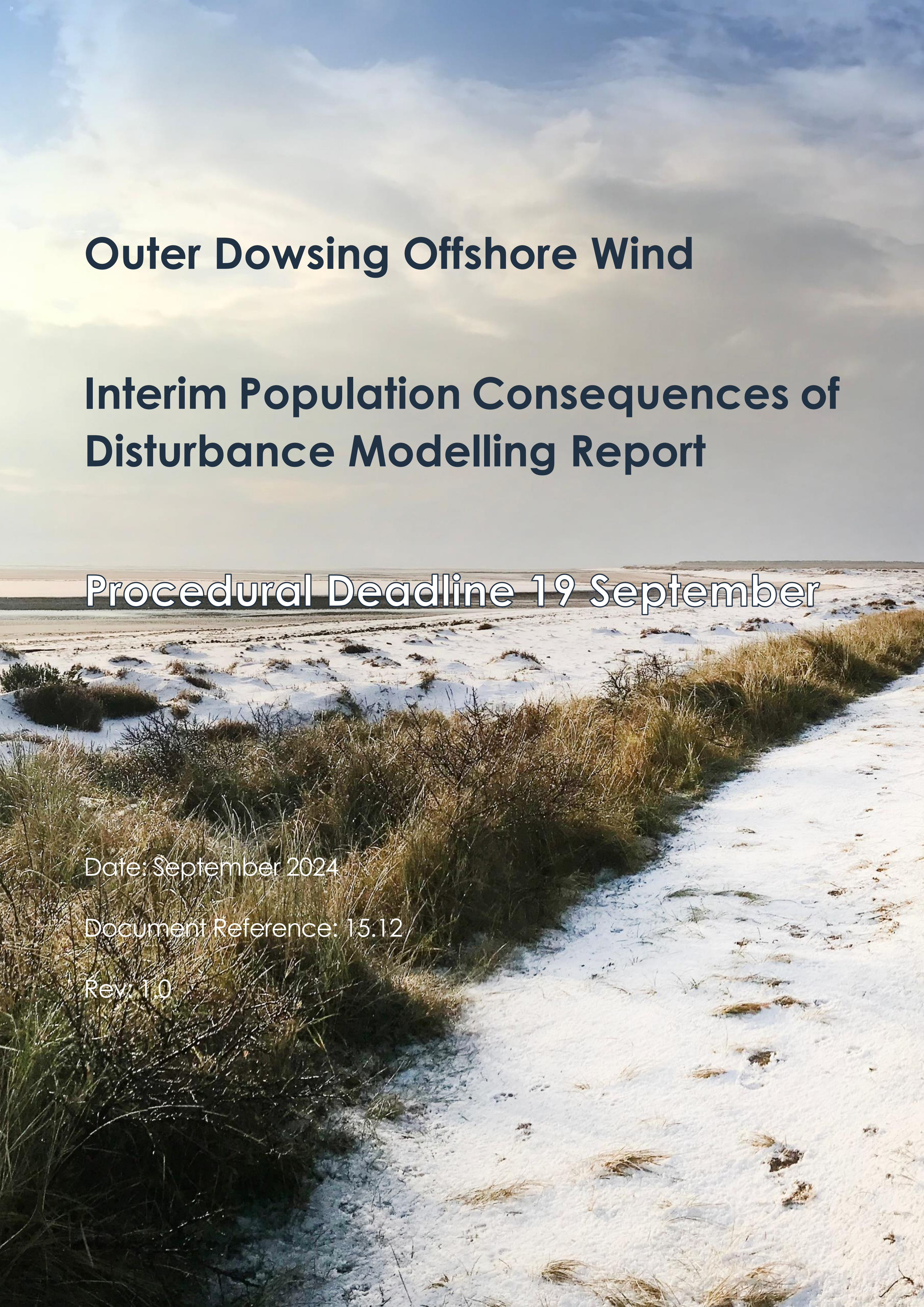

Outer Dowsing Offshore Wind

Interim Population Consequences of Disturbance Modelling Report

Procedural Deadline 19 September

Date: September 2024

Document Reference: 15.12

Rev: 1.0

Company:	**Outer Dowsing Offshore Wind**	Asset:	**Whole Asset**
Project:	**Whole Wind Farm**	Sub Project/Package:	Whole Asset
Document Title or Description:	Interim Population Consequences of Disturbance Modelling Report		
Internal Document Number:	P1-ODOW-DEV-CS-REP-0229	3rd Party Doc No (If applicable):	N/A

Rev No.	**Date**	**Status / Reason for Issue**	**Author**	**Checked by**	**Reviewed by**	**Approved by**
1.0	September 2024	Procedural Deadline 19 September	SMRUC	GoBe	Shepherd & Wedderburn	Outer Dowsing

Executive Summary

Within the Relevant Representation submitted by Natural England, a request was made for the Applicant to undertake a project-alone interim Population Consequences of Disturbance (iPCoD) modelling to aid in informing the impact assessment for marine mammals. This report sets out the methodology and results for the modelling. The modelling has confirmed that there is no potential for disturbance associated with piling activity at Outer Dowsing Offshore Wind (the Project) to affect the population trajectories of any marine mammal species, supporting the conclusions of no significant effects drawn within ES Chapter 11 Marine Mammals (APP-066).

