-significant)

4.1.4 Secondary Mitigation

The embedded mitigation includes the commitment to NRA. Following application of this embedded measure, the effect of risk of vessel collisions for all species is considered to be **Not Significant** in EIA term. Therefore, no secondary mitigation is required.

4.1.5 Residual Effect

The overall effect of vessel collisions during O&M is **Negligible** and **Not Significant** in EIA terms.

4.2 Disturbance associated with increased vessel traffic, including to seal haul-out sites

4.2.1 Sensitivity

4.2.1.1 All marine mammals (including seals at-sea)

The sensitivity of marine mammals to vessel disturbance will be species dependent. The sensitivity is considered to be the same as that presented for construction (see Sections 3.5.2.1 – 3.5.2.4). Therefore, the sensitivity to disturbance from vessel activity is therefore classified as **Low** for all marine mammals, with the exception of minke whales which are considered to have **Medium** sensitivity to vessel disturbance.

4.2.1.2 Seal haul-out sites

The sensitivity is considered to be the same as that presented for construction (see Sections 3.4.1.4 & 3.5.2.4). Therefore, the sensitivity of grey seals to disturbance to haul-outs, is classified as **Low** outside of the breeding season and **Medium** during the breeding season. Due to declines in several regional harbour seal populations, this species is considered more vulnerable to pressures, including physical disturbance (SCOS 2022). Therefore, the sensitivity of harbour seal to disturbance during and outside the breeding and moult seasons at haul-outs has been assessed as **Medium.**

4.2.2 Magnitude

The area surrounding the proposed development is already subject to high levels of vessel activity. As outlined in Section 4.1.2, the Port of Ardersier currently experiences approximately ~340 vessel movements per year (Haventus 2025).

During the operational phase of the proposed development, there are anticipated to be a maximum of 400 vessel calls per year as a worst-case scenario (Haventus 2025) representing an increase of ~60 additional vessel calls from current annual movements. The anticipated traffic would primarily consist of large vessels servicing offshore industries.

The expected vessel types and numbers are discussed in Section 4.1.1. These vessel types vary in size and noise output, which can influence the potential for disturbance, as described in Section 3.5. However, the Inner Moray Firth, including the vicinity of the Port of Ardersier, is an area where marine mammals are regularly exposed to commercial vessel activity. Given the existing baseline of high traffic, the increased vessel movements are not considered a novel source of disturbance. Animals in the area, including cetaceans and pinnipeds, are likely to exhibit some degree of habituation to vessel noise and presence. Although the frequency of potential disturbance events is predicted to increase to a moderate level, depending on seasonal animal presence and the timing and routing of vessel transits, the spatial extent remains localised. While a small proportion of individuals may be affected at any one time, the impact is not anticipated to result in long-term changes to population trajectories. The anticipated number of individuals predicted to be impacted by vessel disturbance shall be synonymous with those described in Section 3.5.3.

Table 24: Summary of predicted number of individuals to be impacted by vessel disturbance during operations and maintenance

Species	EDR	Number disturbed	% MU
Harbour porpoise	2 km	4	<0.001%
Bottlenose dolphin	1 km	8 (mean group size)	3.4%
Seals at sea	1 km	2 harbour seals 4 grey seals	0.18% - harbour seals 0.07% - grey seals
Seals hauled-out	NA	50-196 (depending on season)	Harbour seal: 3.7 – 14.4 % Grey seal: 0.93 – 3.64%
Minke whale	0.25 km	<1	<0.001%

Further, to minimise potential impacts, a NRA will be implemented during operations and maintenance. The NRA will include routing protocols, speed restrictions, and awareness training for crews, thereby reducing the likelihood of high-risk interactions with marine mammals.

Taking into account the existing high vessel traffic baseline; the negligible increase in vessel movements; the implementation of mitigation through a NRA; and the anticipated habituation of animals in the area, the magnitude of impact is assessed as **Negligible**.

4.2.3 Significance of Effect

The magnitude of the impact is deemed to be Low. The sensitivity of the receptor is Low for all marine mammals except minke whales which are assessed as Medium sensitivity. For seals at their haul-out sites, the sensitivity is classified as Low outside of the breeding/moult seasons and Medium during the breeding/moult seasons.

The effect will therefore be **Negligible** for all marine mammals except minke whales, which the impact shall be **Minor.** For seals at their haul-out sites, the significance of the impacts shall be **Negligible** outside of the breeding/moult seasons and **Minor** during the breeding/moult seasons. Each of which are **Non-Significant** in EIA terms.

Table 25: Summary of the impact assessment for disturbance from operational and maintenance vessel traffic

Species	Magnitude	Sensitivity	Significance

Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)
Seals at sea	Negligible	Low	Negligible (not significant)
Seals hauled-out	Negligible	Low outside breeding/moult Medium during breeding/moult	Outside breeding/moult: Negligible (not significant) During breeding/moult: Negligible (not significant)
Minke whale	Negligible	Medium	Negligible (not significant)

4.2.4 Secondary Mitigation

The project has already committed to the adoption of an NRA, and no additional mitigation measures are required to reduce the significance of the impact.

4.2.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

4.3 Indirect impacts on prey availability

4.3.1 Sensitivity

The sensitivity is considered to be the same as presented for construction (see Section 3.7.2). Therefore, the sensitivity to indirect impacts on prey availability is classified as **Low** for all marine mammals.

4.3.2 Magnitude

Activities relating to the operations of the proposed development may influence water quality as a result of accidental release of fuels, oils and/or hydraulic fluids.

With regards to the accidental release of fuels, oils and/or hydraulic fluids, the impact of pollution is associated with the construction of infrastructure and use of supply/service vessels may lead to a reduction in prey availability which may affect species' survival rates. However, with implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major incident that may impact any species at a population level is considered very unlikely. The impact of the accidental release of fuels, oils and/or hydraulic fluids is therefore **Negligible** when considering its impact on marine mammal prey items.

4.3.3 Significance of Effect

The magnitude of the impact is deemed to be **Negligible**. The sensitivity of the receptor is **Low** for all marine mammals. Therefore, the effect of indirect impacts on prey is considered to be **Negligible** for all receptors and **Non-significant** in EIA terms.

Table 26: Summary of indirect impacts on prey availability to marine mammals during the O&M phase.

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Low	Negligible (not significant)
Harbour seal	Negligible	Low	Negligible (not significant)
Minke whale	Negligible	Low	Negligible (not significant)

4.3.4 Secondary Mitigation

No additional marine mammal mitigation is considered necessary because the likely effect in the absence of further mitigation is not significant in EIA terms.

4.3.5 Residual Effect

The overall effect of indirect impacts to prey species during construction is Negligible and Not Significant in EIA terms.

4.4 Long term habitat changes, displacement and/or barrier effects

This section assesses the potential for long-term barrier effects on marine mammals resulting from the operation of the proposed development . Barrier effects refer to the disruption of regular movement or migration routes due to physical or behavioural avoidance of anthropogenic structures or activities, potentially affecting access to foraging, breeding, or resting habitats.

4.4.1 Sensitivity

As aforementioned, despite ongoing port and harbour operations and vessel activity, bottlenose dolphins and seals continue to be regularly sighted in the Inner Moray Firth, and long-term surveys indicate continued and regular use by dolphins and seals. This suggests that the presence of coastal industrial structures and increased vessel activity have not created permanent or large-scale movement barriers (Cheney et al. 2018, Hague et al. 2019, Cheney et al. 2024, Benhemma-Le Gall and Cheney 2025). As disturbance associated with increased operational vessel traffic is likely the primary source of habitat change, displacement or long-term barrier effects, it can be assumed that the sensitivity of marine mammals here shall be synonymous with those described in Section 0. As such, sensitivity of the receptor is **Low** for all marine mammals except minke whales which are assessed as **Medium** sensitivity. For seals at their haul-out sites, the sensitivity is classified as **Low** outside of the breeding/moult seasons and **Medium** during the breeding/moult seasons.

4.4.2 Magnitude

The proposed development is situated in a coastal environment within the inner Moray Firth, within the Moray Firth SAC designated for bottlenose dolphins, and adjacent to the Ardersier (Whiteness Sands) seal haul-out site designated site the Marine (Scotland) Act 2010. Bottlenose dolphins in this region are known to show high site fidelity and regularly use specific coastal corridors, such as the narrow channel between Chanonry Point, Ardersier, and Fort George (Cheney et al. 2013, Benhemma-Le Gall and Cheney 2025). Harbour and grey seals are known to haul out at the Ardersier (Whiteness Sands) seal-haul out site which overlaps with the proposed development, and harbour porpoise have also been reported as present within the Inner Moray Firth (see Appendix 11.3 for full details).

Although situated in a coastal environment within the inner Moray Firth, the proposed development will not obstruct the Chanonry Point–Fort George–Ardersier channel. All new operational structures associated with the Port of Ardersier are either land-based or positioned within the existing port envelope and inner harbour. While some temporary displacement during operational vessel activity is expected (Section 4.2.1), this will be spatially and temporally limited, with no evidence suggesting permanent habitat loss for marine mammals.

There is limited evidence suggesting that coastal port infrastructure such as breakwaters, jetties, or quays causes long-term displacement or movement disruption to marine mammals. For example, Nigg Energy Park and the Invergordon Service Base have undergone significant port extension, allowing for the fabrication and storage offshore wind turbine structures, the mooring of oil & gas platforms, and the berthing of large vessels such as cruise liners. Despite ongoing operations and vessel activity, marine mammals continue to be regularly sighted in the Inner Moray Firth, including around Nigg Energy Park, Invergordon and the Port of Ardersier (Graham et al. 2017b, Benhemma-Le Gall and Cheney 2025). Long-term surveys in the Moray Firth indicate continued and regular use by dolphins and seals, suggesting that the presence of coastal industrial structures and increased vessel activity have not created permanent or large-scale movement barriers (Cheney et al. 2018, Hague et al. 2019, Cheney et al. 2024, Benhemma-Le Gall and Cheney 2025).

This body of evidence supports the conclusion that marine mammals can continue to use industrialised port areas where movement corridors are preserved and activities are spatially predictable. All operational infrastructure is confined to land or the existing port envelope, avoiding key marine mammal movement corridors such as the Chanonry Point–Fort George–Ardersier channel. While minor, temporary displacement during vessel activity may occur, such effects are spatially and temporally limited and very unlikely to occur at a frequency that would influence population dynamics. Evidence from similar nearby developments shows continued and regular presence of marine mammals despite ongoing industrial activity, indicating no lasting displacement or behavioural change. The extension is not expected to result in any perceptible change to local marine mammal populations or alter their long-term population trajectory and as such, the magnitude of any long-term barrier effect is assessed as **Negligible.**

4.4.3 Significance of Effect

The sensitivity of the receptor is Low for all marine mammals except minke whales which are assessed as Medium sensitivity. For seals at their haul-out sites, the sensitivity is classified as Low outside of the breeding/moult seasons and Medium during the breeding/moult seasons.

The magnitude of the impact is deemed to be Negligible.

The effect will therefore be **Negligible** to **Minor** for all marine mammals**.** For seals at their haul-out sites, the significance of the impacts shall be **Negligible** outside of the breeding/moult seasons and **Minor** during the breeding/moult seasons. Each of which are **Non-Significant** in EIA terms.

Table 27: Summary of the impact assessment for disturbance from long term habitat changes, displacement and/or barrier effects

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (not significant)
Bottlenose dolphin	Negligible	Low	Negligible (not significant)
Grey seal	Negligible	Low (outside breeding/moult	Negligible (not significant) outside breeding/moult
		Medium (during breeding/moult)	Minor (not significant) during breeding/moult
Harbour seal	Negligible	Low (outside breeding/moult	Negligible (not significant) outside breeding/moult
		Medium (during breeding/moult)	Minor (not significant) during breeding/moult
Minke whale	Negligible	Medium	Minor (not significant)

4.4.4 Secondary Mitigation

The project has already committed to the adoption of an NRA, and no additional mitigation measures are required to reduce the significance of the impact.

4.4.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

5 Cumulative Effects

5.1 Marine Mammal CEA Methodology

Effects of the proposed development alone are generally spatially restricted to the inner harbour area, however, certain impacts have the potential to be observed over a wider area in the inner Moray Firth. These cumulative effects are the effects of the proposed development, combined with the effects from other projects, on the same receptor or group of receptors. Chapter 14 (Cumulative) details how potential cumulative effects will be assessed for the proposed development through a CEA. A CEA screening process has identified the relevant other plans, projects, and activities which are to be included in the assessment. These other plans or projects may present different levels of potential cumulative effect when combined with the Proposed Development, informed by other plan/project's readiness and likelihood for actual operation. The screening process for potential impacts on marine mammals as well as projects to be included in the cumulative assessment are presented in this section.

Certain impacts assessed for the proposed development alone are not considered in the marine mammal CEA due to:

- the highly localised nature of the impacts; and
- management and mitigation measures (embedded commitments) in place at the proposed development and on other projects will reduce the risk of cumulative effects occurring.

The impacts excluded from the marine mammal CEA for these reasons are presented in Table 28.

Table 28: Impacts screened out from further consideration in the CEA with justification for screening

Impact	Justification
Auditory injury (PTS)	Where PTS may result from activities such as pile driving, geophysical surveys and UXO clearance, as a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce injury risk to marine mammals to negligible levels across all projects considered in the cumulative assessment (JNCC 2010b, a, 2017). Similarly, any risk of PTS during decommissioning will be determined via appropriate decommissioning plans and if required, mitigated. Any non-piling construction noise sources will have an extremely local spatial extent and therefore represent a minimal risk of injury. Moreover, it is anticipated that underwater noise associated with vessel activity will deter animals from the injury zone. As such, assuming application of appropriate mitigation measures, any risk of injury it is considered highly unlikely and potential for cumulative effects on marine mammals due to PTS as a result of piling, UXO, other non-piling construction activities and decommissioning was not considered further.
Disturbance from Unexploded Ordnance (UXOs)	In line with the DEFRA et al. (2021) joint interim position statement, it is expected that, where feasible, across all projects, UXO clearance campaigns will be conducted using low-order deflagration techniques. These techniques are now considered to have 100% success rate (Ocean Winds 2024). Moreover, it is

Impact	Justification
	expected that the detonation of a UXO would elicit a startle response and potentially very short-duration behavioural responses and would therefore not be expected to cause widespread and prolonged displacement (JNCC 2020). Given that behavioural disturbance is considered negligible in the context of UXO clearance as the duration of the impact (underwater noise) is extremely short, the potential for cumulative effects is considered unlikely and this impact was not considered further.
Disturbance from other construction activities (excluding dredging)	Disturbance from other (non-piling) construction activities is anticipated to be highly localised and is closely associated with the disturbance from vessel presence required for the activity. As such, cumulative effects have been assessed under “disturbance from vessels” impact and potential for cumulative effects due to other (non-piling) construction activities was not considered further.
Indirect impacts associated resulting in marine mammal prey item disturbance and/or displacement	The changes in prey availability are expected to be highly localised across all projects. As such, the potential for significant cumulative effects is minimal and, therefore, this impact was not considered further.
Long-term habitat changes, displacement and/or barrier effects	The potential risks associated with long term displacement and barrier effects are expected to be highly localised across harbour developments. As such, the potential for significant cumulative effects is minimal and therefore this impact was not considered further.
Disturbance from vessels during construction	Vessel routes to and from offshore construction projects will, for the majority, use existing vessel routes for pre-existing vessel traffic which marine mammals will be accustomed to. They may also have become habituated to the volume of regular vessel movements and therefore the additional risk is predominantly confined to construction sites. The vessel movements for offshore developments are likely to be limited and slow, resulting in less risk of disturbance to marine mammal receptors. NRAs shall also be in place for each development during construction, to help minimise the interactions between marine mammal and vessels despite minimal increases in vessel traffic beyond the baseline.
Vessel collision risks	During both construction and operational phases, it is expected that across all projects’, vessel movements will be managed through the implementation of vessel codes of conduct that will mitigate the negative impacts to marine mammals (e.g. limited vessel speeds, adherence to vessel transit routes), following relevant guidance to minimise the risks of injury to marine mammals. As such, the potential for significant cumulative effects is minimal and this impact was not considered further.

The impacts that are considered in the marine mammal CEA are as follows:

- The potential for disturbance from underwater noise from piling during construction of offshore wind farms (OWFs) (where data are available) and the construction of other projects and developments (including dredging activities);
- Disturbance to seal haul-out sites; and
- Disturbance from vessels during construction and O&M.

5.2 CEA Project Screening

The time period considered in the CEA for marine mammals is 2025 to 2034 inclusive to account for projects constructing up to a year on either side of the Proposed Development construction. This allows for the quantification of impacts both prior to and post construction of the proposed development and during the period when piling and/or dredging at the proposed development is anticipated (between 2026 and 2029). The screening range was defined as the Moray Firth.

Each project, plan or activity has been considered and screened in or out based on effect–receptor pathway, data confidence and the temporal and spatial scales involved. The CEA long-list of projects was screened to remove all projects that have:

- No temporal overlap;
- No physical effect-receptor overlap; and
- No effect-receptor pathway.

The following projects were screened out of the marine mammal CEA short list as they were already operational/active and thus considered to be existing impacts included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines), or no construction timeline was available:

- Maintenance Dredging and Deposit – Macduff Harbour;
- Caithness-Moray HVDC Link;
- SHEFA 2;
- FARICE-1; and
- Flora Floating OWF.

Projects which were screened into the CEA for marine mammals are detailed in Table 29.

Table 29: List of projects and developments screened into the marine mammal CEA (all projects were screened in for each species). Pre-C = pre-construction, C = offshore construction, D = dredging, P = piling, P & D = piling and dredging.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Ardersier ETF Extension	Port	Pre-C	P	P & D		D	Operational				
Invergordon Phase 5	Port	Pre-C	P	P	Operational						
Port of Nigg East Quay - Inner Berthing Structure	Port	P	P	Operational							
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	D	D	Operational							
Maintenance Dredging - Port of Cromarty Firth	Port	D	D	D	D	Operational					
Dredging and Sea Deposit - Banff Harbour	Port	N/A	D	D	D	Operational					
Maintenance Dredging and Deposit- Portsoy Harbour	Port	D	D	D	Operational						

<table>
<tr><th>Proposed Development</th><th>Type</th><th>2025</th><th>2026</th><th>2027</th><th>2028</th><th>2029</th><th>2030</th><th>2031</th><th>2032</th><th>2033</th><th>2034</th></tr>
<tr><td>Buckie Maintenance Dredging and Deposit</td><td>Port</td><td>D</td><td>D</td><td colspan="2">D</td><td colspan="6">Operational</td></tr>
<tr><td>Portknockie Maintenance Dredging and Deposit</td><td>Port</td><td>D</td><td>D</td><td colspan="8">Operational</td></tr>
<tr><td>Moray West</td><td>Fixed OWF</td><td>C</td><td colspan="9">Intended to be operational from 2025</td></tr>
<tr><td>Caledonia</td><td>Fixed & Floating OWF</td><td colspan="3">N/A</td><td>P</td><td>P</td><td>P</td><td colspan="4">Intended to be operational from 2030</td></tr>
<tr><td>Shetland HVDC Link</td><td>Cable</td><td>C</td><td colspan="9">Operational</td></tr>
<tr><td>Broadshore</td><td>Floating OWF</td><td colspan="4">N/A</td><td>P</td><td>P</td><td>P</td><td>P</td><td colspan="2">Operational</td></tr>
<tr><td>Sinclair</td><td>Floating OWF</td><td colspan="4">N/A</td><td>P</td><td>P</td><td>P</td><td>P</td><td colspan="2">Operational</td></tr>
<tr><td>Stromar</td><td>Floating OWF</td><td colspan="6">N/A</td><td>P</td><td>P</td><td>P</td><td>P</td></tr>
<tr><td>Fraserburgh Harbour Expansion</td><td>Port</td><td colspan="3">N/A</td><td>C</td><td>C</td><td>C</td><td>C</td><td>C</td><td colspan="2">Operational</td></tr>
<tr><td>Maintenance Dredging - Wick Harbour</td><td>Port</td><td>D</td><td colspan="9">Operational</td></tr>
</table>

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Orkney - Caithness 220 kV Link	Cable	C	C	C	C	Operational					

5.3 CEA Assumptions and Limitations

5.3.1 Assumptions - Number of Impacted Individuals

For all screened-in offshore developments that had a quantitative impact assessment available (EIAR chapter), the maximum number of animals predicted to be disturbed was obtained from the Marine Mammals EIAR chapter and used in this CEA for that specific project. It is noted that different quantitative impact assessments used different methods to assess disturbance from pile driving and/or other construction activities such as dredging. For pile driving activities, all project assessments used a dose-response function. For other construction activities, such as dredging, impacts were largely assessed qualitatively. Where no quantitative impact assessment was undertaken for a specific project (i.e., for qualitative assessments) despite an EIAR being available, it was assumed that the number of individuals impacted was zero.

For all projects that have no EIAR chapter, the following piling assumptions were made:

- a 26 km EDR was assumed for fixed foundation OWF projects;
- a 15 km EDR for floating OWF projects; and
- a 5 km EDR was assumed for port and/or harbour development extensions.

For dredging activities, the EDRs assumed for each species and used in CEA were in-line with the assessment methodology undertaken for the proposed development (5 km for harbour porpoise, minke whales and seals, 1 km for bottlenose dolphins, see Appendix 11.2).

5.3.2 Assumptions – Density Estimates

Where no quantitative impact assessment was available (no project specific EIAR), for harbour porpoise and minke whales, the density was assumed to be that of the SCANS IV block in which the development was located. For seals, the density was assumed to be the average at-sea density estimate (derived from Carter et al. (2025)) throughout the array area (for OWF projects) and/or project development area. For bottlenose dolphins, the density was assumed to be the average density estimate (derived from the scaled Thompson et al. (2015) surface) throughout the array area (for OWF projects) and/or project development area.

5.3.3 Limitations

It should be noted that there are significant levels of precaution / conservatism within this CEA, resulting in the estimated effects being highly precautionary. The main areas of precaution / conservatism in the assessment include:

- The approach of summing across concurrent activities assumes that there is no spatial overlap in the impact footprints between individual activities, which is highly conservative considering the close proximity of many of the offshore developments;
- The inclusion of projects with a high degree of uncertainty; for example, those lacking consent, an EIAR, and/or scoping report. In such instances, realistic worst-case scenarios are assumed in the absence of other information;
- The exact timing of pile driving or construction activities for each development is unknown, therefore it has been assumed that these activities could occur at any point throughout the construction window. This has resulted in piling/construction activities occurring over multiple consecutive years with associated estimated disturbance levels far greater than would occur in reality;

- The timelines presented in EIAR chapters are realistic worst-case scenarios and the true period of piling/construction activity will likely be shorter;
- The assumption that all floating OWF developments will install pile-driven anchor (pin-pile) foundations.
- For projects with likely piling activities, in the absence of project-specific assessments of the number of disturbed animals from piling, EDRs based on those recommended for harbour porpoise have been applied; these can be considered precautionary for other species of marine mammal, which have not been reported to respond as strongly to relevant underwater noise as harbour porpoise.

5.4 Disturbance from Construction Activities (including Piling and Dredging)

5.4.1 Harbour Porpoise

5.4.1.1 Sensitivity

Harbour porpoise have been assessed as having a **Low** sensitivity to disturbance from pile driving activities, dredging activities, and other construction activities which involve vessels to be present on-site.

5.4.1.2 Magnitude

Error! Reference source not found. outlines the number of harbour porpoise predicted to be disturbed at each project in each year. The data have been split by whether a quantitative impact assessment is available as there is considerably more certainty in the number of animals predicted to be disturbed from project specific quantitative impact assessments. Therefore, the CEA results focus on projects with a quantitative impact assessment, while acknowledging that other projects are planned/expected.

Focusing on those projects for which a quantitative impact assessment is already available, there is expected to be disturbance to a maximum of 8,202 harbour porpoise per day in 2028 and 2029 (2.37% MU, 5.14% UK MU), assuming pile driving at Caledonia occurs concurrently with pile driving and dredging activities at the proposed development (Error! Reference source not found.). **Of this, the proposed development is predicted to contribute 0.01% of the disturbance impact.**

Including projects with no quantitative impact assessment available yet, the maximum number of harbour porpoise anticipated to be disturbed is in 2028, where the number increases slightly to 8,268 harbour porpoise per day (2.39% MU, 5.18% UK MU) (Table 30). **Of this, the proposed development is predicted to contribute 0.01% of the disturbance impact.**

It is expected that disturbance from construction activities across multiple projects is likely to occur at a low frequency or intensity, affecting a small proportion of the harbour porpoise population which has the potential to cause short-term changes in the population from baseline conditions[4]. Therefore, the magnitude has been assessed as **Low**.

Table 30: Harbour porpoise Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Construction, Dredging, Piling & Dredging.

[4] Note: no population modelling has been conducted for this CEA due to a lack of detailed information on potential piling schedules across projects.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Port	Pre-C	0	1	1	1	Operational					Yes
Invergordon Phase 5	Port	Pre-C	0	0	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	Port	0	0	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	22	22	Operational								No
Maintenance Dredging - Port of Cromarty Firth	Port	22	22	22	22	Operational						No
Dredging and Sea Deposit - Banff Harbour	Port	N/A	22	22	22	Operational						No
Maintenance Dredging and Deposit- Portsoy Harbour	Port	22	22	22	Operational							No
Buckie Maintenance Dredging and Deposit	Port	22	22	22	Operational							No
Portknockie Maintenance Dredging and Deposit	Port	22	22	Operational								No
Moray West	Fixed OWF	0	Intended to be operational from 2025									Yes
Caledonia	Fixed & Floating OWF	N/A			8201	8201		Intended to be operational from 2030				Yes
Shetland HVDC Link	Cable	22	Operational									No
Broadshore	Floating OWF	N/A				199	199	199	199	No		No
Sinclair	Floating OWF	N/A				199	199	199	199	No		No
Stromar	Floating OWF	N/A						199	199	199	199	No

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Fraserburgh Harbour Expansion	Port	N/A			22	22	22	22	22	Operational		No
Maintenance Dredging - Wick Harbour	Port	22	Operational									No
Orkney - Caithness 220 kV Link	Cable	0	0	0	0	Operational						Yes
Results of CEA												
All Projects	# Individuals	154	**132**	**89**	**8268**	**8622**	8621	619	619	199	199	**Yes & No**
	% MU	0.04%	**0.04%**	**0.03%**	**2.39%**	**2.49%**	2.49%	0.18%	0.18%	0.06%	0.06%	
	% UK MU	0.10%	**0.08%**	**0.06%**	**5.18%**	**5.40%**	5.40%	0.39%	0.39%	0.12%	0.12%	
	% Ardersier ETF	0.00%	**0.00%**	**1.12%**	**0.01%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	
Projects with a EIAR Available	# Individuals	0	**0**	**0**	**8202**	**8202**	8201	0	0	0	0	**Yes**
	% MU	0.00%	**0.00%**	**0.00%**	**2.37%**	**2.37%**	2.37%	0.00%	0.00%	0.00%	0.00%	
	% UK MU	0.00%	**0.00%**	**0.00%**	**5.14%**	**5.14%**	5.14%	0.00%	0.00%	0.00%	0.00%	
	% Ardersier ETF	0.00%	**0.00%**	**0.00%**	**0.01%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	

5.4.1.3 Significance of Effect

The sensitivity of harbour porpoise to disturbance from piling and other construction activities, including dredging, has been assessed as Low, and the magnitude of the cumulative impact has been assessed as Low. Therefore, the cumulative effect of disturbance from underwater noise is considered to be of **Negligible** significance, which is **Not Significant** with respect to the EIA Regulations.

5.4.2 Minke Whale

5.4.2.1 Sensitivity

Minke whale have been assessed as having a **Negligible** to **Low** sensitivity to disturbance from pile driving activities, dredging activities, and other construction activities which involve vessels to be present on-site.

5.4.2.2 Magnitude

Table 31outlines the number of minke whale predicted to be disturbed at each project in each year. The data have been split by whether a quantitative impact assessment is available as there is considerably more certainty in the number of animals predicted to be disturbed from project specific quantitative impact assessments. Therefore, the CEA results focus on projects with a quantitative impact assessment, while acknowledging that other projects are planned/expected.

Focusing on those projects for which a quantitative impact assessment is already available, there is expected to be disturbance to a maximum of 502 minke whales per day between 2028 and 2030 (2.49% MU, 4.88% UK MU). This assumes a 100% contribution from the Caledonia OWF.

Including projects with no quantitative impact assessment available yet increases this slightly to 519 minke whales per day (2.57% MU, 5.04% UK MU) (Error! Reference source not found.) between 2029 and 2030, outside of the construction window for the proposed development . **The proposed development is not expected to contribute to the cumulative disturbance of minke whale within the Moray Firth.**

It is expected that disturbance from construction activities across multiple projects is likely to occur at a low frequency or intensity, affecting a small proportion of the minke whale population which has the potential to cause short-term changes in the population from baseline conditions[5]. Therefore, the magnitude has been assessed as **Low**.

Table 31: Minke whale Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Construction, Dredging, Piling & Dredging.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Port	Pre-C	0	0	0	0	Operational					Yes
Invergordon Phase 5	Port	Pre-C	0	0	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	Port	0	0	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	1	1	Operational								No
Maintenance Dredging - Port of Cromarty Firth	Port	1	1	1	1	Operational						No
Dredging and Sea Deposit - Banff Harbour	Port	N/A	1	1	1	Operational						No
Maintenance Dredging and Deposit- Portsoy Harbour	Port	1	1	1	Operational							No
Buckie Maintenance Dredging and Deposit	Port	1	1	1	Operational							No
Portknockie Maintenance Dredging and Deposit	Port	1	1	Operational								No
Moray West	Fixed OWF	0	Intended to be operational from 2025									Yes
Caledonia	Fixed & Floating OWF	N/A			502	502	502	Intended to be operational from 2030				Yes

[5] Note: no population modelling has been conducted for this CEA due to a lack of detailed information on potential piling schedules across projects.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Shetland HVDC Link	Cable	1	Operational									No
Broadshore	Floating OWF	N/A				8	8	8	8	No		No
Sinclair	Floating OWF	N/A				8	8	8	8	No		No
Stromar	Floating OWF	N/A						8	8	8	8	No
Fraserburgh Harbour Expansion	Port	N/A			1	1	1	1	1	Operational		No
Maintenance Dredging - Wick Harbour	Port	1	Operational									No
Orkney - Caithness 220 kV Link	Cable	0	0	0	0	Operational						Yes
Results of CEA												
All Projects	# Individuals	0	**6**	**4**	**505**	**519**	519	25	25	8	8	**Yes & No**
	% MU	0.03%	**0.03%**	**0.02%**	**2.50%**	**2.57%**	2.57%	0.12%	0.12%	0.04%	0.04%	
	% UK MU	0.07%	**0.06%**	**0.04%**	**4.91%**	**5.04%**	5.04%	0.24%	0.24%	0.08%	0.08%	
	% Ardersier ETF	0.00%	**0.00%**	**0.00%**	**0.00%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	
Projects with a EIAR Available	# Individuals	0	**0**	**0**	**502**	**502**	502	0	0	0	0	**Yes**
	% MU	0.00%	**0.00%**	**0.00%**	**2.49%**	**2.49%**	2.49%	0.00%	0.00%	0.00%	0.00%	
	% UK MU	0.00%	**0.00%**	**0.00%**	**4.88%**	**4.88%**	4.88%	0.00%	0.00%	0.00%	0.00%	
	% Ardersier ETF	0.00%	**0.00%**	**0.00%**	**0.00%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	

5.4.2.3 Significance of Effect

The sensitivity of minke whale to disturbance from piling and other construction activities, including dredging, has been assessed as Negligible to Low, and the magnitude of the cumulative impact has been assessed as Low. Therefore, the cumulative effect of disturbance from underwater noise is considered to be of **Negligible** significance, which is **Not Significant** with respect to the EIA Regulations

5.4.3 Bottlenose dolphin

5.4.3.1 Sensitivity

Bottlenose dolphin have been assessed as having a **Low** sensitivity to disturbance from pile driving activities, dredging activities, and other construction activities which involve vessels to be present on-site.

5.4.3.2 Magnitude

Error! Reference source not found. outlines the number of bottlenose dolphin predicted to be disturbed at each project in each year. The data have been split by whether a quantitative impact assessment is available as there is considerably more certainty in the number of animals predicted to be disturbed from project specific quantitative impact assessments. Therefore, the CEA results focus on projects with a quantitative impact assessment, while acknowledging that other projects are planned/expected.

Focusing on those projects for which a quantitative impact assessment is already available, there is expected to be disturbance to a maximum of 60 bottlenose dolphins per day in 2028 and 2029 (25.64%

MU) (**Error! Reference source not found.**). This assumes concurrent piling, and/or concurrent piling and dredging activities from the Caledonia OWF and the proposed development . **Of this, the proposed development is predicted to contribute 13.33% of the disturbance impact.**

Including projects with no quantitative impact assessment available yet increases this slightly to 63 bottlenose dolphins per day (26.92% MU) (Table 32) in 2028 and 2029. **Of this, the proposed development is predicted to contribute 12.70% of the disturbance impact.**

Disturbance from construction activities associated with multiple projects is anticipated to occur at a low frequency and intensity, impacting a moderate portion of the bottlenose dolphin population. This may result in short-term deviations from baseline population conditions. The magnitude of potential cumulative effects is **Medium**.

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Table 32: Bottlenose dolphin Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Construction, Dredging, Piling & Dredging.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Port	Pre-C	8	8	8	8	Operational					Yes
Invergordon Phase 5	Port	Pre-C	0	0	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	Port	0	0	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	0	0	Operational								No
Maintenance Dredging - Port of Cromarty Firth	Port	0	0	0	0	Operational						No
Dredging and Sea Deposit - Banff Harbour	Port	N/A	0	0	0	Operational						No
Maintenance Dredging and Deposit- Portsoy Harbour	Port	0	0	0	Operational							No
Buckie Maintenance Dredging and Deposit	Port	0	0	0	Operational							No
Portknockie Maintenance Dredging and Deposit	Port	1	1	Operational								No
Moray West	Fixed OWF	0	Intended to be operational from 2025									Yes

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Caledonia	Fixed & Floating OWF	N/A			52	52	52	Intended to be operational since 2030				Yes
Shetland HVDC Link	Cable	2	Operational									No
Broadshore	Floating OWF	N/A				0	0	0	0	Operational		No
Sinclair	Floating OWF	N/A				0	0	0	0	Operational		No
Stromar	Floating OWF	N/A						2	2	2	2	No
Fraserburgh Harbour Extension	Port	N/A		3	3	3	3	3	Operational			No
Maintenance Dredging - Wick Harbour	Port	0	Operational									No
Orkney - Caithness 220 kV Link	Cable	0	0	0	0	Operational						Yes
Results of CEA												
All Projects	# Individuals	3	**9**	**8**	**63**	**63**	55	5	5	2	2	**Yes & No**
	% MU	1.28%	**3.85%**	**3.42%**	**26.92%**	**26.92%**	23.50%	2.14%	2.14%	0.85%	0.85%	
	% Ardersier ETF	0.00%	**88.89%**	**100%**	**12.70%**	**12.70%**	0.00%	0.00%	0.00%	0.00%	0.00%	
Projects with a EIAR Available	#Number of Individuals	0	**8**	**8**	**60**	**60**	52	0	0	0	0	**Yes**
	% MU	0.00%	**3.42%**	**3.42%**	**25.64%**	**25.64%**	22.22%	0.00%	0.00%	0.00%	0.00%	
	% Ardersier ETF	0.00%	**100%**	**100%**	**13.33%**	**13.33%**	0.00%	0.00%	0.00%	0.00%	0.00%	

5.4.3.3 Significance of Effect

The sensitivity of bottlenose dolphin to disturbance from piling and other construction activities, including dredging, has been assessed as Low, and the magnitude of the cumulative impact has been assessed as Medium. Therefore, the cumulative effect of disturbance from underwater noise is considered to be of **Minor** significance, which is **Not Significant** with respect to the EIA Regulations.

5.4.4 Harbour seal

5.4.4.1 Sensitivity

Harbour seals at-sea, and subject to underwater noise impacts, have been assessed as having a **Low** sensitivity to disturbance from pile driving activities, dredging activities, and other construction activities which involve vessels to be present on-site.

5.4.4.2 Magnitude

Table 33 outlines the number of harbour seals predicted to be disturbed at each project in each year. The data have been split by whether a quantitative impact assessment is available as there is considerably more certainty in the number of animals predicted to be disturbed from project specific quantitative impact assessments. Therefore, the CEA results focus on projects with a quantitative impact assessment, while acknowledging that other projects are planned/expected.

Focusing on those projects for which a quantitative impact assessment is already available, there is expected to be disturbance to a maximum of 105 harbour seals per day in 2027 (7.69% MU). **Of this, the proposed development is predicted to contribute 0.00% of the disturbance impact** (**Error! Reference source not found.**). It should be noted however, that in 2026, a maximum of 82 harbour seals are predicted to be impacted per day (6.01%). This represents similar levels of disturbance which are predicted to occur in 2028 and 2029. In 2026, **the proposed development is predicted to contribute 19.78% of the disturbance impact** (Table 33).

Including projects with no quantitative impact assessment available yet, the number of seals predicted to be disturbed increases to 352 harbour seals per day (25.79% MU) (Table 33) in 2026. **Of this, the proposed development is predicted to contribute 0.00% of the disturbance impact** (Table 33). However, when considering years for which the proposed development shall contribute to cumulative disturbance of harbour seals, the largest number of harbour seals disturbed per day occurs in 2027 (240 individuals, 17.58% MU, 9.58% contribution) when Invergordon Phase 5, the Port of Cromarty Firth, Banff Harbour, Portsoy Harbour, Buckie Harbour, and the Orkney-Caithness Cable Link are all constructing.

It is expected that disturbance from construction activities across multiple projects is likely to occur at a low frequency or intensity, but could impact a large proportion of the harbour seal population which has the potential to cause short-term changes in the population from baseline conditions[6]. Therefore, the magnitude has been assessed as **Medium**.

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Table 33: Harbour seal Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Construction, Dredging, Piling & Dredging.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Port	Pre-C	0	23	23	23	Operational					Yes
Invergordon Phase 5	Port	Pre-C	0	0	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	Port	0	0	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	109	109	Operational								No

[6] Note: no population modelling has been conducted for this CEA due to a lack of detailed information on potential piling schedules across projects.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Maintenance Dredging - Port of Cromarty Firth	Port	109	109	109	109	Operational						No
Dredging and Sea Deposit - Banff Harbour	Port	N/A	9	9	9	Operational						No
Maintenance Dredging and Deposit- Portsoy Harbour	Port	5	5	5	Operational							No
Buckie Maintenance Dredging and Deposit	Port	12	12	12	Operational							No
Portknockie Maintenance Dredging and Deposit	Port	26	26	Operational								No
Moray West	Fixed OWF	0	Intended to be operational from 2025									Yes
Caledonia	Fixed & Floating OWF	N/A			58	58	58	Intended to be operational from 2030				Yes
Shetland HVDC Link	Cable	1	Operational									No
Broadshore	Floating OWF	N/A				8	8	8	8	No		No
Sinclair	Floating OWF	N/A				8	8	8	8	No		No
Stromar	Floating OWF	N/A						8	8	8	8	No
Fraserburgh Harbour Expansion	Port	N/A			1	1	1	1	1	Operational		No
Maintenance Dredging - Wick Harbour	Port	1	Operational									No
Orkney - Caithness 220 kV Link	Cable	0	0	0	0	Operational						Yes
Results of CEA												
All Projects	# Individuals	267	**352**	**240**	**201**	**83**	60	3	3	1	1	**Yes & No**
	% MU	19.56%	**25.79%**	**17.58%**	**14.73%**	**6.08%**	4.40%	0.22%	0.22%	0.07%	0.07%	

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
	% Ardersier ETF	0.00%	**0.00%**	**9.58%**	**11.44%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	
Projects with a EIAR Available	# Individuals	0	**82**	**105**	**81**	**81**	58	0	0	0	0	Yes
	% MU	0.00%	**6.01%**	**7.69%**	**5.93%**	**5.93%**	4.25%	0.00%	0.00%	0.00%	0.00%	
	% Ardersier ETF	0.00%	**0.00%**	**0.00%**	**28.40%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	

5.4.4.3 Significance of Effect

The sensitivity of harbour seals to disturbance from piling and other construction activities, including dredging, has been assessed as Low, and the magnitude of the cumulative impact has been assessed as Medium. Therefore, the cumulative effect of disturbance from underwater noise is considered to be of **Minor** significance, which is **Not Significant** with respect to the EIA Regulations

5.4.5 Grey seal

5.4.5.1 Sensitivity

Grey seals at-sea, and subject to underwater noise impacts, have been assessed as having a **Negligible** to **Low** sensitivity to disturbance from pile driving activities, dredging activities, and other construction activities which involve vessels to be present on-site.

5.4.5.2 Magnitude

Table 34 outlines the number of grey seals predicted to be disturbed at each project in each year. The data have been split by whether a quantitative impact assessment is available. There is considerably more certainty in the number of animals predicted to be disturbed from project specific quantitative impact assessments. Therefore, the CEA results focus on projects with a quantitative impact assessment, while acknowledging that other projects are planned/expected.

Focusing on those projects for which a quantitative impact assessment is already available, there is expected to be disturbance to a maximum of 2,273 grey seals in 2028 and 2029 (42.22% MU). **Of this, the proposed development is predicted to contribute 1.63% (37 individuals) of the disturbance impact**, in combination with the Caledonia OWF (Table 34).

Including projects with no quantitative impact assessment available yet, the maximum number of grey seals predicted to be impacted this increases to 2,378 grey seals (42.72% MU) (Table 34) in 2029. **Of this, the proposed development is predicted to contribute 1.61% of the disturbance impact**, in combination with the Caledonia OWF, Fraserburgh Harbour Development, and dredging activities within the Port of Cromarty Firth harbour limits and at Banff harbour (Table 34).

It is expected that disturbance from construction activities across multiple projects is likely to occur at a low frequency or intensity, but a significantly large proportion of the grey seal population which has the potential to cause short--term changes in the population from baseline conditions[7]. However, as the largest contributions to grey seal disturbance arise from a single project, the risks of cumulative disturbance are low. Therefore, the magnitude has been assessed as **Medium**.

Table 34: Grey seal Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Construction, Dredging, Piling & Dredging

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Port	Pre-C	1	37	37	37	Operational					Yes
Invergordon Phase 5	Port	Pre-C	0	0	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	Port	0	0	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	Port	4	4	Operational								No
Maintenance Dredging - Port of Cromarty Firth	Port	4	4	4	4	Operational						No
Dredging and Sea Deposit - Banff Harbour	Port	N/A	7	7	7	Operational						No
Maintenance Dredging and Deposit- Portsoy Harbour	Port	13	13	13	Operational							No
Buckie Maintenance Dredging and Deposit	Port	2	2	2	Operational							No
Portknockie Maintenance Dredging and Deposit	Port	361	361	Operational								No
Moray West	Fixed OWF	0	Intended to be operational from 2025									Yes
Caledonia	Fixed & Floating OWF	N/A			2236	2236	2236	Intended to be operational from 2030				Yes
Shetland HVDC Link	Cable	31	Operational									No

[7] Note: no population modelling has been conducted for this CEA due to a lack of detailed information on potential piling schedules across projects.

Proposed Development	Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Broadshore	Floating OWF	N/A				43	43	43	43	No		No
Sinclair	Floating OWF	N/A				46	46	46	46	No		No
Stromar	Floating OWF	N/A						221	221	221	221	No
Fraserburgh Harbour Expansion	Port	N/A			16	16	16	16	16	Operational		No
Maintenance Dredging - Wick Harbour	Port	13	Operational									No
Orkney-Caithness 220 kV Link	Cable	0	0	0	0	Operational						Yes
Results of CEA												
All Projects	# Individuals	428	**391**	**63**	**2300**	**2378**	2341	326	326	221	221	**Yes & No**
	% MU	7.95%	**7.26%**	**1.17%**	**42.72%**	**44.17%**	43.48%	6.05%	6.05%	4.10%	4.10%	
	% Ardersier ETF	0.00%	**0.00%**	**58.73%**	**1.61%**	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	
Projects with a EIAR Available	# Individuals	0	**0**	**37**	**2273**	**2273**	2236	0	0	0	0	**Yes**
	% MU	0.00%	**0.00%**	**0.69%**	**42.22%**	**42.22%**	41.53%	0.00%	0.00%	0.00%	0.00%	
	% Ardersier ETF	0.00%	**0.00%**	**0.00%**	**1.63%**	**1.63%**	0.00%	0.00%	0.00%	0.00%	0.00%	

5.4.5.3 Significance of Effect

The sensitivity of grey seals to disturbance from piling and other construction activities, including dredging, has been assessed as Negligible to Low, and the magnitude of the cumulative impact has been assessed as Medium. Therefore, the cumulative effect of disturbance from underwater noise is considered to be of **Negligible** to **Minor** significance, which is **Not Significant** with respect to the EIA Regulations**.**

5.4.6 Summary

For all marine mammal species, the sensitivity has been assessed as Negligible to Low, or Low. The magnitude of impact has been assessed as Low or Medium for all species. This has resulted in the significance of effects being **Negligible** or **Minor** for each species. Overall, this is **Not Significant** in EIA terms.