Table of Contents

Table of Tables

Table of Figures

Acronyms & Definitions

Abbreviations / Acronyms

Abbreviation / Acronym	Description
ANS	Artificial Nesting Structure
BND	Bottlenosed Dolphin
ES	Environmental Statement
GS	Grey Seal
HP	Harbour Porpoise
HS	Harbour Seal
iPCoD	interim Population Consequences of Disturbance
MU	Management Unit
MW	Minke Whale
ODOW	Outer Dowsing Offshore Wind (The Project)
PTS	Permanent Threshold Shift
WTG	Wind Turbine Generator

Terminology

Term	Definition
The Applicant	GT R4 Ltd. The Applicant making the application for a DCO. The Applicant is GT R4 Limited (a joint venture between Corio Generation, Total Energies and Gulf Energy Development (GULF)), trading as Outer Dowsing Offshore Wind. The Project is being developed by Corio Generation (a wholly owned Green Investment Group portfolio company), TotalEnergies and GULF.
Array area	The area offshore within which the generating station (including wind turbine generators (WTG) and inter array cables), offshore accommodation platforms, offshore transformer substations and associated cabling will be positioned.
Baseline	The status of the environment at the time of assessment without the development in place.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the sensitivity of the receptor, in accordance with defined significance criteria.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Regulations, including the publication of an Environmental Statement (ES).

Term	Definition
Environmental Statement (ES)	The suite of documents that detail the processes and results of the EIA.
Habitats Regulations Assessment (HRA)	A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European conservation sites and Ramsar sites. The process consists of up to four stages of assessment: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI) and compensatory measures.
Outer Dowsing Offshore Wind (ODOW)	The Project.
The Project	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.
Wind Turbine Generator (WTG)	A structure comprising a tower, rotor with three blades connected at the hub, nacelle and ancillary electrical and other equipment which may include J-tube(s), transition piece, access and rest platforms, access ladders, boat access systems, corrosion protection systems, fenders and maintenance equipment, helicopter landing facilities and other associated equipment, fixed to a foundation

1 Introduction

1.1 Overview

1. This report was produced to address the following Relevant Representations from Natural England (RR-045):
   - RR-045 Comment E1: Natural England strongly advises the average summer density for harbour porpoise (2.63 individuals/km) is used in the impact assessment to reflect the importance of the project area during the summer.
   - RR-045 Comment E2: Natural England advises the Applicant uses population modelling, for example interim Population Consequences of Disturbance (iPCoD), to understand the impacts of the project alone and in combination with other plans and projects at a population level to inform the conclusions of the Environmental Impact Assessment and Habitats Regulations Assessment.
2. This report provides population modelling for disturbance from pile driving for the offshore infrastructure (Wind Turbine Generators (WTG) and Offshore Platforms (Offshore Reactive Compensation Platforms (ORCP), Offshore Platforms and Artificial Nesting Structures (ANS))) at Outer Dowsing Offshore Wind (the Project), using disturbance values presented in the ES Chapter 11 Marine Mammals (APP-066) as well as revised disturbance values as recommended by Natural England.

1.2 Project Background

3. GT R4 Limited (trading as Outer Dowsing Offshore Wind) hereafter referred to as the ‘Applicant’, is proposing to develop the Project. The Applicant submitted an application for a DCO (‘the Application’) for the Project to the Planning Inspectorate in March 2024, which was accepted for Examination in April 2024.
4. The Project array will be located approximately 54km from the Lincolnshire coastline in the southern North Sea. The Project will include both offshore and onshore infrastructure including an offshore generating station (windfarm), export cables to landfall, ORCPs, onshore cables, connection to the electricity transmission network, ancillary and associated development and areas for the delivery of up to two ANS and the creation of a biogenic reef (if these compensation measures are deemed to be required by the Secretary of State) (see ES Chapter 3: Project Description (APP-058) for full details).
5. The maximum design scenario (MDS) for the Project is detailed in ES Chapter 3: Project Description (APP-058), with up to 100 WTG and two ANS structures being piled. All foundation type MDS is provided within the Chapter for piled and non-piled bases, both piled foundation types (monopile and jacket pin-piles) are assessed within this report.

2 Method

6. The iPCoD framework (Harwood *et al.*, 2014, King *et al.*, 2015) was used to predict the potential population consequences of the predicted amount of PTS and disturbance resulting from the piling. The iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults 10 years and older). The model is used to run a number of simulations of future population trajectory with and without the predicted level of impact, to allow an understanding of the potential future population level consequences of predicted behavioural responses and auditory injury.
7. Simulations were run comparing projections of the baseline population (i.e., under current conditions, assuming current estimates of demographic parameters persist into the future) with a series of paired 'impact' scenarios with identical demographic parameters, incorporating a range of estimates for disturbance. Each simulation was repeated 1,000 times and each simulation draws parameter values from a distribution describing the uncertainty in the parameters. This creates 1,000 matched pairs of population trajectories, differing only with respect to the effect of the disturbance and the distributions of the two trajectories can be compared to demonstrate the magnitude of the long-term effect of the predicted impact on the population, as well as demonstrating the uncertainty in predictions.
8. The effects of disturbance on vital rates (survival and reproduction) are currently unknown. Therefore, expert elicitation was used to construct a probability distribution to represent the knowledge and beliefs of a group of experts regarding a specific Quantity of Interest. In this case, the quantity of interest is the effect of disturbance on the probability of survival and fertility in harbour porpoise, harbour seal and grey seals (Booth *et al.*, 2019). The elicitation assumed that the behaviour of the disturbed porpoise would be altered for 6 hours on the day of disturbance, and that no feeding (or nursing) would occur during the 6 hours of disturbance. For seals, the experts assumed that on average, the behaviour of the disturbed seals would be impacted for much less than 24 hours, but did not define an exact duration.

3 iPCoD Model Limitations

3.1 Overview

9. There is a lack of empirical data on the way in which changes in behaviour and hearing sensitivity may affect the ability of individual marine mammals to survive and reproduce. Therefore, in the absence of empirical data, the iPCoD framework uses the results of an expert elicitation process conducted according to the protocol described in Donovan *et al.* (2016) to predict the effects of disturbance and PTS on survival and reproductive rate. The process generates a set of statistical distributions for these effects and then simulations are conducted using values randomly selected from these distributions that represent the opinions of a "virtual" expert. This process is repeated many 100s of times to capture the uncertainty among experts.
10. There are several precautions built into the iPCoD model and this specific scenario that mean that the results are considered to be highly precautionary and likely over-estimate the true population level effects. These include:
    - The fact that the model assumes a minke whales will not forage for 24 hours after being disturbed;
    - The lack of density dependence in the model (meaning the population will not respond to any reduction in population size);
    - The level of environmental and demographic stochasticity in the model; and
    - The estimates of the number of animals disturbed come from noise impact assessments with many levels of precaution.

3.2 Duration of disturbance: minke whales and bottlenose dolphins

11. The iPCoD model for minke whale and bottlenose dolphin disturbance was last updated following the expert elicitation in 2013 (Harwood *et al.*, 2014). When this expert elicitation was conducted, the experts provided responses on the assumption that a disturbed individual would not forage for 24 hours. However, the most recent expert elicitation in 2018 highlighted that this was an unrealistic assumption for harbour porpoises (generally considered to be more responsive than minke whales and bottlenose dolphins), and was amended to assume that disturbance resulted in 6 hours of non-foraging time (Booth *et al.*, 2019). Unfortunately, neither minke whale nor bottlenose dolphins were included in the updated expert elicitation for disturbance, and thus the iPCoD model still assumes 24 hours of non-foraging time for both minke whales and bottlenose dolphins. This is unrealistic considering what we now know about marine mammal behavioural responses to pile driving. A recent study estimated energetic costs associated with disturbance from sonar, where it was assumed that 1 hour of feeding cessation was classified as a mild response, 2 hours of feeding cessation was classified as a strong response and 8 hours of feeding cessation was classified as an extreme response (Czapanskiy *et al.*, 2021). Assuming 24 hours of feeding cessation for both minke whales and bottlenose dolphins in the iPCoD model is significantly beyond that which is considered to be an extreme response, and is therefore considered to be unrealistic and will over-estimate the true disturbance levels expected from the Project.

3.3 Lack of density dependence

12. Density dependence is described as "*the process whereby demographic rates change in response to changes in population density, resulting in an increase in the population growth rate when density decreases and a decrease in that growth rate when density increases*" (Harwood et al., 2014). The iPCoD assumes no density dependence for any of the species available in the model, since there is insufficient data to parameterise this relationship. Essentially, this means that there is no ability for the modelled, impacted population to increase in size and return to carrying capacity following disturbance. It is possible that populations with a positive growth rate (i.e. an increasing population) will continue to increase in the absence of disturbance.
13. At a recent expert elicitation, conducted for the purpose of modelling population impacts of the Deepwater Horizon oil spill (Schwacke *et al.*, 2021), experts agreed that there would likely be a concave density dependence on fertility. That means, for a population which is assumed to be stable (i.e., neither increasing or decreasing), it would be expected that if the impacted population declines, it would later recover to carrying capacity, rather than continuing at a stable trajectory that is smaller than that of the un-impacted population. Note that in the iPCoD model, for stable populations, carrying capacity is assumed to be equal to the size of un-impacted population – i.e., it is assumed the un-impacted population is at carrying capacity.