Table 35: Summary of the impact assessment for cumulative disturbance from piling and dredging

Species	Sensitivity	Magnitude	Impact Significance	% contribution of Ardersier to total CEA

				disturbance (in year with max impact)
Harbour porpoise	Low	Low	Negligible (not significant)	<0.1%
Minke whale	Negligible – Low	Low	Negligible (not significant)	0.00%
Bottlenose dolphin	Low	Medium	Minor (not significant)	12.70%
Harbour seal	Low	Medium	Minor (not significant)	24.58%
Grey seal	Negligible – Low	Medium	Negligible – Minor (not significant)	3.78%

5.5 Disturbance from Vessels (Construction)

5.5.1 Sensitivity

As assessed for the proposed development alone (Section 3.5.2 of Appendix 11.4 the sensitivity of all marine mammals to disturbance from vessel activity is assessed as Low, with the exception of minke whales, which were assessed as Medium. For hauled-out seals, the sensitivity of grey seals to disturbance to haul-outs, is classified as Low outside of the breeding season and Medium during the breeding season. For hauled-out harbour seals, the sensitivity has been assessed as Medium during and outside the breeding and moult seasons.

5.5.2 Magnitude

It is challenging to reliably quantify the level of increased disturbance to marine mammals resulting from increased vessel activity on a cumulative basis, given the large degree of temporal and spatial variation in vessel movements between projects and regions, coupled with the spatial and temporal variation in marine mammal movements across the region.

Although construction vessels may transit to and from varying locations, at variable speeds depending on where they are located in the seascape (e.g., slower speeds are likely in more coastal areas, compared with offshore), vessels often travel in predictable routes. Further, vessel type plays an important role in vessel speed. For example, in offshore windfarm construction, jack-up vessels, and pilot or attending vessels travel more slowly within the wind farm site or spend long periods of time jacked-up at anchor, minimising movement and acoustic signature from engines and the use of dynamic positioning systems. In addition, during dredging activities at port and harbour development, the type of dredging vessel being utilised plays an important role in underwater noise generation. Hydraulic dredges, like cutter suction dredges, tend to produce more continuous, lower-frequency sounds, while mechanical dredges, such as clamshell or backhoe dredges, create more impulsive, higher-frequency noises. Unfortunately, there are very few species-specific studies covering these vessel types that capture vessel movement patterns as well as their acoustic signatures and the corresponding response of marine mammals.

Vessel routes to and from offshore developments will, for the majority, use existing vessel routes for pre-existing vessel traffic which marine mammals will be accustomed to. They may also have become habituated to the volume of regular vessel movements and therefore the additional risk is predominantly confined to construction sites. The vessel movements for offshore construction are likely to be limited and slow, resulting in less risk of disturbance to marine mammal receptors. In addition, most projects are likely to adopt NRAs and/or comply with the existing Scottish Marine Wildlife Watching Codes such as SNH (2017b) and SNH (2017a) to minimise any potential effects on marine mammals.

To strengthen the cumulative assessment, known construction vessel activity from current and upcoming regional projects has been considered. At Nigg South Quay, a total of 482 construction vessel movements are projected over a 6-month period between 2025 and 2026 (EnviroCentre Limited 2019). At Invergordon, approximately 272 one-way construction vessel movements are anticipated over a 3-year period (2025–2027), translating to an estimated 90–120 movements per year, including transits to and from the dredge disposal site during 2026–2027 (Affric 2025). The proposed development is expected to contribute significantly to temporary increases in vessel activity, with a worst-case scenario involving up to 11 vessels present simultaneously (including dredging and barge delivery operations). During peak spoil disposal operations over a 10-week period, 13–23 barge movements per day may occur, potentially resulting in up to ~450 additional vessel movements within the inner Moray Firth.

An assessment of construction timeframes indicates that there is temporal overlap between Nigg South Quay and Invergordon, with both projects expected to be under construction during 2025–2026. There is also some overlap between the proposed development , Invergordon Phase 5 and Nigg South Quay in 2026. However, the greatest potential for temporal overlap persists in 2027 when the proposed development and Invergordon Phase 5 projects shall be in peak construction periods. This overlap presents the highest potential for cumulative marine mammal disturbance, particularly in the Cromarty Firth area, due to increased vessel movements associated with concurrent dredging and port development activity.

Although construction vessels will be moving throughout the Moray Firth, the impact is considered to be localised to the vicinity of the moving vessel and only when the vessel is moving or stationary with the engine running. The impact will therefore be temporary. Due to the number of projects included within the CEA and the frequency of overlapping timescales, it is likely that the effect will occur at moderate frequency. Although it could affect a small proportion of respective populations across the duration of the construction, it is unlikely to alter population trajectories in the long-term due to the fact that it will be taking place in areas already characterised by relatively high vessel traffic. It is anticipated that any animals displaced from the area will return once vessels leave. As such, the magnitude of the cumulative disturbance from vessels during construction is assessed as **Low**.

5.5.3 Significance of Effect

The sensitivity of all marine mammals, including hauled-out grey seals outside of the breeding and moulting season, to disturbance from vessel activity is assessed as Low, with the exception of minke whales, hauled-out harbour seals, and hauled-out grey seals during the breeding and moulting season, which were assessed as Medium. The magnitude of the cumulative disturbance from vessels during construction is assessed as Low. Therefore, the significance of effect is assessed as **Negligible, Not Significant** for all marine mammals, including hauled-out grey seals outside of the breeding and moulting season, with the exception of minke whales, hauled-out harbour seals, and hauled-out grey seals during the breeding and moulting season, where the significance of effect is assessed as **Minor,** which is **Not Significant** in EIA terms.

Table 36: Summary of significance of effects from cumulative vessel disturbance during construction, on marine mammal receptors

Species	Sensitivity	Magnitude	Significance
Harbour porpoise	Low	Low	Negligible (not significant)
Minke whale	Medium	Low	Minor (not significant)**)**
Bottlenose dolphin	Low	Low	Negligible (not significant)
Harbour seal	Low	Low	Negligible (not significant)
Grey seal	Low	Low	Negligible (not significant)
Hauled-out seals	Grey seals during breeding/moult: Medium	Low	Minor (not significant)
	Grey seals outside breeding/moult: Low		Negligible (not significant)
	Harbour seals: Medium		Minor (not significant)

5.5.4 Secondary Mitigation

The project has already committed to the adoption of an NRA, and no additional mitigation measures are required to reduce the significance of the impact.

5.5.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

5.6 Disturbance from Vessels (Operational)

5.6.1 Sensitivity

As assessed for the proposed development alone (Section 4.2.1 of Appendix 11.4), the sensitivity of all marine mammals to disturbance from vessel activity is assessed as Low, with the exception of minke whales, which were assessed as Medium. For seals at their haul-out sites, the sensitivity was classed as Low outside of the breeding season and Medium during the breeding season.

5.6.2 Magnitude

Within the Cromarty Firth Harbour Authority limits - covering Deephaven, Nigg South Quay, and Invergordon - movements of vessels greater than 50 gross tonnes averaged approximately 882 movements per year (2019–2023), with fluctuations depending on OWF project activities (Affric 2025). Recent data for the Cromarty Firth shows an average 786 vessel movements were recorded in 2023, with monthly peaks reaching up to 150 vessel movements, resulting in an overall annual traffic volume that can approach or exceed 1,000 vessel movements per year (Affric 2025). It is important to note that within this data, vessels under 50 gross tonnes, including pilot, safety, and recreational vessels, are not recorded but are expected to contribute further to overall vessel presence (Affric 2025). Including the current volume of vessel traffic associated with vessel calls at the Cromarty Firth Ports

(~1,000), the Port of Ardersier (~340) and at the Port of Inverness (~200)[8], baseline vessel movements in the inner Moray Firth amount to approximately ~1,540 movements per year.

At the individual port level, operational vessel movements at Nigg South Quay are projected to increase modestly from a 2019 baseline of approximately 220 movements per year to around 246–255 movements per year, representing an increase of 26–35 additional vessel calls annually (EnviroCentre Limited 2019). For the proposed development, vessel movements are anticipated to increase to 400 vessel calls per year as a maximum worst-case scenario, representing an increase of ~60 additional vessel calls from current annual movements. By contrast, Invergordon is expected to operate at a higher intensity that both Nigg South Quay and the Port of Ardersier, with a worst-case scenario estimating 468 vessel movements per year, the majority of which (420) are tug operations (Affric 2025). However, there is expected to be no overall change to the number of typical operation vessel movements across all Cromarty Firth Ports (other than for Nigg South Quay). No data on anticipated vessel movements are available for the Port of Inverness.

Taking the combined operational activity across the Port of Ardersier, Port of Inverness, Nigg South Quay, Invergordon, and those within the Cromarty Firth Harbour Authority Limits (which includes those at Deephaven and the Cromarty (Car Ferry) Slipway), the total annual vessel movements within the inner Moray Firth are expected to reach approximately ~1,635 vessel movements per year. This represents a small increase in vessel presence within the Moray and Cromarty Firth regions, with associated potential for disturbance to marine mammals known to inhabit or transit these waters.

The increase in vessel movements is likely to elevate underwater noise levels and cause behavioural disturbance, particularly in areas where vessel traffic is concentrated. While many vessel transits will follow existing navigational routes (routes to which local marine mammals may be habituated) the scale and increased frequency of movements shall be small. Operational vessels tend to maintain consistent transit speeds and established routes, limiting variability in acoustic disturbance. However, the sheer volume of vessels, including numerous tug operations at Invergordon and increased offshore renewable industry construction and/or support vessels in the inner Moray Firth and arriving the Port of Ardersier, Nigg South Quay and Invergordon, may contribute to heightened cumulative disturbance pressures, particularly during periods of peak activity.

The projected increase in vessel movements within the inner Moray Firth is expected to result in approximately ~1,635 annual vessel movements, compared to a recent baseline of ~1,540. While the proposed development's contributions to these figures are small, this represents a small increase in vessel presence associated with operational activities at the Port of Ardersier, Nigg South Quay, Invergordon, Inverness, and other Cromarty Firth Harbour Authority facilities. The increase in vessel traffic is regional in extent (covering the Moray and Cromarty Firths) and of a long-term, ongoing duration, with the potential to influence areas regularly used by marine mammals for foraging and transit. Disturbance and underwater noise exposure are expected to increase, particularly in concentrated activity areas (e.g., tug operations at Invergordon, offshore wind support at Ardersier and Nigg). While this represents only a small rise in vessel activity, the consequences for marine mammal populations remain uncertain, particularly for the two qualifying features of nearby designated sites. For the resident bottlenose dolphin population of the Moray Firth SAC, the cumulative effect of increased vessel presence may contribute to behavioural disturbance, though it is unclear whether this would occur at a scale sufficient to alter population dynamics. For harbour seals, which are in decline regionally and make use of the designated haul-out site at Whiteness Sands, as well as the Dornoch Firth and Morrich More SAC, additional disturbance pressures may be of greater concern given their reduced resilience and reliance on nearshore haul-out sites close to

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[8] https://portofinverness.co.uk/wp-content/uploads/2023/03/Annual-Report-2022.pdf

existing vessel routes. Accordingly, while the projected increase in vessel traffic during the operational phase is considered small, the extent to which current vessel activity has already resulted in measurable impacts is unknown. This limits confidence in determining whether cumulative vessel disturbance could reach thresholds of biological significance for these populations. Thus, based on the information available, the scale and persistence of vessel traffic assume a **Medium** magnitude of impact for bottlenose dolphins and harbour seals. For harbour porpoise, minke whale and grey seals, the magnitude of impact is assessed as **Low.**

5.6.3 Significance of Effect

The sensitivity of all marine mammals to disturbance from vessel activity is assessed as Low, with the exception of minke whales, which were assessed as **Medium**. The magnitude of the cumulative disturbance from vessels during operation is assessed **Medium** for bottlenose dolphins and harbour seal, and **Low** for harbour porpoise, minke whale and grey seal. Therefore, the significance of effect is assessed as **Minor (Not Significant)** for minke whale, bottlenose dolphins and harbour seal, and **Negligible (Not Significant)** for harbour porpoise and grey seal.

The expected rise in traffic within already active shipping corridors and port areas underscores the importance of continued implementation of mitigation measures, including adherence to marine mammal awareness protocols (incorporated in NRAs) and compliance with relevant wildlife-watching guidelines (i.e., SNH (2017b)) to minimise potential adverse effects. However, adherence to existing protocols alone may not be sufficient. There remains considerable uncertainty around the behavioural responses of marine mammals—particularly bottlenose dolphins and seals in the inner Moray Firth—to increased and cumulative acoustic and physical disturbance from vessels. To better understand and manage these impacts, enhanced monitoring is essential. This may focus on quantifying changes in bioacoustic space, bioavailable habitat, and the extent of highly ensonified zones, which may compromise marine mammal communication, foraging, and other key behaviours. These insights may, in turn, necessitate additional, adaptive mitigation measures to protect these sensitive species effectively.

Table 37: Summary of significance of effects from cumulative vessel disturbance during the operational phase, on marine mammal receptors

Species	Sensitivity	Magnitude	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant)
Minke whale	Medium	Low	Minor (Not Significant)
Bottlenose dolphin	Low	Medium	Minor (Not Significant)
Harbour seal	Low	Medium	Minor (Not Significant)
Grey seal	Low	Low	Negligible (Not Significant)

5.6.4 Secondary Mitigation

The project has already committed to the adoption of an NRA, and no additional mitigation measures are required to reduce the significance of the impact.

5.6.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains Non-Significant in EIA terms.

5.7 Disturbance to Seal Haul-Out Sites

5.7.1 Sensitivity

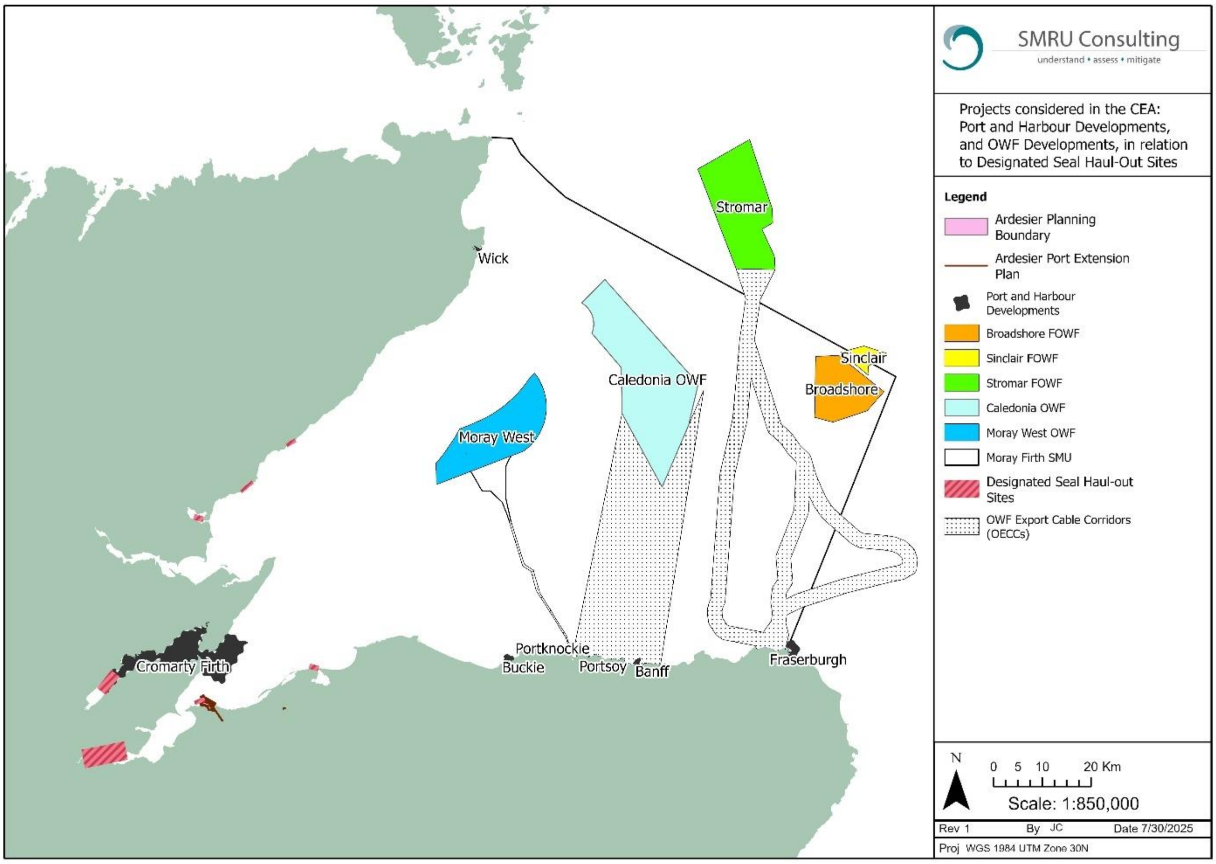
As assessed for the proposed development alone in Section 3.5.2 of Appendix 11.4, the sensitivity of seals at their haul-out sites has been assessed as **Low** (outside the breeding and moult period) to **Medium** (during the breeding and moult period).

5.7.2 Magnitude

It is difficult to reliably quantify the level of increased disturbance to seals resulting from increased vessel activity around haul-out sites on a cumulative basis. This is due to the large degree of spatial and temporal variation in vessel movements between projects in the Moray Firth, and the spatial and temporal variation in seal haul-out sites within the Moray Firth themselves. However, it is expected that the greatest additive effect to disturbance at haul-out sites would come from projects located along coastal areas within the Moray Firth. This includes the proposed development, Invergordon Phase 5, Port of Nigg East Quay, any dredging related Port Development, and the Fraserburgh Harbour Development.

In the Moray Firth, there are seven designated seal haul-out sites based on August counts (Figure 10) and three seasonal grey seal breeding sites and, therefore, vessel traffic near these haul-out sites could be increased as a result of activities from these OWFs which has the potential to increase the level of disturbance.

Figure 10: Projects considered in the CEA for impacts on designated seal haul-out sites. It should be noted that the Cromarty Firth harbour development area (as shown by its Harbour Authority Limits in the figure) includes the Invergordon Phase 5, Cromarty Firth Maintenance Dredging and Port of Nigg Developments.



The majority of port and/or harbour developments within the Moray Firth are located >10 km from the designated seal haul-out sites, except for the proposed development and for developments located within the Cromarty Firth harbour limits (Invergordon Phase 5, Cromarty Firth Maintenance Dredging and Port of Nigg Developments). Therefore, cumulative effects cannot be excluded at the Ardersier and Cromarty Firth designated haul-out sites.

Further, there are many seal haul-out sites at various locations outside these designated sites within the Moray Firth. Seals hauled-out at these non-designated sites also have the potential be disturbed by vessels transiting to and from development areas. All major ports, except Ardersier, are located approximately 1 km or further from locations where haul-out counts have been made (Table 38). Both Cromarty and Nigg are in close proximity to multiple haul-out locations: those at the Port of Nigg are the closest but there are also several more in the Cromarty Firth and Nigg (primarily grey seals) and at Ardersier (primarily harbour seals). However, vessel traffic will not be a novel occurrence in major port areas and, therefore, it is expected that seals in these areas are habituated to vessel movements nearby when considering the small increase in vessel traffic during construction.

Table 38: Proximity of port and harbours with prospective construction activities within the Moray Firth to designated seal haul-out sites, seasonal grey seal haul-out sites and August haul-out count locations

Port or Harbour	Designated Haul-Out Site		Harbour Seal August Count Location		Grey Seal August Count Location	
	Haul-Out Site	Distance	Haul-Out Site	Distance	Haul-Out Site	Distance
Wick	Duncansby – Wick	20.0 km	Wick	4.0 km	Noss Head	4.0 km

Invergordon	Cromarty Firth	8.9 km	Cromarty Firth	8.9 km	Nigg	10.1 km
Cromarty	Ardersier	11.0 km	Nigg	3.0 km	Nigg	2.0 km
Port of Nigg	Ardersier	12.0 km	Nigg	2.0 km	Nigg	1.0 km
Ardersier	Ardersier	0.5 km	Ardersier	0.5 km	Ardersier	0.5 km
Fraserburgh	Findhorn	97.9 km	Sandhaven	2.5 km	Sandhaven	2.0 km
Banff	Findhorn	66.7 km	Buckie	23.9 km	Craigenroan	23.4 km
Portsoy	Findhorn	56.1 km	Buckie	16.1 km	Craigenroan	30.9 km
Portknockie	Findhorn	46.1 km	Buckie	6.0 km	Craigenroan	20.9 km
Buckie	Findhorn	41.1 km	Buckie	2.5 km	Craigenroan	2.0 km

Vessel routes to and from offshore developments will, for the majority, use existing vessel routes for pre-existing vessel traffic which marine mammals will be accustomed to. They may also have become habituated to the volume of regular vessel movements and therefore the additional risk is predominantly confined to construction sites. The vessel movements for offshore construction are likely to be limited and slow, resulting in less risk of disturbance to marine mammal receptors. In addition, most projects are likely to adopt NRAs and/or comply with the existing Scottish Marine Wildlife Watching Codes such as SNH (2017b) and SNH (2017a) to minimise any potential effects on marine mammals.

Although construction vessels will be moving throughout the Moray Firth, the impact is considered to be localised to the vicinity of the moving vessel and only when the vessel is moving close to seal haul-out locations. Due to the number of projects included within the CEA and the frequency of overlapping timescales, it is likely that the effect will occur at moderate frequency. Although it could affect a small proportion of respective populations across the duration of the construction, it is unlikely to alter population trajectories in the long-term due to the fact that it will be taking place in areas already characterised by relatively high vessel traffic. Further, embedded mitigation measures such as NRAs shall ensure construction vessels routinely use specified transit routes. As such, it is unlikely that cumulative disturbance to haul-outs could alter harbour and grey seal population trajectories and magnitude of the disturbance to haul-outs is assessed as **Low** during construction.

5.7.3 Significance of Effect

The sensitivity of seals at their haul-out sites has been assessed as Low (outside breeding and moult) to Medium (during breeding and moult). The magnitude of the disturbance to haul-outs is assessed as Low during construction. Therefore, the significance of effect is assessed as **Negligible** (outside breeding and moult) to **Minor** (during breeding and moult)**,** which is **Not Significant** in EIA terms.

Table 39: Summary of significance of effects from cumulative disturbance to seal haul-out sites during construction

Species	Sensitivity	Magnitude	Significance
Hauled-out seals	During breeding/moult: Medium	Low	Minor (not significant)
	Outside breeding/moult: Low		Negligible (not significant)

5.7.4 Secondary Mitigation

The project has already committed to the adoption of an NRA, and no additional mitigation measures are required to reduce the significance of the impact.

5.7.5 Residual Effect

As no additional mitigation commitments are required, the residual effect remains **Non-Significant** in EIA terms.

6 Glossary of Terms, Acronyms and Abbreviations

Term	Description
ADD	Acoustic Deterrent Device
CEA	Cumulative Effects Assessment
CES MU	Coastal East Scotland Management Unit
CGNS MU	Celtic and Greater North Sea Management Unit
CSD	Cutter Suction Dredger
dB	Decibel
dB re 1 µPa	Decibel referenced to 1 micropascal (underwater sound pressure unit)
dB re 1 $\mu Pa^2 s$	Decibel referenced to 1 micropascal squared per second (used in SEL)
DPH	Detection Positive Hours
EDR	Effective Deterrence Range
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EPS	European Protected Species
ETF	Energy Transition Facility
HRA	Habitats Regulations Appraisal
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
kJ	kilojoules
km	Kilometres
L_p	Sound Pressure Level
$L_{p,pk}$	Peak Sound Pressure Level
L_{rms}	Root Mean Square Sound Pressure Level
m	Metres

MF SMU	Moray Firth Seal Management Unit
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Mammal Observer
MU	Management Unit
NMFS	National Marine Fisheries Service (USA)
NS MU	North Sea Management Unit
NRA	Navigational Safety Risk Assessment
OSPAR	Oslo-Paris Convention (for Protection of the Marine Environment of the North-East Atlantic)
OWF	Offshore Windfarm
PAHS	Polyaromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PCBs	Polychlorinated Biphenyls
PCOD	Population Consequences of Disturbance
PTS	Permanent Threshold Shift
RAL	Revised Action Levels
RMS	Root Mean Square
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance in the North Sea and Adjacent Waters
SCOS	Scientific Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SHB	Split Hopper Barges
SMU	Seal Management Unit
SNCB	Statutory Nature Conservation Body
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
spm	Strikes per minute
TBT	Tributyl Tin
TSHD	Trailer Suction Hopper Dredger
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance

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ARDERSIER PORT
ENERGY TRANSITION FACILITY
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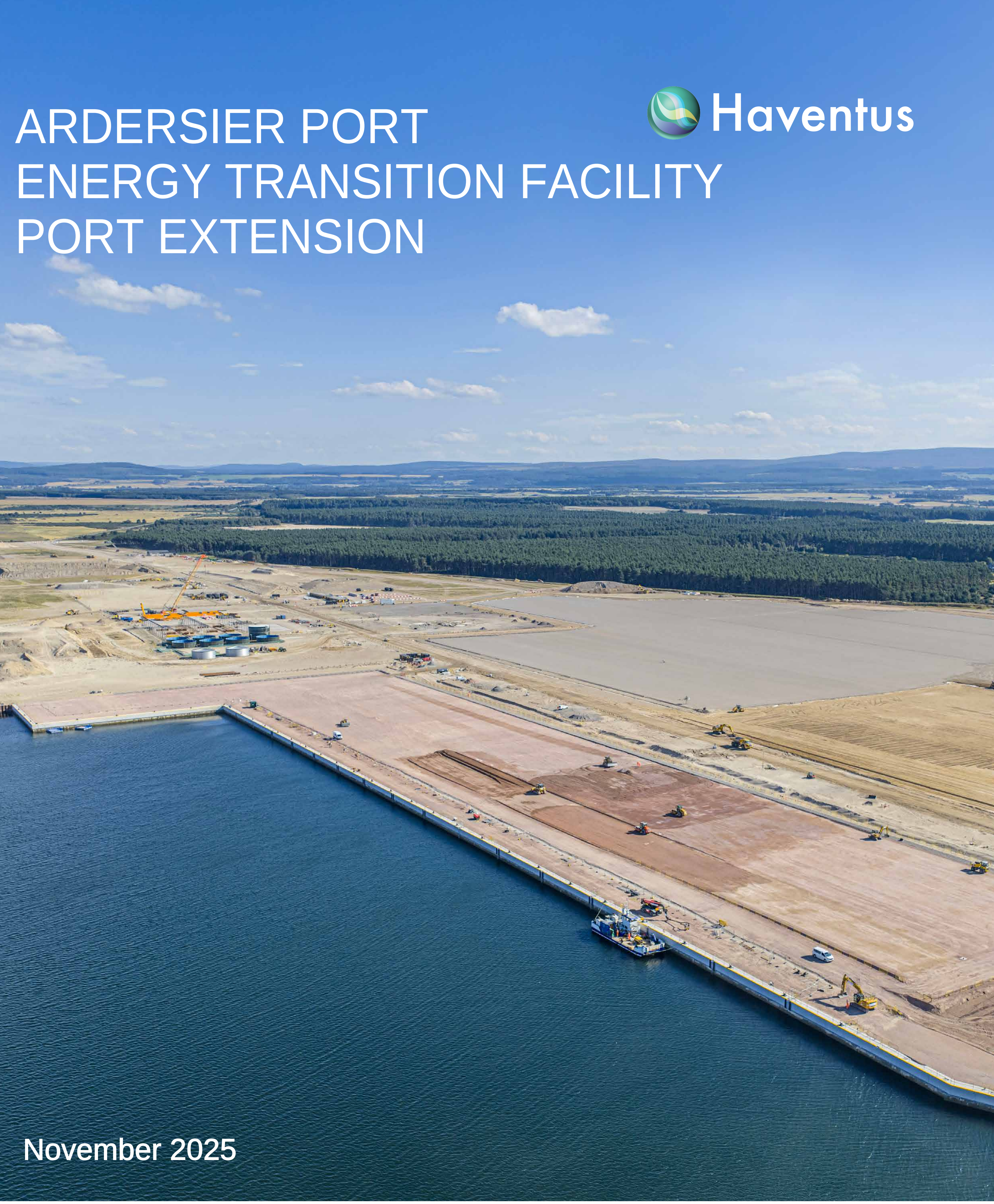

November 2025

Appendix 11.5: Underwater Noise Modelling Assessment

Construction Works – Port of Ardersier: Underwater Noise Modelling Assessment

Issy Morgan

12th August 2025

Subacoustech Environmental Report No. P430R0101

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Executive Summary

An assessment of the likely effect of underwater noise on marine mammals and fish from planned construction works at the Port of Ardersier, Scotland, has been undertaken by Subacoustech Environmental Ltd. The assessment covers the noise generated from impact piling, vibropiling and cutter suction dredging. Detailed numerical noise propagation modelling of the survey was used to generate noise contours, which were then used to predict the likely impact ranges to the relevant noise exposure criteria for marine mammals and fish.

The results have been interpreted using the guidelines provided in Southall *et al.* (2019), NMFS (2024) and NOAA (2005) for marine mammals, and Popper *et al.* (2014) for fish. These interpretations are based on worst-case parameters with no implemented mitigation measures.

The most sensitive marine mammal species, harbour porpoise, are likely to exceed the permanent auditory injury onset if they are 60 m from impact piling at maximum energy, based on the instantaneous criteria, but in practice marine mammals would be expected to flee from the piling position and would be much further than this distance by the time maximum energy is reached. As a result, when considering the cumulative exposure criteria, any marine mammal species would have to be less than 10 m from the pile at the commencement of piling soft start for the criteria to be exceeded. It is unlikely that vibropiling or dredging will cause permanent auditory injury at any distance from the source for all marine mammal species. Marine mammals are likely to be at risk of disturbance at 2900 m from vibropiling, 2500 m from dredging, and 1000 m from impact piling.

Fish, such as salmon, trout, herring, cod, sprat and shad are predicted to be at risk of mortality if they are at 30 m of impact piling. All fish are at low risk of mortality at any distance from vibropiling or dredging, however, fish such as herring, cod, sprat and shad at risk of recoverable injury if they are within 20 m from the vibropiling, or within < 10 m from dredging.

Note that the modelling calculations and predicted impact ranges will produce results that should be considered indicative of the potential onset of effects on receptors during the works and should not be considered as absolute ranges.

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Terminology

Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. The dB represents a ratio/comparison of a sound measurement (e.g., sound pressure) over a fixed reference level. The dB symbol is followed by a reference value (e.g., re 1 µPa).
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Permanent Threshold Shift (PTS)	Noise threshold that represents the onset level of a permanent impairment hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Root Mean Square (RMS)	The square root of the arithmetic average of a set of squared instantaneous values. Used for presentation of an average sound pressure level.
Sound Exposure Level (SEL or $L_{E,p}$)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Exposure Level, cumulative (SEL_{cum} or $L_{E,p,t}$)	Single value for the collected, combined total of sound exposure over a specified time or multiple instances of a noise source.
Sound Exposure Level, single strike (SEL_{ss})	Calculation of the sound exposure level representative of a single noise impulse, typically a pile strike.
Sound Pressure Level (SPL or L_p)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 µPa for water and 20 µPa for air.
Sound Pressure Level Peak (SPL_{peak} or $L_{p,pk}$)	The highest (zero-peak) positive or negative sound pressure, in decibels.
Temporary Threshold Shift (TTS)	Onset threshold level for a temporary reduction of hearing acuity caused by exposure to sound over time.
Unweighted sound level	Sound levels which are “raw” or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a “auditory weighting function” or “weighting envelope” in the frequency domain, typically to make an unweighted level relevant to a particular species.

Units

dB	Decibel (sound pressure)
Hz	Hertz (frequency)
kg	Kilogram (mass)
kJ	Kilojoule (energy)
kHz	Kilohertz (frequency)
km	Kilometre (distance)
kW	Kilowatt (power)
m	Metre (distance)
mm	Millimetre (distance)
mms^{-1}	Millimetres per second (particle velocity)
ms^{-1}	Metres per second (speed)
Pa	Pascal (pressure)
Pa^2s	Pascal squared seconds (acoustic energy)
µPa	Micropascal (pressure)

Acronyms

CSD	Cutter Suction Dredging
EMODnet	European Marine Observation and Data Network
HF	High-Frequency Cetaceans
LF	Low-Frequency Cetaceans
MHWS	Mean High Water Springs
PCW	Phocid Carnivores in Water
PW	Phocid Pinnipeds in Water
PPV	Peak Particle Velocity
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SE	Sound Exposure
SEL ($L_{E,p}$)	Sound Exposure Level
SEL_{cum} ($L_{E,p,t}$)	Cumulative Sound Exposure Level
SEL_{ss} ($L_{E,p,s}$)	Single Strike Sound Exposure Level
SPL (L_p)	Sound Pressure Level
SPL_{peak} ($L_{p,pk}$)	Peak Sound Pressure Level
SPL_{RMS} ($L_{p,RMS}$)	Root Mean Square Sound Pressure Level
TSHD	Trailer Suction Hopper Dredging
TTS	Temporary Threshold Shift
VHF	Very High-Frequency Cetaceans

1 Introduction

1.1 Project Overview

Subacoustech Environmental have been requested by SMRU Consulting to undertake an underwater noise modelling assessment for the planned construction works at the Port of Ardersier in the Moray Firth, Scotland, UK.

The construction works are part of plans to expand the port to facilitate the growing demand in port space from the offshore wind industry. The anticipated works plan to install 34 steel tubular piles, which may require the use of impact piling, vibratory (vibro) piling or a combination of both techniques. Deepening of the inner harbour is also planned to use both trailer suction hopper dredging (TSHD) or cutter suction dredging (CSD) in an area near the pile installation site.

An underwater noise assessment is required to consider the potential impact from the noise generated from the works on all marine mammals and fish in the region. This report provides the results of a detailed modelling assessment for piling and dredging activities associated with the works. The modelling has been used to predict the received sound pressure levels and sound exposure levels generated during these noise-generating activities in the region, which are then used to assess the potential impacts for marine mammals and fish.

1.2 Noise Sources

Underwater noise sources that could impact marine fauna, and have therefore been included in the assessment are:

- Impact piling
- Vibropiling
- Dredging

Since CSD is louder than TSHD, only CSD was considered in the assessment, as a worst-case scenario. Details of the input parameters used for the modelling of each of these sources in the assessment are presented in Section 3.1.5.

1.3 Study Area

The area associated with the piling and dredging activities are shown in Figure 1-1. The area is strongly tidal, with tidal levels of a maximum astronomical tidal range of 4.6 m, a mean spring tidal range of 3.3 m and mean neap tidal range of 1.6 m. The area shows bathymetry which gradually gets deeper towards the North Sea, and deep channels running into the Moray Firth and the Cromarty Firth. The maximum depth in the area shown in Figure 1-1 is 57.3 m.

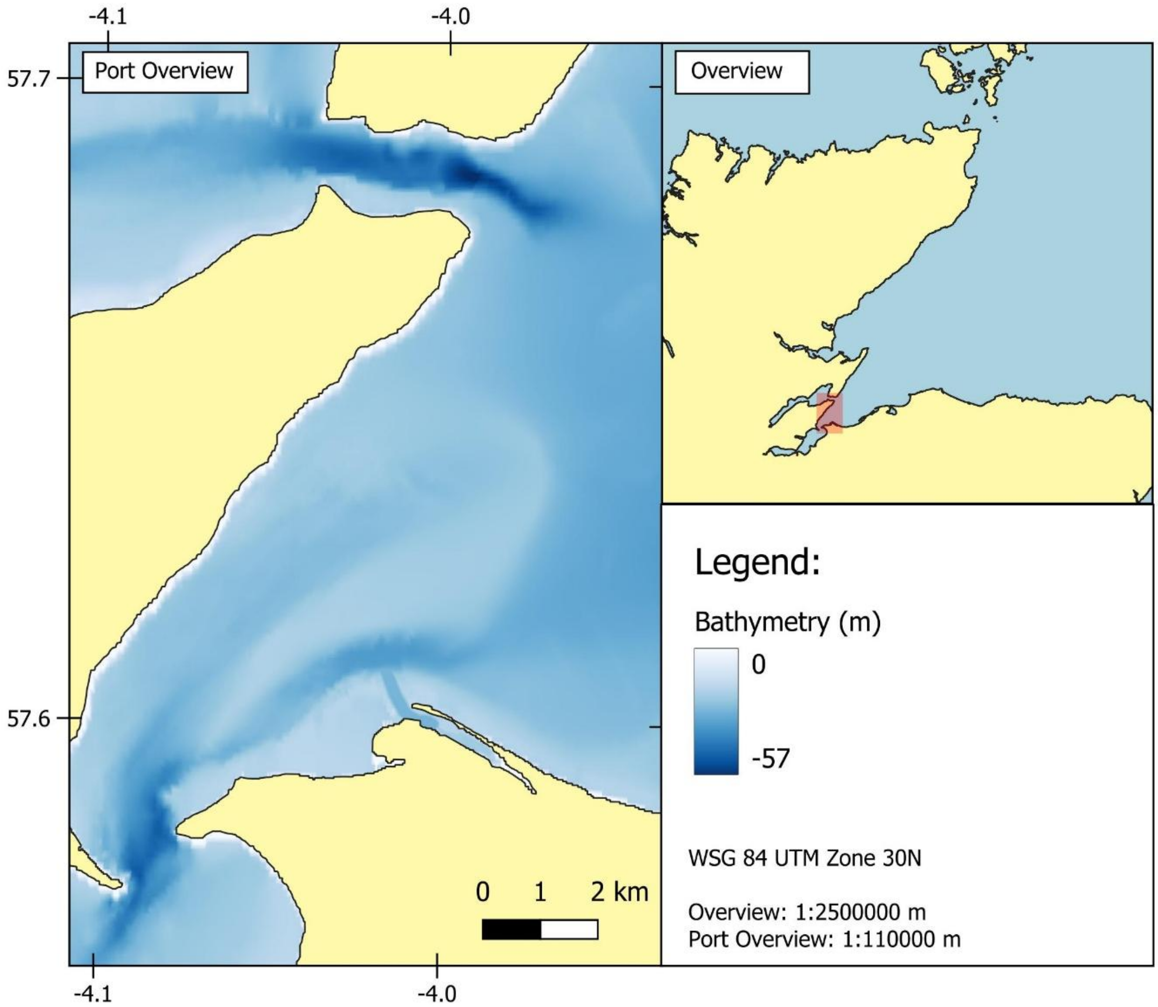

Figure 1-1: An overview of the Port of Ardersier, Moray Firth, Scotland, in the context of the UK, including the bathymetry of the area.

1.4 Document Overview

This report presents a detailed assessment of the potential underwater noise from the construction works at the Port of Ardersier, and covers the following:

- Section 2: Review of background information on the units for measuring and assessing underwater noise.
- Section 3: Discussion of the modelling approach, input parameters and assumptions for the noise modelling undertaken.
- Section 4: Presentation of detailed noise modelling and interpretation of the results using suitable noise metrics and criteria.
- Section 5: Summary and conclusions.

2 Underwater Noise Concepts

Sound travels much faster in water (approximately 1,500 ms^{-1}) than in air (343 ms^{-1}) as water is relatively incompressible and has a higher density than air. This affects the way in which sound measurements are expressed between the two mediums, which means that underwater sound levels are not directly comparable to airborne sound levels. This is noted for context; this report does not contain or include any reference to airborne sound levels.

2.1 Units of Measurement

Sound measurements are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. The dB scale represents a ratio, and therefore, it is used with a reference unit, which is the base from which the ratio is expressed. The fundamental definition of the dB scale is given in Equation 1:

$$Sound\ pressure\ level\ (L_p) = 20\log_{10}\left(\frac{P}{P_{ref}}\right) \quad (1)$$

where P is pressure, measured in Pascals (Pa), and P_{ref} is the reference pressure, also measured in Pa. For underwater noise, a reference pressure of 1 µPa ($1\text{x}10^{-6}$ Pa) is used as defined in ISO 18405:2017. Noise can be quantified using various metrics depending on the nature of the sound, as discussed below.

2.1.1 Sound Pressure Level

Sound Pressure Level (SPL or L_p) is a measure of the pressure variation caused by sound waves, expressed in decibels (dB), as seen in Equation 1. Variations of L_p are used depending on the noise source being measured. Unless otherwise defined, all L_p noise levels in this report are referenced to 1 µPa.

2.1.1.1 Level of the Mean Squared Sound Pressure

For continuous, non-impulsive noise sources such as drilling or vibropiling, an unweighted sound pressure level, averaged over a measurement period, known as a root mean squared (RMS) sound pressure level (SPL_{RMS} or $L_{p,RMS}$), can be used to represent the noise levels. The RMS period must be specified (e.g. $L_{p,RMS,125ms}$), as the mean level can vary significantly depending on the measurement duration.

2.1.1.2 Level of the Peak Sound Pressure

Transient, impulsive pressure waves, such as generated from impact piling are usually expressed using level of the peak sound pressure (SPL_{peak} or $L_{p,pk}$). This is calculated using the maximum pressure variation from positive to zero, representing the peak change in pressure as the transient wave propagates.

2.1.2 Sound Exposure Level

Sound Exposure Level (SEL or $L_{E,p}$) is a measure of Sound Exposure (SE), which represent the total acoustic energy of a sound event in decibels (dB), accounting for both the sound's intensity and duration. $L_{E,p}$ provides a way to quantify the total energy in a sound, making it useful for assessing the impact of both continuous and transient sounds. Variations of $L_{E,p}$ are used depending on the noise source being measured. For context, $L_{E,p}$ can be compared L_p using Equation 2:

$$L_{E,p} = L_p + 10 \times \log_{10} T \tag{2}$$

where the L_p is a measure of the average level of broadband noise and the $L_{E,p}$ sums the cumulative broadband noise energy. For continuous sounds shorter than one second, the $L_{E,p}$ is lower than the L_p. For durations longer than one second, the $L_{E,p}$ exceeds the L_p (e.g., a 10-second sound results in a 10 dB higher $L_{E,p}$ and a 100-second sound gives a 20 dB higher $L_{E,p}$). Unless otherwise defined, all $L_{E,p}$ noise levels in this report are referenced to 1 µPa^{2}s.

2.1.2.1 Single Strike Sound Exposure Level

Single strike Sound Exposure Level (SEL_{ss} or $L_{E,p,ss}$) refers to the total acoustic energy from a single, loud, short duration noise event (such as a blast or impact) measured over a specified duration. This can be expressed using Equation 3:

$$L_{E,p,ss} = 10 \times \log_{10} \left(\frac{\int_0^T p^2(t)dt}{{p^2}_{ref} T_{ref}} \right) \tag{3}$$

where p is the acoustic pressure in Pascals, T is the total duration of sound in seconds, and t is time in seconds.

2.1.2.2 Cumulative Sound Exposure Level

A cumulative Sound Exposure Level (SEL_{cum} or $L_{E,p,t}$) accounts for the exposure from multiple impulses or pile strikes over time, where the number of impulses replaces the T in the Equation 3, leading to Equation 4:

$$L_{E,cum} = L_{E,p,ss} + 10 \times \log_{10} X \tag{4}$$

Where X is the total number of impulses or strikes.

2.2 Properties of Sound

2.2.1 Impulsive vs Non-impulsive

Sound can be categorised loosely into two types: impulsive and non-impulsive. These can be defined as:

- Non-impulsive: a steady-state sound. It does not necessarily have to have a long duration.
    - Examples: vibropiling, drilling
- Impulsive: a sound with a high peak sound pressure, short duration, fast rise-time and broad frequency content at the source.
    - Examples: seismic airguns, explosives, impact piling

These differences are crucial for assessing auditory injury, as impulsive sound is typically more harmful than non-impulsive sound. Different metrics are needed to describe these distinct sound sources:

- Impulsive: Use SPL_{peak} ($L_{p,pk}$) or SEL_{cum} ($L_{E,p,ss}$ or $L_{E,p,t}$)
- Non-impulsive: Use SPL_{RMS} ($L_{p,RMS}$) or SEL_{cum} ($L_{E,p,t}$).

Categorising sound as impulsive or non-impulsive can be challenging, especially over long distances. As impulsive sounds travel, their energy dissipates, making them less impulsive and therefore potentially less injurious. Ongoing research, such as Martin *et al.* (2020), aims to define these categories. Hastie *et al.* (2019) found that impulsive sound can be considered non-impulsive 3.5 km from the source, while Southall (2021) suggests noise should be non-impulsive if energy above 10 kHz is absent. Research is ongoing to refine pulse characteristics, like kurtosis, for better categorisation.

2.2.2 Particle Motion

Particle motion, a key component of sound, describes the back-and-forth movement of particles in a medium, such as water, caused by sound waves. Unlike sound pressure, particle motion contains directional information (Hawkins and Popper, 2017). It is typically quantified by peak particle velocity (PPV), though acceleration or displacement can also be used. Research shows many fish species and marine invertebrates are sensitive to particle motion (e.g., Popper and Hawkins, 2019; Nedelec *et al.,* 2016, Radford *et al.,* 2012, Sole *et al.,* 2023), but sound pressure metrics are still more commonly used due to limited data (Popper and Hawkins, 2018). Calls for further research on particle motion levels and effects continue.