3.4 Environmental and demographic stochasticity

14. The iPCoD model attempts to model some of the sources of uncertainty inherent in the calculation of the potential effects of disturbance on marine mammal population. This includes demographic stochasticity and environmental variation. Environmental variation is defined as "*the variation in demographic rates among years as a result of changes in environmental conditions*" (Harwood *et al.*, 2014). Demographic stochasticity is defined as "*variation among individuals in their realised vital rates as a result of random processes*" (Harwood *et al.*, 2014).
15. The iPCoD protocol describes this in further detail: "*Demographic stochasticity is caused by the fact that, even if survival and fertility rates are constant, the number of animals in a population that die and give birth will vary from year to year because of chance events. Demographic stochasticity has its greatest effect on the dynamics of relatively small populations, and we have incorporated it in models for all situations where the estimated population within an MU is less than 3000 individuals. One consequence of demographic stochasticity is that two otherwise identical populations that experience exactly the same sequence of environmental conditions will follow slightly different trajectories over time. As a result, it is possible for a "lucky" population that experiences disturbance effects to increase, whereas an identical undisturbed but "unlucky" population may decrease*" (Harwood et al., 2014).
16. This is clearly evidenced in the outputs of iPCoD where the un-impacted (baseline) population size varies greatly between iterations, not as a result of disturbance but simply as a result on environmental and demographic stochasticity. In the example provided in Figure 1, after 25 years of simulation, the un-impacted population size varies between 6,692 (lower 2.5%) and 16,516 (upper 97.5%). Thus, the change in population size resulting from the impact of disturbance is significantly smaller than that driven by the environmental and demographic stochasticity in the model.

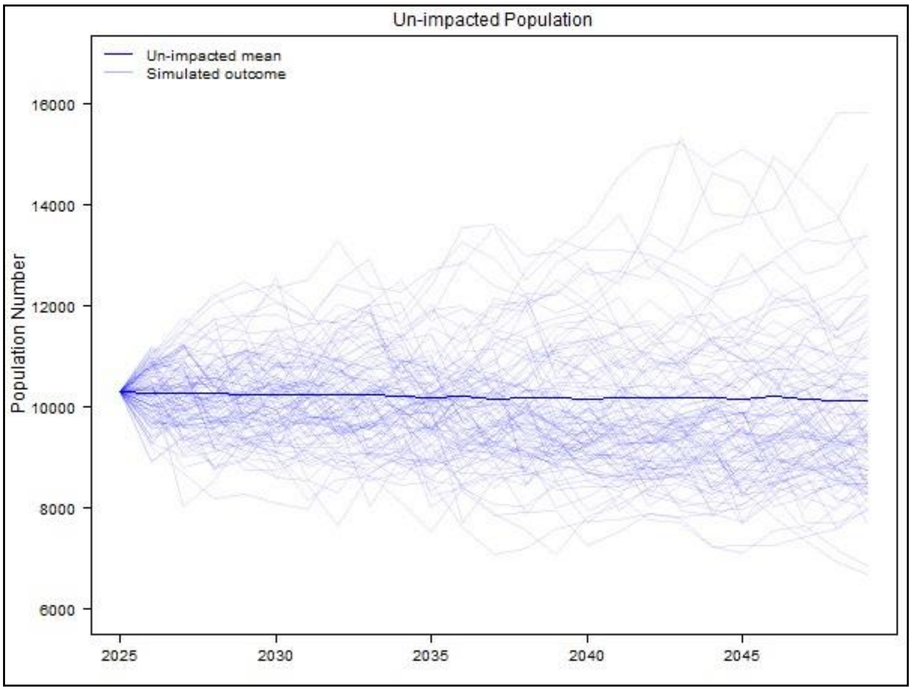

Figure 1: Simulated un-impacted (baseline) population size over the 25 years modelled.

3.5 Summary

17. All of these precautions built into the iPCoD model mean that the results are considered to be highly conservative. Despite these limitations and uncertainties, this assessment has been carried out according to best practice and using the best available scientific information. The information provided is therefore considered to be sufficient to carry out an adequate assessment, though a level of precaution around the results should be taken into account when drawing conclusions.

4 iPCoD inputs

4.1 Piling schedules

18. The Project provided two indicative piling schedules, one for monopiles and one for jacket pin-piles, for piling of the artificial nesting structures (ANS) and wind turbine generators (WTGs) (Table 1). The number of piling days were randomly distributed across each month listed. It should be noted that during the period when the WTG foundations may be installed, up to seven OP foundations may also be installed. The numbers within Table 1 are inclusive of these seven OP foundations.