2.3 Analysis of Environmental Effects: Assessment Criteria

Over the past 20 years, it has become clear that human-generated underwater noise impacts marine species. The severity of these effects depends on factors like sound level, frequency, exposure duration, and repetition rate (Hastings and Popper, 2005). As a result, research on aquatic species' hearing abilities has grown, with studies focused on high-level noise sources such as seismic airguns, impact piling, and blasting, which have the most immediate environmental effects, though interest in chronic noise exposure is rising.

The impacts of underwater sound on marine species can be broadly summarised as follows:

- Physical traumatic injury and fatality.
- Auditory injury (either permanent or temporary).
- Behavioural responses (including disturbance)

The following sections outline the underwater noise criteria used in this study for marine mammals and fish species in the Moray Firth.

2.3.1 Marine Mammals

Three criteria exist. These are:

- Southall et al. (2019): Marine Mammal Noise Exposure Criteria
- NMFS (2024): Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing
- NOAA (2005): National Marine Fisheries Service: Summary of Marine Mammal Protection Act Acoustic Thresholds

It should be noted that notation in these sources referring to peak SPL, root-mean-square SPL and cumulative SEL has since been deprecated (ISO 18405:2017) and will be referred to as $L_{p,pk}$, $L_{p,RMS}$ and $L_{E,p,t}$ in the rest of this report.

These criteria present noise impact thresholds for marine mammal groups based on:

- The sound type (impulsive or non-impulsive)
- The type of auditory injury of concern

Impact ranges based on impulsive criteria are recommended for most sources, except clearly non-impulsive ones. However, if the predicted range exceeds 3.5 km (see Section 1.2.1), the true impact range is likely to lie between the impulsive and non-impulsive ranges. Thus, both criteria are considered unless the sound source is explicitly non-impulsive.

For SEL_{cum} ($L_{E,p,t}$) thresholds in marine mammals, a fleeing animal model is used, assuming the animal swims away from the sound source. These are worst-case assumptions, as marine mammals can swim faster under stress (Kastelein *et al*., 2018), particularly at the start of a noisy event when they are closest to the source. The following flee speeds are applied for each marine mammal group:

- 2.1 ms^{-1} for LF cetaceans (Scottish Natural Heritage; SNH, 2016)
- 1.52 ms^{-1} for HF cetaceans (Bailey and Thompson, 2006)
- 1.4 ms^{-1} for VHF cetaceans (SNH, 2016)
- 1.8 ms^{-1} for PCW/PW pinnipeds (SNH, 2016)

2.3.1.1 Southall *et al.* (2019): Auditory Injury (PTS and TTS) criteria

Southall *et al.* (2019), an update of the 2007 version, is the most recognised reference for marine mammal hearing thresholds and aligns with the thresholds provided in the National Marine Fisheries Service (NMFS, 2018) guidance. However, the hearing groups are described differently, so caution is needed when comparing results using these criteria.

The Southall *et al.* (2019) guidance categorises marine mammals into groups based on similar species and applies filters to the unweighted noise levels to approximate their hearing sensitivities. These groups are summarised in Table 2.1, with auditory weighting functions in Figure 2.1. Additional groups for sirenians and other marine carnivores are provided but not included in this study, as these species are not common in the Moray Firth.

Table 2-1: Marine mammal hearing groups (from Southall et al., 2019).

Hearing group	Auditory Weighting Function	Generalised hearing range	Species group	Example species
Low-frequency Cetaceans	LF	7 Hz to 35 kHz	Baleen whales	Fin Whale, Minke Whale, Humpback Whale
High-frequency Cetaceans	HF	150 Hz to 160 kHz	Toothed whales, including dolphins and beaked whales	Bottlenose Dolphin, White-beaked Dolphin, Risso's Dolphin, Common Dolphin, Orca
Very high-frequency Cetaceans	VHF	275 Hz to 160 kHz	True porpoise	Harbour porpoise
Phocid carnivores in water	PCW	50 Hz to 86 kHz	True seals	Harbour seal, Grey Seal

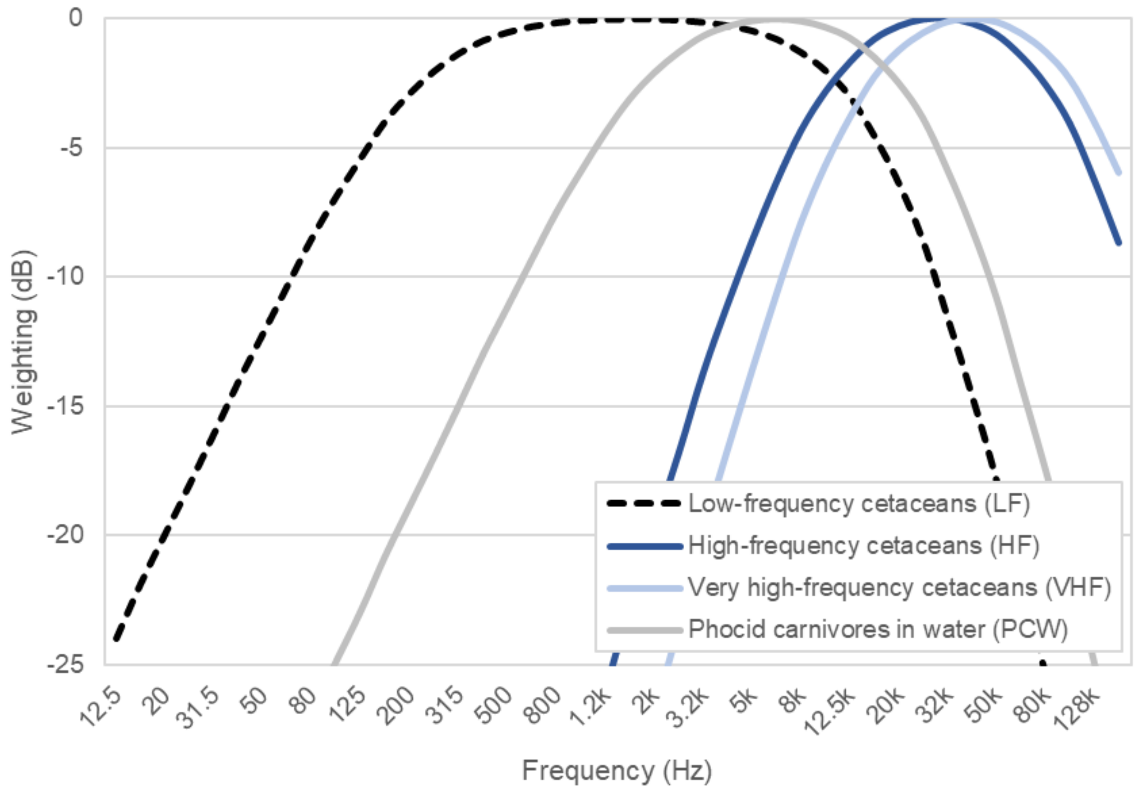

Figure 2-1: Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PCW) (from Southall et al., 2019)

Southall *et al.* (2019) presents different impact thresholds for impulsive and non-impulsive sound criteria, based on varying levels of auditory injury at different sound levels. Potential auditory impacts are categorised into two types:

- PTS (permanent threshold shift): the greatest severity, which is unrecoverable (but incremental) reduction in hearing sensitivity.
- TTS (temporary threshold shift): the least severity, which is a short-term reduction in hearing sensitivity.

TTS typically results in the largest impact range, but PTS represents the most significant and permanent impairment, making it the key impact threshold.

Impact piling is an impulsive sound source, and vibropiling and dredging are non-impulsive sound sources. Therefore, this study has considered the both impulsive and non-impulsive sound criteria for marine mammal PTS and TTS thresholds using the $L_{p,pk}$ and $L_{E,p,24h}$ metrics from Southall et al. (2019), which is summarised in Table 2-2 and

Table 2-3.

Table 2-2: Peak SPL ($L_{p,pk}$) criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al.* (2019)	$L_{p,pk}$ (dB re 1 µPa)	
	Impulsive	
	PTS	TTS
Low-frequency cetaceans (LF)	219	213
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid carnivores in water (PCW)	218	212

Table 2-3: Cumulative SEL ($L_{E,p,24h,wtd}$) criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al.* (2019)	$L_{E,p,24h,wtd}$ (dB re 1 µPa²s)			
	Impulsive		Non-impulsive	
	PTS	TTS	PTS	TTS
Low-frequency cetaceans (LF)	183	168	199	179
High-frequency cetaceans (HF)	185	170	198	178
Very high-frequency cetaceans (VHF)	155	140	173	153
Phocid carnivores in water (PCW)	185	170	201	181

2.3.1.2 NMFS (2024): Auditory Injury (AUD INJ and TTS) criteria

The NMFS (2024) guidance categorises marine mammals into groups based on similar species and applies filters to the unweighted noise levels to approximate their hearing sensitivities in a similar way to the Southall *et al.* (2019) criteria. These groups are summarised in Table 2-4, with auditory weighting functions in Figure 2-2. Additional groups other marine mammals are provided in NMFS (2024) but are not included in this study, as these species are not common in the Moray Firth.

NMFS is effectively an update to Southall *et al.* (2019) with revisions to the hearing sensitivities of the various marine mammal species groups, and adjustments to the impact criteria. There are only minor adjustments to terminology, with the exception of the use of “auditory injury” instead of PTS (see the following section), and phocid pinnipeds, where the abbreviation is “PW” rather than “PCW” previously.

Table 2-4: Marine mammal hearing groups (from NMFS 2024).

Hearing group	Auditory Weighting Function	Generalised hearing range	Species group	Example species
Low-frequency Cetaceans	LF	7 Hz to 36 kHz	Baleen whales	Fin Whale, minke whale, humpback Whale
High-frequency Cetaceans	HF	150 Hz to 160 kHz	Toothed whales, including dolphins and beaked whales	Bottlenose dolphin, white-beaked dolphin, Risso's dolphin, common dolphin, orca
Very high-frequency Cetaceans	VHF	200 Hz to 165 kHz	True porpoise	Harbour porpoise
Phocid pinnipeds in water	PW	40 Hz to 90 kHz	True seals	Harbour seal, grey seal

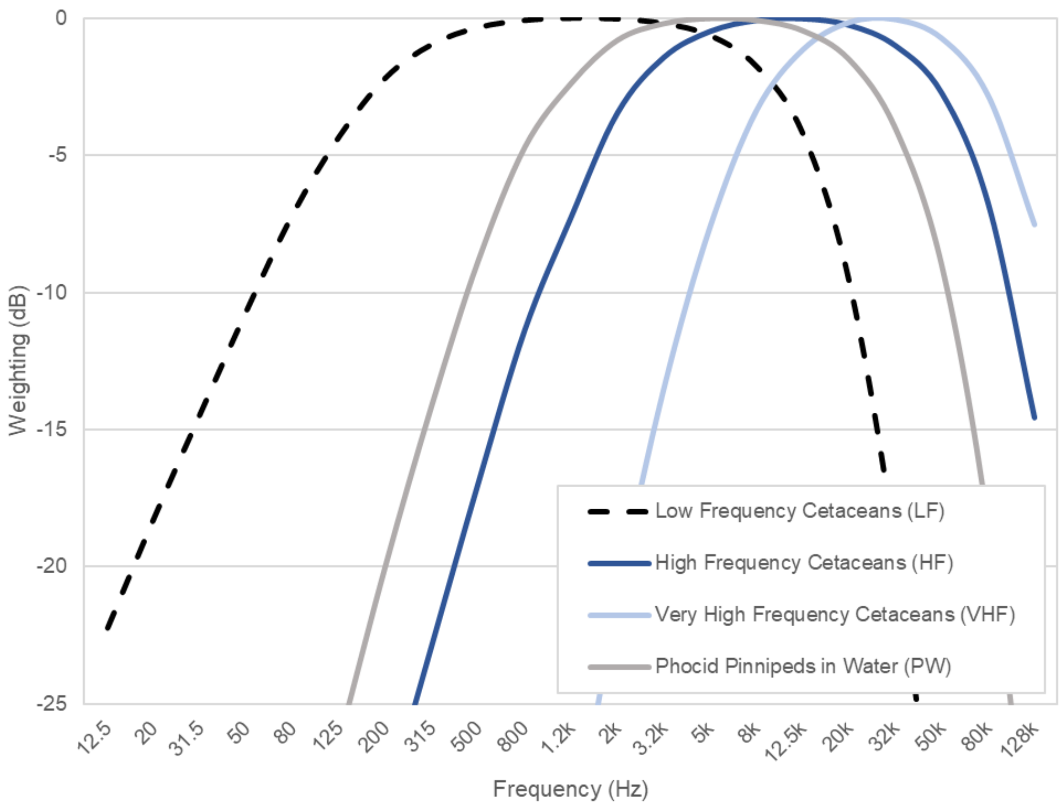

Figure 2-2: Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PW) (from NMFS 2024)

NMFS (2024) defines separate impact thresholds for impulsive and non-impulsive sounds, based on auditory injury risk at different sound levels. Auditory impacts are classified as:

- Auditory injury (AUD INJ): the onset of irreversible inner ear damage, potentially leading to PTS.
- Temporary threshold shift (TTS): a lower severity, onset of a short-term reduction in hearing sensitivity.

TTS typically results in the largest impact range, but AUD INJ represents the onset of the most significant impairment, making it the key impact threshold.

As impact piling is impulsive and vibropiling/dredging are non-impulsive, this study applies both impulsive and non-impulsive criteria for marine mammal AUD INJ and TTS thresholds, using the $L_{p,pk}$ and $L_{E,p,24h}$ metrics from NMFS (2024), which is summarised in Table 2-5 and Table 2-6.

Table 2-5: $L_{p,pk}$ criteria for AUD INJ and TTS in marine mammals (NMFS 2024)

NMFS (2024)	$L_{p,pk}$ (dB re 1 µPa)	
	Impulsive	
	AUD INJ	TTS
Low-frequency cetaceans (LF)	222	216
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid pinnipeds in water (PW)	223	217

Table 2-6: $L_{E,p,24h}$ criteria for AUD INJ and TTS in marine mammals (NMFS 2024)

NMFS (2024)	$L_{E,p,24h,wtd}$ (dB re 1 µPa²s)			
	Impulsive		Non-impulsive	
	AUD INJ	TTS	AUD INJ	TTS
Low-frequency cetaceans (LF)	183	168	197	177
High-frequency cetaceans (HF)	193	178	201	181
Very high-frequency cetaceans (VHF)	159	144	181	161
Phocid pinnipeds in water (PW)	183	168	195	175

2.3.1.3 NOAA (2005): Underwater Level B Harassment Acoustic Thresholds

Data on behavioural effect or disturbance in marine mammals is limited, so the NOAA (2005) Level B harassment criterion is used to account for potential effects, presented in Table 2-8. Impulsive thresholds are used for impact piling, whereas continuous thresholds are used for vibropiling and dredging.

Table 2-7: $L_{p,RMS}$ criteria for continuous and impulsive/intermittent sources in marine mammals (NOAA 2005)

Source Type	$L_{p,RMS}$ (dB re 1 µPa)
Continuous	120
Impulsive or Intermittent	160

2.3.2 Fish

2.3.2.1 Popper *et al.* (2014): Mortality, injury and behavioural effects

The Popper *et al.* (2014) guidelines are a reliable reference for underwater noise impacts on marine fauna, excluding marine mammals. Unlike previous studies based on limited or irrelevant data, Popper *et al.* (2014) provides updated research and guidelines, using fish categories that include species found in the UK.

Popper *et al.* (2014) provides specific criteria for common anthropogenic underwater sound sources. If a source is not listed, it is common practice to use the criteria which is the best fit to the source required in the assessment. Across all sources, marine faunae are categorised into sea turtles, eggs and larvae, and fish. Fish are further divided into three groups based on their hearing capabilities, determined by the presence and role of a swim bladder:

- Fish: no swim bladder
- Fish: swim bladder not involved in hearing
- Fish: Swim bladder involved in hearing.

Popper *et al.* (2014) then provides impact thresholds for each marine faunae category related to sound exposure, including:

- Mortality and potential mortal injury: immediate or delayed death.
- Impairment, such as:
    - Recoverable injury: injuries unlikely to result in mortality.
    - Temporary Threshold Shift (TTS): short or long-term changes in hearing sensitivity that may or may not reduce fitness.
    - Masking: Reduction in sound detectability due to the simultaneous presence of another sound.
- Behavioural effects: substantial change in behaviour for the animals exposed to a sound (long or short term).

Despite emerging evidence of fish sensitivity to particle motion (see Section 1.2.2), the Popper *et al.* (2014) criteria provide a quantitative criterion as thresholds for impact onsets in terms of sound pressure related functions (e.g., SPL_{peak}, SPL_{rms}, SEL_{ss}, SEL_{cum}). For fish, both stationary and fleeing animal models are used for SEL_{cum} thresholds to account for species diversity and varying responses to noise. Most species in Popper *et al.* (2014) are likely to swim away from harmful sounds (Dahl *et al.,* 2015), and these speeds are likely to vary widely across species. Therefore, a conservative swim speed of 1.5 ms^{-1} (Hirata, 1999) is used in fleeing animal models. However, some species in Popper *et al.* (2014) have lower sensitivity not sound, such as benthic or swim bladderless species, remain stationary even when exposed to high intensity sounds (e.g., Goertner *et al.,* 1994, 1978; Stephenson *et al.,* 2010; Halvorsen *et al.,* 2012). Therefore, to avoid overestimating risk, a combined approach, which presents both fleeing and stationary models, is used in this report.

When data is insufficient to provide a quantitative criterion, Popper *et al.* (2014) provides a relative risk, which describes the risk of an effect on a receptor occurring in either the near-field (tens of meters), intermediate-field (hundreds of meters) or far-field (thousands of meters) from the sound source, as high, moderate or low.

For impact piling, this this study uses the criteria from Popper *et al.* (2014) for pile driving, summarised in Table 2-8. Since vibropiling and dredging are non-impulsive, continuous sound sources, this study uses the criteria from Popper *et al.* (2014) for shipping and continuous sounds, summarised in Table 2-9.

Table 2-8: Recommended guidelines for pile driving according to Popper et al. (2014) for speices of fish, sea turtles and eggs and larvae (N = Near-field; I = Intermediate-field; F = Far-field).

Popper *et al.* (2014) criteria for Pile Driving					
Type of fish	**Mortality and potential mortal injury**	**Impairment**			**Behaviour**
		Recoverable injury	**TTS**	**Masking**	
Fish: no swim bladder	**>219 $L_{E,p}$** **>213 $L_{p,pk}$**	**>216 $L_{E,p}$** **>213 $L_{p,pk}$**	**>>186 $L_{E,p}$**	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	**210 $L_{E,p}$** **>207 $L_{p,pk}$**	**203 $L_{E,p}$** **>207 $L_{p,pk}$**	**>186 $L_{E,p}$**	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	**207 $L_{E,p}$** **>207 $L_{p,pk}$**	**203 $L_{E,p}$** **>207 $L_{p,pk}$**	**186 $L_{E,p}$**	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea Turtles	**210 $L_{E,p}$** **>207 $L_{p,pk}$**	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and Larvae	**>210 $L_{E,p}$** **>207 $L_{p,pk}$**	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Table 2-9: Recommended guidelines for shipping and continuous sounds according to Popper et al. (2014) for speices of fish, sea turtles and eggs and larvae (N = Near-field; I = Intermediate-field; F = Far-field).

Popper *et al.* (2014) criteria for Shipping and Continuous sounds					
Type of fish	**Mortality and potential mortal injury**	**Impairment**			**Behaviour**
		Recoverable injury	**TTS**	**Masking**	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	**170 $L_{p,48h}$**	**158 $L_{p,12h}$**	((N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea Turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Eggs and Larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

3 Underwater Noise Modelling: Methodology

Modelling of underwater noise is complex and can be approached in several different ways. Measurements are only possible at limited locations, so modelling has been undertaken to provide a more comprehensive set of results. To estimate the noise levels generated by impact piling, vibropiling and dredging, Subacoustech have chosen to utilise the dBSea noise modelling software (www.dbsea.co.uk), which uses various numerical solvers to calculate underwater noise. This assessment uses two different solvers:

- A parabolic equation (PE) method for lower frequencies (12.5 Hz to 250 Hz).
    - Widely used within the underwater acoustics community but has computational limitations at high frequencies.
- A ray tracing method for higher frequencies (315 Hz to 100 kHz).
    - More computationally efficient at higher frequencies but is not suited to low frequencies (Etter, 1991).

These solvers account for a wide array of environmental input parameters within the study area, including bathymetry, sediment data and sound speed, as well as the characteristics of the noise source, such as source frequency content, to ensure as detailed results as possible. The input parameters used in this study are described in the following sections.

The results of the modelling will be presented as noise contour plots. It should be noted that noise levels and propagation paths in reality will not be as clearly defined or linear as shown in these plots. This is an artifact of the modelling approach. Scattering, reflection, and diffraction can cause sound to propagate around and behind obstacles like protruding landmasses (although to a much lesser degree than when there is line-of-sight), but the model cannot accurately account for these effects, so they are not represented in the plots.

3.1 Input Parameters

3.1.1 Modelling Location

Two worst-case locations were selected for modelling based on the different planned activities: one is suitable for piling for both impact and vibropiling, and a separate dredging site for dredging activities. Piling was modelled at mid-water depth, whereas CSD was modelled at the maximum depth of the modelling location at the seabed. Derivation of the piling source level used in modelling was based on empirical data from piling in harbours (e.g. Midforth and East, 2019). A location to the seaward side of the dredged area was selected for CSD. Details of the locations used for modelling are presented in Table 3-1, and the location of each modelling area is shown in Figure 3-1.

Table 3-1: Details of the modelling locations. Eastings/Northings are in WGS84, UTM Zone 30N.

Modelling location	Latitude (DD)	Longitude (DD)	Depth of Source (m)	Depth at source location (m)
Piling Site	57.600417°N	004.009850°W	4	9
Dredging Site	57.602553°N	004.008732°W	5	5

3.1.2 Bathymetry

The bathymetry data used in the modelling was a combination of bathymetry of the wider area obtained from the European Marine Observation and Data Network (EMODnet, 2018), and bathymetry provided by the client on the dredged area (not available from EMODnet) close to the modelling location. The EMODnet data has a resolution of 1/16th arcminutes (approximately 115 × 115 m). The bathymetry used for modelling covers an area of 10 km × 20 km surrounding the survey area, and represents depths associated with mean high-water springs (MHWS). The extent of the bathymetry is shown in the "Port Overview" map in Figure 3-1.

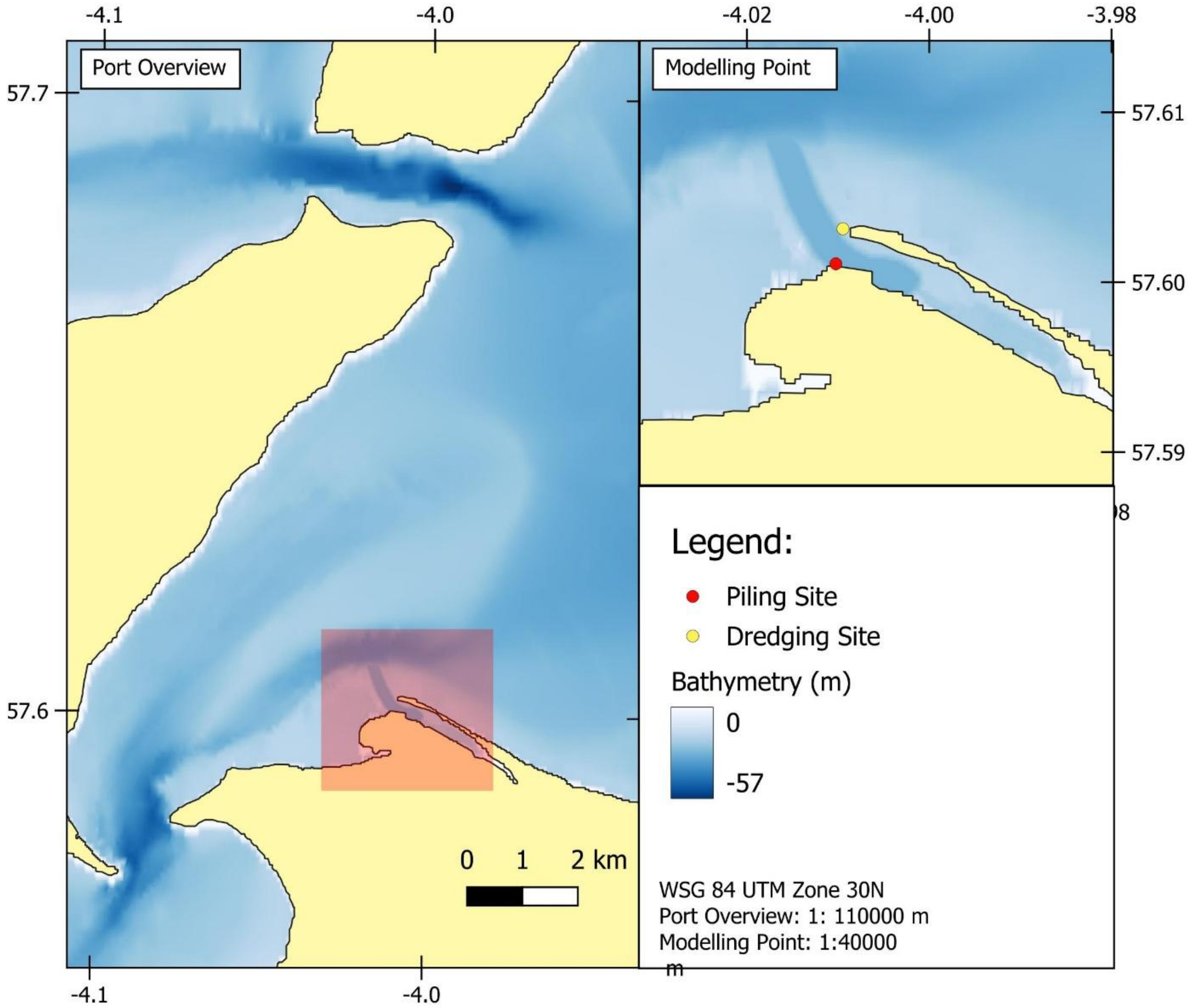

Figure 3-1: Overview of the modelling locations selected for each activity. The impact piling and vibropiling modelling location are marked by the "Piling Site" and the CSD modelling location is marked by "Dredging Site".

3.1.3 Seabed Properties

Seabed characteristics were based on local data provided from the project scoping report. At the Port of Ardersier, the seabed was assumed to consist of 20 m of gravelly sand overlying sandstone bedrock. Geo-acoustic properties were taken from Jensen *et al.* (1994, 2011) as listed in Table 3-2.

Table 3-2: Seabed geo-acoustic properties of the area.

Material	Compressive sound speed profile in substrate (m/s)	Density profile in substrate (kg/m³)	Attenuation profile in substrate (dB/wavelength)
Gravelly Sand	1,725	1,950	0.7
Sandstone	3,000	2,500	0.1

3.1.4 Sound Speed Profile

The speed of sound in the water has been calculated for the average annual temperature and salinity using the Mackenzie (1981) equation, with data from the National Marine Plan Interactive (Marine Scotland, 2025) for the modelling location. The resulting profile is shown in Figure 3-2.

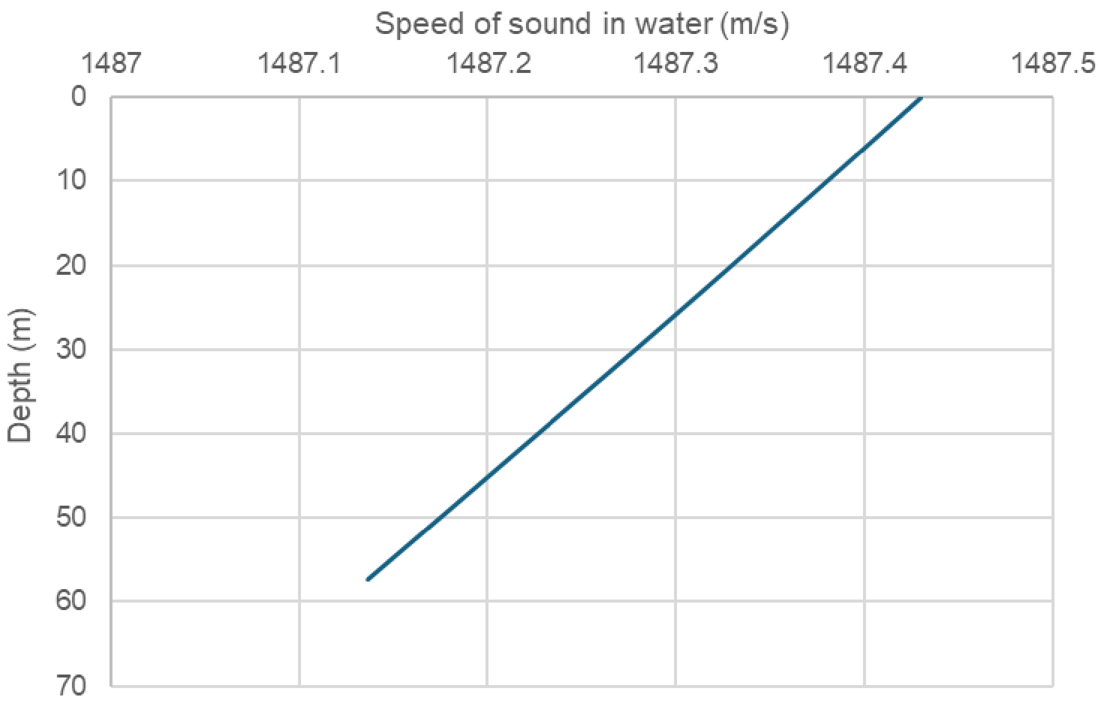

Figure 3-2: Sound speed profile used for detailed modelling of the area.

3.1.5 Noise Source

At the time of writing, the following information has been provided:

- Impact piling:
  - Pile: Steel Tubular Piles 1200 mm diameter.
  - Strike rate: 34 blows per minute.
  - Piling time per pile: 10 hours (including surveying and pile positioning etc.).
    - Includes Soft Start: 20 minutes (assumed at 20% energy).
  - Maximum Energy: 294 kJ.

- Vibropiling
    - Equipment: No detailed information has been provided. The equipment proxy used in modelling is described below.
    - Piling time per pile: 10 hours (including surveying and pile positioning etc.).
- Dredging
    - Equipment: No detailed information has been provided. The equipment proxy used in modelling is described below.
    - Although TSHD and CSD are proposed to be used, CSD is louder than TSHD, and therefore, only CSD was considered in the assessment, as a worst-case scenario.

Source spectrums for each activity were obtained from Subacoustech's measurement library. For impact and vibropiling, data was measured from 1067 mm diameter piles driven in Portsmouth Harbour, UK using a 260 kJ hammer (Midforth and East, 2019). For CSD, recordings were obtained from the 112.6 m dredger *Taurus II* operating in the Persian Gulf, Qatar, with 24,610 kW total power and 2 × 3380 kW dredge pump power (Collett and Mason, 2015).

Source levels for $L_{p,pk}$, $L_{E,p,ss}$ and $L_{p,RMS}$ metrics were then calculated from the obtained source spectrums. For impact and vibropiling, the source level was scaled to reflect the provided pile specifications relevant to the project. Since no project specific details were provided for CSD equipment, the source levels used were those calculated directly from the recordings of *Taurus II*. The source levels used in modelling for each activity are presented in Table 3-3.

Table 3-3: Summary of the calculated $L_{p,pk}$, $L_{E,p,ss}$ and $L_{p,RMS}$ source levels for the impact piling, vibropiling and CSD.

Equipment	Estimated source level @ 1 m		
	$L_{p,pk}$ (dB re 1 µPa)	$L_{E,p,ss}$ (dB re 1 µPa²s)	$L_{p,RMS}$ (dB re 1 µPa)
Impact Piling	222.9	195.1	202.1
Vibropiling	-	-	183.0
CSD	-	-	181.4

The 1/3rd octave levels in each source spectra were then adjusted to achieve the required source levels for each source type (values stated in Table 3-3). The 1/3rd octave source spectrums used for modelling is shown in Figure 3-3 for impact piling, Figure 3-4 for vibropiling and Figure 3-5 for CSD.

Where $L_{E,p,24h}$ exposure levels are required for continuous noise sources, this is based on an equivalence of 1-second $L_{E,p}$ and $L_{p,RMS}$ values for this type of noise. For piling, since the active piling time is unknown at the time of writing, 10 hours of continuous piling is assumed as a worst-case scenario to remain precautionary. CSD was assumed to take place continuously for 24-hours.

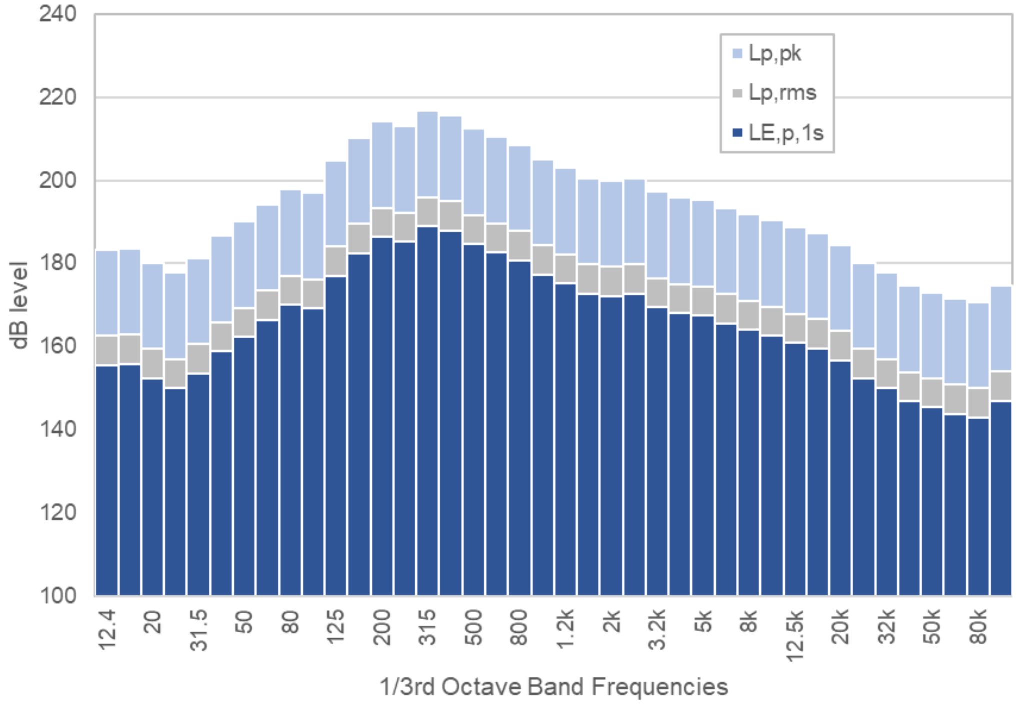

Figure 3-3: The $L_{p,pk}$, $L_{p,RMS}$ and $L_{E,p,1s}$ source spectrums containing 1/3rd octave band levels used to model impact piling.

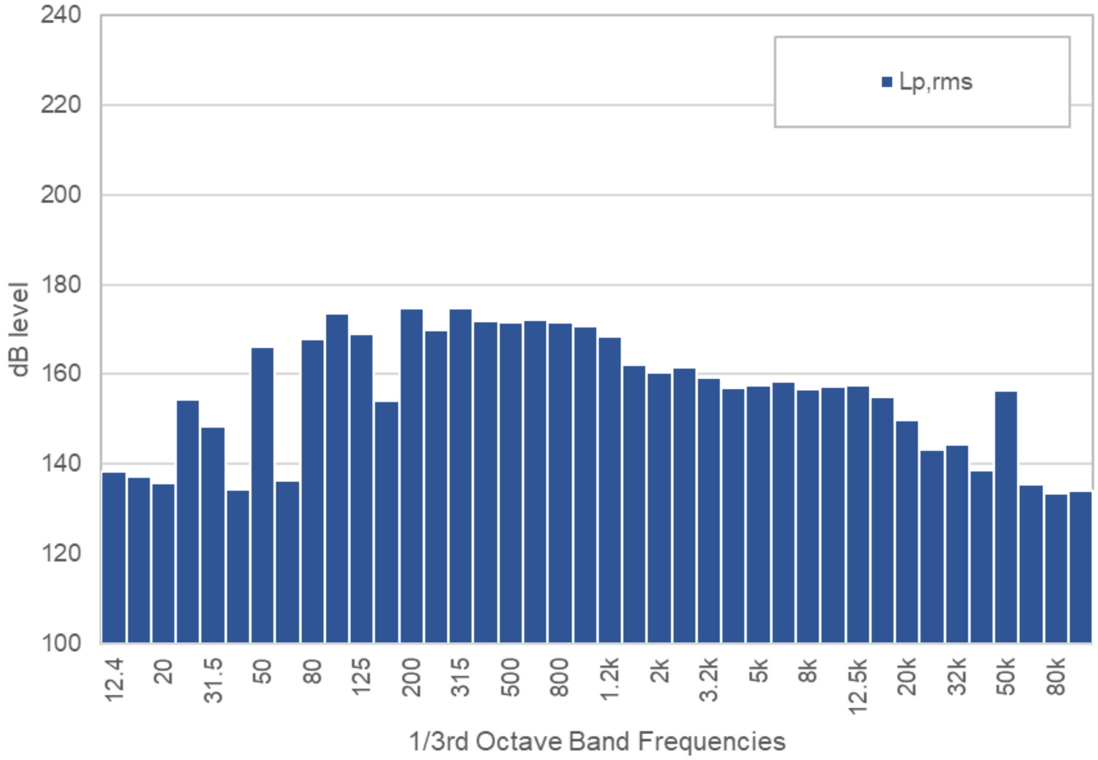

Figure 3-4: The $L_{p,RMS}$ source spectrum containing 1/3rd octave band levels used to model vibropiling.

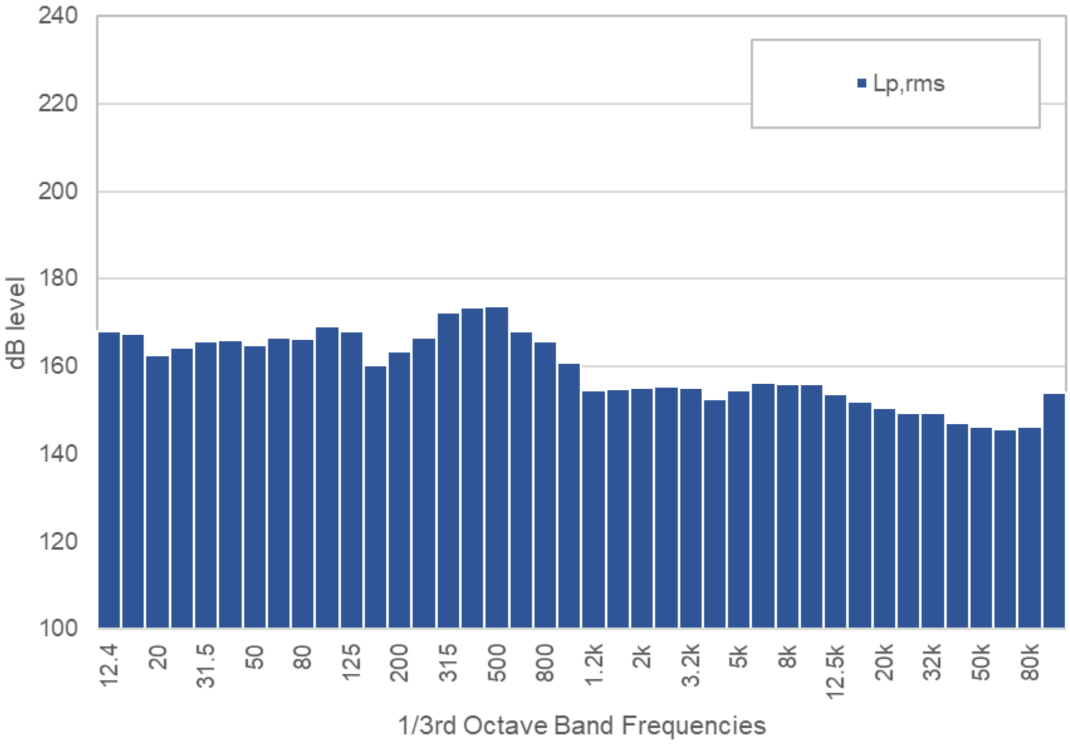

Figure 3-5: The $L_{p,RMS}$ source spectrum containing 1/3rd octave band levels used to model CSD.

4 Underwater Noise Modelling: Results

The distribution of noise from impact piling, vibropiling and CSD are presented as noise contour plots in the following section. These noise contours were then interpreted into impact ranges using the relevant criteria from Southall *et al.* (2019), NMFS (2024) and NOAA (2005) for marine mammals, and Popper *et al.* (2014) for fish.

For single strike criteria ($L_{p,pk}$, $L_{p,RMS}$), the maximum, mean and minimum impact ranges are presented across all transects. For $L_{E,p,t}$ metrics only the maximum impact ranges are presented, based on transects that are not constrained by land limitations near the noise source. These transects represent worst-case fleeing directions.

For impact piling and vibropiling, the relevant transects were:

- North Northwest (NNW): out to the mouth of the Moray Firth between bearings 312° - 010°.
- West (W): out to the mouth of the Moray Firth between bearings 270°- 278°.
- Southeast (SE): within the harbour between bearings 102°- 108°.

And for CSD, the relevant transects were:

- Northwest (NW): out to the mouth of the Moray Firth between bearings 256° - 46°.

Due to the complexity in noise conditions at close range to the source, estimated impact ranges are limited to a resolution of 10 m from the sources, and as such, any modelled ranges that would be smaller than this have been presented as "< 10 m". Any impact range noted as "–" indicates that no exceedance is expected for the given criteria based on the results of the modelling, due to relatively low source levels.

4.1 Impact Piling

4.1.1 Predicted Noise Levels

The distribution of noise from the impact piling at the Port of Ardersier is presented as noise contour plots in Figure 4-1, Figure 4-2 and Figure 4-3. These plots show the maximum predicted noise level in the water column.

Note that the break in the modelled contours that can be seen to the WNW of the modelling locations is due to the presence of a small, submerged island that blocks the propagation path along these transects.

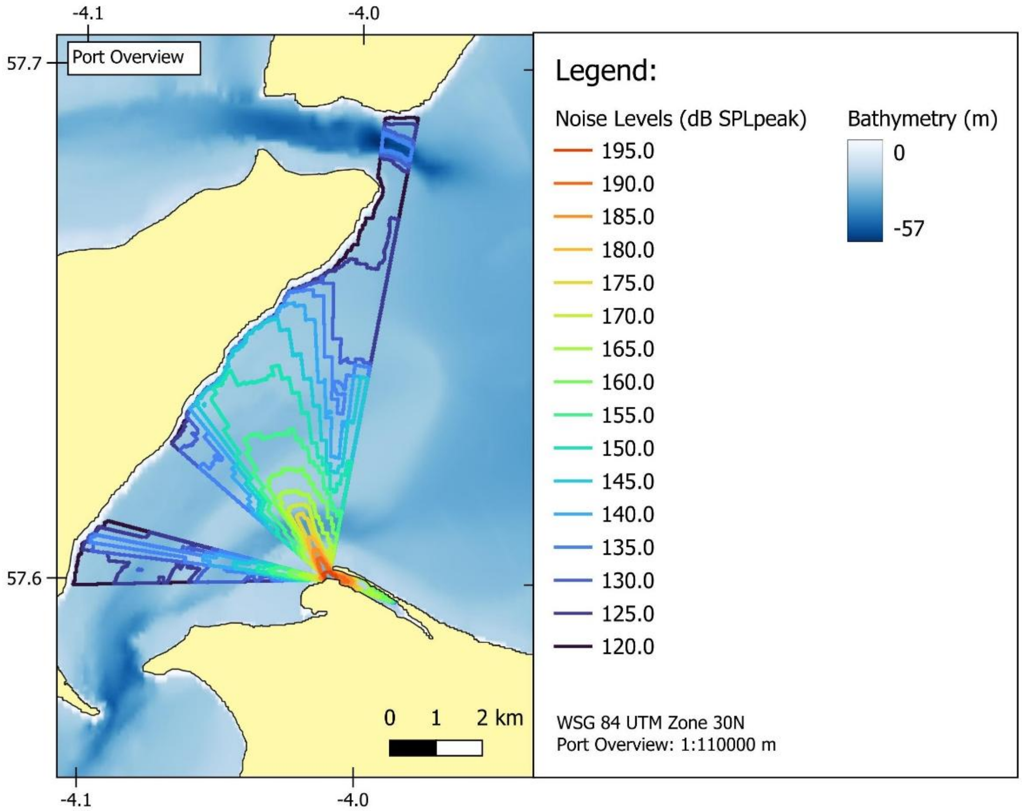

Figure 4-1: $L_{p,pk}$ noise level contours predicted for impact piling at the Port of Ardersier.

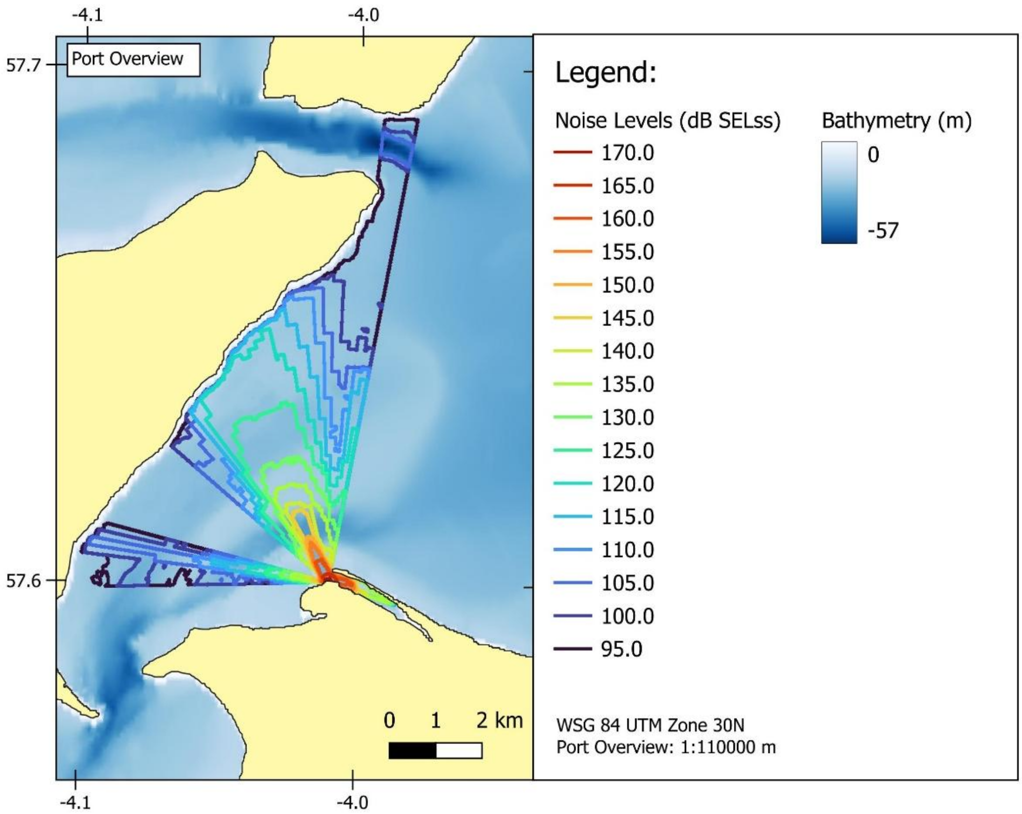

Figure 4-2: $L_{E,p,ss}$ noise level contours predicted for impact piling at the Port of Ardersier.

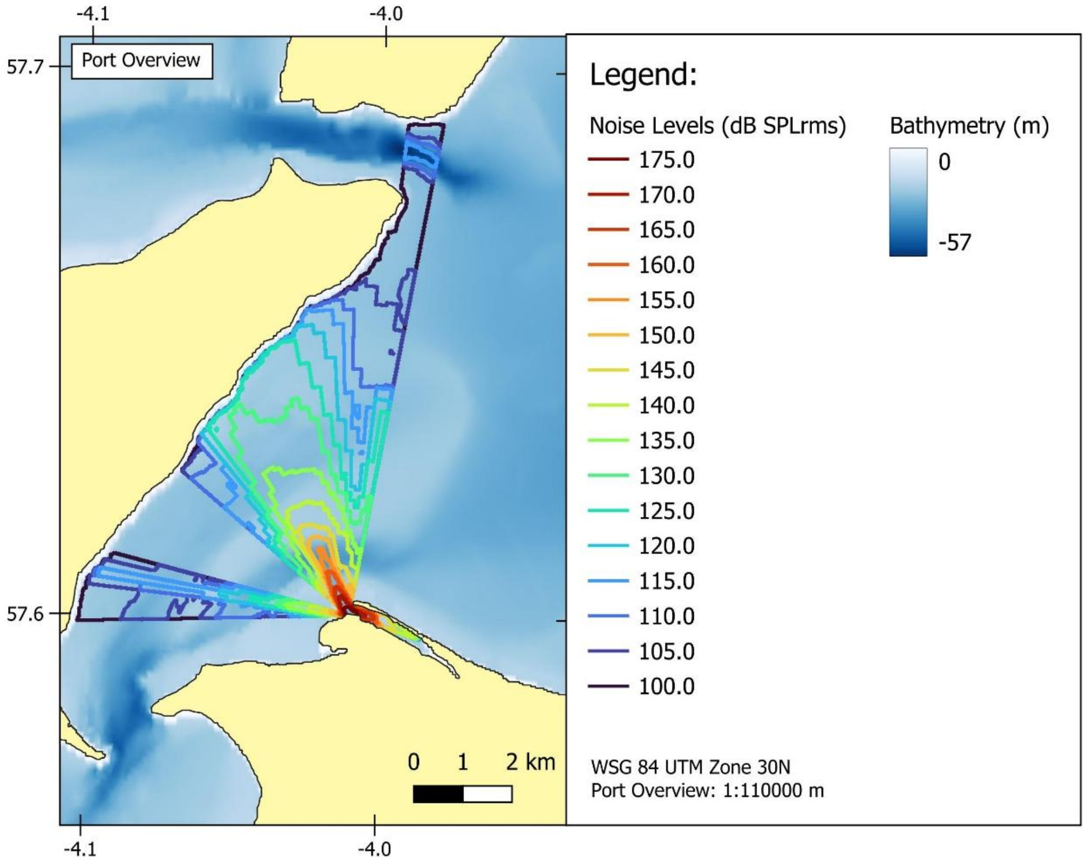

Figure 4-3: $L_{p,RMS}$ noise level contours predicted for impact piling at the Port of Ardersier.

4.1.2 Interpretation

4.1.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.1.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{p,pk}$ criteria applied to the predicted noise contours, the largest PTS ranges are associated with VHF cetaceans. Animals will exceed the VHF PTS threshold if they are within 60 m from the piling activities. These results, along with the PTS and TTS impact ranges predicted across all groups, are presented in Table 4-1.

Table 4-1: Predicted impact ranges associated with impact piling, using the Southall et al. (2019) $L_{p,pk}$ PTS and TTS criteria in marine mammals for impulsive noise sources.

Southall *et al.* (2019) criteria $L_{p,pk}$ (Impulsive)			**Estimated Impact Ranges (m)**		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	219 dB	< 10	< 10	< 10
	TTS	213 dB	20	< 10	< 10
HF Cetaceans	PTS	230 dB	-	-	-
	TTS	224 dB	-	-	-
VHF Cetaceans	PTS	202 dB	60	40	20
	TTS	196 dB	170	90	20
PCW Pinnipeds	PTS	218 dB	< 10	< 10	< 10
	TTS	212 dB	20	10	< 10

- = No predicted exceedance

By applying the Southall *et al.* (2019) weightings to the predicted $L_{E,p,24h}$ noise contours, and comparing these against the impulsive criteria for marine mammals, it is unlikely that any animal will exceed its PTS threshold at any range from the impact piling activities. This is based on a $L_{E,p,24h,wtd}$ calculated over the maximum potential impact piling period (10 hours) and the animals fleeing at a constant speed. These results, along with PTS and TTS impact ranges predicted across all groups, are presented in Table 4-2.

Table 4-2: Predicted impact ranges associated with impact piling, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for impulsive noise sources, assuming a fleeing receptor.

Southall *et al.* (2019) criteria $L_{E,p,24h,wtd}$ (Impulsive)			**Maximum Estimated Impact Ranges (m)**		
			NNW	W	SE
LF Cetaceans	PTS	183 dB	< 10	< 10	< 10
	TTS	168 dB	380	30	60
HF Cetaceans	PTS	185 dB	< 10	< 10	< 10
	TTS	170 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	155 dB	< 10	< 10	< 10
	TTS	140 dB	360	40	50
PCW Pinnipeds	PTS	185 dB	< 10	< 10	< 10
	TTS	170 dB	< 10	< 10	< 10

4.1.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.1.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{p,pk}$ criteria applied to the predicted noise contours, the largest AUD INJ ranges are associated with VHF cetaceans. Animals will exceed the VHF AUD INJ threshold if they area within 60 m from the piling activities. These results, along with the AUD INJ and TTS impact ranges predicted across all groups, are presented in Table 4-3.

Table 4-3: Predicted impact ranges associated with impact piling, using the NMFS (2024) $L_{p,pk}$ auditory injury (AUD INJ) and TTS criteria in marine mammals for impulsive noise sources.

NMFS (2024) criteria $L_{p,pk}$ (Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
LF Cetaceans	AUD INJ	222 dB	< 10	< 10	< 10
	TTS	216 dB	20	< 10	< 10
HF Cetaceans	AUD INJ	230 dB	-	-	-
	TTS	224 dB	-	-	-
VHF Cetaceans	AUD INJ	202 dB	60	40	20
	TTS	196 dB	170	90	20
PW Pinnipeds	AUD INJ	223 dB	-	-	-
	TTS	217 dB	< 10	< 10	< 10

- = No predicted exceedance

By applying the NMFS (2024) weightings to the predicted $L_{E,p,24h}$ noise contours, and comparing these against the impulsive criteria for marine mammals, it is unlikely that any animal will exceed its AUD INJ threshold at any range from the impact piling activities. This is based on a $L_{E,p,24h,wtd}$ calculated over the maximum potential impact piling period (10 hours) and the animals fleeing at a constant speed. These results, along with AUD INJ and TTS impact ranges predicted across all groups, are presented in Table 4-4.

Table 4-4: Predicted impact ranges associated with impact piling, using the NMFS (2024) $L_{E,p,24h,wtd}$ auditory injury (AUD INJ) and TTS criteria in marine mammals for impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wtd}$ (Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	AUD INJ	183 dB	< 10	< 10	< 10
	TTS	168 dB	380	30	60
HF Cetaceans	AUD INJ	193 dB	< 10	< 10	< 10
	TTS	178 dB	< 10	< 10	< 10
VHF Cetaceans	AUD INJ	159 dB	< 10	< 10	< 10
	TTS	144 dB	380	40	50
PW Pinnipeds	AUD INJ	183 dB	< 10	< 10	< 10
	TTS	168 dB	30	< 10	< 10

4.1.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are at 1000 m on the transect of greatest noise propagation. These results are presented in Table 4-5.

Table 4-5: Predicted impact ranges associated with impact piling, using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals in relation to impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
All Marine Mammals	Level B Disturbance	160 dB	1000	230	20

4.1.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.1.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for pile driving would be exceeded by fish.

Based on the results for $L_{p,pk}$ metric, fish with a swim bladder (both involved and not involved in hearing) are predicted to exceed their mortality/recoverable injury threshold if they are within 30 m from the impact piling activities. These results, along with mortality/recoverable injury thresholds for other fish groups, are presented in Table 4-6.

Table 4-6: Predicted impact ranges associated with impact piling, using the Popper et al. (2014) $L_{p,pk}$ criteria for pile driving.

Popper *et al.* (2014) criteria $L_{p,pk}$ (Pile Driving)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	Mortal and potential mortal injury / Recoverable injury	> 213 dB	20	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury / Recoverable injury	> 207 dB	30	20	20
Fish: swim bladder involved in hearing	Mortal and potential mortal injury / Recoverable injury	> 207 dB	30	20	20

Using the $L_{E,p}$ metric, if the fish are to flee from the source at a constant speed, it is unlikely that the thresholds for any fish species will be exceeded at any range from the impact piling activities. However, if they are assumed to remain stationary for the maximum potential piling duration of 10 hours, animals at up to 420 m of the impact piling activities will exceed the mortality and potential mortal injury threshold, and the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along mortality and potential mortality injury, recoverable injury and TTS thresholds for other fish species are provided in Table 4-7 and Table 4-8 for stationary and fleeing receptors respectively.

Table 4-7: Predicted impact ranges associated with impact piling, using the Popper et al. (2014) $L_{E,p,24h}$ criteria for pile driving, assuming a stationary receptor.

Popper *et al.* (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Maximum Estimated Stationary Impact Ranges (m)		
			NNW	W	SE
Fish: no swim bladder	Mortal and potential mortal injury	> 219 dB	40	30	30
	Recoverable injury	> 216 dB	60	40	50
	TTS	>> 186 dB	1760	240	730
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	210 dB	180	60	90
	Recoverable injury	203 dB	520	70	340
	TTS	> 186 dB	1760	240	730
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	420	70	150
	Recoverable injury	203 dB	520	70	340
	TTS	186 dB	1760	240	730

Table 4-8: Predicted impact ranges associated with impact piling, using the Popper et al. (2014) $L_{E,p,24h}$ criteria for pile driving, assuming a fleeing receptor.

Popper *et al.* (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Maximum Estimated Fleeing Impact Ranges (m)		
			NNW	W	SE
Fish: no swim bladder	Mortal and potential mortal injury	> 219 dB	< 10	< 10	< 10
	Recoverable injury	> 216 dB	< 10	< 10	< 10
	TTS	>> 186 dB	< 10	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	210 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	> 186 dB	< 10	< 10	< 10
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	186 dB	< 10	< 10	< 10

4.2 Vibropiling

4.2.1 Predicted Noise Levels

The distribution of noise from the vibropiling at the Port of Ardersier is presented as noise contour plots in Figure 4-4. These plots show the maximum predicted noise level in the water column.

As in section 4.1, the break in the modelled contours that can be seen to the WNW of the modelling location is due to the presence of a small, submerged island that blocks the propagation path along these transects.

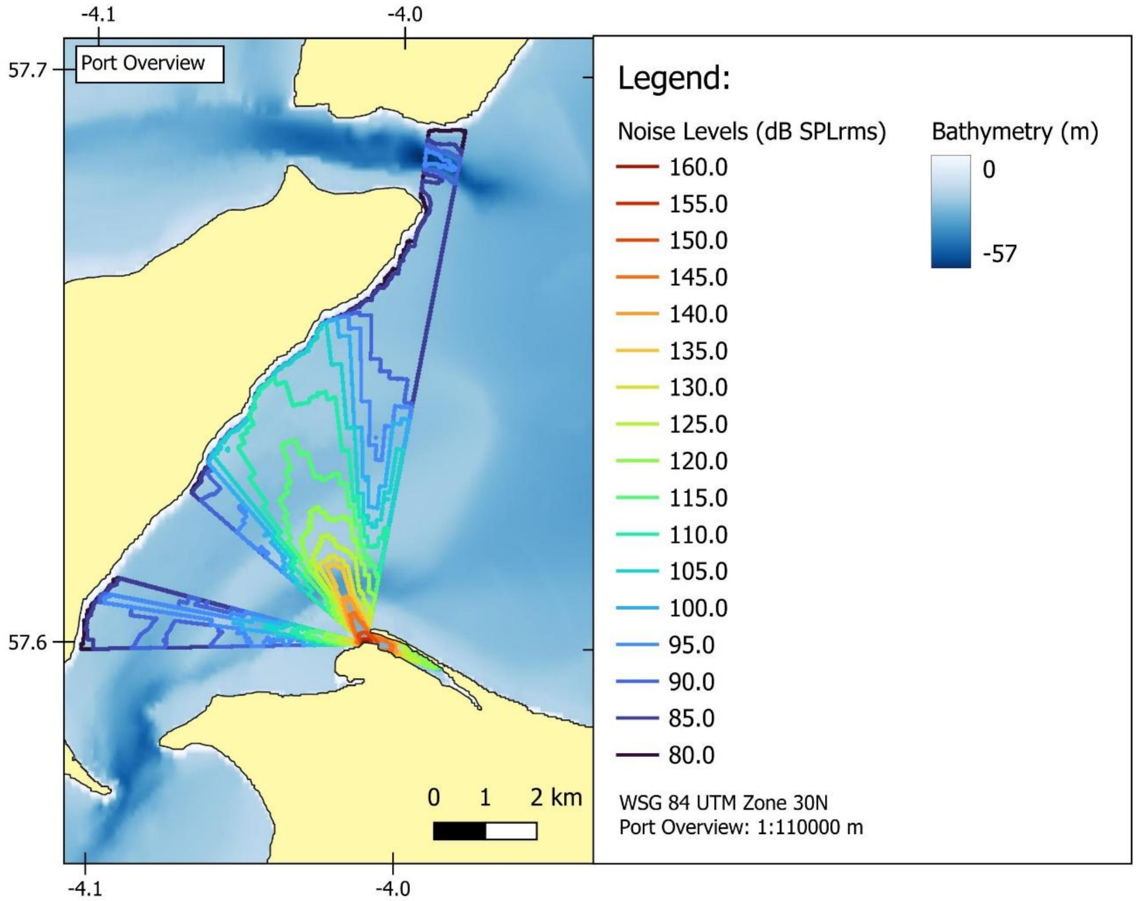

Figure 4-4: $L_{p,RMS}$ noise level contours predicted for vibropiling at the Port of Ardersier.

4.2.2 Interpretation

4.2.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.2.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely in practice that any animal will exceed the PTS threshold at any distance from the vibropiling activities. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-9.

Table 4-9: Predicted impact ranges associated with vibropiling, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

Southall *et al.* (2019) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	PTS	199 dB	< 10	< 10	< 10
	TTS	179 dB	20	< 10	< 10
HF Cetaceans	PTS	198 dB	< 10	< 10	< 10
	TTS	178 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	173 dB	< 10	< 10	< 10
	TTS	153 dB	140	30	30
PCW Pinnipeds	PTS	201 dB	< 10	< 10	< 10
	TTS	181 dB	< 10	< 10	< 10

4.2.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.2.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal in practice will exceed the AUD INJ threshold at any distance from the vibropiling activities. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-10.

Table 4-10: Predicted impact ranges associated with vibropiling, using the NMFS (2024) $L_{E,p,24h,wtd}$ auditory injury and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	AUD INJ	197 dB	< 10	< 10	< 10
	TTS	177 dB	40	10	10
HF Cetaceans	AUD INJ	201 dB	< 10	< 10	< 10
	TTS	181 dB	< 10	< 10	< 10
VHF Cetaceans	AUD INJ	181 dB	< 10	< 10	< 10
	TTS	161 dB	20	10	< 10
PW Pinnipeds	AUD INJ	195 dB	< 10	< 10	< 10
	TTS	175 dB	10	< 10	< 10

4.2.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are within 2900 m. These results are presented in Table 4-11.

Table 4-11: Predicted impact ranges associated with vibropiling, using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals for non-impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (Non-Impulsive)			Estimated Impact Ranges (m)		
			Maximum	**Mean**	**Minimum**
All Marine Mammals	Level B Disturbance	120 dB	2900	500	20

4.2.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.2.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for shipping and continuous sounds would be exceeded by fish.

Based on the results for the $L_{p,RMS}$ metric, animals within 20 m of the vibropiling activities may exceed the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along with TTS impact ranges, are provided in Table 4-12.

Table 4-12: Predicted impact ranges associated with vibropiling, using the Popper et al. (2014) $L_{p,RMS}$ criteria for shipping and continuous sounds.

Popper *et al.* (2014) criteria $L_{p,RMS}$ (continuous sounds)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
Fish: swim bladder involved in hearing	Recoverable injury	170 dB	20	20	10
	TTS	158 dB	80	50	20

Across all species of fish, the relative risk of mortality and potential mortal injury, as well as recoverable injury associated with vessel noise is low in the near-field, intermediate field and far field distance. Of all the potential impacts, the impact associated with the highest relative risk for all species of fish is masking, which is deemed as high in the near-field and intermediate field, and moderate in the far-field. These details are presented in Table 4-13.

Table 4-13: The relative risk of impacts on fish in the near-field (N), intermediate field (I) and far-field (F) for the noise associated with vibropiling using the Popper et al. (2014) fish criteria for shipping and continuous sounds.

Popper *et al.* (2014) criteria for shipping and continuous sounds					
Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	**See Table 4-12**	**See Table 4-12**	((N) High (I) High (F) High	(N) High (I) Moderate (F) Low

4.3 Cutter Suction Dredging (CSD)

4.3.1 Predicted Noise Levels

The distribution of noise from the CSD equipment at the Port of Ardersier is presented as noise contour plots in Figure 4-5. These plots show the maximum predicted noise level in the water column.

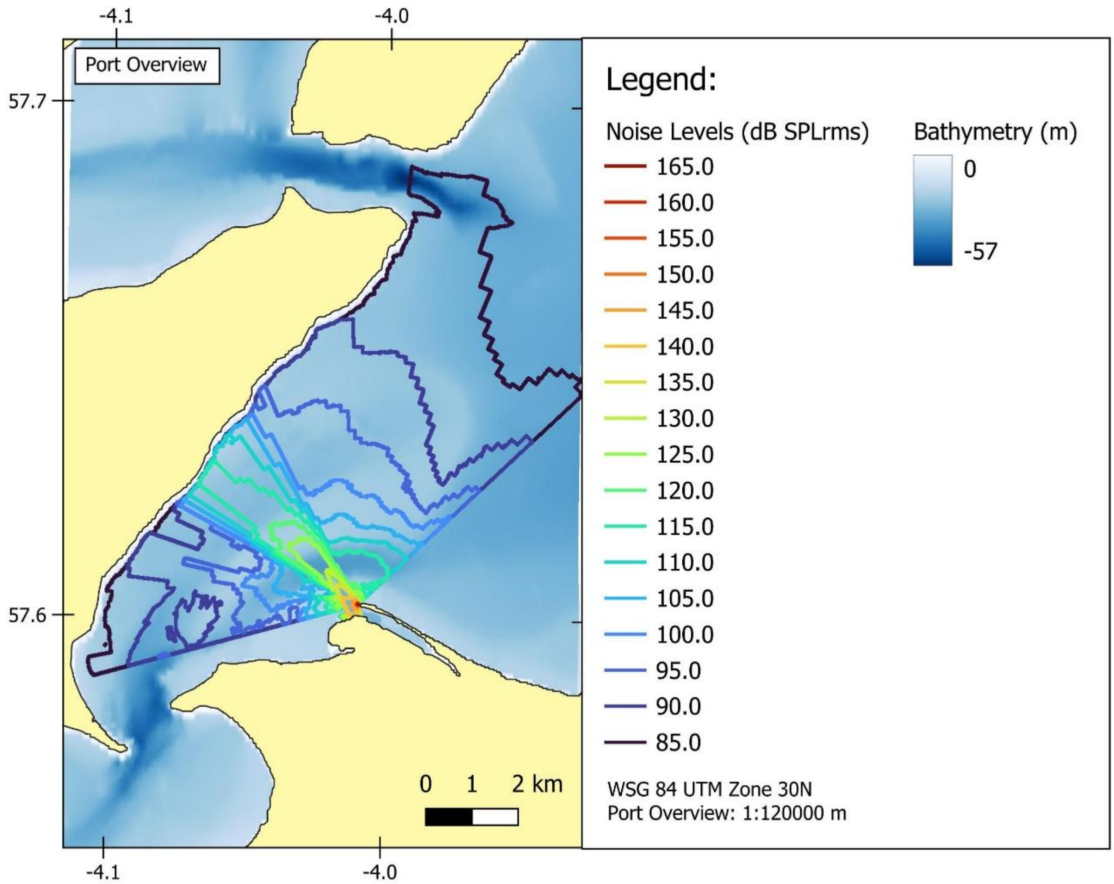

Figure 4-5: $L_{p,RMS}$ noise level contours predicted for CSD at the Port of Ardersier.

4.3.2 Interpretation

4.3.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.3.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for non-impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal will exceed the PTS threshold at any distance from the CSD equipment. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-14: Predicted impact ranges associated with CSD, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.Table 4-14.

Table 4-14: Predicted impact ranges associated with CSD, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

Southall *et al.* (2019) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)
			NW
LF Cetaceans	PTS	199 dB	< 10
	TTS	179 dB	< 10
HF Cetaceans	PTS	198 dB	< 10
	TTS	178 dB	< 10
VHF Cetaceans	PTS	173 dB	< 10
	TTS	153 dB	< 10
PCW Pinnipeds	PTS	201 dB	< 10
	TTS	181 dB	< 10

4.3.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.3.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal will exceed the AUD INJ threshold at any distance from the CSD equipment. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-15.

Table 4-15: Predicted impact ranges associated with CSD, using the NMFS (2024) $L_{E,p,24h,wtd}$ auditory injury and TTS criteria for in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)
			NW
LF Cetaceans	AUD INJ	197 dB	< 10
	TTS	177 dB	< 10
HF Cetaceans	AUD INJ	201 dB	< 10
	TTS	181 dB	< 10
VHF Cetaceans	AUD INJ	181 dB	< 10
	TTS	161 dB	< 10
PW Pinnipeds	AUD INJ	195 dB	< 10
	TTS	175 dB	< 10

4.3.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are within 2500 m from the CSD equipment. These results are presented in Table 4-16.

Table 4-16: Predicted impact ranges associated with CSD using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals in relation to non-impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (Non-Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
All Marine Mammals	Level B Disturbance	120 dB	2500	410	< 10

4.3.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.3.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for shipping and continuous sounds would be exceeded by fish.

Based on the results for the $L_{p,RMS}$ metric, animals within < 10 m of the CSD equipment may exceed the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along with TTS impact ranges are provided in Table 4-17.

Table 4-17: Predicted impact ranges associated with CSD, using the Popper et al. (2014) $L_{p,RMS}$ criteria for shipping and continuous sounds.

Popper *et al.* (2014) criteria $L_{p,RMS}$ (continuous sounds)			Estimated Impact Ranges (m)		
			Maximum	**Mean**	**Minimum**
Fish: swim bladder involved in hearing	Recoverable injury	170 dB	< 10	< 10	< 10
	TTS	158 dB	20	< 10	< 10

Across all species of fish, the relative risk of mortality and potential mortal injury, as well as recoverable injury associated with vessel noise is low in the near-field, intermediate field and far field distance. Of all the potential impacts, the impact associated with the highest relative risk for all species of fish is masking, which is deemed as high in the near-field and intermediate field, and moderate in the far-field. These results are presented in Table 4-18.

Table 4-18: The relative risk of impacts on fish in the near-field (N), intermediate field (I) and far-field (F) for the noise associated with CSD using the Popper et al. (2014) fish criteria for shipping and continuous sounds.

Popper *et al.* (2014) criteria for shipping and continuous sounds					
Type of fish	**Mortality and potential mortal injury**	**Impairment**			**Behaviour**
		Recoverable injury	**TTS**	**Masking**	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	**See Table 4-17**	**See Table 4-17**	((N) High (I) High (F) High	(N) High (I) Moderate (F) Low

5 Summary and Conclusion

Subacoustech Environmental has undertaken an underwater noise modelling study in anticipation of planned construction works in the Port of Ardersier, in the Moray Firth, Scotland. The works are proposed to include the use of impact piling and vibropiling for pile installation and dredging to deepen the inner harbour.

The level of underwater noise generated by the works was estimated using a combined parabolic equation and ray tracing modelling approach. The modelling considers a wide array of input parameters including the equipment source level, sound frequency content, seabed properties and the sound speed profile in the water column. Full account is also taken of the bathymetry in the areas surrounding the survey site.

The modelled noise levels were then interpreted in accordance with the guidelines associated with PTS/auditory injury outlined in Southall *et al.* (2019) and NMFS (2024), and guidelines for disturbance outlined in NOAA (2005) for marine mammals in relation to impulsive and non-impulsive noise sources. The guidance outlined in Popper *et al.* (2014) for fish in relation to pile driving and continuous sounds was also considered.

Of all noise sources included in the assessment, the greatest impact ranges associated with PTS/AUD INJ or mortality for both marine mammals and fish were predicted for impact piling.

For marine mammals in relation to impact piling noise:

- the greatest distance where there is a predicted risk of auditory injury according to the $L_{p,pk}$ metric was found for VHF cetaceans that must be within 60 m of the impact piling activity to exceed their PTS (Southall *et al.* 2019) or AUD INJ (NMFS, 2024) criteria.
- Using the $L_{E,p,24h,wtd}$ criteria, both PTS (Southall *et al.* 2019) and AUD INJ (NMFS, 2024) is predicted to be unlikely for all groups, as the receptor is modelled to flee from the piling noise and will only be near to the pile during a soft start period.

For fish, using the Popper *et al.* (2014) guidance for pile driving:

- The greatest distance where there is a risk of mortality according to the $L_{p,pk}$ metric was predicted at 30 m from impact piling for fish with a swim bladder involved and not involved in hearing.
- If they remain stationary for 10 hours, the greatest distance associated with a risk of mortality, according to the $L_{E,p,24h}$ metric, was predicted at 420 m from impact piling for fish with a swim bladder involved in hearing.

For disturbance effects, the greatest impact ranges for marine mammals are associated with vibropiling, where marine mammals at up to 2900 m from the vibropiling activities on the maximum transect will exceed their Level B Disturbance criteria (NOAA, 2005). It is predicted that, according to this criterion, marine mammals will be disturbed if they are up to 2500 m from dredging, and up to 1000 m from impact piling. This is based on disturbance noise criteria of 160 dB $L_{p,RMS}$ for impulsive noise and 120 dB $L_{p,RMS}$ for non-impulsive noise.

By its nature, mathematical modelling will produce results that indicate a precise range at which a criterion will be reached, but this does not reflect the inherent uncertainty in the physical processes, including many that change constantly under real world conditions. While the results present specific ranges at which each impact threshold is met based on the modelling results, the ranges should be taken as indicative in determining where environmental effects may occur in receptors during the proposed operations.

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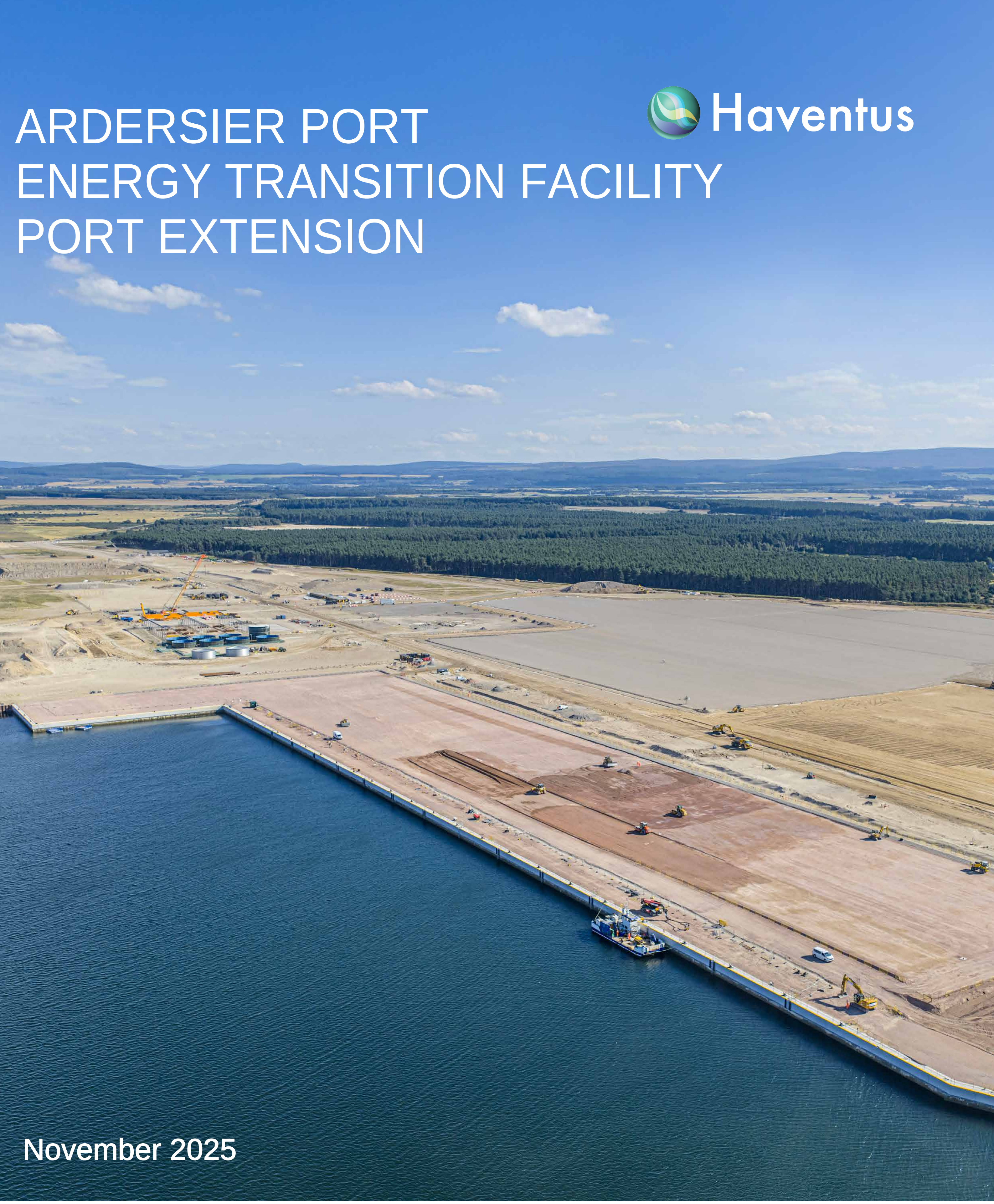

November 2025

Appendix 11.6: RIAA – Marine Mammal Designated Sites

SMRU Consulting

understand • assess • mitigate

Ardersier Port Extension
Report to Inform Appropriate Assessment – Marine Mammal Designated Sites

Authors:	Katarzyna Majewska
Report Code:	SMRUC-POA-2025-018
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Contents

Table of Figures

1 Document Purpose

The United Kingdom (UK) maintains a legally designated network of protected sites established for the conservation of important species and habitats, initially legislated under international obligations. The Scottish Government is required to assess the potential impacts of plans and projects on these designated sites through the Appropriate Assessment (AA) process.

Guidance under the Habitats Regulations for assessing plans and projects with potential impacts on European sites, outlines a four-stage process known collectively as the Habitats Regulations Assessment (HRA). Stage one, screening for Likely Significant Effects (LSE) was undertaken as part of the EIA Scoping Report (SCOP-0062), which was issued to consultees in January 2025. The second stage of this process is the AA (see section 2).

This document presents the outcomes of the assessment regarding the potential for LSE on the conservation objectives of the screened-in European sites. Where LSE could not be excluded at the screening stage, the report evaluates the potential for an Adverse Effect on Site Integrity (AEoSI), either alone or in combination with other plans or projects, arising from the proposed development.

The RIAA forms part of the wider suite of documents submitted in support of the consent application for the proposed development. Key sources of information used in this assessment include the following Environmental Impact Assessment Report (EIAR) documents:

- EIAR Chapter 11: Marine Mammals
- EIAR Appendix 11.3: Ardersier ETF Extension Marine Mammal Baseline Characterisation
- EIAR Appendix 11.5: Underwater Noise Modelling
- EIAR Appendix 11.7: Marine Mammal Mitigation Plan (MMMP)

2 HRA Process

The Habitats Directive (92/43/EEC), on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Directive provides the European Union's legal framework for the protection of wild fauna and flora and birds (see section 3 for more details regarding legislation and policy).

HRA is a multistage process which aims to determine the potential for LSE, assesses the potential for adverse impact on the integrity of a European site, examines alternative solutions and provides justification of Imperative Reasons of Overriding Public Interest (IROPI), as required. Defra (2021) guidance describes that the process can have up to three stages as outlined below:

- Screening - the first stage involves a screening for LSE which is a simple assessment to check or screen if, in the absence of mitigation, a proposal:
  - is directly connected with or necessary for the conservation management of a European site; and
  - risks having a significant effect on a European site on its own or in-combination with other proposals.
- Appropriate Assessment - the second stage is an Appropriate Assessment, which must be carried out if it is decided that there is a risk of a LSE on a European site or if there is not enough evidence to rule out a risk (as required by Article 6(3) of the Habitats Directive). The Appropriate Assessment (AA) should assess the likely significant effects of a proposal on the integrity of the site and its conservation objectives and consider ways to avoid or reduce (mitigate) any potential for an 'adverse effect on the integrity of the site'.
- Derogations - the third stage is known as a derogation (as outlined in Article 6(4) of the Habitats Directive) where, in certain circumstances, a proposal that has failed the integrity test may be allowed to go ahead. To decide if the proposal qualifies for a derogation, three legal tests must be applied. All three tests must be passed in sequence for a derogation to be granted:
  - there are no feasible alternative solutions that would be less damaging or avoid damage to the site;
  - the proposal needs to be carried out for imperative reasons of overriding public interest; and
  - the necessary compensatory measures can be secured.

Each stage of the HRA process, excluding the third and final stage, defines the prerequisites and scope for the subsequent stage. This report builds upon the stage 1 Screening that has already been completed as part of the EIA Scoping Report (SCOP-0062), and presents the assessment for stage 2 (Appropriate Assessment) of the HRA process.

3 Legislation and Policy Guidance

3.1 Habitats Directive and Habitats Regulations

Designated site legislation in Scotland is derived from both Scottish and broader UK legislative frameworks. The Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive'), protect habitats and species of European nature conservation importance. Together with the Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive established a network of internationally important sites, designated for their ecological status: Special Areas of Conservation (SACs), under the Habitats Directive promote the protection of flora, fauna and habitats; and SPAs, under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combined to create a Europe wide 'Natura 2000' network of designated sites, which were referred to as 'European sites'.

These Directives were transposed into UK law through a series of regulations. Terrestrial areas of the UK and inshore waters (out to 12 nautical miles) are covered by the Conservation (Natural Habitats, &c.) Regulations 1994 and the Conservation of Habitats and Species Regulations 2017. Offshore waters, extending beyond 12 nautical miles to the limits of the British Fishery Limits and the UK Continental Shelf Designated Area, are governed by the Conservation of Offshore Marine Habitats and Species Regulations 2017. Collectively, these statutory instruments are referred to in this report as the Habitats Regulations.

In line with Scottish Government policy, Ramsar sites (wetlands of international importance designated under the Convention on Wetlands of International Importance; Ramsar Convention, 1971) are treated as having the same level of protection as SACs and SPAs when assessing the potential impacts of development proposals. This policy also extends equivalent protection to potential SPAs (pSPAs) and candidate SACs (cSACs). The assessment of impacts on Ramsar sites and SPAs have been addressed in Appendix 13.9.

3.2 EU Exit Regulations

The UK left the European Union on Exit Day, 31 January 2020, following Completion Day on 31 December 2020. Although the UK is no longer a member of the EU, the Habitats Directive, along with the transposing Habitats Regulations, continues to serve as the legislative foundation for HRA in the UK via the EU Exit Regulations. The HRA process under the Habitats Regulations remains applicable, with minor modifications introduced by the EU Exit Regulations[1]. Consequently, this document has been prepared on the assumption that all pertinent HRA-related legislation is still in effect, adhering to the Habitats Regulations that incorporated European HRA requirements into UK law.

[1] The EU (Withdrawal) Act 2018, as amended as by the EU (Withdrawal Agreement) Act 2020, gives Ministers in the UK Government and in the devolved administrations of Northern Ireland, Scotland and Wales, powers to make subordinate legislation amending laws that otherwise would not work appropriately as a result of the UK leaving EU, or to implement the Withdrawal Agreement.

With respect to marine mammals, the objective of the Habitats Regulations is to maintain Favourable Conservation Status (FCS) for the habitats and species listed in Annex II of the Habitats Directive. Post-EU Exit, the Habitats Regulations continue to reference these annexes, and accordingly, this report refers to the annexes of the Habitats Directive.

European sites, European marine sites and European offshore marine sites within the UK as defined by the Habitats regulations, are now excluded from the EU's Natura 2000 network. Instead, they constitute a nationwide network of protected areas known as the National Site Network (NSN) and continue to benefit from equivalent levels of protection. The term adopted within this report is hereafter European Sites.

3.3 Further Guidance

The Statutory Nature Conservation Bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. This conservation advice provides information on sites and features and guidance on how to achieve FCS. The following guidance documents were used to inform the AA in this report:

- NatureScot (2025a). Conservation and Management Advice - Dornoch Firth and Morrich More SAC. April 2025.
- NatureScot (2025b). Conservation and Management Advice - Moray Firth SAC. June 2025.

4 Screening Summary

A screening exercise was carried out as part of the EIA Scoping Report (SCOP-0062) to identify which European Sites are at risk of likely significant signigicant effects from the proposed development. The following European Sites with marine mammal qualifying features (for which there is potential connectivity with an impact from the construction) were screened in:

- Dornoch Firth and Morrich More SAC (harbour seal); and
- Moray Firth SAC (bottlenose dolphin).

Details about both sites, including COs, are provided in section 5. It was not possible to conclude no LSE for potential effects at the screening stage and therefore all both European Sites were taken forward to the AA (see section 6.3).

5 European Sites

5.1 Dornoch Firth and Morrich Moore SAC

5.1.1 Site overview

The Dornoch Firth and Morrich More SAC lies approximately 30 km north of the Port of Ardersier. The Dornoch Firth is the most northerly large estuary in Britain and the SAC site was initially designated in part for Annex II species harbour seals.

The SAC is located within the Moray Firth Seal Monitoring Unit (SMU). Since data collection began during the 1996/97 period, harbour seal counts in the Moray Firth SMU have declined from 1,409 in 1996/97 to 983 in the latest 2023 counts (SCOS, 2024). This results in the latest population estimate for the entire Moray Firth SMU (scaled to account for those at-sea at the time of the count) of 1,365 harbour seals (95% CIs 1,117 – 1,820). Overall, harbour seal abundance in the Moray Firth SMU is depleted but stable (SCOS, 2023, 2024).

However, SCOS (2024) reported that for the Dornoch Firth and Morrich More SAC is more severely depleted and is still in decline. Trends for the Dornoch Firth and Morrich More SAC show that the population has decreased by 7.5% over 1-year and has decreased by 37.5% over the last 6 years (SCOS, 2024).

5.1.2 Conservation Objectives

The Conservation Objectives associated with the harbour seal feature of the Dornoch Firth and Morrich More SAC are presented in Table 1.

Table 1: Conservation Objectives and Site Specific Advice for Dornoch Firth and Morrich More SAC

Site	Conservation Objectives	Site specific advice
Dornoch Firth and Morrich More SAC	1) To ensure that the qualifying features of Dornoch Firth and Morrich More SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	Harbour seals are considered to be in unfavourable (inadequate) condition at the Dornoch Firth and Morrich More SAC. The SAC trend is declining. When carrying out appraisals of plans and projects against these Conservation Objectives, it is not necessary to understand the status of qualifying features within each individual SAC in the UK. If the site Conservation Objectives are met then the site's contribution to FCS across the UK will continue to be achieved. Further advice on how these appraisals should be focussed is provided by Conservation Objective 2.
	2) To ensure that the integrity of Dornoch Firth and Morrich More SAC is maintained or restored in the context of environmental changes: 2a - harbour seals are a viable component of the Dornoch Firth and Morrich More SAC; 2b - the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance of harbour seals; 2c - the supporting habitats and processes relevant to harbour seal are maintained, including prey resources.	This conservation objective is considered to be met if the conditions to support all the species' essential behaviours and activities are in place. This includes: • avoiding effects that could prevent or reduce the ability of the harbour seal population to recover. • avoiding effects within and out with the site that could lead to a permanent reduction in the harbour seal population through mortality, injury, or impacts caused by disturbance, displacement, barrier effects or reduction in mobile prey resources. • maintaining the species' ability to use all areas of importance within the site (to be considered under conservation objective 2b) • maintaining access to, and availability of, supporting habitats within the site (to be considered under conservation objective 2c). At a site level, harbour seals are considered to be viable if they can carry out their life cycle functions and, for harbour seal, if conditions are right to accommodate a recovery in numbers. The long-term viability of these species in the SAC is intrinsically linked to their ability to access and use habitat and prey resources both on site and in areas of functionally linked sea out with the SAC. The objective 2b seeks to ensure that harbour seals continue to have access to and use all areas of the site by avoiding significant disturbance. The objective 2c seeks to maintain the current extent, quality and distribution of supporting habitats of harbour seals within the site. Given that the activities within the Ardersier EFT Site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC, there is no potential to directly affect the supporting habitats within the site. As such, conservation objective 2c is not considered further.

5.2 Moray Firth SAC

The Port of Ardersier lies within the Moray Firth SAC, for which the bottlenose dolphin is the primary Annex II species for site selection. This SAC supports the only known resident bottlenose dolphin population in the North Sea.