Table 1: Outer Dowsing indicative piling schedule (number of piling days per month) for monopiles and jackets (ANS and WTG).

Month	Foundation	Monopile	Jacket
Feb	ANS	2	4
Jul	WTGs	4	8
Aug	WTGs	6	12
Sep	WTGs	4	8
Oct	WTGs	0	0
Nov	WTGs	8	15
Dec	WTGs	8	16
Jan	WTGs	4	9
Feb	WTGs	8	16
Mar	WTGs	8	16
Apr	WTGs	9	17
May	WTGs	11	23
Jun	WTGs	12	24
Jul	WTGs	15	29
Aug	WTGs	10	21
Sep	WTGs	0	0
Total		109	218

4.2 Number disturbed

19. The iPCoD model was run using the maximum number of animals disturbed per day by WTG or ANS piling as presented in APP-066. In addition to this, in response to Natural England's relevant representation regarding porpoise density (Natural England Comment E1 from RR-045), porpoise were also assessed using the average summer density from the site-specific surveys (2.63 porpoise/km^2). It is important to note here that while the site-specific density estimate has been used as requested, there is no evidence that the density estimate is valid for impacted areas beyond the boundary of the site-specific surveys (i.e.: most of the disturbance contours).

Table 2: Number of animals predicted to be disturbed per piling day for monopile WTGs and ANS.

Species	MU	Source	WTG monopile	ANS monopile
HP	346,601	ES values	2,012	2,758
		2.63 density	3,989	5,263
BND	2,022	ES values	27	31
MW	20,118	ES values	15	23
HS	4,868	ES values	21	9
GS	65,505	ES values	342	724

Table 3: Number of animals predicted to be disturbed per piling day for jacket WTGs and ANS.

Species	MU	Source	WTG Jacket	ANS jacket
HP	346,601	ES values	1,799	2,720
		2.63 density	3,567	5,190
BND	2,022	ES values	23	30
MW	20,118	ES values	13	22
HS	4,868	ES values	18	9
GS	65,505	ES values	291	709

4.3 Demographic parameters

20. The MU specific demographic parameters used in the iPCoD modelling were obtained from Sinclair *et al.* (2020) and are summarised in Table 4. In Sinclair *et al.* (2020) the southeast England harbour seal MU was modelled to be stable, however, recent counts show that this population is now in decline (SCOS, 2023). Therefore, both a stable and a declining population has been modelled.

Table 4: Demographic parameters used in the iPCoD modelling from Sinclair *et al.* (2020).

	Harbour porpoise	Bottlenose dolphin	Minke whale	Harbour seal		Grey seal
Trend	Stable	Stable	Stable	Stable	Declining[1]	Increasing
Calf/pup survival	0.8455	0.86	0.7	0.4	0.24	0.222
Juvenile survival	0.85	0.94	0.77	0.78	0.86	0.94
Adult survival	0.925	0.94	0.96	0.92	0.8	0.94
Fertility	0.34	0.25	0.91	0.85	0.9	0.84
Age at independence	1	2	1	1	1	1
Age at first birth	5	9	9	4	4	6

[1] Using demographic parameters for the declining North Coast and Orkney harbour seal MU in the absence of declining parameters specific to the southeast England MU

5 Results

5.1 Harbour porpoise

21. Table 5, Figure 2 and Figure 3 show the results for the iPCoD simulations for harbour porpoise using the ES disturbance values. The counter-factual metric indicates that the impacted population size remains at 99.7-99.9% of the unimpacted population size, and the population continues on a stable trajectory. **Therefore, disturbance from piling at the Project will not result in a population level effect.**

Table 5: Results of the harbour porpoise iPCoD simulations using the disturbance values from the ES chapter.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	346,602	346,602	100.00%
End year 1 piling	346,964	346,962	100.00%
End year 2 piling	346,849	346,752	99.97%
1 year after pilings ends	346,661	346,542	99.97%
6 years after piling ends	346,789	346,701	99.97%
12 years after piling ends	347,267	347,179	99.97%
18 years after piling ends	347,337	347,248	99.97%
Monopiles			
Before piling	346,602	346,602	100.00%
End Year 1 piling	346,236	346,234	100.00%
End year 2 piling	346,149	346,103	99.99%
1 year after pilings ends	346,530	346,467	99.98%
6 years after piling ends	346,048	346,003	99.99%
12 years after piling ends	348,120	348,075	99.99%
18 years after piling ends	347,720	347,674	99.99%