5.2.1 Site overview

The Moray Firth SAC extends from the inner firths to Helmsdale on the north coast, and Lossiemouth on the south coast, including areas that are regularly utilised by the resident population of bottlenose dolphins along the East coast of Scotland. Bottlenose dolphins associated with this SAC are a part of a wider Coastal East Scotland (CES) Management Unit (MU) population. This population has experienced significant changes in its distribution over the past three decades. During the late 1980s and early 1990s, the inner Moray Firth was identified as the core area of occurrence for the population and distributional pattern formed the basis for defining the boundaries of the Moray Firth SAC (Arso Civil *et al.*, 2025). Since the 1990s, the CES population has been recorded ranging further south in the Tay Estuary and the Firth of Forth and more recently, sightings have been recorded around the coast of northern England (Wilson *et al.*, 2004, Arso Civil *et al.*, 2018a, b, Arso Civil *et al.*, 2021a, Arso Civil *et al.*, 2021b, Arso Civil *et al.*, 2022, Arso Civil *et al.*, 2023, Arso Civil *et al.*, 2025).

Between 2009 and 2022, the proportion of the population utilising the Moray Firth SAC declined, while use of the Tayside and adjacent waters increased (Cheney *et al.*, 2024). However, in most years, more than 50% of the population continued to use both areas. The most recent Mark-recapture analysis of photographs collected during photo-identification surveys indicates that, as of 2022, the Moray Firth SAC supports an estimated number of 94 individuals (Cheney *et al.*, 2024). Despite the number of animals using the SAC declined by 4.9% from 122 individuals in 2017, the number of dolphins using the SAC is still considered stable over longer timescales (2001 - 2022) with some inter-annual variability (Cheney *et al.*, 2024).

Passive acoustic monitoring conducted between 2017 and 2022 revealed that, despite inter-annual and seasonal variability, bottlenose dolphins were present at one long-term monitoring site within the SAC on more than 80% of days from April to December. During these periods, dolphins were acoustically detected for between 3 and 10 hours per day. Further detail on the passive acoustic monitoring results is provided in EIAR Appendix 11.3.

5.2.2 Conservation Objectives

The Conservation Objectives associated with the bottlenose dolphin feature of the Moray Firth SAC are presented in Table 2 .

Table 2: Conservation Objectives and Site Specific Advice for Moray Firth SAC

Site	Conservation Objectives	Site Specific Advice
Moray Firth SAC (NatureScot, 2025b)	1) To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	As the long-term trend in the number of dolphins using the SAC remains stable, the use of this protected area continues to be high, and the east coast population is increasing, the condition status is Favourable (maintained) (Cheney *et al.*, 2024, NatureScot, 2025b).
	2) To ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for bottlenose dolphin: 2a - the population of bottlenose dolphin is a viable component of the site; 2b - the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance; 2c - the supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.	Objective 2a seeks to minimise the risk to bottlenose dolphins from injury or killing posed by activities. It specifically protects the species from significant risk of incidental killing and injury within and out with the site. Objective 2b seeks to ensure that bottlenose dolphins can continue to use and have access to all areas of the site by avoiding significant disturbance. Interpretation of 'significant disturbance' will depend on the context, including the information that is provided through the plan or project, and is then subject to the appraisal to assess risk. It should be interpreted to mean disturbance that affects the integrity of the site through alteration of the distribution of bottlenose dolphin within the SAC such that recovery cannot be expected, or effects can be considered long term. Bottlenose dolphin calves are highly dependent on their mothers for up to 2 years therefore prolonged disturbance is more likely to constitute significant disturbance and to have an impact on site integrity. It is expected that significant disturbance will lead to more than a transient effect on the distribution of bottlenose dolphin. It may result in the following effects: • Contributes to the long-term decline in the use of the site by bottlenose dolphin. • Changes to the distribution of bottlenose dolphin on a continuing or sustained basis. • Changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. Objective 2c seeks to maintain sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site. Relevant activities (e.g. hydraulic dredging, aggregate extraction, dumping) should be considered within appraisals

6 Assessment of potential AEoI

6.1 Project Alone

6.1.1 Maximum Design Scenario

Potential LSEs on this European Site were identified for the following potential impacts:

- Construction phase:
  - Auditory injury (PTS) associated with piling (vibro and impact) for installation of mooring dolphins;
  - Auditory injury (PTS) associated with dredging and spoil disposal activities;
  - Disturbance associated with piling (vibro and impact) for installation of mooring dolphins;
  - Disturbance associated with dredging and spoil disposal activities;
  - Disturbance associated with increased vessel traffic; and
  - Collision risks associated with increased vessel traffic.
- Operation and maintenance phase:
  - Collision risk impacts associated with increased vessel traffic due to the proposed development during operations and maintenance;
  - Disturbance impacts associated with increased vessel traffic due to the proposed development during operations and maintenance (including disturbance to seal haul-outs); and
  - Long term habitat changes, displacement and/or barrier effects.

The maximum design scenario and a summary of the impacts are provided in sections 6.1.2 and 6.1.3 for construction and maintenance and operation phases, respectively. Detailed project information is provided in the EIAR Chapter 11 (Marine Mammals).

6.1.2 Construction

6.1.2.1 Auditory injury (PTS) associated with piling for installation of mooring dolphins as well as dredging

Impact piling is the only impulsive noise source during construction of the proposed development with the potential to cause auditory injury. Based on the underwater noise modelling, there is no risk for high frequency cetaceans (e.g. bottlenose dolphins) to experience Permanent Threshold Shift (PTS; using the peak Sound Pressure Level (SPL_{peak}) metric) due to impact piling of mooring dolphins. The low risk can be associated with the piling sequence starting with a soft-start and low maximum hammer energy (294 kJ). The maximum instantaneous injury range as a result of impact piling for harbour seals is <10 m. A piling MMMP will be in place to mitigate the risk of injury to both bottlenose dolphins and harbour seals (see section 6.1.4.1 for a summary and Appendix 11.7 for full details).

The maximum cumulative injury ranges (using the cumulative Sound Exposure Level (SEL_{cum}) metric) across all activities with the potential to cause cumulative PTS (impact piling and dredging) are <10 m for bottlenose dolphins and harbour seals.

Considering the low risk of injury based on underwater noise modelling, coupled with the embedded mitigation measures through the MMMP, the risk of auditory injury (PTS) to both bottlenose dolphins and harbour seals is considered **Negligible**.

6.1.2.2 Disturbance associated with piling for installation of mooring dolphins, dredging and spoil disposal activities as well as increased vessel traffic

The noise sources with a potential to cause behavioural disturbance to marine mammals during the construction phase of the proposed development include piling, dredging and spoil disposal as well as increased vessel traffic. These activities will be taking place at different spatial and temporal scales with respect to both bottlenose dolphin and harbour seal distribution.

Pile driving: The quantitative assessment using a dose-response approach and species-specific density maps (Thompson *et al.*, 2015, Carter *et al.*, 2025) showed that <1 individual dolphin or seal is at risk of experiencing disturbance from piling due to the localised extent of the impacts (see the EIAR Chapter 11 (Marine Mammals) for more details). The mean dolphin group size at Ardersier during boat based surveys was 8 individuals (1-56) (Benhemma-Le Gall and Cheney, 2025). As such, on average, 8 individuals (1 - 56) could experience behavioural disturbance at any given time. It should be however noted that piling will be restricted to only a short duration with 12 piles installed over 12 non-consecutive days, with a maximum of 10 hours of activity per pile.

Dredging: A combination of hydraulic and mechanical dredging will be carried out during the construction phase. The number of interactions between the dredging activity and bottlenose dolphins as well as harbour seals utilising waters surrounding the proposed development shall be minimal for most of the dredging campaign (10-weeks within a 6 month window (March to September)) as dredging activity shall take place deeper into the site boundary. The quantitative assessment was carried out in the EIAR Chapter 11 (Marine Mammals) using the effective deterrence ranges approach (1 km for bottlenose dolphin and 5 km for seals). It was estimated that up to 23 harbour seals (1.71% Moray Firth SMU) and no bottlenose dolphins may be disturbed by dredging activity.

Vessels: For the majority of time during the construction period (2026 – 2028), a maximum of five vessels (primarily barges for material delivery) may operate within the site boundary at any one time. These vessel movements are expected to be dispersed and intermittent and are not anticipated to result in significant spatial overlap with areas of highest dolphin activity (e.g. within the site boundary). The disturbance is most likely to occur during the spoil disposal events and vessel associated with dredging activities (between 2027 – 2029), which would be associated with approximately 450 additional vessel movements within the inner Moray Firth over the ten-week period. The semi-quantitative assessment (see Section 3.4.2.2 of Appendix 11.4) estimated that bottlenose dolphins may be present in the vicinity of the proposed development approximately 14.6% of the total spoil disposal operational time (which represents 66 of the 450 vessel movements) where there is expected to be disturbance to an average of 8 individuals (maximum 56). This higher intensity in vessel movement is short-term but represents a significant temporary increase in marine traffic local to the proposed development and the spoil disposal area(s) (Inverness, the Sutors or Burghead). The anticipated increase in vessel movements may lead to short-term, localised impacts, particularly relating to increased underwater noise, and a higher risk of disturbance to both harbour seals and bottlenose dolphins.

6.1.2.3 Collision risks associated with increased vessel traffic

During construction of the proposed development, there is a risk that increased vessel activity could result in death, or physical trauma from collision with a construction vessel. These injuries include blunt trauma to the body, or injuries consistent with propeller strikes. There is currently limited information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. The Scottish Marine Animal Stranding Scheme (SMAS) data shows that very few strandings have been attributed to vessel collisions (SMASS, 2018, 2019, 2020, 2021, 2022, 2023), therefore while there is evidence that mortality from vessel collisions can and does occur in Scottish waters, it is not considered to be a key source of mortality highlighted from post-mortem examinations.

During the construction phase of the proposed development, under a worst-case scenario, peak vessel activity is expected to occur during spoil disposal operations between March and September 2028, with up to 13 - 23 barge movements per day and a maximum of approximately 450 additional vessel movements within the inner Moray Firth over a ten-week period. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks of collision. The risk of vessel collision with marine mammals is also influenced by vessel speed and size. While dredging vessels typically operate at low speeds (1–3 knots), project vessels may reach speeds up to 12 knots during transit. The embedded mitigation of a Navigational Safety Risk Assessment (NSRA) will ensure that vessel traffic moves along predictable routes, set recommended speed and define how vessels should behave in the presence of marine mammals. Consequently, the overall likelihood of a collision is low; in the unlikely event that one does occur, it would be infrequent.

6.1.2.4 Indirect impact on prey availability

The activities associated with construction which could give rise to indirect impacts by affecting prey availability are increases in underwater noise associated with piling, impacts of contaminants and sediment suspension as a result of dredging, and pollution events from the accidental release of hydraulic fluids and oils from the construction plant into the marine environment. Sandeels are of particular importance to harbour seals and cod, saithe and whiting are the main prey items eaten by bottlenose dolphins in Scottish waters (Santos *et al.*, 2001, Pierce *et al.*, 2004, Santos *et al.*, 2004, Wilson and Hammond, 2019). Salmon are also a seasonally important component of the bottlenose dolphin diet, with the presence of bottlenose dolphins in the summer months coinciding with seasonal migrations of Atlantic salmon and sea trout through the Moray Firth (NatureScot, 2025b). The Nairn District Salmon Fisheries Board advise that the Port of Ardersier lies in close proximity to the River Nairn, which is an important river for migratory salmonids (salmon and sea trout), and as such it is likely that migratory fish travel close to the proposed works location while seeking their natal river (MD-LOT, 2025).

With implementation of an appropriate Port Environmental Management Plan (POEMP) and Port Oil Spill Contingency Plans, a major pollution incident that may impact any fish species at a population level is considered very unlikely. The sediment samples tested historically against the Revised Action Levels (RAL) showed low levels of chemical contaminants and organic hydrocarbons present and they have been previously identified as suitable for disposal. Whilst a BPEO has not yet been concluded for the dredging activities as part of the proposed development, any future BPEO that is authored for the proposed development shall take the appropriate measures to ensure that dredged materials meet acceptable environmental standards. Sediment disturbance and habitat loss will occur within the dredged area. Although the temporary and localised exposures to noise associated with construction activity are unlikely to have any long-lasting effects on the fitness and survival of fish and cephalopods, the noise associated with construction activity may cause temporary relocation, communication making, and changes in behaviour of marine mammal prey species. Consequently, sediment disturbance and underwater noise may locally affect marine mammals' access to prey within the site boundary. Overall, impacts to prey species could result in very slight changes to marine mammal receptors and it is expected that this will not result in any population level change.

6.1.3 Operation and Maintenance

6.1.3.1 Disturbance impacts associated with increased vessel traffic

The area surrounding the proposed development is already subject to high levels of vessel activity with the Port of Ardersier currently experiencing approximately 340 vessel movements per year (Haventus, 2025). The Inner Moray Firth is an area where marine mammals are regularly exposed to commercial vessel activity. During the operational phase of the proposed development, vessel movements associated with the Port of Ardersier are expected to increase to a maximum worst-case scenario of 400 vessel movements per year (increase of ~60 vessels per year compared to current levels (17.65% increase)). The types of vessels expected to operate from the Port of Ardersier are primarily large vessels servicing offshore industries, including heavy load carriers, heavy lift vessels, jack-up barges, general cargo vessels, bulk carriers and semi-submersibles. Vessel activity levels will be sustained over a long-term duration (50 years).

Bottlenose dolphins and harbour seals are likely to exhibit some degree of habituation to vessel noise and presence due to existing high baseline traffic level and thus, the frequency of potential disturbance events is predicted to remain the same. Further, the spatial extent remains of disturbance shall remain localised over the operational phase and does not represent a significant increase in marine traffic over a broad geographical area (e.g., from the port to offshore wind farm sites).

6.1.3.2 Collision risk impacts associated with increased vessel traffic

As discussed in section 6.1.2.3 for construction, vessel activity during the operational phase could result in death or physical trauma to marine mammals from collisions with vessels. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic, as it allows marine mammals to better anticipate and avoid vessels (Nowacek *et al.*, 2001, Lusseau, 2006, New *et al.*, 2020).

Vessel traffic during the operational phase is expected to increase from approximately 340 vessel movements per year (Haventus, 2025) to a maximum worst-case scenario of 400 vessel movements per year (increase of ~60 vessels per year compared to current levels). While some of the vessels expected to operate are capable of reaching speeds up to 13 knots, most are expected to transit at typical speeds around 10 knots. Although vessels may transit over a broad geographical area (e.g., from the port to offshore wind farm sites), the physical risk of collision is localised to the immediate vicinity of the moving vessel. The adoption of a NSRA based on best practice vessel handling protocols (e.g., following the Scottish Marine Wildlife Watching Code) will minimise the potential for any impact by ensuring that vessel traffic moves along predictable routes, setting recommended speed and defining how vessels should behave in the presence of marine mammals. Consequently, the overall likelihood of a collision is low; in the unlikely event that one does occur, it would be infrequent.

6.1.3.3 Indirect impact on prey availability

Activities relating to the operations of the proposed development may influence water quality as a result of accidental release of fuels, oils and/or hydraulic fluids. With implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident that may impact any fish species at a population level is considered very unlikely. Consequently, changes in water quality are unlikely, and effects on prey species are not anticipated. Overall, the potential for impacts on prey is low and unlikely to influence marine mammal receptors or lead to any population-level change.

6.1.3.4 Long term habitat changes, displacement and/or barrier effects

Bottlenose dolphins in this region are known to show high site fidelity and regularly use specific coastal corridors, such as the narrow channel between Chanonry Point, Ardersier, and Fort George (Cheney *et al.*, 2013, Benhemma-Le Gall and Cheney, 2025). Harbour seals are known to haul-out at the Ardersier (Whiteness Sands) designated haul-out site, which overlaps with the site boundary.

Although situated within the Moray Firth SAC, the proposed development will not permanently obstruct the Chanonry Point–Fort George–Ardersier channel and the entry to the SAC. All new operational structures associated with the Port of Ardersier are either land-based or positioned within the existing port envelope and inner harbour. For example, Nigg Energy Park and the Invergordon Service Base have undergone significant port expansion, allowing for the fabrication and storage offshore wind turbine structures, the mooring of oil & gas platforms, and the berthing of large vessels such as cruise liners. Despite ongoing operations and vessel activity, marine mammals continue to be regularly sighted in the Inner Moray Firth, including around Nigg Energy Park, Invergordon and the Port of Ardersier (Graham *et al.*, 2017, Benhemma-Le Gall and Cheney, 2025). Long-term surveys in the Moray Firth indicate continued and regular use by dolphins and seals, suggesting that the presence of coastal industrial structures and increased vessel activity have not created permanent or large-scale movement barriers (Cheney *et al.*, 2018, Hague *et al.*, 2019, Cheney *et al.*, 2024, Benhemma-Le Gall and Cheney, 2025). As such, barrier effects associated with presence of infrastructure is unlikely. However, intermittent displacement during operational vessel activity is expected and is further discussed under disturbance in section 6.1.3.1.

6.1.4 Marine Mammal Mitigation Plans

The draft MMMP is detailed in EIAR Appendix 11.7. The mitigation developed and included as part of the MMMP is to ensure the protection of marine mammals during the installation of three mooring dolphins using impact piling or vibropiling, as well as during dredging and spoil disposal operations.

6.1.4.1 Impact Piling MMMP

A 500 m Mitigation Zone (MZ) will be implemented. This is based on the minimum 500 m MZ recommended by the JNCC (2010) for pile driving activities and will be more than sufficient to mitigate the predicted instantaneous PTS ranges (max 60 m). The MZ will be monitored by a Marine Mammal Observer (MMO) and/or PAM Operator (PAM Obs). A pre-piling search will be conducted for a minimum of 30 minutes prior to the commencement of piling. Following the completion of the pre-piling search, a 20-minute soft-start procedure will commence.

6.1.4.2 Dredging MMMP

A 500 m Mitigation Zone (MZ) will be implemented. This is based on the minimum 500 m MZ recommended by the JNCC (2010) for pile driving activities in the absence of dredging specific guidance. This will be more than sufficient to mitigate the predicted instantaneous PTS ranges (max 10 m). The MZ will be monitored by a MMO and/or PAM Obs. A pre-dredging search will be conducted for a minimum of 30 minutes prior to the commencement of dredging. Once the 30-minute pre-dredging search is complete and MZ is clear of animals, a 20-minute soft-start procedure can commence (where operationally feasible for the suction cutter).

6.1.4.3 Soil Disposal MMMP

The Mitigation Zone (MZ) that should be monitored during spoil disposal operations on the vessel approach to, and at the spoil disposal site, is a 200 m MZ established around the spoil disposal vessel, with mitigation only being implemented for marine mammal visual observations or acoustic detections within the MZ. This shall be conducted for a minimum of 15 minutes. This shall be applied for all marine mammal species.

The JNCC (2010) guidelines for pile driving activities have been adapted here to reduce the duration of the pre-disposal search, and the delay to commencing activities after the last marine mammal detection. This is due to the reduced area of search when compared with the dredge area itself (i.e., a 200 m MZ versus a 500 m MZ) which is an area that is >80% smaller. However, the timings have only been reduced by 50% as a conservative measure to account for the fact that marine mammals are not always available at the surface for observation and may not be constantly vocalising.

6.2 In-Combination

6.2.1 Project Screening

The in-combination effects are the effects of the proposed development, combined with the effects from other projects, on the same receptor, in case of this report, on the protected feature of a designated site or any supporting habitats and processes. A cumulative impact assessment screening process carried out as a part of the EIAR Chapter 11 (Marine Mammals), has identified the relevant other plans, projects, and activities which are to be included in the assessment. The time period considered in the EIAR and in this report is 2025 to 2034 inclusive to account for projects constructing up to a year on either side of the proposed development construction. This allows for the quantification of impacts prior to, during and post construction.

The screening range in the EIAR was defined as the Moray Firth. For the purposes of this report, only projects with the potential to adversely affect the integrity of SACs in relation to their respective Conservation Objectives were considered. If a project overlaps spatially with the SACs, it has been carried forward to the in-combination assessment. To identify projects which may affect the protected features adversely but are located outside of the SAC, the following EDRs were applied:

- 26 km for fixed OWF piling;
- 15 km for floating OWF piling;
- 5 km for dredging (seals), 1 km for dredging (bottlenose dolphin);
- 5 km for cables (assuming 5 km low-order UXO clearance EDR), and
- 5 km for port developments.

For harbour seals, in order to account for behavioural impacts out with the site, the overlap was also considered with respect to the foraging range of 50 km from the SAC. For bottlenose dolphin, the site-specific management advice refers to potential injury and/or killing (conservation objective 2a; see Table 2) as the only potential impacts that should be managed outside of the site. As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury is considered highly unlikely, and this assessment focuses solely on projects with the potential to cause adverse effects within the site boundaries, such as disturbance.

As a result of this in-combination screening exercise, the following projects were identified for both SACs:

- Invergordon Phase 5 (piling between 2026 and 2027; operational from 2028)
- Port of Cromarty Firth (dredging between 2025 and 2028)
- Port of Nigg:
    - East Quay - Inner Berthing Structure (piling between 2025 and 2026)
    - Maintenance Dredging and Sea Disposal (dredging between 2025 and 2026)

Timing of each project with respect to the proposed development is presented in Table 3. Impacts associated with piling and dredging will be assessed for species in the assessment against COs in section 6.3 and a summary of vessel impacts is provided in section 6.2.2.

Table 3: Projects screened into the in-combination assessment.

Project	2025	2026	2027	2028	2029
Proposed development	-	Construction Piling	Construction Piling Dredging	Construction Piling Dredging	Dredging
Invergordon	-	Piling	Piling	-	-
Cromarty	Dredging	Dredging	Dredging	Dredging	-
Nigg	Piling Dredging	Piling Dredging	-	-	-

6.2.2 Vessel Impacts

6.2.2.1 Construction

At Nigg East Quay, a total of 482 construction vessel movements are projected over a 6-month period between 2025 and 2026 (EnviroCentre Limited, 2019). At Invergordon, approximately 272 one-way construction vessel movements are anticipated over a 3-year period (2025–2027), translating to an estimated 90–120 movements per year, including transits to and from the dredge disposal site during

2026–2027 (Affric, 2025). The proposed development is expected to contribute significantly to temporary increases in vessel activity, with a worst-case scenario involving up to 11 vessels present simultaneously (including dredging and barge delivery operations). During peak spoil disposal operations over a 10-week period between March and September (sometime between 2027 – 2029), 13–23 barge movements per day may occur, potentially resulting in up to ~450 additional vessel movements within the inner Moray Firth.

Considering the current baseline of >500 movements/km² throughout 2024 in the vicinity of the proposed development and Cromarty Firth (overall annual traffic volume that can approach or exceed 1,000 vessel movements per year (Affric, 2025)), due to the number of projects included within the CEA and the frequency of overlapping timescales, it is likely that the effect will occur at moderate frequency. An assessment of construction timeframes indicates that there is temporal overlap between Nigg South Quay and Invergordon, with both projects expected to be under construction during 2025–2026. This overlap presents the highest potential for cumulative marine mammal disturbance, particularly in the Cromarty Firth area, due to increased vessel movements associated with concurrent dredging and port development activity. In contrast, there is no direct temporal overlap between Invergordon and Ardersier, or between Nigg South Quay and Ardersier, as the Ardersier peak construction period may not commence until 2027.

6.2.2.2 Operation and Maintenance

Recent data for the Moray Firth the current volume of vessel traffic associated with vessel calls at the Cromarty Firth Ports (~1,000) (EnviroCentre Limited, 2019, Affric, 2025), the Port of Ardersier (~340) (Haventus, 2025) and at the Port of Inverness (~200)[2], baseline vessel movements in the inner Moray Firth amount to approximately ~1,540 movements per year.

At the individual port level, operational vessel movements at Nigg East Quay are projected to increase modestly from a 2019 baseline of approximately 220 movements per year to around 246 - 255 movements per year, representing an increase of 26 - 35 additional vessel calls annually (EnviroCentre Limited, 2019). In contrast, Invergordon is expected to operate at a higher intensity, with a worst-case scenario estimating 468 vessel movements per year, the majority of which (420) are tug operations (Affric, 2025). The same is anticipated for the proposed development, whereby vessel movements are anticipated to increase to 400 vessel calls per year as a maximum worst-case scenario, representing

[2] https://portofinverness.co.uk/wp-content/uploads/2023/03/Annual-Report-2022.pdf

an increase of ~60 additional vessel calls from current annual movements. Taking the combined operational activity across the Port of Ardersier, Nigg South Quay, Invergordon, and those within the Cromarty Firth Harbour Authority Limits (which includes those at Deephaven and the Cromarty (Car Ferry) Slipway), the total annual vessel movements within the inner Moray Firth are expected to reach approximately ~1,635 vessel movements per year. This represents a 6.17% increase on the current baseline of ~1,540 vessel movements per year.

6.3 Assessment against Conservation Objectives

6.3.1 Dornoch Firth and Morrich Moore SAC

In the UK, the harbour seal breeding period occurs between June and July, with moulting taking place from late July to mid-September. During these periods, there is typically a greater number of harbour seals hauled-out during low tide periods than at other times of year. The construction at the proposed development will take place between 2026 and 2028, with dredging activities taking place sometime between 2027 – 2029. As such, overlap with the construction at the proposed development and harbour seal breeding and moulting seasons cannot be discounted.

6.3.1.1 Project Alone

The Project Alone assessment of AEoI of the Dornoch Firth and Morrich Moore SAC with respect to harbour seal COs is presented in sections 6.3.1.1.1 to 6.3.1.1.1.3 and conclusions are provided in section 6.3.1.1.1.4.

6.3.1.1.1 Construction

6.3.1.1.1.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

The conservation status of harbour seals at the site is currently assessed as "unfavourable – inadequate" (NatureScot, 2025a). The unfavourable status of the harbour seal population at the Dornoch Firth and Morrich Moore SAC reflects an approximate 90% decline compared to population counts from the 1990s (NatureScot, 2025a). However, this rate of decline is not representative of the wider Moray Firth SMU, which is considered depleted but stable. NatureScot (2025a) recognised that the reasons for the unfavourable condition appear to lie out with the SAC, and that the reasons for harbour seal population variations and fluctuations across Scotland are unclear. Research is indicating that off-site factors such as predation, competition for prey, prey quality and availability, and toxin exposure from harmful algae maybe possible causes of the decline.

The focus of the appraisal should be to understand the impact of the proposed development on site integrity by ensuring that it does not prevent or reduce the potential for recovery. In light of the COs presented in Table 1 and the assessment carried out in sections 6.3.1.1.1.2 to 6.3.1.1.1.4, it can be concluded that the construction of the proposed development will not compromise the ability of the site and the harbour seal designated feature within to recover (e.g. it will not result in a further decline or accelerate the rate of decline).

6.3.1.1.1.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

The risk of auditory injury to harbour seals from all noise sources is negligible due to the extremely small predicted injury ranges as well as the application of mitigation measures (see sections 6.1.2.1 and 6.1.4). Similarly, any risk of death or injury through collision with vessels will be managed via a NSRA (see section 6.1.2.3). As such, killing or injury is highly unlikely and construction activities at the proposed development are not expected to affect harbour seals associated with the Dornoch Firth and Morrich Moore SAC.

In line with the advice provided in NatureScot (2025a), given that there is no site-reference population for harbour seal at this site, the site trend is considered in relation to the wider Moray Firth SMU. The quantitative assessment estimated that less than one harbour seal is expected to be disturbed during piling representing <0.001% of the Moray Firth SMU (Figure 1). As such, although temporary impacts associated with behavioural disturbance out with the site cannot be excluded, this may affect only a very small number of individuals and any displacement is expected to be localised to the immediate vicinity of the proposed development (Figure 1). Additionally, piling duration is not expected to last longer than 12 non-consecutive days.

Increased vessel activity and underwater noise as a result of dredging may also result in seal displacement from foraging areas. The site boundary is located approximately 30 km from the SAC and similarly to piling, it is anticipated that some individuals may be temporarily disturbed from their foraging distributional range out with the SAC. Based on the precautionary EDR of 5 km (McQueen *et al.*, 2020) and the Carter *et al.* (2025) density map (representing distribution during the main foraging season in autumn-winter-spring), up to 23 harbour seals may experience disturbance during dredging at the most seaward location of the dredge footprint (1.71% of the Moray Firth SMU; section 6.1.2.2). The dredging activities will be carried out over a 10-week period within the 6-month window between April and September (sometime between 2027 – 2029). The dredging activity shall take place deeper into the site boundary and therefore interactions between the dredging activity and harbour seals utilising waters surrounding the proposed development is expected to be minimal for most of the time.

The increase in vessel traffic associated with construction activities, particularly during the 10-week dredging and spoil disposal phase, which will involve approximately 450 additional vessel movements, has the potential to disturb harbour seals, both in the water and while hauled out on land. When considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The increased vessel activity for dredging and soil disposal may occur anytime between April and September (sometime between 2027 – 2029), thus potentially overlapping with harbour seal breeding and moulting periods when seals spent more time hauled-out than at other times of year. The evidence suggests that seals are more reluctant to enter the water during the annual moult, which may reduce the likelihood of disturbance from vessel movements while seals are hauled out (Henry and Hammill, 2001). However, the SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier (Figure 2).

Considering the above, although temporary displacement cannot be excluded, underwater noise from piling and dredging as well as increased vessel traffic is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

Figure 1: Disturbance contours for piling of mooring dolphins at the proposed development, the Dornoch Firth and Morrich Moore SAC overlain on the Carter et al. (2025) at-sea harbour seal density surface (representing distribution during the main foraging season in autumn-winter-spring)

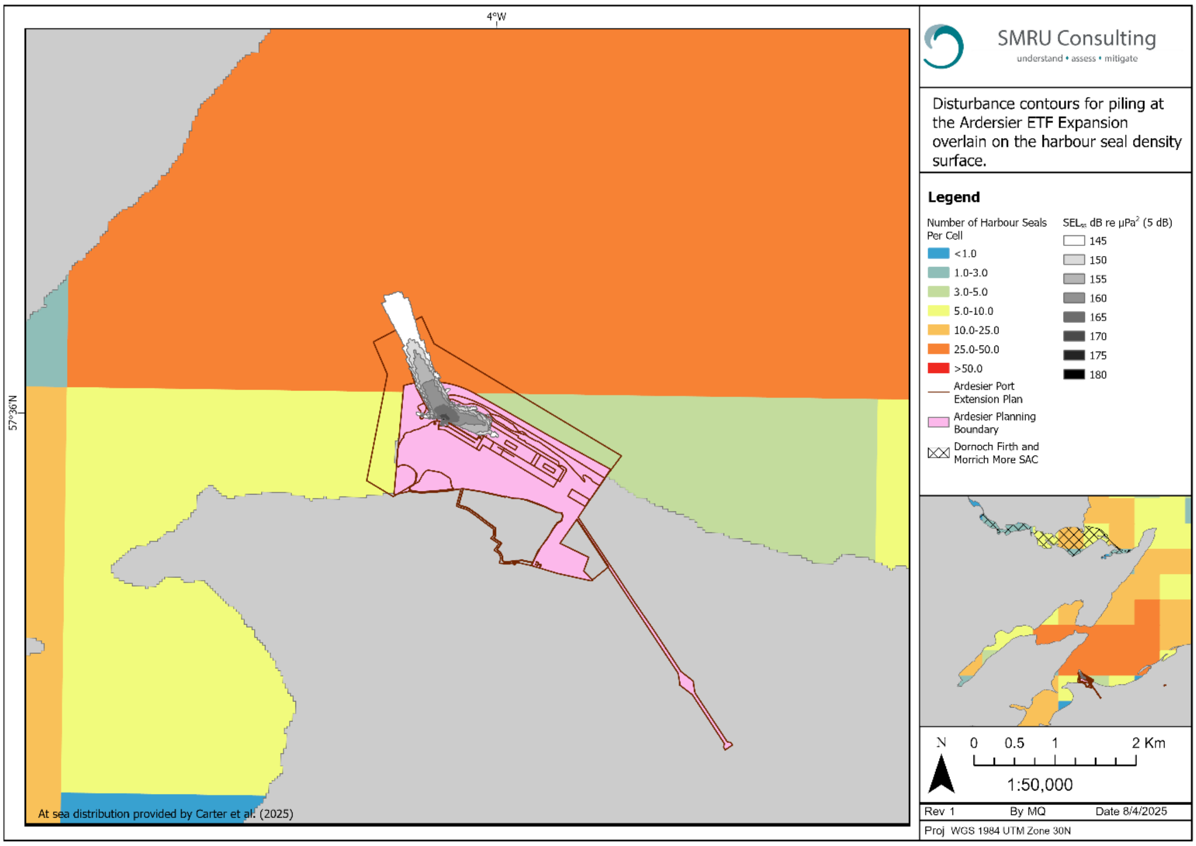
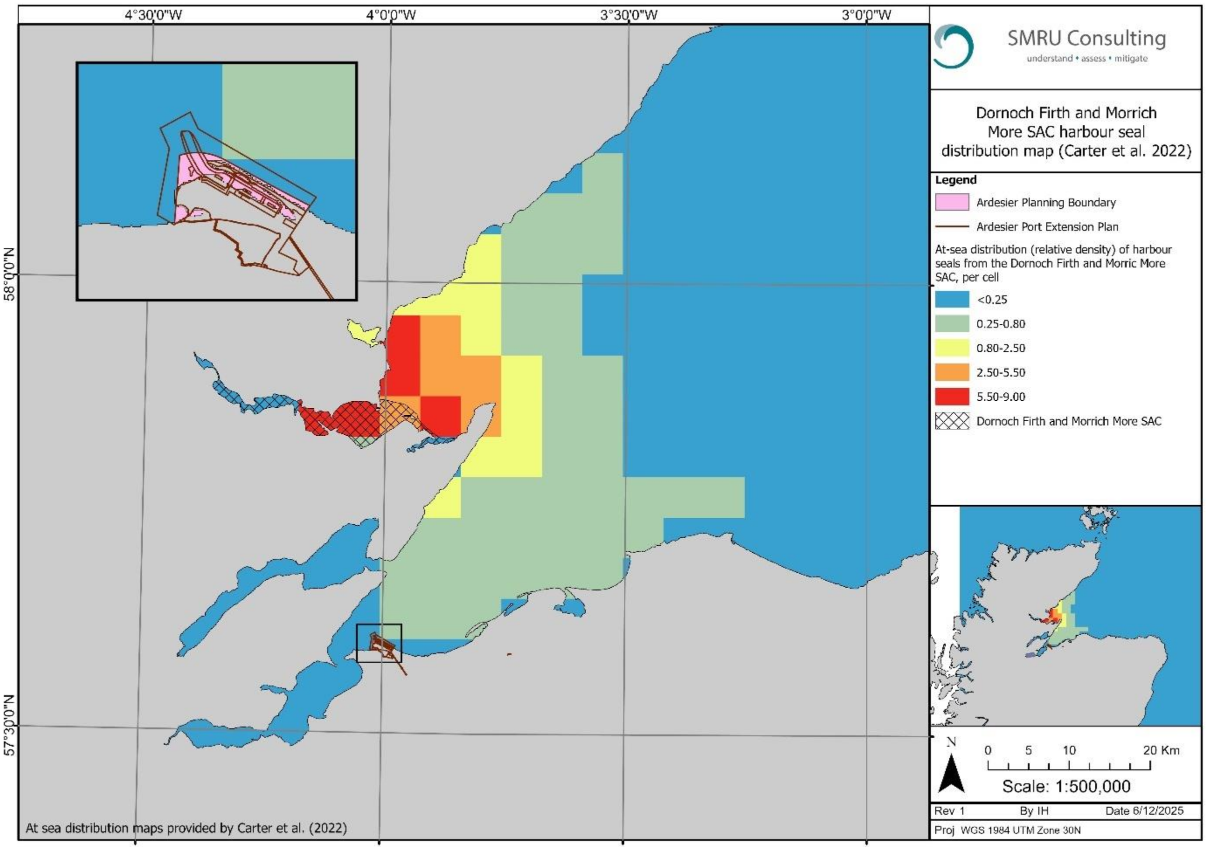

4°W
57°36'N
At sea distribution provided by Carter et al. (2025)
SMRU Consulting
understand • assess • mitigate
Disturbance contours for piling at the Ardersier ETF Expansion overlain on the harbour seal density surface.
Legend
Number of Harbour Seals Per Cell
<1.0
1.0-3.0
3.0-5.0
5.0-10.0
10.0-25.0
25.0-50.0
>50.0
Ardesier Port Extension Plan
Ardesier Planning Boundary
Dornoch Firth and Morrich More SAC
SEL dB re µPa² (5 dB)
145
150
155
160
165
170
175
180
N
0 0.5 1 2 Km
1:50,000
Rev 1
By MQ
Date 8/4/2025
Proj WGS 1984 UTM Zone 30N

Figure 2: The mean percentage of the SAC population estimated to be present in each 5 km x 5 km grid cell at any one time in the foraging season (spring). Data from Carter et al. (2022).



6.3.1.1.1.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site).

The activities within the site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC. Vessel movements associated with dredging and spoil disposal are also not going to spatially overlap with the SAC. Based on the underwater noise modelling, there will be no overlap of noise contours from pile driving with the SAC (Figure 1). Therefore, underwater noise associated with construction is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.1.1.4 Conclusions

Based on the assessment presented in sections 6.3.1.1.1.1 to 6.3.1.1.1.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of construction activities.

6.3.1.1.2 Operation and Maintenance

6.3.1.1.2.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as "unfavourable – inadequate" and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a).

The focus of the appraisal should be to understand the impact of the proposed development on site integrity by ensuring that it does not prevent or reduce the potential for recovery. In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.1.2.2 to 6.3.1.1.2.4, it can be concluded that the operation and maintenance of the proposed development will not compromise the ability of the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.1.2.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

The risk of injury through collision with vessels will be managed via a NSRA (see section 6.1.3.2). As such, killing or injury is highly unlikely and operation and maintenance activities at the proposed development are not expected to affect harbour seals associated with the Dornoch Firth and Morrich Moore SAC.

During the operational phase of the proposed development, vessel movements associated with the Port of Ardersier are expected to increase slightly to approximately 400 vessel movements per year. However, when considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and the hotspots of vessel activity within the Inner Moray Firth (Figure 2).

Considering the above, underwater noise from vessel traffic as well as vessel presence is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

6.3.1.1.2.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The operation and maintenance activities within the site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC. Additionally, based on the location of option plan areas available in Scottish leasing rounds (ScotWind[3] and INTOG[4]), it is not anticipated that there would be any spatial overlap of vessel movements between the port and offshore wind farms areas and the SAC boundary. Therefore, underwater noise associated with operation and maintenance is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.1.2.4 Conclusions

Based on the assessment presented in sections 6.3.1.1.2.1 to 6.3.1.1.2.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of operation and maintenance activities.

6.3.1.2 In-combination

The in-combination screening exercise and the list of projects taken forward to the assessment are presented in section 6.2.

6.3.1.2.1 Construction

6.3.1.2.1.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as “unfavourable – inadequate” and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a). In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.2.1.2 to 6.3.1.2.1.4, it can be concluded that the construction of the proposed development in-combination with other projects will not compromise the ability of

[3] ScotWind leasing round sites and developers | Offshore Wind Scotland

[4] INTOG ¦ Innovation and Targeted Oil and Gas leasing round | Offshore Wind Scotland

the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.2.1.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

In line with the advice provided in NatureScot (2025a), given that there is no site-reference population for harbour seal at this site, the site trend is considered in relation to the wider Moray Firth SMU. Based on the assessment for the proposed development alone, less than one harbour seal is expected to be disturbed during piling and up to 23 harbour seals may experience behavioural disturbance due to dredging at any one time (see section 6.1.2; Table 1). Based on information presented in Invergordon Phase 5 project EIA, the disturbance zone associated with piling noise is likely to include a large area of the Cromarty Firth in the vicinity of the project site which may prevent animals transiting to and from the Cromarty Firth harbour seal non-breeding haul-out site, which has been found to be utilised by over 82 individuals (Affric, 2025). The impacts of piling at the berthing structure within the Port of Nigg were not quantified in the project's EIA (EnviroCentre Limited, 2019), therefore this impact has not been assessed quantitatively in this in-combination assessment. Given that the EIA was not available for maintenance dredging and sea disposal at port of Nigg and Port of Cromarty Firth, the number of harbour seals was quantified based on 5 km EDR and Carter *et al.* (2025) at-sea density maps with up to 109 individuals being disturbed at any given time. Therefore, under a worst-case scenario between 2025 and 2029, it is estimated that between 23 and 300 harbour seals could be subject to behavioural disturbance from piling and dredging activities at any given time. This represents approximately 1.71% to 21.98% of the Moray Firth SMU population (Table 4). It should be however noted that this number is highly as the activities at different ports may not occur on the same day.

Table 4: Harbour seal Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Dredging, Piling & Dredging.

Project	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?
Ardersier ETF Extension	Pre-C	0	23	23	23	Operational					Yes
Invergordon Phase 5	Pre-C	82	82	Operational							Yes
Port of Nigg East Quay - Inner Berthing Structure	-	-	Operational								Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	109	109	Operational								No
Maintenance Dredging - Port of Cromarty Firth	109	109	109	109	Operational						No

Increased vessel activity may also result in seal displacement from foraging areas. A summary of the magnitude of vessel impacts is provided in section 6.2.2. However, when considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The evidence suggests that seals are more reluctant to enter the water during the annual moult, which may reduce the likelihood of disturbance from vessel movements while seals are hauled-out (Henry and Hammill, 2001). Most importantly, the SAC distribution map shows that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and Cromarty Firth (Figure 2).

Considering the above, although temporary displacement as a result of increased vessel movements at the proposed development in-combination with other projects cannot be excluded, it is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

6.3.1.2.1.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The activities within the respective project boundaries will not overlap spatially with the Dornoch Firth and Morrich More SAC. Vessel movements associated with dredging and spoil disposal at the proposed development, Port of Nigg, port of Cromarty and Invergordon are not anticipated to spatially overlap with the SAC. Therefore, underwater noise associated with construction of the proposed development in-combination with other projects is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.2.1.4 Conclusions

Based on the assessment presented in sections 6.3.1.2.1.1 to 6.3.1.2.1.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of construction activities at the proposed development in-combination with other projects.

6.3.1.2.2 Operation and Maintenance

6.3.1.2.2.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as "unfavourable – inadequate" and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a). In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.2.2.2 to 6.3.1.2.2.4, it can be concluded that the operation and maintenance of the proposed development in-combination with other projects will not compromise the ability of the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.2.2.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

Increased vessel activity throughout the operational and maintenance phase may result in seal displacement from foraging areas. A summary of the magnitude of vessel impacts is provided in section 6.2.2. The vessel activity may increase by 6.17% above estimated baseline conditions. When considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). Most importantly, the SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and Cromarty Firth (Figure 2).

Considering the above, underwater noise from vessel traffic as well as vessel presence from the proposed development and other in-combination projects are not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

6.3.1.2.2.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The activities within the respective project boundaries will not overlap spatially with the Dornoch Firth and Morrich More SAC. Additionally, based on the location of option plan areas available in Scottish leasing rounds (ScotWind[5] and INTOG[6]), it is not anticipated that there would be any spatial overlap of vessel movements between the port and offshore wind farms areas and the SAC boundary. Therefore, underwater noise associated with operation and maintenance of the proposed development as well as other in-combination projects is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.2.2.4 Conclusions

Based on the assessment presented in sections 6.3.1.1.2.1 to 6.3.1.1.2.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch

[5] ScotWind leasing round sites and developers | Offshore Wind Scotland

[6] INTOG ¦ Innovation and Targeted Oil and Gas leasing round | Offshore Wind Scotland

Firth and Morrich Moore SAC will not occur as a result of operation and maintenance activities at the proposed development in-combination with other projects.

6.3.2 Moray Firth SAC

Bottlenose dolphins are present within the Moray Firth SAC throughout the year, with May to September being important for breeding and calving (NatureScot, 2025b). The construction at the proposed development will take place between 2026 and 2028, with dredging taking place sometime between 2027 – 2029. As such, overlap with the construction at the proposed development and bottlenose dolphin breeding and calving cannot be discounted.

6.3.2.1 Project Alone

The Project Alone assessment of AEoI of the Moray Firth SAC with respect to bottlenose dolphin COs is presented in sections 6.3.2.1.1.1 to 6.3.2.1.1.3 and conclusions are provided in section 6.3.2.1.1.5.

6.3.2.1.1 Construction

6.3.2.1.1.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). The focus of the appraisal should be to understand whether the integrity of the Moray Firth SAC would be maintained. In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.1.1.2 to 6.3.2.1.1.5, it can be concluded that the construction of the proposed development will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.1.1.2 The population of bottlenose dolphin is a viable component of the site.

The risk of auditory injury (PTS) to bottlenose dolphins from all noise sources is negligible due to extremely small predicted injury ranges as well as the application of mitigation measures (see sections 6.1.2.1 and 6.1.4). Similarly, any risk of injury through collision with vessels will be managed via a NSRA (see section 6.1.2.3). As such, killing or injury is highly unlikely and construction activities at the proposed development are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.1.1.3 The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphins are likely to be impacted.