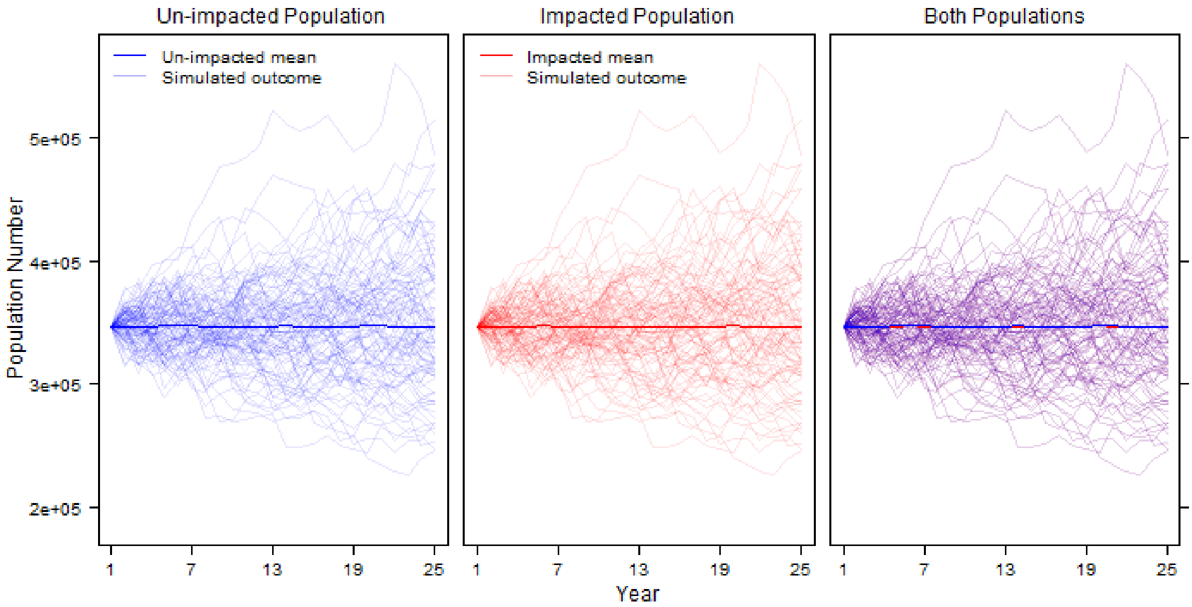

Figure 2: Results of the harbour porpoise iPCoD simulations for jacket foundations using the ES disturbance values.

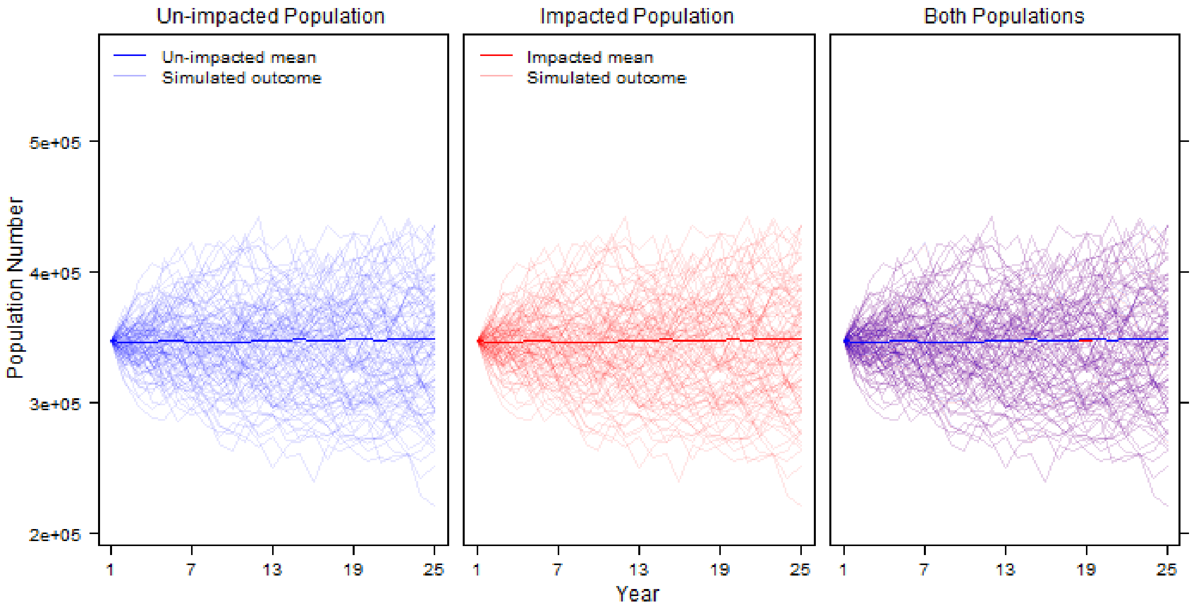

Figure 3: Results of the harbour porpoise iPCoD simulations for monopile foundations using the ES disturbance values.

22. Table 6, Figure 4 and Figure 5 show the results for the iPCoD simulations for harbour porpoise using the new disturbance values (using the average summer site specific density of 2.63 porpoise/km^2). The counter-factual metric indicates that the impacted population size remains at 99.1-99.7% of the unimpacted population size, and the population continues on a stable trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 6: Results of the harbour porpoise iPCoD simulations using the new disturbance values (based on site-specific density estimates).

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	346,602	346,602	100.00%
End Year 1 piling	345,993	345,988	100.00%
End year 2 piling	346,242	346,004	99.93%
1 year after pilings ends	346,920	346,615	99.91%
6 years after piling ends	347,060	346,839	99.94%
12 years after piling ends	348,453	348,229	99.94%
18 years after piling ends	347,592	347,368	99.94%
Monopiles			
Before piling	346,602	346,602	100.00%
End Year 1 piling	346,728	346,725	100.00%
End year 2 piling	346,796	346,671	99.96%
1 year after pilings ends	346,399	346,250	99.96%
6 years after piling ends	346,203	346,093	99.97%
12 years after piling ends	344,786	344,676	99.97%
18 years after piling ends	344,828	344,718	99.97%

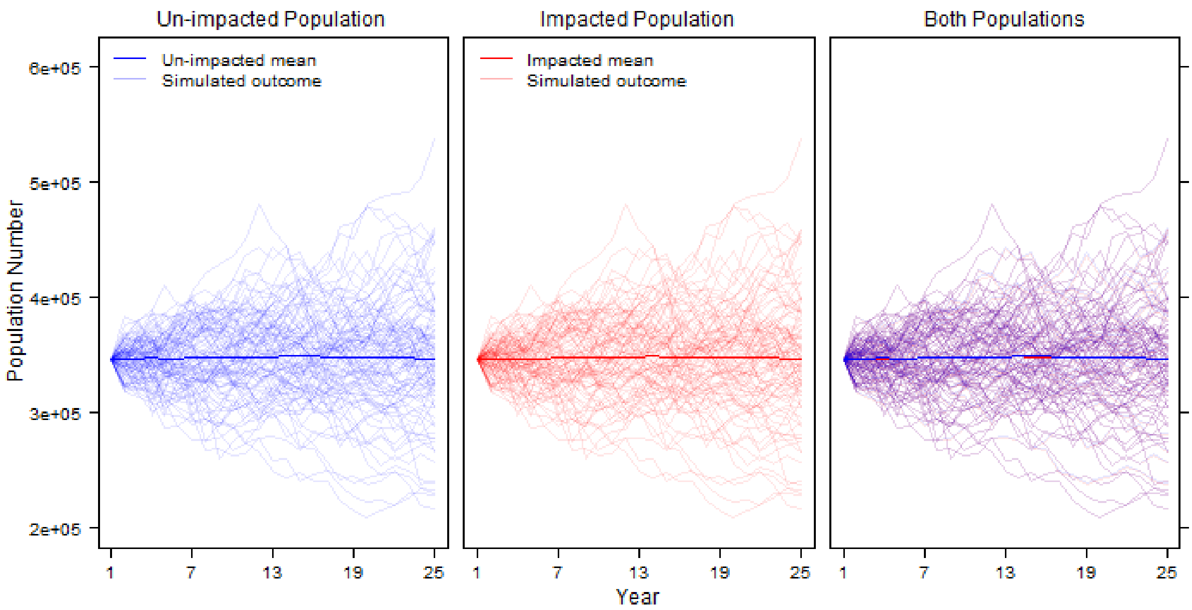

Figure 4: Results of the harbour porpoise iPCoD simulations for jacket foundations using the new disturbance values.