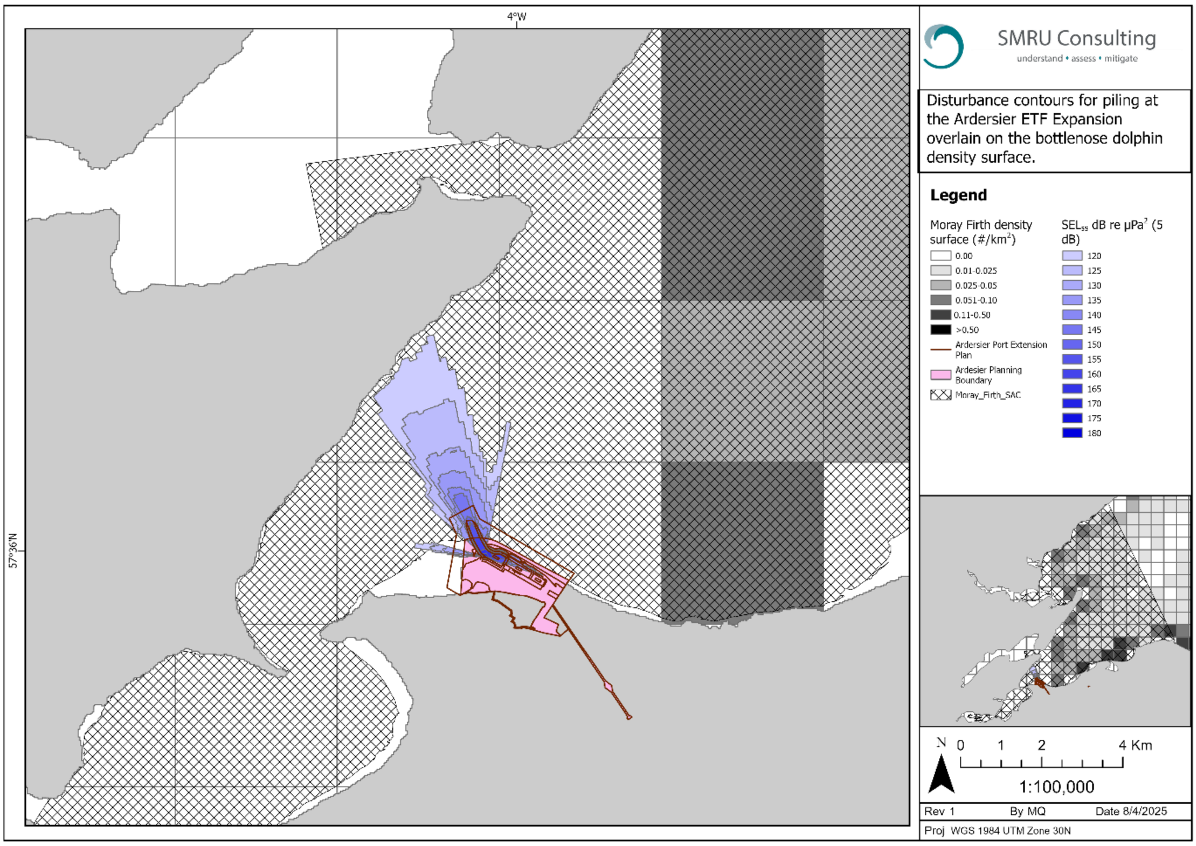
Type of disturbance

Underwater noise associated with piling, dredging, spoil disposal and vessel movements may result in behavioural response and lead to individuals being displaced from the affected area. There is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by offshore construction activities; for example, avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities, piling and vessel activity (Pirotta *et al.*, 2013, Graham *et al.*, 2017, Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as an important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

Bottlenose dolphin occurrence was studied at three acoustic monitoring stations in the vicinity of the proposed development - east, west and entrance to the port of Ardersier (Benhemma-Le Gall and Cheney, 2025). Typically, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel. Considering the extent of the Moray Firth SAC, the area within which bottlenose dolphins could experience behavioural disturbance as a result of piling is localised (Figure 3). Similarly for dredging and vessel movements, both activities are likely to exclude dolphins from approximately a 1 km radius (Pirotta *et al.*, 2013, Pirotta *et al.*, 2015, Puszka *et al.*, 2021, Mills *et al.*, 2023). Some of the activities, such as dredging, will take place deeper into the site boundary for most of the time and therefore interactions with bottlenose dolphins will be limited. However, spoil disposal and associated vessel activity will be taking place outside of the site boundary with more potential to displace bottlenose dolphins from the areas that they use daily, including the potential for intermittent barrier effects in movement between the SAC and the rest of the distributional area. Given the extent of the SAC, bottlenose dolphins would still be able to access sufficient food whilst they are subject to disturbance.

Figure 3: Disturbance contours for piling of mooring dolphins at the proposed development, overlain on the scaled Thompson et al. (2015) bottlenose dolphin density surface.



Timing and duration of disturbance

Overall, the construction is anticipated to take place between 2026 to 2028. Piling will be restricted to only a short duration with 12 piles installed over 12 non-consecutive days, with a maximum of 10 hours of activity per pile sometime within the construction timeframe. The dredging and soil disposal activities will be carried out over a 10-week period within the 6-month window between April and September (sometime between 2027 – 2029). The peak vessel activity is expected to occur during spoil disposal operations within this 10-week period. Given that activities such as piling are expected to result in a localised and short-term disturbance footprint, and that dredging will predominantly occur within the existing port limits, disturbance beyond the site boundary is primarily anticipated during the 10-week spoil disposal phase.

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the construction of the proposed development:

- Is not expected to contribute to the long-term decline in the use of the site by bottlenose dolphins; however, intermittent displacement from the areas used by individuals within the site cannot be excluded over medium-term.
- Is not expected to result in changes to the distribution of bottlenose dolphins on a continuing or sustained basis; beyond the 10-week period of soil disposal activities.
- Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young.

As such, although bottlenose dolphin may be deterred temporarily from areas within the SAC intermittently over the short term (10 weeks), the behavioural disturbance during construction is not considered significant (NatureScot, 2025b).

6.3.2.1.1.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The dredging and spoil disposal activities are the main impacts that could have a negative effect the characteristics of the seabed and water column relevant to their use by bottlenose dolphin. The dredging activities within the site boundary are predominantly confined to the existing port area, where bottlenose dolphins are generally absent. As discussed in section 6.1.2.4 with respect to sediment contamination, any future BPEO that is authored for the proposed development shall take the appropriate measures to ensure that dredged materials meet acceptable environmental standards. The spoil dumping may be taking place in the vicinity of Burghead, outside of the SAC boundaries. The alternative locations include Inverness and Sutors and therefore the spatial overlap of spoil disposal and SAC cannot be excluded.

When considering sediment disturbance, dumping works are the most likely contributor to sediment disturbance and thus, increased turbidity. The risks of sediment disturbance and fish habitat loss are particularly relevant to demersal spawning species present in the Moray Firth, such as herring and sandeels. Sandeels are highly substrate-specific spawners and spend a large amount of time buried in the sediment, with specific requirements in terms of the silt content of the sediment. They are absent in substrates with a silt content greater than 10% (Wright *et al.*, 2000, Holland *et al.*, 2005). Their eggs remain attached to the seabed during development. However, sandeel eggs are expected to be tolerant to increased sediment deposition and smothering, due to the common resuspension and deposition events which occur in their natural high energy environment. Herring are a mobile species with the capacity to avoid unfavourable areas, but nonetheless rely on the substrate for spawning and sediment deposition could potentially smother herring eggs and disrupt the development of larvae. When considering the material to be dredged as part of the proposed development, it is expected to be predominantly composed of undisturbed sands and gravels (EnviroCentre Limited, 2024). The sand component is expected to remain suspended for a longer time than the gravel component, but the effects are expected to be temporary and localised due to the short duration of dredging and spoil disposal activity (~6 months). As a result of the short duration of dredging and spoil disposal activity and the localised impacts on fish prey species present in the area, marine mammals are not expected to have reduced access to prey within the SAC. As such, construction activities associated with the proposed development are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.1.1.5 Conclusions

Based on the assessment presented in sections 6.3.2.1.1.1 to 6.3.2.1.1.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of construction activities.

6.3.2.1.2 Operation and Maintenance

6.3.2.1.2.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). The focus of the appraisal should be to understand whether the integrity of the Moray Firth SAC would be maintained. In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.1.2.2 to 6.3.2.1.2.5, it cannot be excluded that the operation and maintenance of the proposed development will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.1.2.2 The population of bottlenose dolphin is a viable component of the site.

The risk of death or injury through collision with vessels will be managed via a NSRA (see section 6.1.3.2). As such, killing or injury is highly unlikely and operation and maintenance activities at the proposed development are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.1.2.3 *The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.*

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphin are likely to be impacted.

Type of disturbance

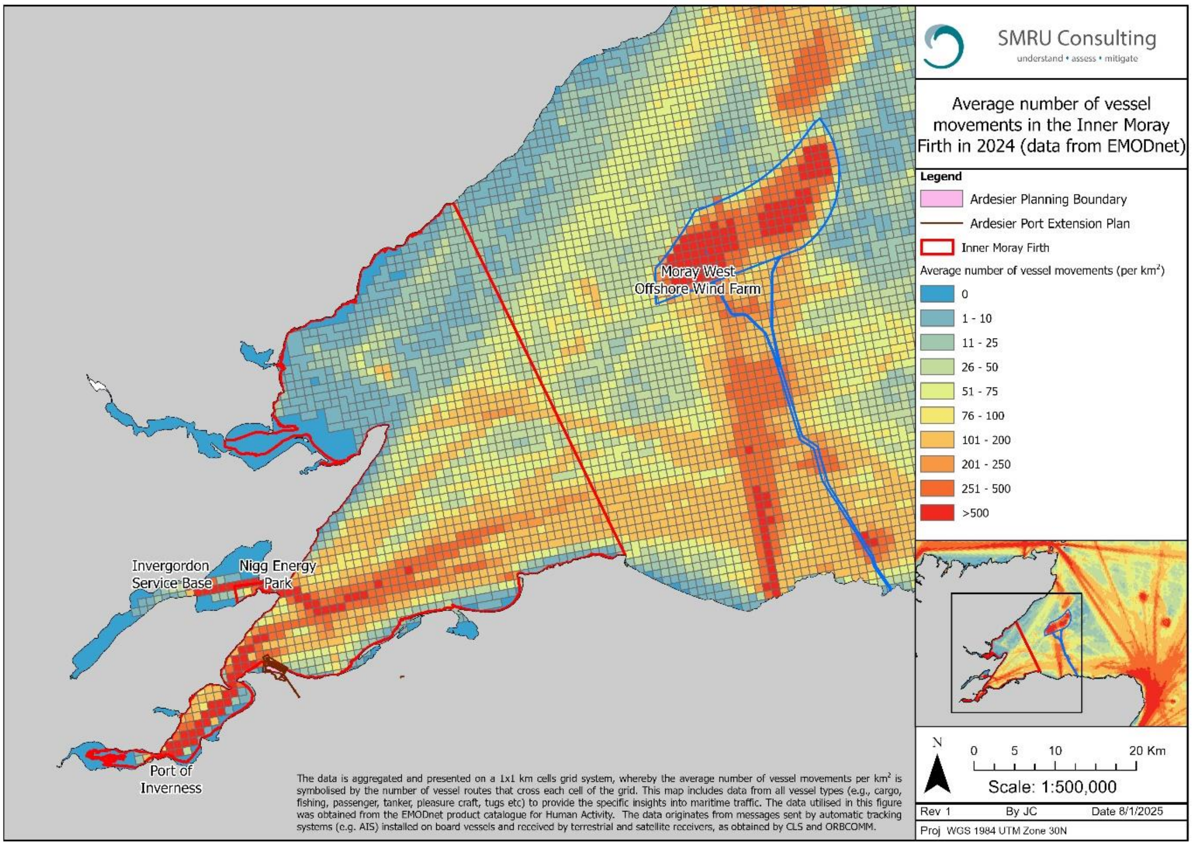
Underwater noise associated with vessel movements will be the main impact during the operational and maintenance phase which may result in behavioural responses and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.1.1.3, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel (Benhemma-Le Gall and Cheney, 2025). Detailed information about the importance of the areas in the vicinity of the proposed development to bottlenose dolphins is presented in Appendix 11.3.

The area within which bottlenose dolphins could experience behavioural disturbance as a result of vessel movements is localised to the vicinity of the vessel. However, the vessel movements will take place over a broad geographical area (e.g., from the port to offshore wind farm sites). It is likely that in the inner Moray Firth the vessels will follow the existing routes aligned with the hotspots of vessel activity already within the Inner Moray Firth. The existing vessel hotspots presented in Figure 3 overlap with the coastal distribution with bottlenose dolphins. As such, a 17.65% increase in vessel activity has a small potential to displace bottlenose dolphins from the areas within the Moray Firth SAC which bottlenose dolphins use daily, including intermittent barrier effects in movement within the SAC and between the SAC and the rest of the distributional area.

Figure 4: Average number of vessel movements in the Inner Moray, per km2, throughout 2024 (data from EMODnet).



Timing and duration of disturbance

Increased activity levels will be sustained over a long-term duration (50 years).

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the operation and maintenance phase of the proposed development:

- Is not expected to contribute to the continuous decline in the use of the site by bottlenose dolphin; however, intermittent displacement from the areas used by individuals within the site over the long-term cannot be excluded.
- Is not expected to result in changes to the distribution of bottlenose dolphin on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over long-term period.
- Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. However, given that individuals may experience behavioural disturbance intermittently over the long-term, bottlenose dolphins may choose to use alternative areas within the SAC or outside the SAC to survive, breed or read their young.

Although there remains considerable uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels, current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. Thus, when considering the small increase in vessel traffic movements associated with operations at the proposed development, it is unlikely that the projected rise in vessel traffic may elevate disturbance to a level that could constitute significant disturbance.

6.3.2.1.2.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

As discussed in section 6.1.3.3, with implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The current application does not include dredging or spoil disposal activities during the operational and maintenance phase. Consequently, no activities are anticipated that could negatively affect the characteristics of the seabed (e.g. abrasion) or the water column (e.g. increased suspended sediments) in ways that would impact their suitability for use by bottlenose dolphins. As such, operation and maintenance activities associated with the proposed development are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.1.2.5 Conclusions

Based on the assessment presented in sections 6.3.2.1.2.1 to 6.3.2.1.2.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of operational activities.

6.3.2.2 In-combination

The in-combination screening exercise and the list of projects taken forward to the assessment are presented in section 6.2.

6.3.2.2.1 Construction

6.3.2.2.1.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.2.1.2 to 6.3.2.2.1.5, it can be concluded that the construction of the proposed development in-combination with other projects will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.2.1.2 The population of bottlenose dolphin is a viable component of the site.

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely and construction activities at the proposed development in-combination with other projects are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.2.1.3 The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphins are likely to be impacted.

Type of disturbance

Underwater noise associated with piling, dredging, spoil disposal and vessel movements at the proposed development as well as other projects screened into the in-combination assessment may result in behavioural response and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.1.1.3, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel (Benhemma-Le Gall and Cheney, 2025). Acoustic occurrence was also studied at Chanonry Point and the Sutors, the latter located at the entrance to the Cromarty Firth and in close vicinity of the Port of Nigg. Bottlenose dolphins were recorded for a greater number of Detection Positive Hours (DPH) per day at the Sutors monitoring site compared to Ardersier, while detections were similar between the Chanonry and Ardersier monitoring sites (Benhemma-Le Gall and Cheney, 2025). During boat-based surveys, bottlenose dolphin encounters occurred mostly between the North Sutor, Chanonry, and east of the Port of Ardersier.

Considering the extent of the Moray Firth SAC, the area within which bottlenose dolphins could experience behavioural disturbance as a result of piling at port works is expected to be localised (as per the example of the proposed development, Figure 3).

Similarly for dredging and vessel movements, both activities are likely to exclude dolphins from approximately a 1 km radius (Pirotta *et al.*, 2013, Pirotta *et al.*, 2015, Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). For example, the Invergordon Phase 5 EIA included information that the measured underwater sound pressure level resulting from dredging during the phase 3 development did not exceed the NMFS marine mammal disturbance threshold (160 dB rms). Piling and dredging may also take place deeper into the respective project boundaries for most of the time and therefore interactions with bottlenose dolphins will be limited. However, spoil disposal and associated vessel activity at Invergordon and the Port of Nigg between 2025 and 2027, in combination with similar activities associated with the proposed development primarily between 2027 and 2028, have the potential to displace bottlenose dolphins from areas they use daily (Ardersier, Sutors, and Chanonry). This includes the potential for intermittent barrier effects on their movement between the SAC and the wider distributional range.

Given the extent of the SAC, it is expected that bottlenose dolphins would still be able to access sufficient food whilst they are subject to disturbance.

Timing and duration of disturbance

The timings and duration of construction activities at the proposed development is discussed in section 6.3.2.1.1.3. Maintenance dredging and sea disposal at the Port of Nigg as well as inner bething structure and associated piling is expected to take place between 2025 to 2026, as such prior to the commencement of piling and dredging at the proposed development, e.g. 2026 – 2029, respectively. Piling at Invergordon phase 5 is anticipated to take place between 2026 and 2027, therefore overlapping with piling at the proposed development. Maintenance dredging at the Port of Cromarty Firth is planned to take place between 2025 to 2028, therefore overlapping with piling and dredging campaign at the proposed development.

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the construction of the proposed development in-combination with other projects:

- Is not expected to contribute to the long-term decline in the use of the site by bottlenose dolphins; however, intermittent displacement from the areas used by individuals within the site cannot be excluded over medium-term.
- Is not expected to result in changes to the distribution of bottlenose dolphins on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over medium-term period.
- Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young.

As such, although bottlenose dolphin may be deterred temporarily from areas within the SAC intermittently over the medium term, the behavioural disturbance during construction of the proposed development in-combination with other projects is not considered significant.

6.3.2.2.1.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The same measures are expected to be followed at all projects as best practice. The dredging and spoil dumping works are the main impacts that could have a negative effect the characteristics of the seabed and water column relevant to their use by bottlenose dolphin. The maintenance dredging at the Port of Nigg and Port of Cromarty, is expected to be predominantly confined to the existing port areas, where bottlenose dolphins are generally absent. The spoil disposal by the proposed development may be taking place in the vicinity of Burghead, outside of the SAC boundaries. The alternative locations include Inverness and the Sutors, and therefore the spatial overlap of spoil disposal and the SAC cannot be excluded. The disposal of excess suitable dredged material at the Port of Nigg will take place within the already licenced disposal site at the Sutors (within the SAC) (EnviroCentre Limited, 2019). The risks of sediment disturbance and fish habitat loss are particularly relevant to demersal spawning species present in the Moray Firth, such as herring and sandeels. As discussed above, most of the dredging / maintenance dredging activity will be predominantly confined to the existing port areas, where bottlenose dolphins are generally absent. Spoil dumping may have localised impacts on fish prey species; however, marine mammals are not expected to have reduced access to prey within the SAC as a whole. As such, construction activities associated with the proposed development in-combination with other projects are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.2.1.5 Conclusions

Based on the assessment presented in sections 6.3.1.2.1.1 to 6.3.1.2.1.3, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of construction activities at the proposed development in-combination with other projects.

6.3.2.2.2 Operation and Maintenance

6.3.2.2.2.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.2.2.2 to 6.3.2.2.2.5, it cannot be excluded that the operation and maintenance of the proposed development in-combination with other projects will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.2.2.2 The population of bottlenose dolphin is a viable component of the site.

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

6.3.2.2.2.3 The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphin are likely to be impacted.

Type of disturbance

Underwater noise associated with vessel movements will be the main impact during the operational and maintenance phase which may result in behavioural responses and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.2.1.3, acoustic monitoring and boat-based surveys showed that bottlenose dolphins use areas of Sutors, Chanonry and Ardersier on a daily basis, with for a median of 3 - 6 hours per day at the PAM sites around Ardersier. Increased vessel activity has the potential to displace bottlenose dolphins from these regularly used habitats. The area within which bottlenose dolphins could experience behavioural disturbance as a result of vessel movements is localised to the vicinity of the vessel. However, the vessel movements will take place over a broad geographical area (e.g., from the ports to offshore wind farm sites). It is likely that the additional vessels will follow the existing routes aligned with the hotspots of vessel activity already within the Inner Moray Firth. A summary of the magnitude of vessel impacts is provided in section 6.2.2. During the operation and maintenance phase, vessel activity, when considered in combination with other projects, may increase by up to 6.17% above baseline levels. Although the existing vessel hotspots presented in Figure 3 overlap with the coastal distribution with bottlenose dolphins (e.g. animals are likely to be habituated to the current level of vessel presence), this constitutes a moderate increase. As such, increased vessel activity has the potential to displace bottlenose dolphins from the areas within the Moray Firth SAC which bottlenose dolphins use daily, including intermittent barrier effects in movement within the SAC and between the SAC and the rest of the distributional area.

Timing and duration of disturbance

Increased activity levels will be sustained over a long-term duration (50 years).

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the operation and maintenance phase of the proposed development:

- Is not expected to contribute to the continuous decline in the use of the site by bottlenose dolphin; however, intermittent displacement from the areas used by individuals within the site over the long-term cannot be excluded.
- Is not expected to result in changes to the distribution of bottlenose dolphin on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over long-term period.
- Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. However, given that individuals may experience

behavioural disturbance intermittently over the long-term, bottlenose dolphins may choose to use alternative areas within the SAC or outside the SAC to survive, breed or read their young.

Although there remains considerable uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels, current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. Thus, when considering the small increase in vessel traffic movements associated with operations at the proposed development in-combination with other projects, it is unlikely that the projected rise in vessel traffic may elevate disturbance to a level that could constitute significant disturbance.

6.3.2.2.2.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The same measures are expected to be followed at all projects as best practice. Based on the timeframes of the projects screened into the assessment (Table 3), no dredging or dumping works are anticipated within the SAC during the operation and maintenance of the proposed development. Consequently, no activities are anticipated that could negatively affect the characteristics of the seabed (e.g. abrasion) or the water column (e.g. increased suspended sediments) in ways that would impact their suitability for use by bottlenose dolphins. As such, operation and maintenance activities associated with the proposed development in-combination with other projects are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.2.2.5 Conclusions

Based on the assessment presented in sections 6.3.2.2.2.1 to 6.3.2.2.2.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin which undermine the COs of the Moray Firth SAC can be excluded as a result of disturbance from vessels during operation and maintenance activities in-combination with other projects. However, there remains uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels even when current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. To better understand and manage these potential vessel disturbance impacts, continued monitoring is essential to ensure that where necessary, additional, adaptive mitigation measures beyond those already prescribed for operational traffic (NSRA) can be implemented to protect sensitive species effectively.

7 Conclusions

This AA has been undertaken for the proposed development in accordance with the Habitats Regulations, following the identification of LSE on designated European Sites. The SACs screened in and considered in this assessment were the Dornoch Firth and Morrich More SAC, designated for harbour seal (*Phoca vitulina*), and the Moray Firth SAC, designated for bottlenose dolphin (*Tursiops truncatus*), both of which are qualifying Annex II marine mammal species.

The assessment considered potential impacts arising from the construction and operation of the proposed development, including underwater noise, vessel traffic, and habitat disturbance, both alone and in-combination with other relevant projects within the Moray Firth region.

The assessment concluded that the construction as well as operation and maintenance of the proposed development, both alone and in-combination with other projects, will **not result in adverse effects** on the integrity of the Dornoch Firth and Morrich More SAC, or the Moray Firth SAC. Embedded mitigation measures, including MMMPs and NSRAs, ensure that impacts on harbour seals remain negligible. However, there remains uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels even when current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. To better understand and manage these potential vessel disturbance impacts, continued monitoring is essential to ensure that where necessary, additional, adaptive mitigation measures beyond those already prescribed for operational traffic (NSRA) can be implemented to protect sensitive species effectively.

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November 2025

Appendix 11.7: Draft Marine Mammal Mitigation Plan

SMRU Consulting

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Ardersier Port Extension
EIAR Appendix 11.7: Draft Marine Mammal Mitigation Plan

Authors:	Stevens, A. & Clarkson, J.
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1 Introduction

This draft Marine Mammal Mitigation Plan (MMMP) has been developed to ensure that all parties involved in the Port of Ardersier Energy Transition Facility (ETF) Extension are aware of the potential impacts to the marine mammal species of concern. The mitigation developed and included as part of this MMMP is to ensure the protection of marine mammals during the installation of three mooring dolphins using impact piling or vibropiling and dredging and spoil disposal operations. Construction activities are planned to take place sometime between 2026 and 2028, with piling operations expected to take place at any point during this time period. Dredging and spoil disposal activities are expected to take place between March and October, sometime between 2027 and 2029. Dredging activities shall predominantly take place within the inner harbour, 0.8 – 1.8 km away from the harbour entrance.

The mitigation measures presented in this MMMP are informed by the data presented in:

- EIAR Chapter 11: Marine Mammals;
- EIAR Appendix 11.1: Legislation, Policy and Guidance;
- EIAR Appendix 11.2: Marine Mammal Assessment Methodology;
- EIAR Appendix 11.3: Marine Mammal Baseline Characterisation;

- EIAR Appendix 11.4: Marine Mammal Impact Assessment;
- EIAR Appendix 11.5: Underwater Noise Modelling; and
- EIAR Appendix 11.6: Habitat Regulations Appraisal.

The draft MMMP summarises the worst-case scenarios considered in the EIAR together with a summary of impacts and current available mitigation measures.

2 Marine Mammal Species

Mitigation measures will be applied to any marine mammal species observed during construction activities. Evidence suggests that there is the potential for various marine mammal species within the area of the development and within the impact range of the piling, dredge, and spoil disposal locations. Species regularly present within the work areas include harbour porpoise, bottlenose dolphins, minke whales, harbour seals and grey seals. Furthermore, there are a number of marine mammal designated sites located in and around the Port of Ardersier. These are:

- Moray Firth Special Area of Conservation (SAC) designated for bottlenose dolphins;
- Whiteness Sands (Ardersier) seal haul-out site designated for grey and harbour seals; and
- Dornoch Firth and Morrich More SAC designated for harbour seals.

Whales, porpoise and dolphins are classed as European Protected Species (EPS) and are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), whilst the main legislation with regard to the protection of seals is The Marine (Scotland) Act 2010, which provides for Scottish Ministers to designate 'seal conservation areas.' Seal haul-out sites are designated under section 117 of Marine (Scotland) Act 2010. Both the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and The Marine (Scotland) Act 2010 prohibit the disturbance, injury or killing (intentionally or recklessly) of cetaceans and seals respectively, thus requiring mitigation to be implemented.

3 Impact Piling Mitigation Plan

This draft piling MMMP has been prepared to support both the future anticipated Marine Licence application and future anticipated EPS Licence applications for the mitigation of pile driving operations to install three mooring dolphins within the Proposed Development. Piling activities are expected to take place over 12 days, sometime between 2026 and 2028 (timings are still to be confirmed). Piling shall take place during daylight hours only.

The mitigation measures proposed during impact piling activities are presented below and summarised in a flowchart in Appendix 1.

3.1 Piling scenario

Subacoustech Environmental Ltd conducted underwater noise modelling for both impact piling and vibropiling. Only impact piling will be considered in this draft MMMP as these impacts represent the worst-case scenario underwater piling noise on marine mammals. The three mooring dolphins will be installed using 12 piles each 1,200 mm in diameter. One pile will be installed per day over a period of 10 hours. The maximum hammer energy during impact piling is expected to be 294 kJ.

The anticipated soft-start modelled for impact piling comprised six blows per minute for the first 20 minutes (20% of the maximum), then increases to 30 blows per minute for the remainder of the ramp-up procedure. Assuming a signal duration of around 0.5 seconds per pile strike, the initial soft-start procedure will be a 5% duty cycle (0.5 second pulse followed by 9.5 seconds of silence) and the ramp-up will be a 25% duty cycle (0.5 second pulse followed by 1.5 seconds of silence).

3.2 Piling impact ranges

The maximum instantaneous PTS-onset range from pile driving was 60 m for harbour porpoise and less than 10 m for all other species groups (Table 1).

Table 1 Predicted impact ranges associated with impact piling, using the Southall et al. (2019) $L_{p,pk}$ PTS criteria in marine mammals for impulsive noise sources.

		Instantaneous PTS		Cumulative PTS	
Hearing group	**Species**	**Southall et al. (2019) PTS criteria $L_{p,pk}$ (impulsive)**	**Maximum impact range (m)**	**Southall et al. (2019) PTS criteria SEL_{cum} (impulsive)**	**Maximum impact range (m)**
Very high frequency cetaceans	Harbour porpoise	202 dB	60	155 dB	<10
High frequency cetaceans	Bottlenose dolphins	230 dB	No predicted exceedance	185 dB	<10
Low frequency cetaceans	Minke whales	219 dB	<10	183 dB	<10
Pinnipeds in water	Harbour and grey seals	218 dB	<10	185 dB	<10

3.3 Mitigation guidelines

The current guidance on minimising the risk of injury to marine mammals from piling noise is provided in JNCC (2010). These mitigation guidelines are supplemented by the JNCC guidance for the use of PAM in UK waters (JNCC 2023). Developers may also follow the guidance in JNCC (2010) by providing the "Best available technique" to be used.

This draft MMMP outlines the current mitigation measures anticipated for the worst-case scenario impact piling parameters. JNCC have advised that an addendum to provided updates to the JNCC (2010) piling guidelines is currently in preparation and, therefore, new advice may be available prior to the finalising of the piling MMMP.

3.4 Mitigation methods

3.4.1 Mitigation Monitoring

Piling shall take place during daylight hours only. Monitoring for marine mammals will be conducted by a Marine Mammal Observer (MMO). Passive Acoustic Monitoring (PAM) conducted by a PAM Operator will be used to supplement or replace visual observations when visibility is poor (e.g. sea state >4, foggy conditions). Sufficient mitigation personnel should be provided to ensure a adequate coverage of the mitigation zone (MZ) during visual monitoring periods. Details of the PAM system used will be provided in the final MMMP.

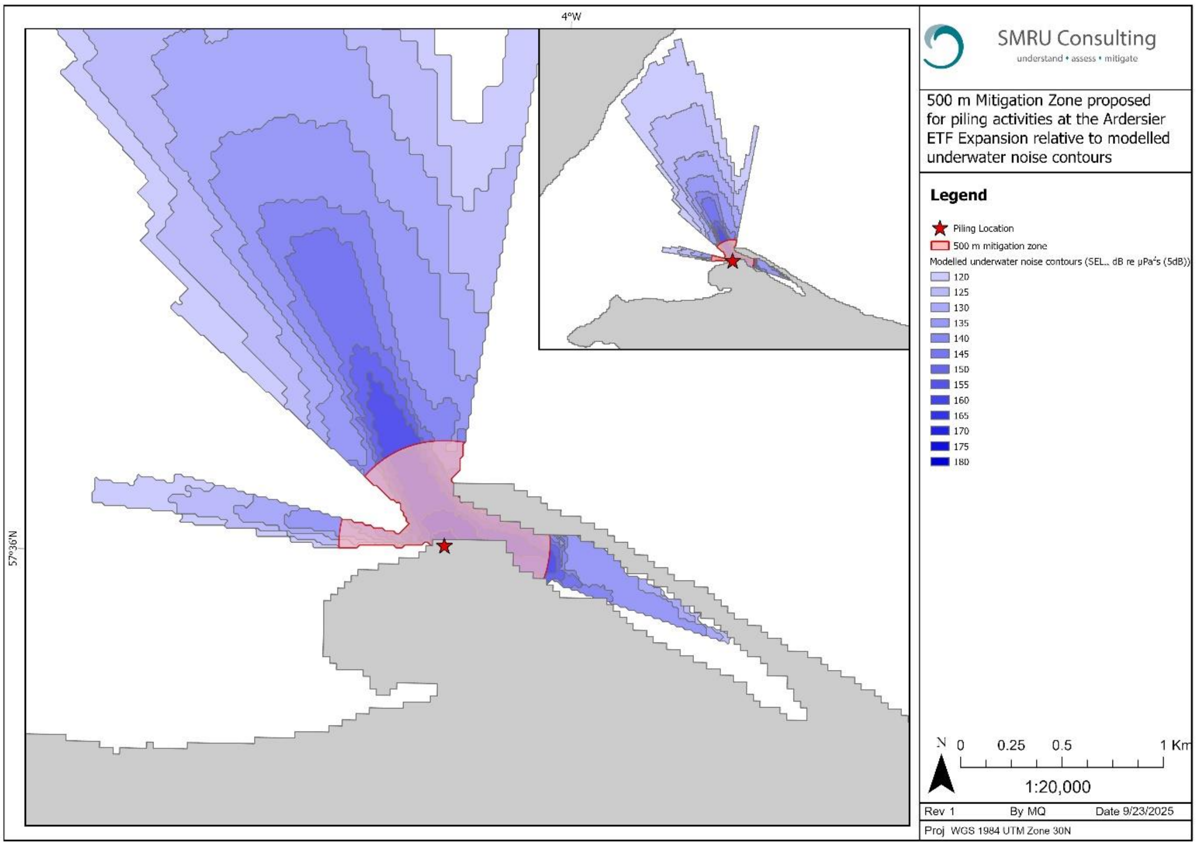
The MMO and PAM Operator will be required to advise contractors and/or crews on the implementation of procedures to ensure compliance.

3.4.2 Mitigation Zone

The minimum mitigation zone (MZ) that should be monitored for piling is recommended in JNCC (2010) as 500 m. The maximum potential instantaneous PTS-onset impact range for piling is 60 m for harbour porpoise which is less than the minimum 500 m MZ recommended by the JNCC (2010). Therefore, a 500 m MZ is considered sufficient to ensure that instantaneous PTS can be effectively mitigated.

The MZ shall extend 500 m from the modelled piling location, and only include areas for which noise contours are predicted to extend, and for which areas of water are thus in 'line of sight'. The proposed 500 m MZ is shown in Figure 1.

Figure 1: A 500 m MZ for piling activities during the proposed development.



3.4.3 Pre-piling Search

A pre-piling search of the 500 m MZ will be conducted for a minimum of 30 minutes prior to the commencement of piling by an MMO and/or PAM Operator.

In the event of a marine mammal detection within the MZ during the pre-piling search, the soft-start will be delayed for a minimum of 20 minutes after the last detection within the mitigation zone and the full 30 minute pre-piling search has been completed to ensure any marine mammals have left the area when piling activities commence.

3.4.4 Soft-start Procedure

Following the completion of the pre-piling search, a soft-start procedure will commence. This is where the piling hammer energy will gradually increase over a minimum of 20 minutes so that if any marine mammals are still present in the vicinity of the piling location, they are encouraged to leave by the initial low levels of underwater noise prior to the noise reaching levels which could cause PTS-onset.

If a marine mammal enters the MZ during the soft-start, then the piling operation should either stop (if technically feasible), or the hammer energy should not be further increased until the marine mammal exits the MZ, and there is no further detection for 20 minutes.

Once the soft-start has been completed, there is no requirement under the JNCC (2010) guidelines to stop piling or reduce the hammer energy if a marine mammal is detected in the MZ as the animal is deemed to have entered voluntarily entered. The JNCC (2010) guidelines also acknowledge that it may not be operationally feasible to stop piling at full power until the pile is fully installed.

3.4.5 Breaks in Piling

Breaks in piling activity could provide the potential for marine mammals to re-enter the MZ. The guidance provided in JNCC (2010) which piling operations will comply with, states that '*If there is a pause in the piling operations for a period of greater than 10 minutes, then the pre-piling search and soft-start procedure should be repeated before piling recommences*'. Any monitoring conducted prior to the break in operations can count towards the 30 minute pre-piling search, meaning that, providing monitoring has been maintained and it is confirmed there are no marine mammals in the MZ, operations can restart as soon as required. If the break in piling is less than 10 minutes, piling activities can continue as normal using the previous hammer energy and strike rate.

3.4.6 Communication

Effective lines of communication between mitigation personnel and the crew conducting piling operations are essential. The communications protocol established will include, but not be limited to:

- Procedure to notify the MMO and/or PAM Operator to begin the 30-minute pre piling search prior to soft-start commencing;
- Procedure for the MMO and/or PAM Operator to notify the installation manager that soft start can commence;
- Procedure for the MMO and/or PAM Operator to notify installation manager that a marine mammal has been detected in the mitigation zone; and
- Procedure to notify MMO and/or PAM Operator that the piling operations have been successfully completed.

3.4.7 Reporting

All reporting will be in line with the best practice procedure outlined in the JNCC (2010) guidelines. Reports detailing the piling activity and marine mammal mitigation should be provided to JNCC and MD-LOT. Reports will include:

- Record of piling operations including date and location, duration of pre-piling and soft-start procedures and instances where operations were delayed or stopped due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, details of the PAM equipment and detections, and details of the piling activity during the watches
- Completed Marine Mammal Recording Forms, detailing any incidental marine mammal sightings (i.e. species, distance);

- Details of problems encountered i.e. non-compliance with agreed protocols, and any recommendations for amendments to the protocols; and
- Any recommendations for amendments to the protocol.

Further, it is good practice to report any dead marine mammals observed to Scottish Marine Mammal Stranding Scheme (SMASS) and live strandings to British Divers Marine Live Rescue (BDMLR), even if they are not attributed to the works. In addition, the MMO and PAM Operator should keep a record of marine mammal sightings and/or acoustic detections out with the MZ, to be submitted to NatureScot for biodiversity data collection purposes.

4 Dredging Mitigation Plan

This draft dredging MMMP has been prepared to support dredging activities at the Port of Ardersier which are expected to take place between March and Octobersometime between 2027 and 2029. Dredging activities shall predominantly take place within the inner harbour, 0.8 – 1.8 km away from the harbour entrance. . There are currently no mitigation guidelines specific to dredging and, therefore, the mitigation measures proposed are adapted from the JNCC (2010) piling guidelines. Any additional conditions included within the license for dredging activities at the Port of Ardersier will also be included in the final MMMP.

The mitigation measures proposed during dredging activities are presented below and summarised in a flowchart in Appendix 2.

4.1 Dredging impact ranges

Subacoustech Environmental Ltd conducted underwater noise modelling for cutter suction dredging. The maximum PTS-onset range from dredging <10 m for all species (Table 2).

Table 2 Predicted impact ranges associated with impact piling, using the Southall et al. (2019) SEL_{cum} PTS criteria in marine mammals for impulsive noise sources.

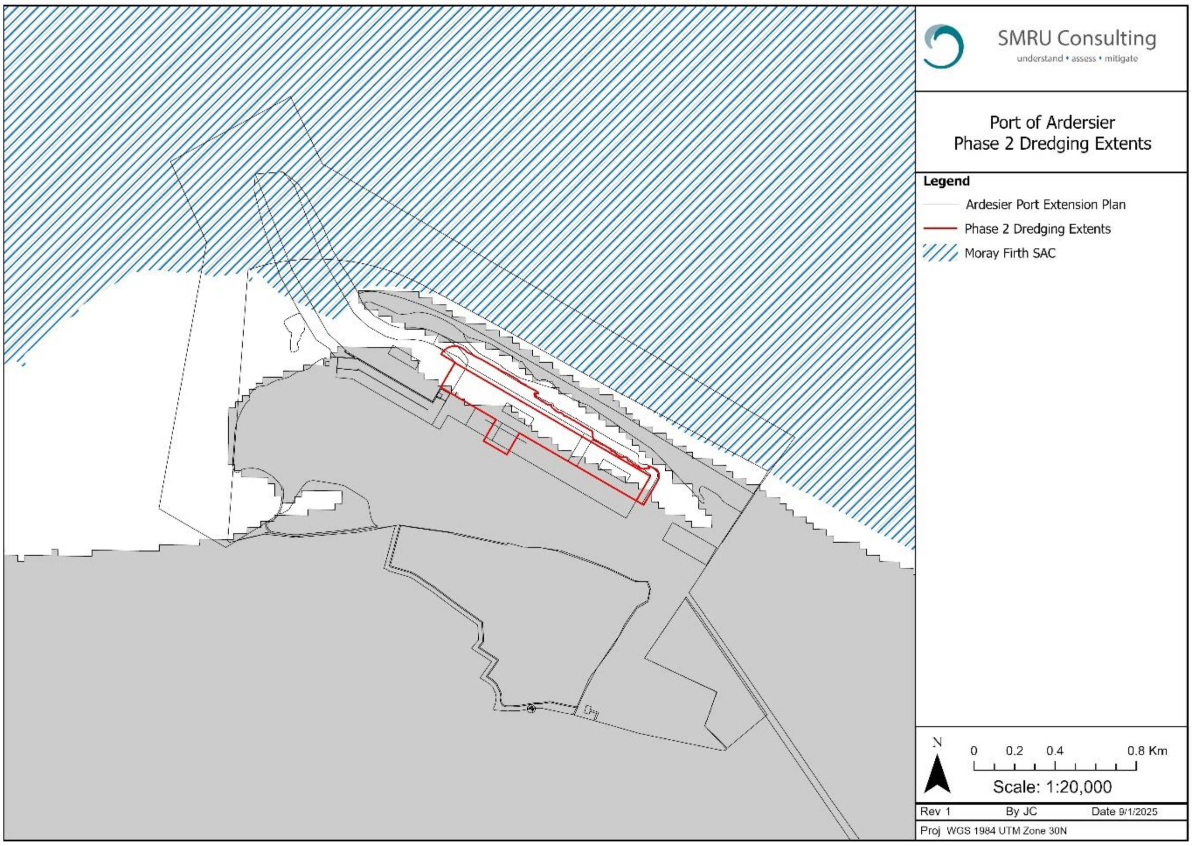
Hearing group	Species	Southall et al. (2019) PTS criteria SEL_{cum} (impulsive)	Maximum estimate impact range (m)
Very high frequency cetaceans	Harbour porpoise	173 dB	<10 m
High frequency cetaceans	Bottlenose dolphins	198 dB	<10 m
Low frequency cetaceans	Minke whales	199 dB	<10 m
Pinnipeds in water	Harbour and grey seals	201 dB	<10 m

4.2 Mitigation methods

As dredging activity shall largely take place deeper within the inner harbour (approximately 0.8 – 1.8 km from the harbour entrance and the Moray Firth SAC, see Figure 2), away from where marine mammals are typically encountered (see Appendix 11.3), the number of interactions between the dredging vessel itself and marine mammals shall be minimal. Further, the applicant notes that, aside from occasional sightings of individual seals within the inner harbour, no other marine mammal species have been recorded within the inner harbour during Port of Ardersier’s operations.

The most seaward extent of the dredging activity is proposed to be very close to land (i.e., Whiteness Point) which will likely create a strong barrier effect for any noise propagation, as will the inner harbour walls. Thus, the JNCC protocol currently provides a disproportionate level of mitigation for the proposed dredging works, which is not justified by the perceived risk to marine mammals (see Section 3.4.2 of Appendix 11.4). Accordingly, the likelihood of significant marine mammal–vessel interactions within the development footprint in the inner harbour is considered to be very limited. During dredging, the operation of the dredge vessel, associated spoil disposal vessels, and routine port activities will contribute to elevated underwater noise levels within the inner harbour. As such, the JNCC protocols have been modified in order to ensure the marine mammal mitigation protocol for dredging activity is proportionate to the perceived risk to marine mammals, and not unduly restrictive.

Figure 2: The proposed development Phase 2 dredging extents



4.2.1 Mitigation Monitoring

Due to the extremely low likelihood of cetacean presence within the inner harbour, monitoring for marine mammals will be conducted by an MMO only. Monitoring conducted by an MMO shall be required during daylight hours only. Sufficient mitigation personnel should be provided to ensure a 360 degree coverage of the inner harbour dredge area during visual monitoring periods. The MMO will be required to advise contractors and/or crews on the implementation of procedures to ensure compliance.

4.2.2 Mitigation Zone

It is proposed that there shall be no distance-specific MZ around the dredge vessel. Instead, it is proposed that prior to dredging operations commencing, the MMO will be required to conduct a pre-dredging search of the inner harbour. This ensures that the inner harbour area is monitored for the presence of seals (the species most likely to be present within the inner harbour area) and other marine mammals.

4.2.3 Pre-dredging Search

As per the JNCC (2010) guidelines, a pre watch is designed to maximise detection probability within a MZ, and thus, a pre-dredging search of the inner harbour is required prior to the commencement of dredging. This shall be conducted for a minimum of 10-minutes by an MMO. A 10-min watch is considered to be sufficient to ensure the inner harbour is clear of marine mammals, as a 30-min watch will not increase detection probability within the inner harbour, particularly when considering the behaviour of seals in the area. The 10-minute pre-watch shall take place during the 'powering-on' phase of the dredge vessel. This is effectively a 'soft-start' procedure (see Section 4.2.4). Dredging can commence at full-power following the completion of the 10-minute pre-watch should no marine mammal be observed.

If a marine mammal is detected within the inner harbour area, dredging shall not commence/proceed from the 'powering-on' phase until 10 minutes after the last visual detection and/or the MMO is satisfied that the animal has left the inner harbour.

4.2.4 'Powering-On' Procedure

The 'powering-on' phase of the dredge vessel is effectively a 'soft-start' procedure whereby the dredging vessel (in this case, a cutter-suction dredger (CSD)) arrives within the area to be dredged with the main vessel engines already powered-on. Following the arrival of the CSD with the engines powered-on, the suction-cutter pumps (which help remove material from the seabed) begin to operate, and the cutter-head is started and begins to rotate. At this stage, the suction-cutter pumps and cutter-head are operating at no more than 50% of full power, and shall do so for at least 15-minutes. If any marine mammals are still present in the vicinity of the dredging location, they are expected to be encouraged to leave by the initial low levels of underwater noise prior to the noise reaching maximum levels. The 10-minute pre-dredging search as described in Section 4.2.3 shall commence during this period.

The timing of the powering-on procedures for the CSD will be determined in consultation with the dredging engineers depending on what is operationally feasible for the suction cutter.

Once the 10-minute pre-dredging search is complete and the inner harbour is clear of animals, dredging can commence at 'full-power'. If a marine mammal is detected in the inner harbour during the 'powering-on' phase, power will not increase (depending on operational feasibility) until the animal exits the inner harbour and/or there have been no further visual detections for 10 minutes.

Once the 'powering-on' procedure has been completed, there is no requirement to stop dredging or reduce the energy in the cutter suction dredger if a marine mammal is detected in the inner harbour as the animal is deemed to have entered voluntarily entered. Therefore, if a marine mammal enters the inner harbour after full power has been achieved, dredging can continue.

4.2.5 Breaks in Dredging

Breaks in the dredging process could provide the potential for marine mammals to re-enter the inner harbour. Where a pause in dredging occurs during the day or nighttime and the CSD pumps and/or cutter-head are non-operational, or engines have been switched off, the pre-dredging search and 'powering-on' procedure will be required to be repeated to recommence activity. Since only the use of MMOs is proposed for mitigation-monitoring during dredging, should a pause in activity occur during the nighttime, which constitutes the need for the pre-dredging search and 'powering-on' procedure to be repeated, this should take place during daylight hours only.

If, during the break, the CSD pumps and engines have been operational, dredging activities can continue as normal without the need for a repeat in pre-dredging search or 'powering-on' procedures (even at night).

4.2.6 Communication

Effective lines of communication between mitigation personnel and the dredging crew conducting dredging are essential. The communications shall include:

- The need for the MMO to be informed by the chief dredge operator/vessel master of the proposed dredge start time, at least 15 minutes prior to the start of the CSD pumps and/or cutter-head being powered-on to allow the mitigation personnel to prepare for the pre-dredging search;
- The need to notify the MMO to begin the 10-minute pre-dredging search during the 'powering-on' procedures, but prior to the CSD operating at full-power;
- The need for the MMO to notify the dredging crew that dredging can commence;
- The need for the MMO to notify the vessel master that a marine mammal has been detected in the inner harbour; and
- The need for the dredging crew to notify the MMO that the dredging operations have been successfully completed and/or when a break in dredging operations are expected so pre-dredging watches can commence to minimise down time if necessary, as dependent on the expected duration of break.

4.2.7 Reporting

All reporting will be in line with the best practice procedure outlined in the JNCC (2010) guidelines. Reports detailing the dredging activity and marine mammal mitigation shall be retained and will be available to NatureScot, JNCC and MD-LOT upon conclusion of all dredging operations. Reports will include:

- Record of dredging operations including date and location, duration of pre-dredging and 'powering-on' procedures and instances where operations were delayed or stopped due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, and details of the dredging activity during the watches;
- Completed Marine Mammal Recording Forms, detailing any incidental marine mammal sightings (i.e. species, distance);
- Details of problems encountered, i.e. non-compliance with agreed protocols, and any recommendations for amendments to the protocols; and
- Any recommendations for amendments to the protocol.

Further, it is good practice to report any dead marine mammals observed to SMASS and live strandings to BDMLR, even if they are not attributed to the works. In addition, the MMO and PAM Operator should keep a record of marine mammal sightings and/or acoustic detections outwith the inner harbour, to be submitted to NatureScot for biodiversity data collection purposes.

5 Spoil Disposal Mitigation Plan

This outline piling MMMP has been prepared to support dredging activities at the Port of Ardersier which are expected to take place over 10 weeks between March and October(sometime between 2027 – 2029). At present, Burghead is considered as the only disposal areas. There are currently no mitigation guidelines specific to spoil disposal and, therefore, the mitigation measures proposed are adapted from the JNCC (2010) piling guidelines. Any additional conditions included within the license for material deposition will also be included in the final MMMP.

The mitigation measures proposed during spoil disposal activities are presented below and summarised in a flowchart in Appendix 3.

5.1 Mitigation methods

It is proposed that a real-time PAM system is utilised for mitigation-monitoring of marine mammals during spoil disposal operations, such that a remote PAM Operator can perform adaptive mitigation-monitoring of the MZ around the spoil disposal ground and/or spoil disposal vessel.

5.1.1 Mitigation monitoring

During daylight hours, monitoring for marine mammals will be conducted by a Marine Mammal Observer (MMO). Passive Acoustic Monitoring (PAM) conducted by a PAM Operator will be used to supplement or replace visual observations when visibility is poor (e.g. darkness and sea state >4). Sufficient mitigation personnel should be provided to ensure a 360 degree coverage of the MZ during visual monitoring periods and to allow for 24 hour monitoring. Details of the real-time PAM system used will be provided in the final MMMP.

The MMO and PAM Operator will be required to advise contractors and/or crews on the implementation of procedures to ensure compliance.

5.1.2 Mitigation Zone

The MZ that will be monitored during spoil disposal operations at the selected disposal site, is a 200 m MZ established around the spoil disposal ground. The MZ that should be monitored during spoil disposal operations on the approach to, and at the spoil disposal site, is a 200 m MZ established around the spoil disposal vessel, with mitigation only being implemented for marine mammal visual observations or acoustic detections within the MZ. This shall be applied for all marine mammal species.

5.1.3 Pre-disposal Search

A pre-disposal search of the 200 m MZ is required prior to the commencement of spoil disposal. This shall be conducted for a minimum of 15 minutes by an MMO and/or the PAM Operator as the vessel is arriving at the disposal location.

Spoil disposal shall not commence if a marine mammal is detected within the 200 m MZ around the disposal location or until the 15 minute search has been completed. If a marine mammal is detected within the MZ, disposal activities will not commence until 10 minutes after the last visual or acoustic detection and both the MMO and/or PAM Operator is satisfied that the animal has left the MZ. If marine mammals are in the MZ, the vessel may also choose to use a different location within the disposal site >200 m from the original intended disposal location and continue the pre-disposal search/delay period at this location instead. The disposal crew shall liaise with the mitigation personnel to ensure that there is a suitable disposal location >200 m from the original intended disposal location.

During spoil disposal when acoustic detection methods are being used (and conditions are not suitable for visual detection methods), if the disposal vessel chooses a different disposal location due to the presence of marine mammals within the 200 m MZ around the original disposal location, the limitations of detecting marine mammals at increasing distances from the real-time PAM monitoring location(s) will be taken into account.

The JNCC (2010) guidelines have been adapted here to reduce the duration of the pre-disposal search, and the delay to commencing activities after the last marine mammal detection. This is due to the reduced area of search when compared with the dredge area itself (i.e., a 200 m MZ versus a 500 m MZ) which is an area that is >80% smaller. However, the timings have only been reduced by 50% as a conservative measure to account for the fact that marine mammals are not always available at the surface for observation and may not be constantly vocalising.

5.1.4 Communication

Effect lines of communication between mitigation personnel and the spoil disposal crew are essential. The communications shall include:

- The need for the MMO and the PAM Operator to be informed by the spoil disposal crew of the proposed disposal start time, at least 30 minutes prior to the start of spoil disposal to allow the mitigation personnel to prepare for the pre-disposal search activity;
- The need to notify the MMO and the PAM Operator to begin the 15-minute pre-disposal search prior to spoil disposal;
- The need for the MMO and the PAM Operator to notify the spoil disposal crew if a marine mammal has been detected in the MZ; and
- The need for the spoil disposal crew to notify the MMO and the PAM Operator that the disposal operations have been successfully completed.

5.1.5 Reporting

All reporting will be in line with the best practice procedure outlined in the JNCC (2010) guidelines. Reports detailing the dredging activity and marine mammal mitigation shall be retained and will be available to NatureScot, JNCC and MD-LOT upon conclusion of all dredging operations. Reports will include:

- Record of spoil disposal operations including date and location and instances where operations were delayed due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, details of the PAM equipment and detections, and details of the disposal activity during the watches;
- Completed Marine Mammal Recording Forms, detailing any incidental marine mammal sightings (i.e. species, distance);
- Details of problems encountered, i.e. non-compliance with agreed protocols, and any recommendations for amendments to the protocols; and
- Any recommendations for amendments to the protocol.

Further, it is good practice to report any dead marine mammals observed to SMASS and live strandings to BDMLR, even if they are not attributed to the works. In addition, the MMO and PAM Operator should keep a record of marine mammal sightings and/or acoustic detections out with the MZ, to be submitted to NatureScot for biodiversity data collection purposes.

6 Vessel Movement Mitigation Plan

The following guidelines will be adhered to in order to minimise any potential risk to marine mammals during vessel movements.

- All vessels involved in construction activities will comply with the measures set out in the MMMP.
- All vessels will adhere to instructions and guidance from the Harbour Master.
- All vessels will comply with the International Maritime Organisation (IMO)/Maritime Coastguard Agency (MCA) codes for the prevention of oil pollution.
- All movements of vessels, which also include site deliveries, will be coordinated with the Harbour Master.

In addition, vessels should comply with the Scottish Marine Wildlife Watching Code (SMWWC), developed by NatureScot under the Nature Conservation (Scotland) Act 2004 (SNH 2017b) and the Guide to Best Practice for Watching Marine Wildlife (SNH 2017a) which complements it. These includes guidance such as:

- Keep a safe distance from visually observed marine mammals. Recommended minimum approach distances are:
  - 50 metres for dolphins and porpoises
  - 100 metres for whales
  - 200–400 metres for mothers and calves, or for animals that are clearly actively feeding or in transit (moderate to fast swimming in a single direction).
- Do not approach animals directly from behind or cut them off by moving across their path.
- Spend no longer than 30 minutes (or 15 minutes if multiple vessels are present) near the animals e.g., seals, dolphins, porpoise and whales.
- Special care must be taken with mothers and young.
- Maintain a steady direction and a slow 'no wake' speed or switch the engine to neutral when animals (e.g., seals, dolphins, porpoise and whales) are present.
- Avoid sudden changes in speed.

Vessel operators should familiarise themselves with the NatureScot Wildlife code of conduct publications which are available on their website.

7 Glossary of Terms, Acronyms and Abbreviations

Term	Description
BDMLR	British Divers Marine Live Rescue
ETF	Energy Transition Facility
EPS	European Protected Species
IMO	International Maritime Organisation

JNCC	Joint Nature Conservation Committee
m	metres
MCA	Maritime Coastguard Agency
MD-LOT	Marine Directorate Licensing and Operations Team
MMO	Marine Mammal Observer
MMMP	Marine Mammal Mitigation Plan
MZ	Mitigation Zone
PAM	Passive Acoustic Monitoring
SAC	Special Area of Conservation
SMASS	Scottish Marine Mammal Stranding Scheme
SMWWC	Scottish Marine Wildlife Watching Code

8 Literature Cited

JNCC. 2010. Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

JNCC. 2023. JNCC guidance for the use of Passive Acoustic Monitoring in UK waters for minimising the risk of injury to marine mammals from offshore activities.

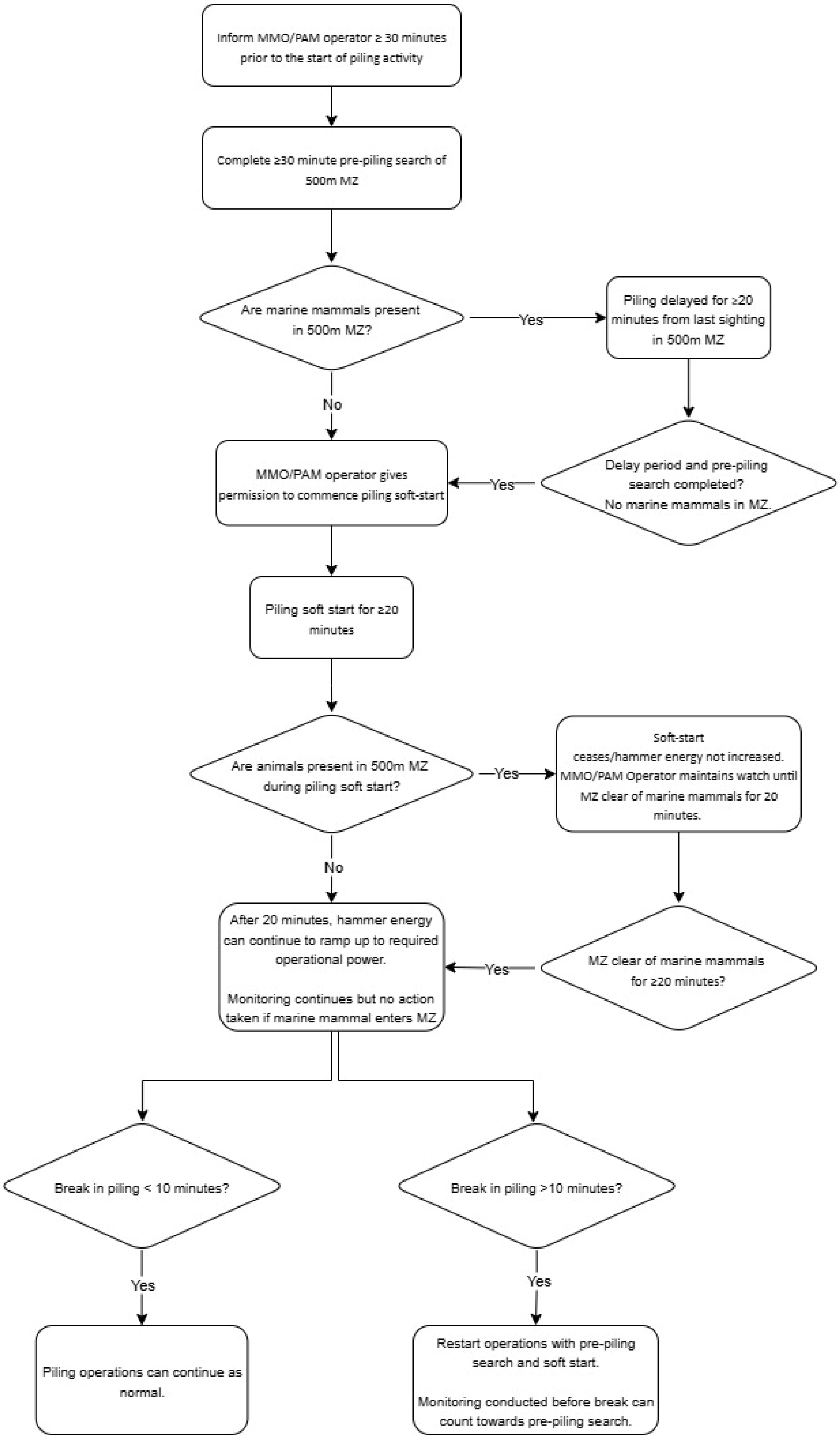
SNH. 2017a. A Guide to Best Practice for Watching Marine Wildlife SMWWC - Part 2. Scottish Natural Heritage.

SNH. 2017b. The Scottish Marine Wildlife Watching Code SMWWC - Part 1. Scottish Natural Heritage.

Southall, B., J. J. Finneran, C. Reichmuth, P. E. Nachtigall, D. R. Ketten, A. E. Bowles, W. T. Ellison, D. Nowacek, and P. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals **45**:125-232.

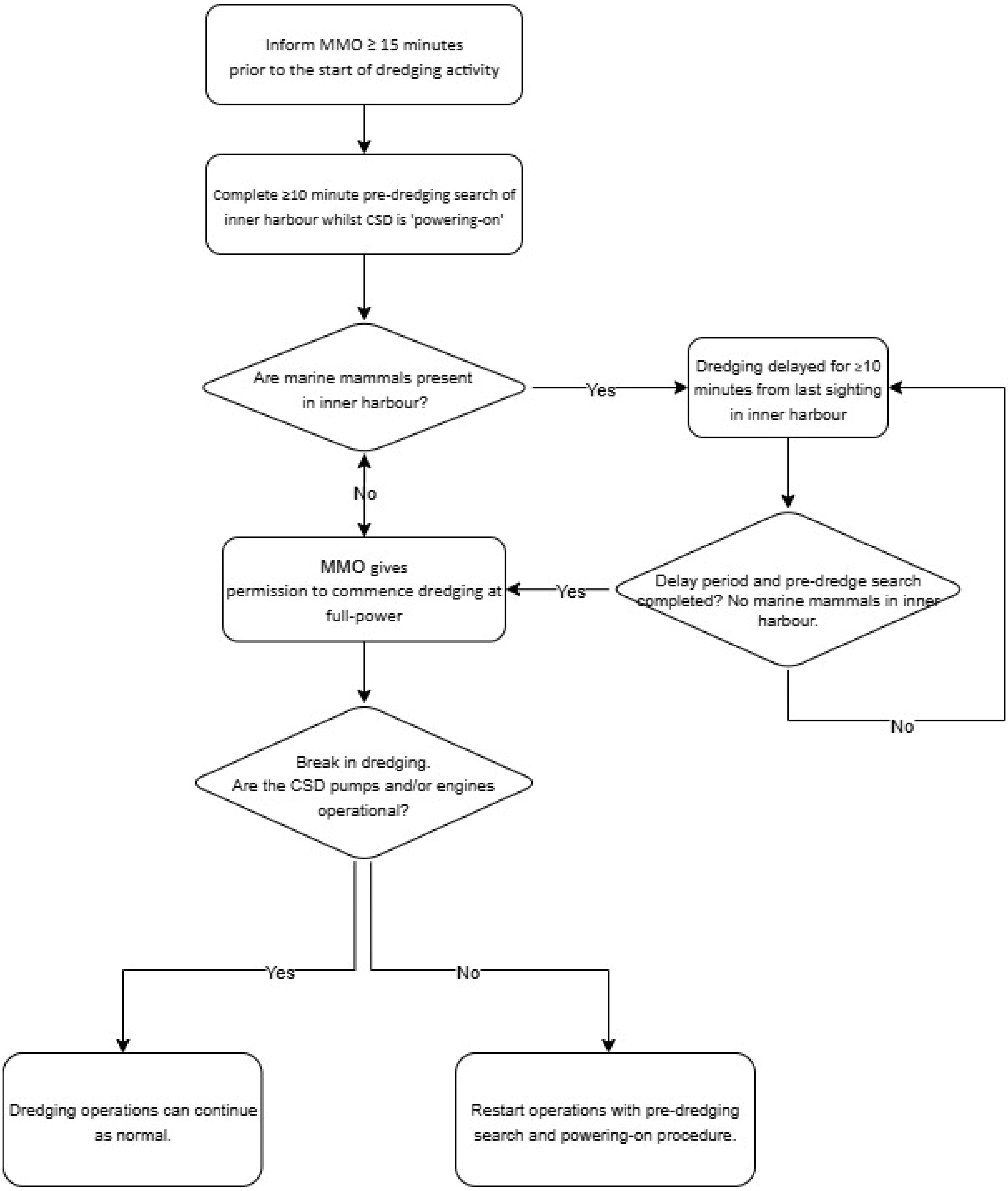
Appendix 1 Impact Piling Flowchart

Figure 3: Flow chart of mitigation procedures during impact piling.



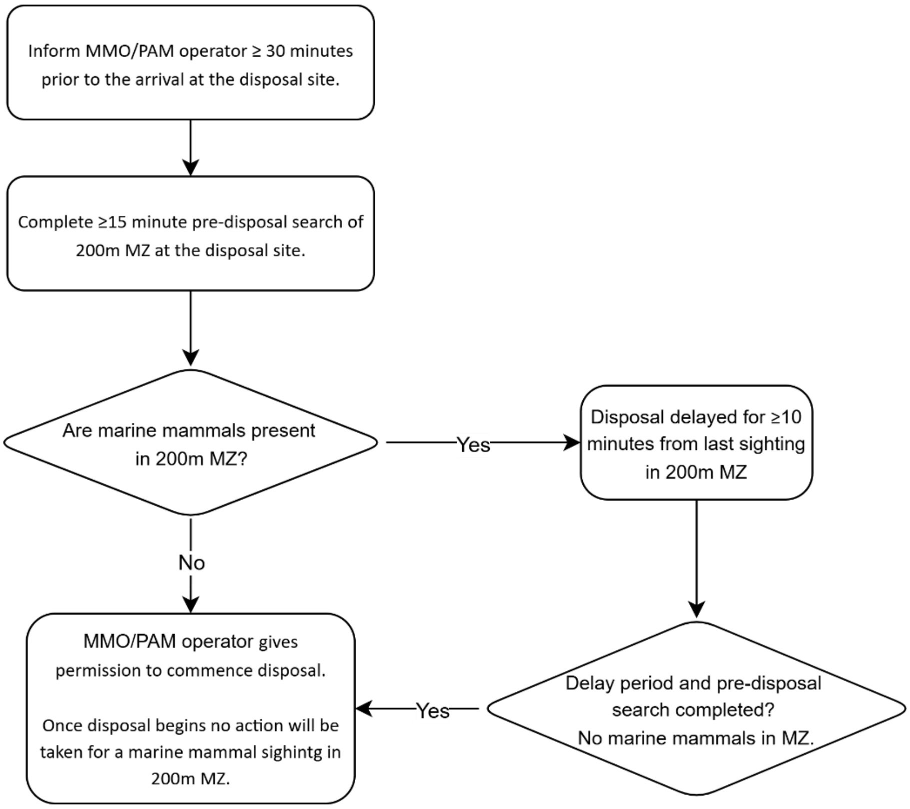
Appendix 2 Dredging Mitigation Flowchart

Figure 4: Flow chart of mitigation procedures during dredging activities.



Appendix 3 Spoil Disposal Mitigation Flowchart

Figure 5: Flow chart of mitigation procedures during spoil disposal activities.



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November 2025

Appendix 11.8 - Cetacean Baseline Distribution, Occurrence and Behaviour in the Moray Firth SAC

Cetacean baseline distribution, occurrence and behaviour in the Moray Firth SAC

Aude Benhemma-Le Gall and Barbara Cheney

University of Aberdeen

June 2025

Contents

Introduction

The University of Aberdeen's Lighthouse Field Station has been conducting long-term monitoring of cetaceans in the Moray Firth for over three decades. The Moray Firth was designated a Special Area of Conservation for bottlenose dolphins (*Tursiops truncatus*) in 2005 (Cheney et al. 2014). A combination of boat-based photo-identification surveys and passive acoustic monitoring (PAM) has enabled individuals to be identified and estimates of population size and vital rates (Cheney et al. 2014; Cheney et al. 2024; Cheney et al. 2019), and understand their acoustic occurrence and behaviour at varying spatial and temporal scales (Fernandez-Betelu et al. 2019). These techniques have also been used to assess dolphin responses to changes in their environment, due to either natural processes (e.g. Fernandez-Betelu et al. (2023)) or anthropogenic activities (Fernandez-Betelu et al. 2021; Graham et al. 2017). These long-term datasets provide an opportunity to understand the baseline distribution and occurrence of this protected species and inform Environmental Impact Assessment of future coastal developments, such as the expansion of the Port of Ardersier in the Inverness and Cromarty Firth Green Freeport area.

This report provides an overview of the seasonal and annual occurrence of bottlenose dolphins and harbour porpoises (*Phocoena phocoena*) at two long-term PAM sites located in the inner Moray Firth (Sutors and Chanonry, see Figure 1), and three sites in the vicinity of the Port of Ardersier. Also, 19 years of boat-based sightings are examined to characterise bottlenose dolphin spatial distribution in the Moray Firth Special Area of Conservation and compare the number of dolphin encounters, individuals and estimated group size around the Port of Ardersier and the two long-term inshore monitoring sites.

Material and Methods

Passive Acoustic Monitoring in the inner Moray Firth

Data collection

Between 2008 and 2024, a total of 100 PAM deployments were made at five coastal sites around the Sutors, Chanonry and Port of Ardersier located in the inner Moray Firth Special Area of Conservation (SAC) (NE Scotland). Autonomous echolocation click loggers (CPODs, Chelonia Limited) were bottom-moored in shallow waters (up to 24 m), with the hydrophone upward facing between 3 and 5 m from the seabed, to detect cetacean echolocation clicks and monitor the acoustic occurrence of both bottlenose dolphins and harbour porpoises. Further details of field methods are provided in Fernandez-Betelu et al. (2019). Given the main delphinid species occurring in the inner Moray Firth is the bottlenose dolphin, we presume that dolphin clicks detected by CPODs are from this species.

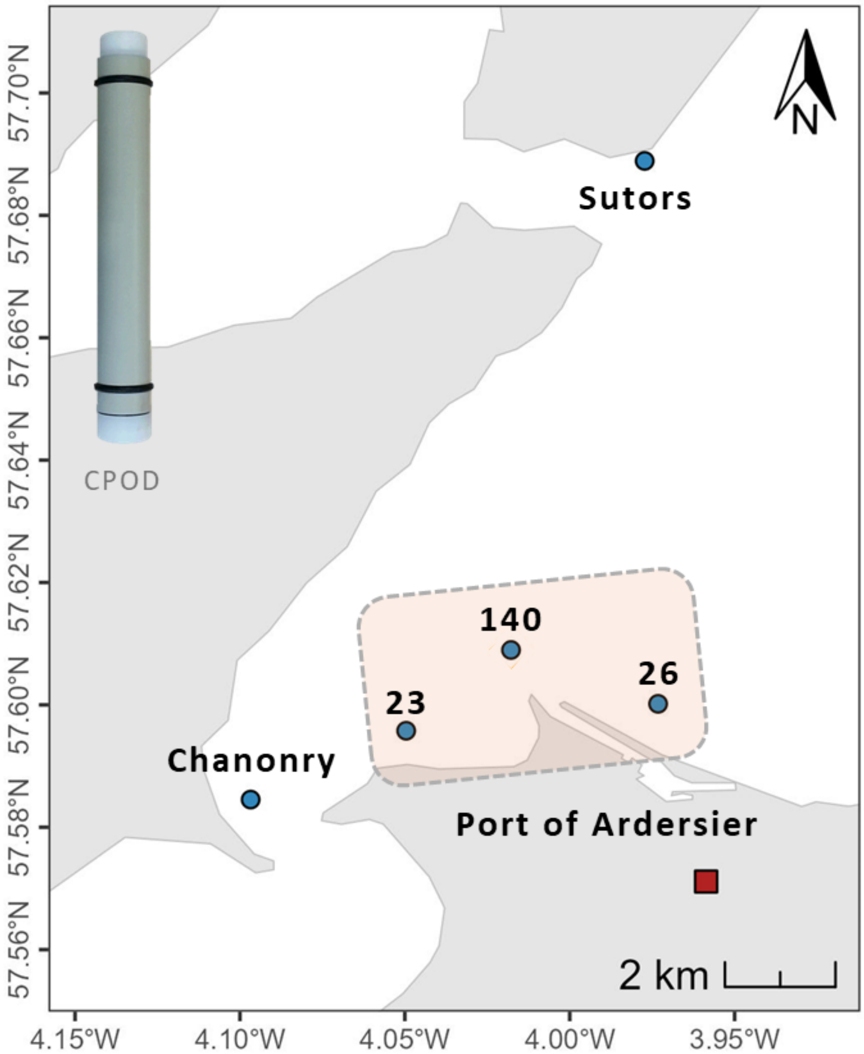

Figure 1. Long-term Passive Acoustic Monitoring (PAM) sites (blue dots) at Chanonry and Sutors (inner Moray Firth, NE Scotland) deployed between 2008 and 2024 and around the Port of Ardersier (red square) where CPODs were deployed intermittently at sites 23, 26 and 140 between 2009 and 2015. The three PAM sites around the Port of Ardersier were grouped for analyses.

Data analyses

The number of hours with bottlenose dolphin and harbour porpoise echolocation click detections were summarised using a daily metric, Detection Positive Hour (DPH) per day. The seasonal and annual variation in bottlenose dolphin and harbour porpoise acoustic occurrence were compared:

a) between the three short-term monitoring sites around the Port of Ardersier to investigate whether these were comparable.
b) between the two long-term monitoring areas at Sutors and Chanonry, and Port of Ardersier.

These comparisons were made for the years and months in which PAM equipment was deployed simultaneously in these areas.

Bottlenose dolphin photo-ID in the Moray Firth SAC

Data collection

Since 1989, bottlenose dolphin surveys in the Moray Firth SAC have used established techniques and protocols to collect data on trends in population size (Cheney et al. 2024) and vital rates (Arso Civil et al. 2019; Cheney et al. 2019). Individual bottlenose dolphins are recognised using their distinct dorsal fin natural marks. Around 20 surveys are made each summer field season (May to September) aiming to target areas that maximise the probability of encountering bottlenose dolphins. On every survey, the track of the boat and locations of encounters with each group of bottlenose dolphins are recorded using a GPS. All survey work is conducted under a NatureScot licence. Boat-based bottlenose dolphin photo-identification data from 2006 to 2024 were included in this report.

Data analyses

To investigate the broad-scale spatial distribution of bottlenose dolphins in the Moray Firth SAC, we summarised the photo-ID survey effort and dolphin encounters within 1 by 1 km and 4 by 4 km grids (Figure 2).

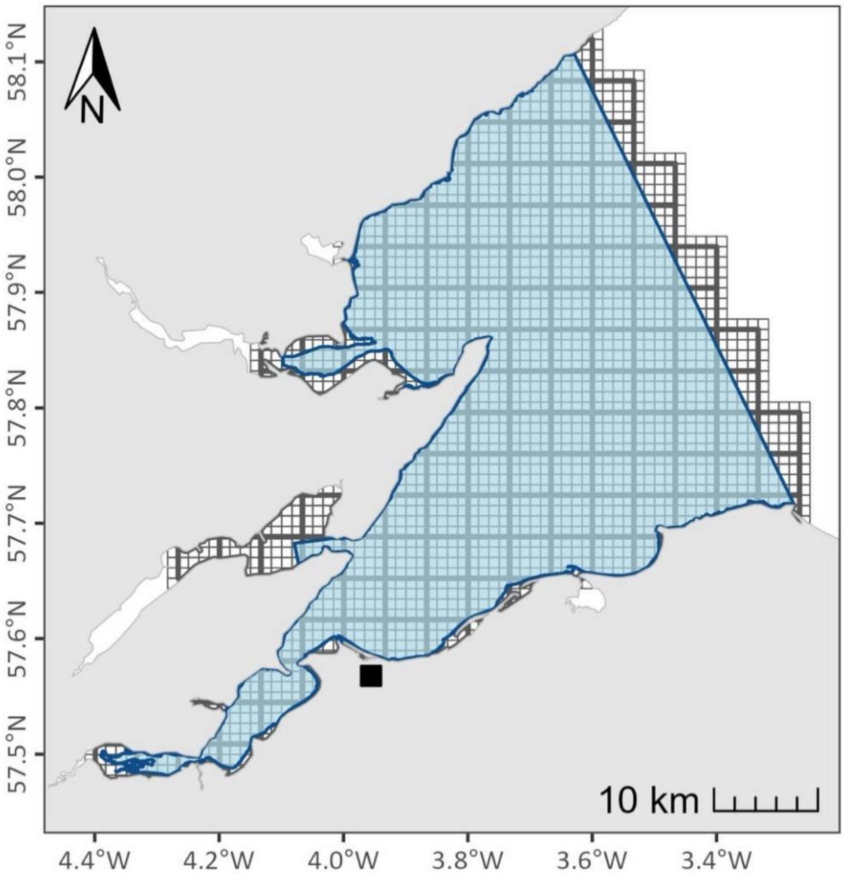

Figure 2 Moray Firth Special Area of Conservation (SAC) for bottlenose dolphins (in blue). 1 km by 1 km and 4 km by 4 km grids that encompass the SAC were created and extended to the west to account for survey effort in the Cromarty Firth. The Port of Ardersier is represented by the black square.

Survey effort

Effort was defined as the time of active search ("on effort") and was calculated using the survey track location and time. Survey GPS points were recorded on average every minute and the number of *on-effort* points within each grid cell was summarised per year and averaged across years, as per hour unit effort. Grid cells with low effort (i.e. only one trip recorded across the survey period, or with less than two minutes of effort per year) were not included in the analyses.

Bottlenose dolphin encounters

The GPS location recorded at the start of each bottlenose dolphin encounter was used to estimate the number of encounters within each grid cell and year. The number of encounters was then divided by the number of hours of effort within each grid cell between 2006 and 2024, and the number of encounters per hour unit effort was averaged across monitoring years.

For each encounter, the best group size estimate was the higher number of individuals either photographed or observed during an encounter (see Cheney et al. (2024)). For 2024, the best group size estimate was derived from the number of individuals observed during the encounter, as the photo-ID data analysis is not yet completed.

To understand how dolphins are using Sutors, Chanonry and the Port of Ardersier, 1 by 1 km grid cells with their centroid within a 2.7 km buffer including the PAM sites deployed at Sutors, Chanonry and Port of Ardersier were extracted (19 to 22 cells, see Figure 3). The number of bottlenose dolphin encounters, individuals identified and group size were compared between these three areas of interest and with the Moray Firth SAC.

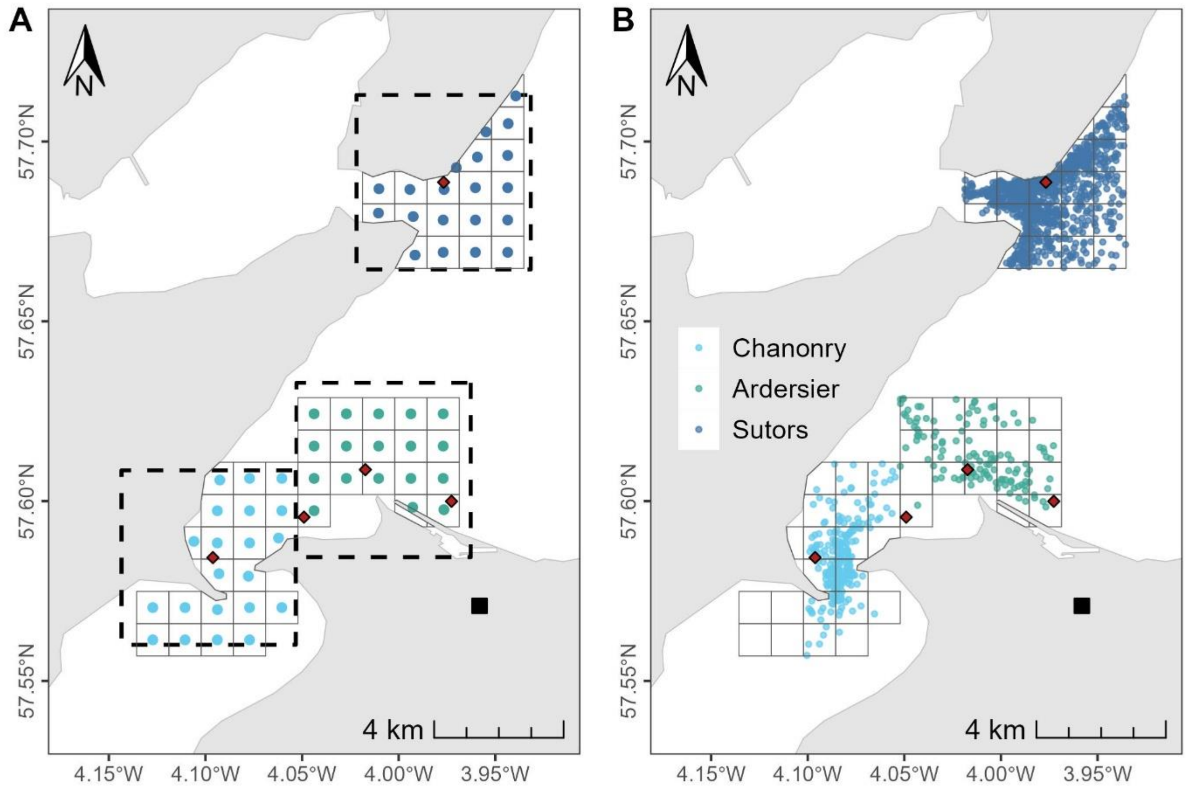

Figure 3 Methodology to extract information on bottlenose dolphin encounters, group size and number of individuals identified around three areas of interest (Sutors, Chanonry and Port of Ardersier (black square)). A) a 2.7 km buffer was created to encompass the Passive Acoustic Monitoring sites (red diamonds) around Sutors, Chanonry and Port of Ardersier. Any 1 km by 1 km grid cells with a centroid falling into one of the three buffer areas were selected for further comparative analyses. B) the bottlenose dolphin encounter locations falling in each buffer area are represented by coloured dots.

Results

Passive Acoustic Monitoring in the inner Moray Firth

Bottlenose dolphin occurrence around the Port of Ardersier

Bottlenose dolphin occurrence around the Port of Ardersier was monitored with CPODs during July to November from 2009 to 2014 on the west side of the Port (site 23) and in 2013 and 2014 on the east side (site 26). At the entrance of the channel (site 140) CPODs were deployed from April to November between 2013 and 2015 (Figure 1A).

Bottlenose dolphin occurrence was significantly higher at the entrance of the Port of Ardersier channel (site 140) than at either the west or east sides of the Port. Annual (Wald test: χ^2 = 7.582, d.f. = 2, p = 0.02, Figure 4) and seasonal (Wald test: χ^2 = 42.92, d.f. = 8, p < 0.001, Figure 5) variations were observed between sites, with a peak in occurrence between June and August. Typically, bottlenose dolphins were seen for a median of 3-6 hours per day at the PAM sites around Ardersier with a peak in 2014 (Figure 4). Within the year, a peak in occurrence was detected in July (Figure 5).

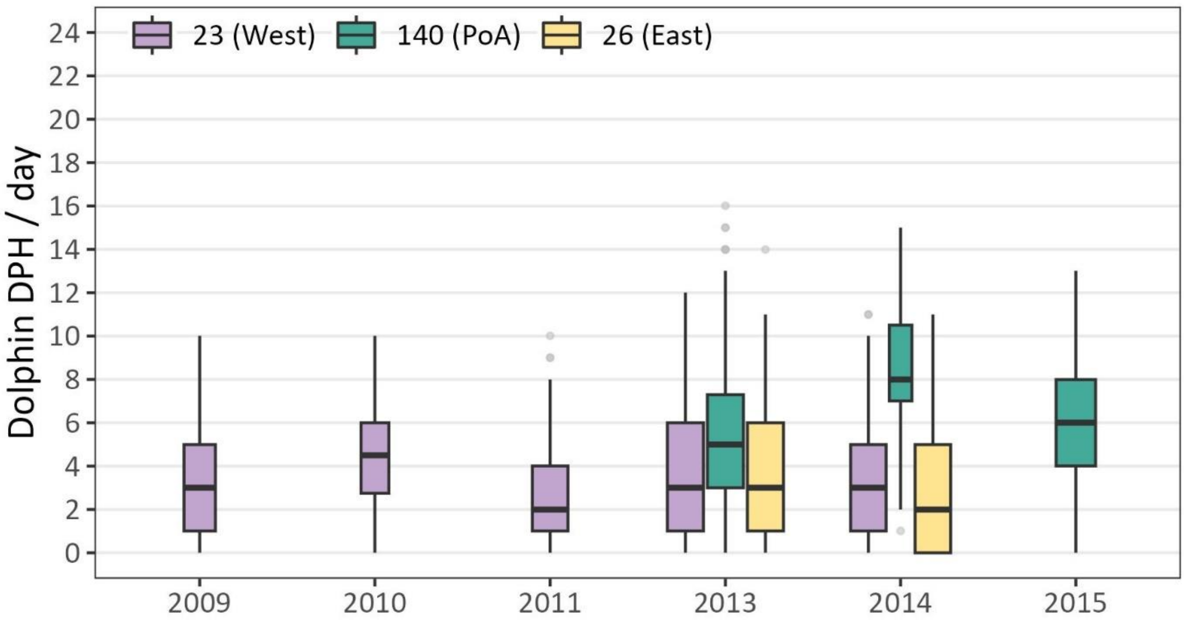

Figure 4 Bottlenose dolphin acoustic detection positive hours (DPH) per day summarised per monitoring year, at the west (site 23; purple boxplot), east (site 26; yellow boxplot) and entrance (site 140; green boxplot) of the Port of Ardersier channel, in the inner Moray Firth, NE Scotland. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

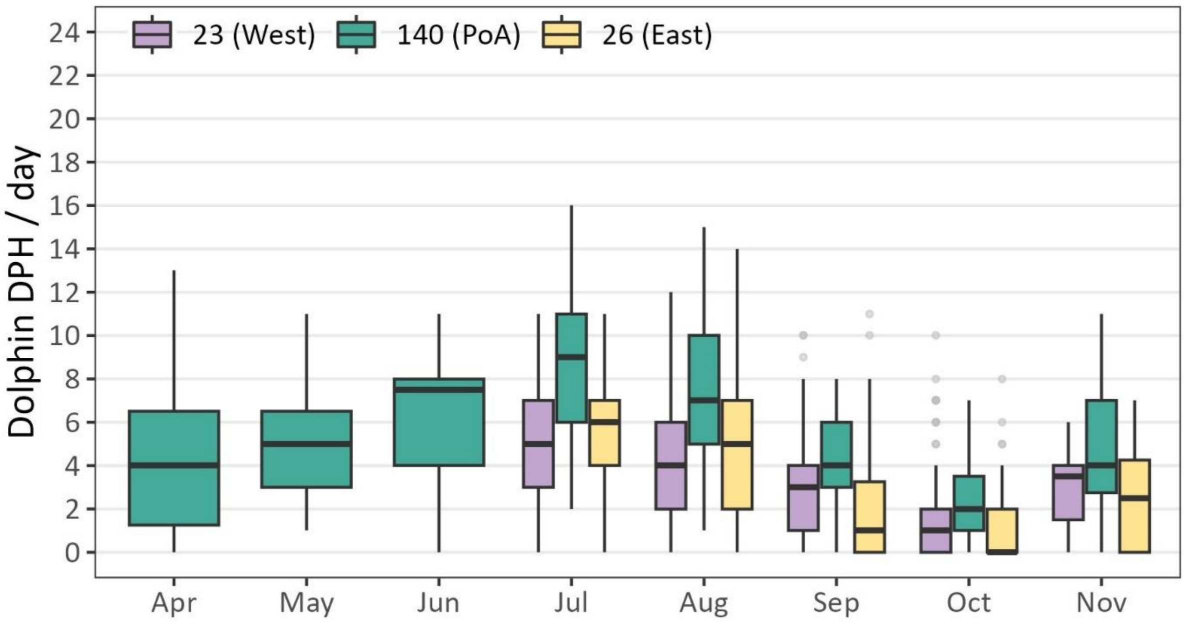

Figure 5 Bottlenose dolphin acoustic detection positive hours (DPH) per day summarised per month (April to November), at the west (site 23; purple boxplot), east (site 26; yellow boxplot) and entrance (site 140; green boxplot) of the Port of Ardersier channel, in the inner Moray Firth, NE Scotland. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

Harbour porpoise occurrence around the Port of Ardersier

Harbour porpoises generally occurred less than bottlenose dolphins around the Port of Ardersier and were mainly detected at the east (site 26) and entrance of the channel (site 140). Overall, porpoise acoustic detections ranged from a median of 0 to 1 hour per day at these PAM sites. Porpoise occurrence also varied both annually (Wald test: $\chi^2 = 22.432$, d.f. = 2, $p < 0.001$, Figure 6) and seasonally between sites (Wald test: $\chi^2 = 93.111$, d.f. = 8, $p < 0.001$, Figure 7) with peaks in occurrence detected from April to June and September to November, when dolphin occurrence was lower (c.f. Figure 5).

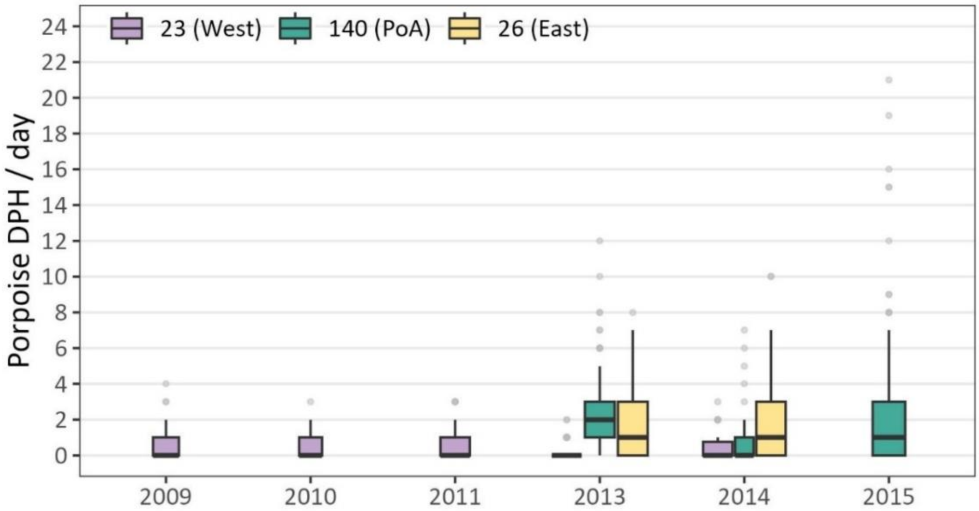

Figure 6 Harbour porpoise acoustic detection positive hours (DPH) per day summarised per monitoring year, at the west (site 23; purple boxplot), east (site 26; yellow boxplot) and entrance (site 140; green boxplot) of the Port of Ardersier channel, in the inner Moray Firth, NE Scotland. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

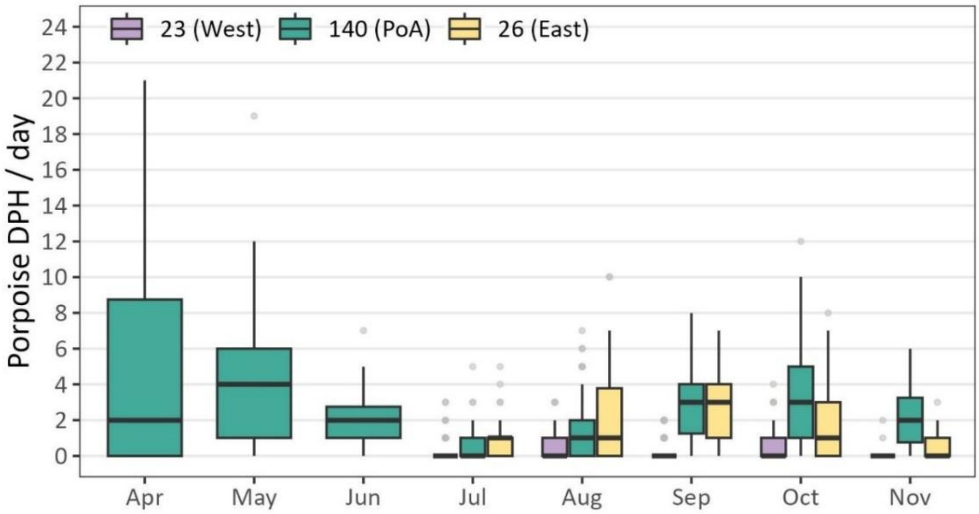

Figure 7 Harbour porpoise acoustic detection positive hours (DPH) per day summarised per month (April to November), at the west (site 23; purple boxplot), east (site 26; yellow boxplot) and entrance (site 140; green boxplot) of the Port of Ardersier channel, in the inner Moray Firth, NE Scotland. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

Variability in occurrence between Sutors and Chanonry reference sites and the Port of Ardersier

Bottlenose dolphin and harbour porpoise occurrence were compared between two long-term monitoring sites, Sutors and Chanonry (see Figure 1B), and the three sites around the Port of Ardersier (hereafter called `Ardersier`). Overall bottlenose dolphins were detected for significantly more hours per day at Sutors than Ardersier, but levels of occurrence were similar between Chanonry and Ardersier (Wald test: $\chi^2 = 36.723$, d.f. = 2, $p < 0.001$, Figure 8A). Despite lower levels of harbour porpoise detections at these coastal sites, porpoise occurrence was significantly higher around Ardersier than Sutors and Chanonry (Wald test: $\chi^2 = 36.115$, d.f. = 2, $p < 0.001$, Figure 8B).

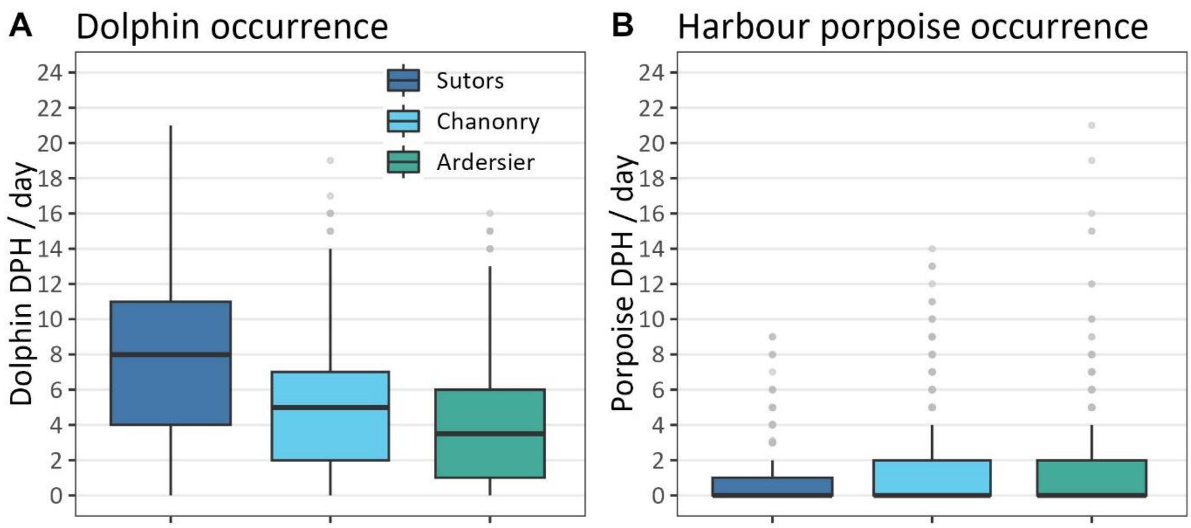

Figure 8 Bottlenose dolphin (A) and harbour porpoise (B) acoustic detection positive hours (DPH) per day summarised per monitoring sites Sutors (dark blue boxplot), Chanonry (light blue boxplot) and Ardersier (teal boxplot), in the inner Moray Firth, NE Scotland. Data included in these analyses were collected from April to November between 2009 and 2015. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

Bottlenose dolphin acoustic occurrence varied annually (Wald test: $\chi^2 = 21.692$, d.f. = 10, p = 0.017, Figure 9A) and seasonally (Wald test: $\chi^2 = 392.976$, d.f. = 14, $p < 0.001$, Figure 10A). Between 2009 and 2015, bottlenose dolphin occurrence peaked at Sutors between May and August and in October and November, while this second peak in occurrence was not observed (or as pronounced) at Chanonry and Ardersier. Instead, at Chanonry, a gradual increase in occurrence was observed late Spring, which peaked between June and August, followed by a gradual decrease in Autumn (Figure 10A). Similar seasonal patterns were observed at Ardersier, except a drop in occurrence was observed in October.

Harbour porpoise acoustic occurrence was relatively similar between monitoring years (Wald test: $\chi^2 = 21.399$, d.f. = 10, p = 0.018, Figure 9A) but varied seasonally (Wald test: $\chi^2 = 312.291$, d.f. = 14, $p < 0.001$, Figure 10B). Porpoises were detected for more hours per day at Ardersier, between April and June, and at Chanonry in September and October (Figure 10).

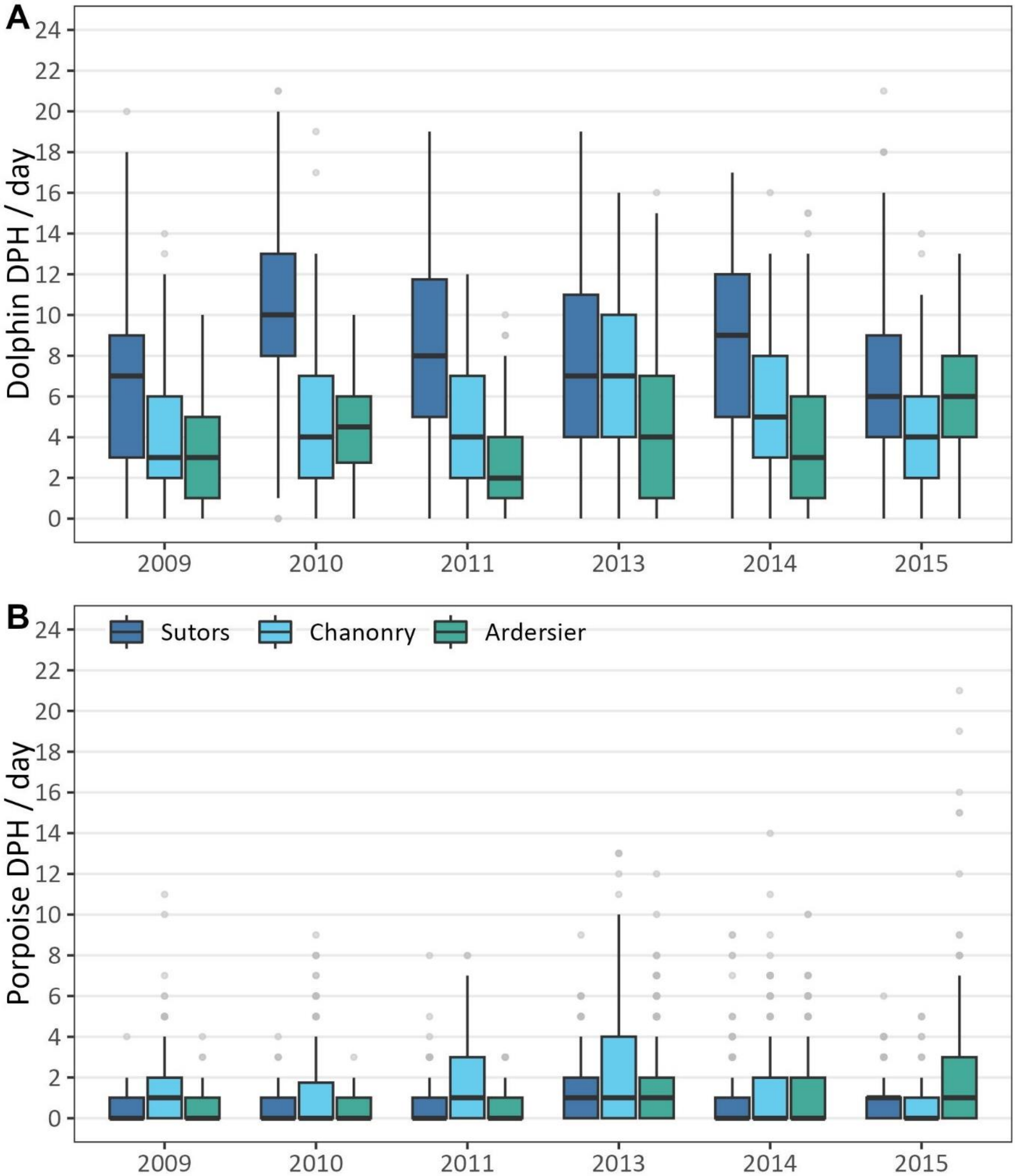

Figure 9 Bottlenose dolphin (A) and harbour porpoise (B) acoustic detection positive hours (DPH) per day summarised per monitoring years and sites at Sutors (dark blue boxplot), Chanonry (light blue boxplot) and Ardersier (teal boxplot), in the inner Moray Firth, NE Scotland. Data included in these analyses were collected from April to November. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

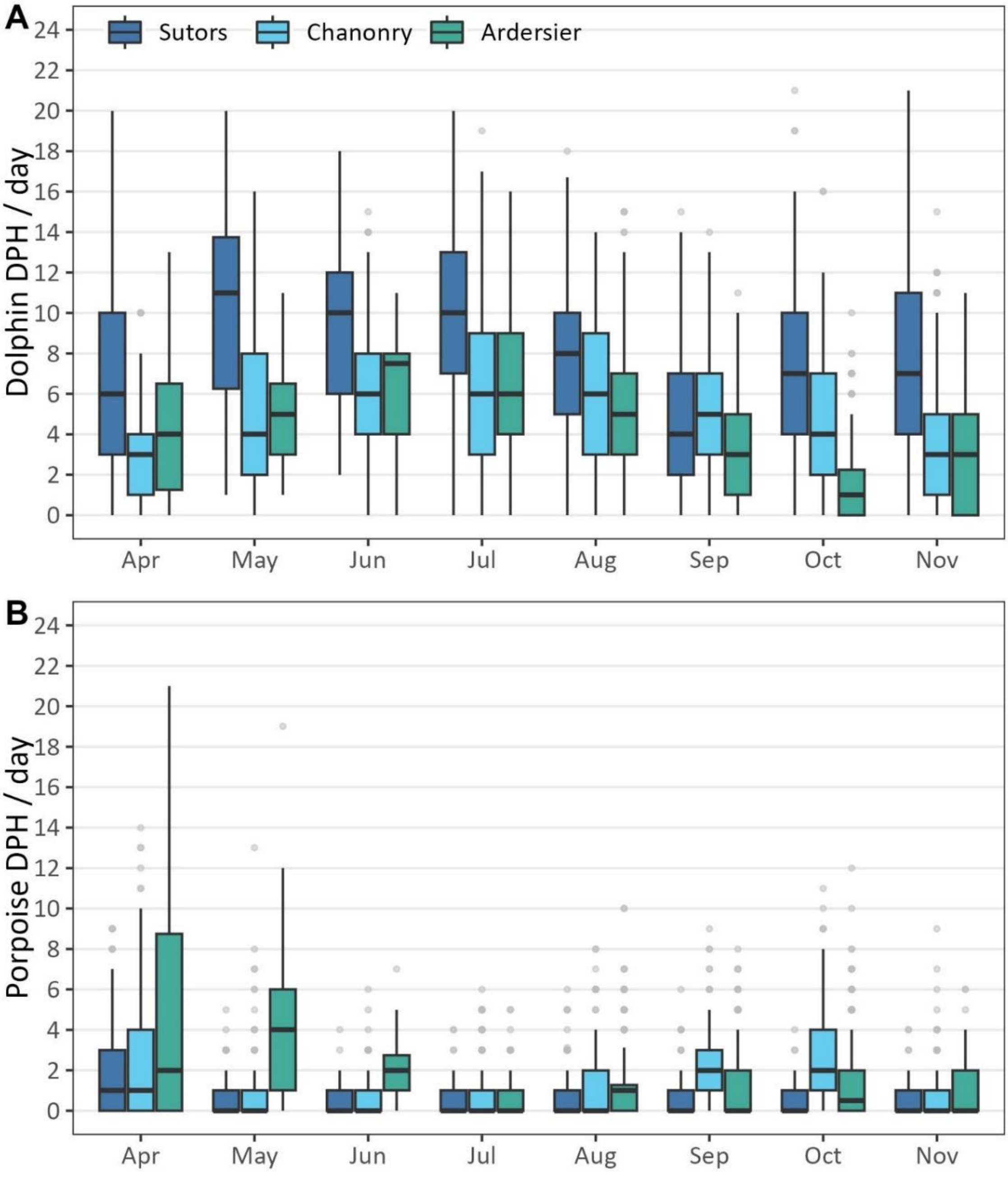

Figure 10 Bottlenose dolphin (A) and harbour porpoise (B) acoustic detection positive hours (DPH) per day summarised per monitoring months and sites at Sutors (dark blue boxplot), Chanonry (light blue boxplot) and Ardersier (teal boxplot), in the inner Moray Firth, NE Scotland. Data included in these analyses were collected between 2009 and 2011 and between 2013 and 2015. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

The patterns observed at Chanonry and Sutors between 2009 and 2015 were similar to those observed up to 2024, with bottlenose dolphin occurrence higher at Sutors (Figure S 1A) and harbour porpoise occurrence higher at Chanonry (Figure S 1B). Further, bottlenose dolphin and harbour porpoise occurrence at Sutors and Chanonry between December and March highlight a gradual decrease in dolphin occurrence (Figure S 2A) and a gradual increase in porpoise occurrence (Figure S 2B) throughout winter months.

Bottlenose dolphin photo-ID in the Moray Firth SAC

Between 2006 and 2024, a total of 462 surveys were conducted in the Moray Firth Special Area of Conservation, surveying around 714 km^2 (47 % of the SAC; yearly mean of 336 km^2). The mean number of encounters per hour unit effort within 1 km by 1 km grid cells varied between 0 and 7.5. Overall, most of bottlenose dolphin encounters were located between North Sutor, Chanonry and the eastern side of Port of Ardersier (Figure 11).

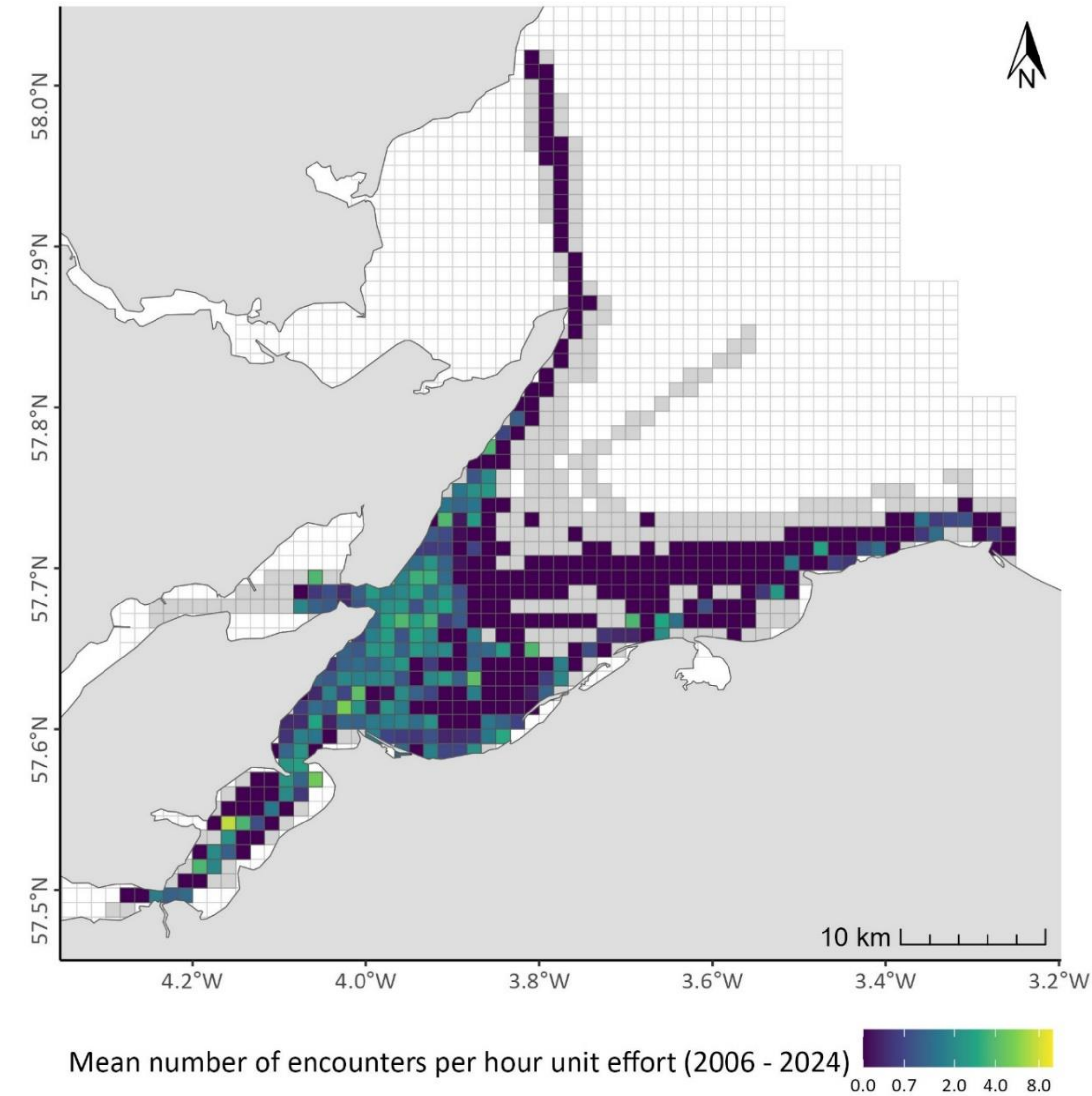

Figure 11 Bottlenose dolphin spatial distribution in the Moray Firth SAC, between 2006 and 2024, based on the number of encounters per hour unit effort within a 1 km by 1 km grid. Grid cells with only one survey and/or with less than two minutes of effort per year are highlighted in grey and were not included in the analyses (see Figure S 3 for individual years).

Between 2006 and 2024, bottlenose dolphins were encountered in groups of between 1 and 56 individuals with an average of 8 individuals (median: 6 individuals) (Figure 12). Group size was similar between monitoring years. However, over the last five monitoring years, median group sizes tended to be slightly higher with less variability, while previously, median group sizes were slightly smaller with greater variability.

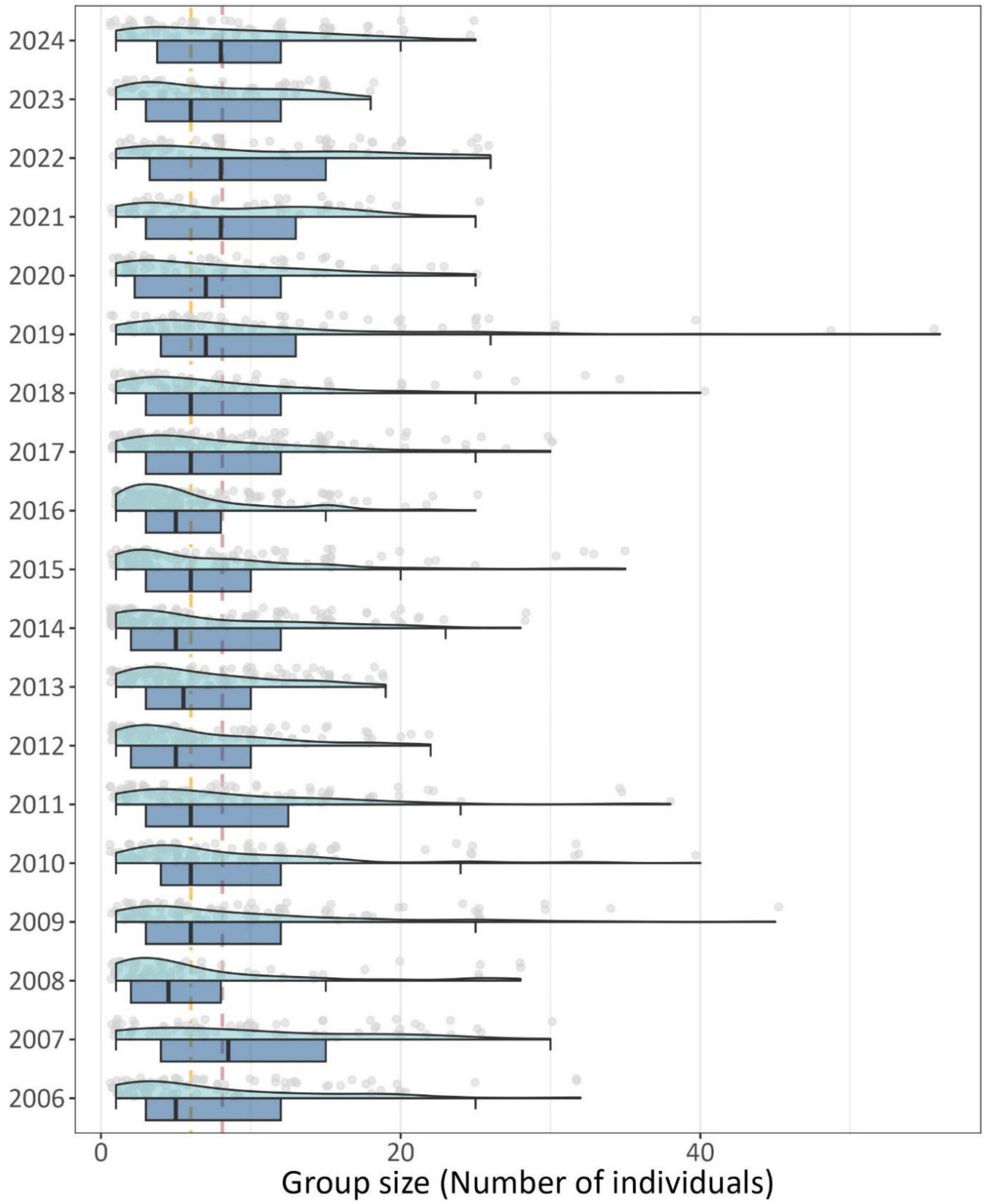

Figure 12 Size of bottlenose dolphin groups encountered in the Moray Firth SAC, between 2006 and 2024. The group size best estimate was the higher number of individuals recorded either during the photo-ID survey or post-hoc from the photo-identification of individuals. Boxplots highlight the median and interquartile range. Violin plots highlight group size distribution and grey dots represent group size estimates recorded each monitoring year. The overall median and mean group size (across the 19 years of data) is represented by the vertical orange dash-dotted line and red dashed line respectively. Nb. The 2024 group sizes were solely estimated with the higher number of individuals recorded during the survey.

At a finer scale, the number of bottlenose dolphin encounters varied between the three areas of interest, with higher encounter rate in Sutors (median = 1.85) in comparison with Chanonry and Ardersier (1.17 and 1.15 respectively, Kruskal-Wallis χ^2 = 6.4, d.f. = 2, p = 0.04) or with the SAC (1.3, Figure 13A). No significant differences in dolphin group sizes were observed between the three monitoring sites (Kruskal-Wallis χ^2 = 1.0, d.f. = 2, p = 0.6, Figure 13B). Median group sizes observed at both Sutors (8.6) and Ardersier (8.3) were similar to the overall SAC group size (8.5), while the group size range in Chanonry (6.6) was more variable but with on average smaller groups observed.

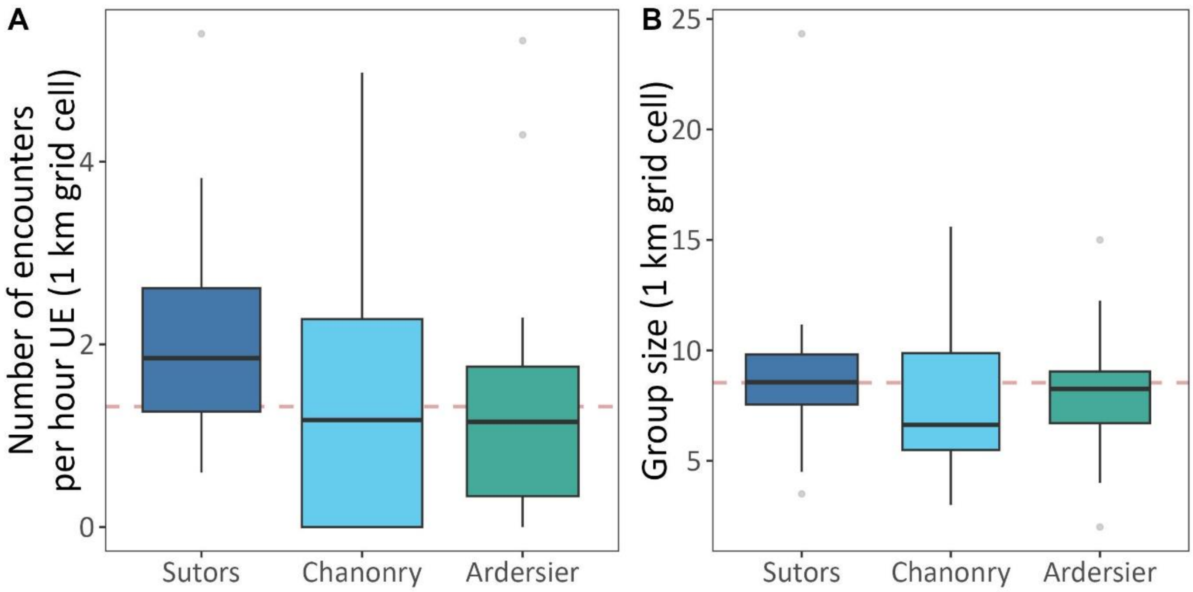

Figure 13 Mean number of bottlenose dolphin encounters per hour unit effort (UE) (A) and mean group size per year (B) within 1 km by 1 km grid cells located around the two long-term monitoring reference sites, Chanonry and Sutors, and Ardersier, across 19 years of data (2006-2024). The median number of encounters (A) and group size (B) within 1 km by 1 km grid cells in the SAC are represented by the red dotted line. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

Between 2006 and 2023, a total of 286 bottlenose dolphins were identified in the Moray Firth SAC, with 241 individuals identified at Sutors (84.3 %), 161 around Port of Ardersier (56.3 %) and 158 at Chanonry (55.2%) (Figure 14). The numbers of individuals using each area varyied between monitoring years (Figure S 4), with more than half of the individuals observed in the Moray Firth SAC observed around the Port of Ardersier.

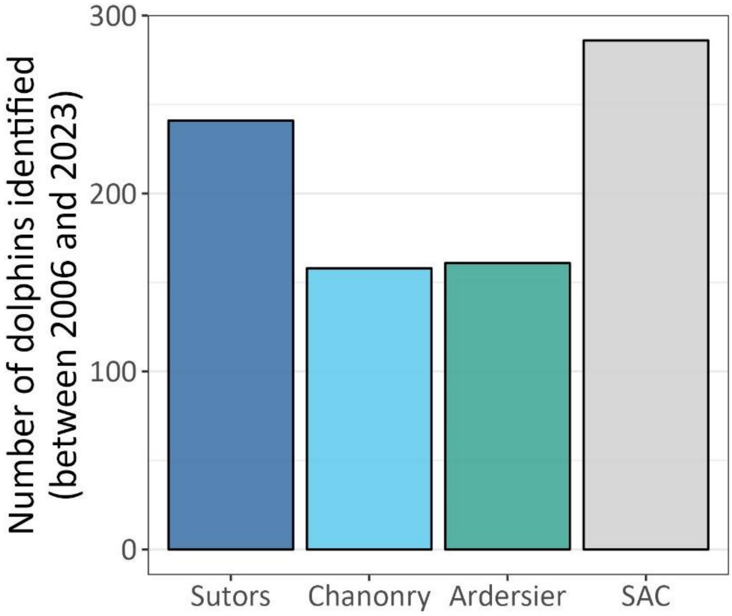

Figure 14 Number of bottlenose dolphins identified around Sutors, Chanonry, Port of Ardersier and within the Moray Firth Special Area of Conservation (SAC), between 2006 and 2023.

Discussion and conclusion

Cetaceans have been monitored in the Moray Firth Special Area of Conservation using a combination of both visual and acoustic techniques for over two decades. In this report, these long-term monitoring datasets have been used to characterise the baseline bottlenose dolphin and harbour porpoise occurrence at Chanonry and Sutors, two known bottlenose dolphin "hotspots" (Wilson et al. 1997) and around the Port of Ardersier. Additionally, bottlenose dolphin distribution, number of encounters, individuals sighted and estimated group size observed in the SAC have been highlighted to inform the Environment Impact Assessment of Port of Ardersier expansion plan.

Between 2006 and 2024, bottlenose dolphins were mainly sighted between the north Sutor, south of Chanonry and east of the Port of Ardersier. Both PAM and photo-ID surveys highlighted that Sutors, Chanony and Ardersier are areas of high occurrence for bottlenose dolphins. Bottlenose dolphin acoustic occurrence, number of encounters per unit effort and number of individuals identified were all slightly higher at the Sutors, with Chanonry and Ardersier areas similar in terms of each of these metrics. Thus, Chanonry could confidently be used as a reference site when assessing potential impact of Port of Ardersier development. Harbour porpoise acoustic occurrence was lower in these coastal areas but seasonally changed with higher occurrence in Spring and Autumn, when bottlenose dolphin occurrence is lower. The continued monitoring of the inner Moray Firth will provide further valuable information on bottlenose dolphin potential response to the Port of Ardersier development as well as any other anthropogenic activities within the Inverness and Cromarty Firth Green Free Port area.

Appendix

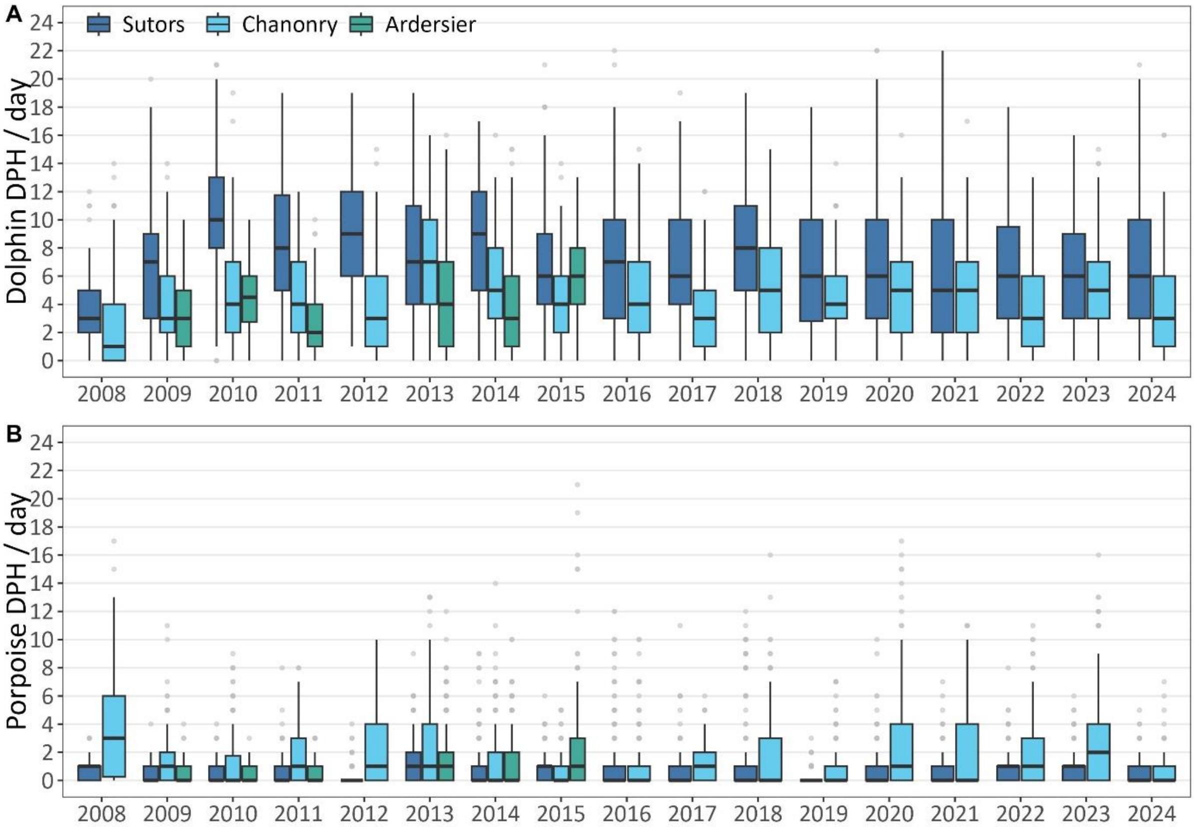

Figure S 1 Bottlenose dolphin (A) and harbour porpoise (B) acoustic detection positive hours (DPH) per day summarised per monitoring year and sites at Sutors (dark blue boxplot), Chanonry (light blue boxplot) and Ardersier (teal boxplot), in the inner Moray Firth, NE Scotland. Data included in these analyses were collected from April to November. No data were collected around Ardersier in 2008, 2012, or after 2015. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

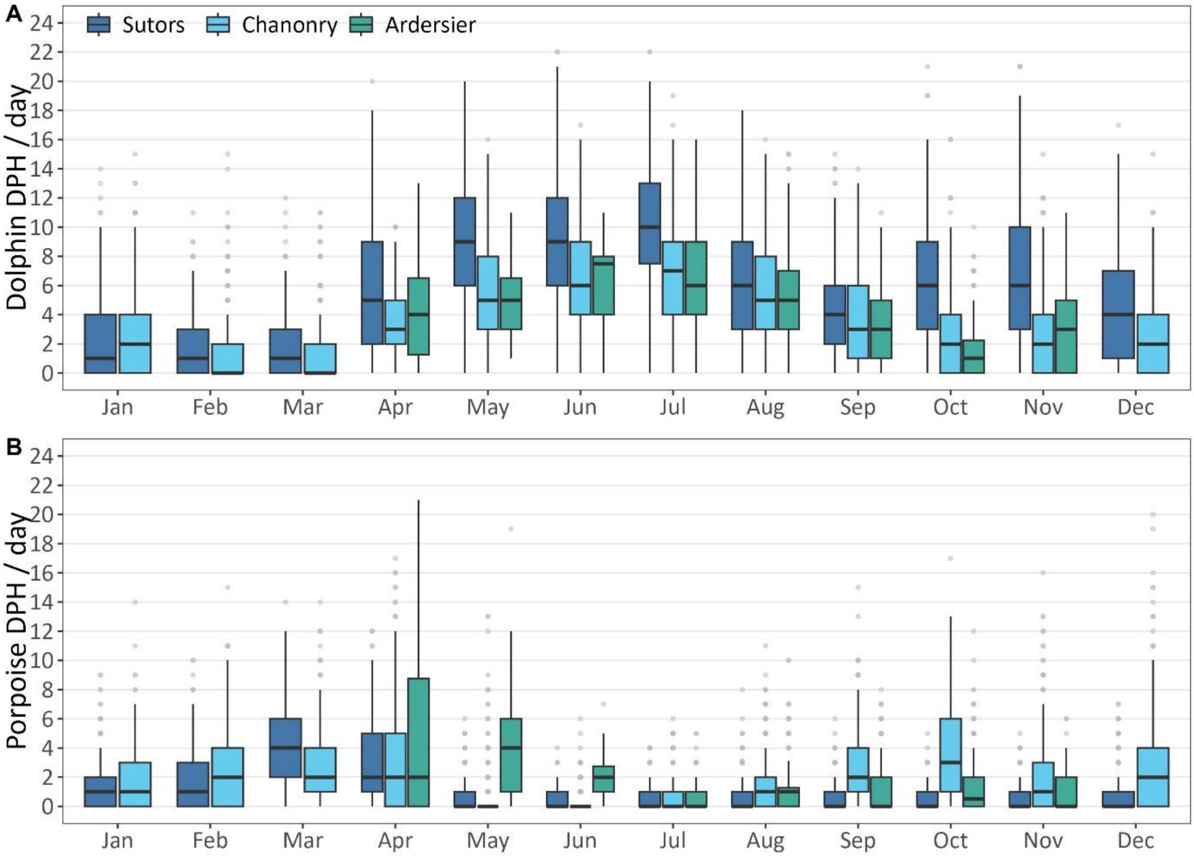

Figure S 2 Bottlenose dolphin (A) and harbour porpoise (B) acoustic detection positive hours (DPH) per day summarised per monitoring months and sites at Sutors (dark blue boxplot), Chanonry (light blue boxplot) and Ardersier (teal boxplot), in the inner Moray Firth, NE Scotland. For Sutors and Chanonry sites, data were collected year-round between 2008 and 2024, and for Ardersier, data were collected between April and November from 2009 to 2011 and from 2013 to 2015. Boxplots highlight the median and interquartile range. Outliers are represented by grey dots.

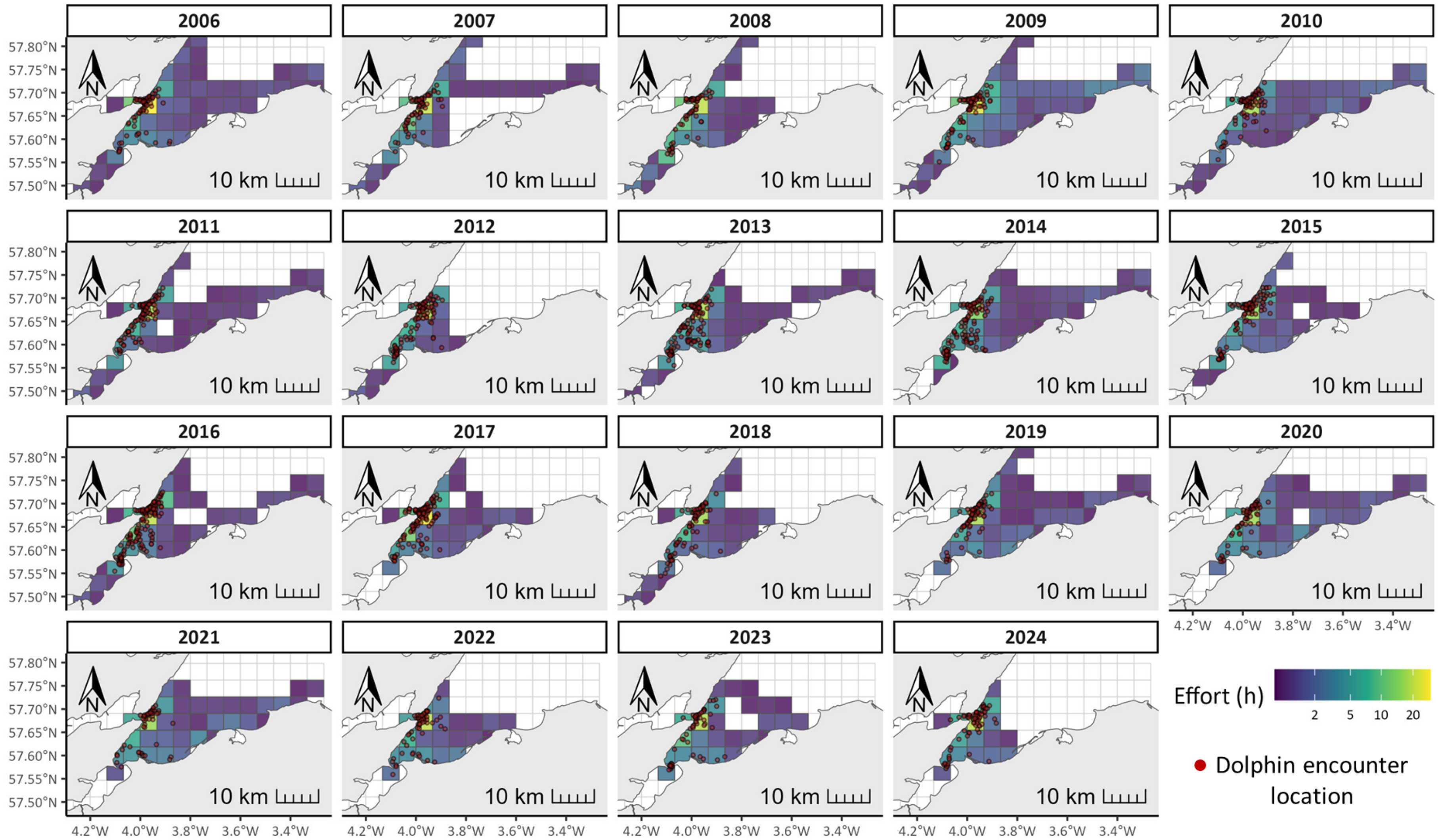

Figure S 3 Mean survey effort (h) per 4 km by 4 km grid cell and bottlenose dolphin encounter locations (red dots) recorded in the inner Moray Firth (NE Scotland) between 2006 and 2024.

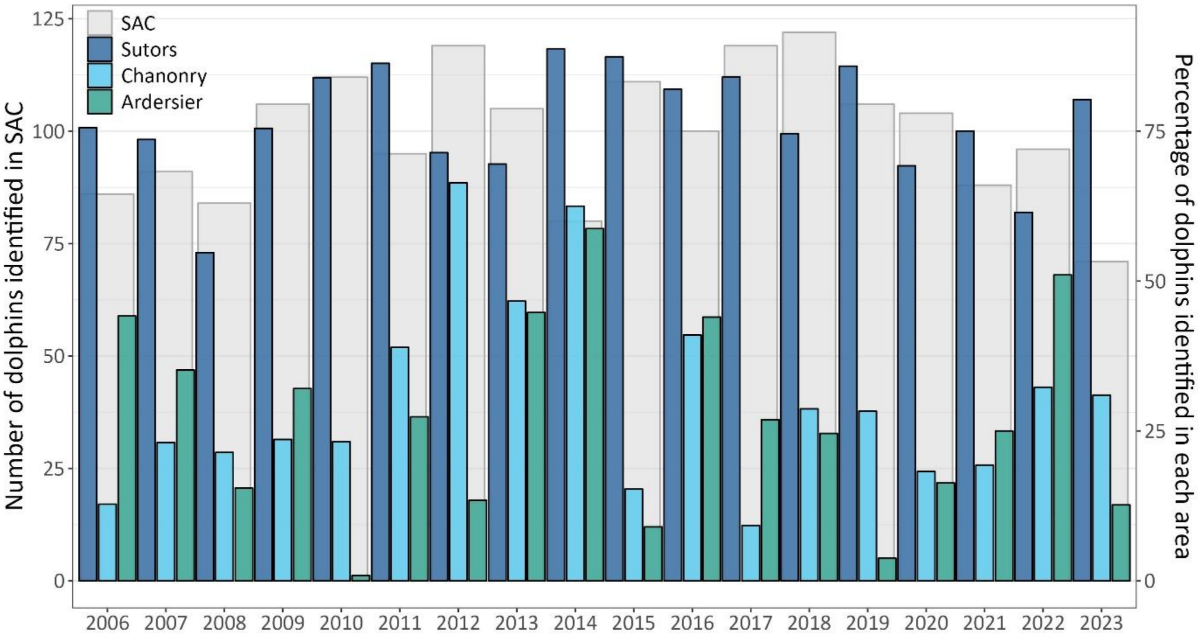

Figure S 4 Number of bottlenose dolphins identified in the Moray Firth Special Area of Conservation (SAC) per year (grey bars). Percentage of bottlenose dolphins identified in each area of interest, Sutors (dark blue), Chanonry (light blue) and Ardersier (teal bars) per year.

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