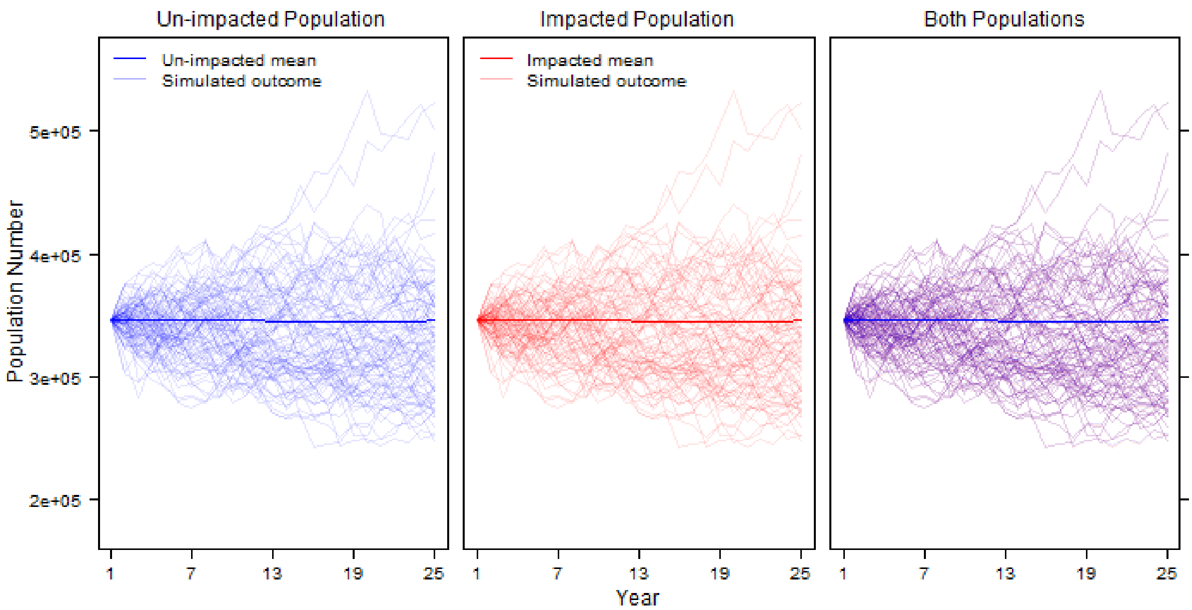

Figure 5: Results of the harbour porpoise iPCoD simulations for monopile foundations using the new disturbance values.

5.2 Bottlenose dolphin

23. Table 7, Figure 6 and Figure 7 show the results for the iPCoD simulations for bottlenose dolphins. The counter-factual metric indicates that the impacted population size remains at 99.85-100.00% of the unimpacted population size, and the population continues on a stable trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 7: Results of the bottlenose dolphin iPCoD simulations.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	2,024	2,024	100.00%
End Year 1 piling	2,025	2,025	100.00%
End year 2 piling	2,027	2,024	99.85%
1 year after pilings ends	2,024	2,021	99.85%
6 years after piling ends	2,032	2,029	99.85%
12 years after piling ends	2,032	2,030	99.90%
18 years after piling ends	2,036	2,034	99.90%
Monopiles			
Before piling	2,024	2,024	100.00%
End Year 1 piling	2,023	2,023	100.00%
End year 2 piling	2,024	2,023	99.95%
1 year after pilings ends	2,025	2,024	99.95%
6 years after piling ends	2,015	2,015	100.00%
12 years after piling ends	2,018	2,017	99.95%
18 years after piling ends	2,014	2,013	99.95%

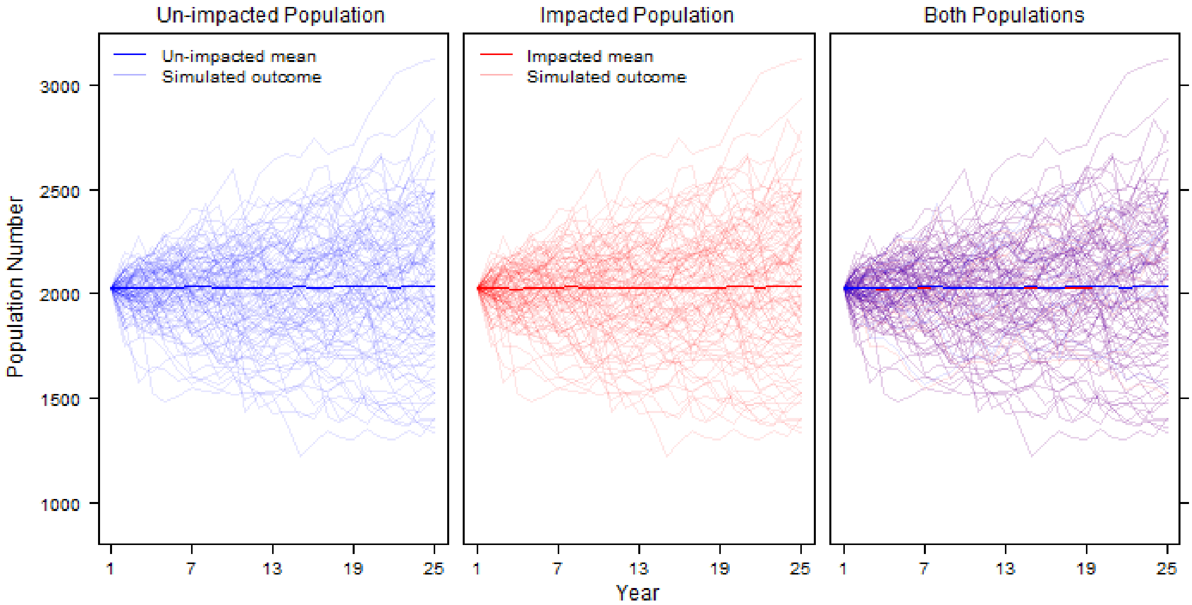

Figure 6: Results of the bottlenose dolphin iPCoD simulations for jacket foundations.

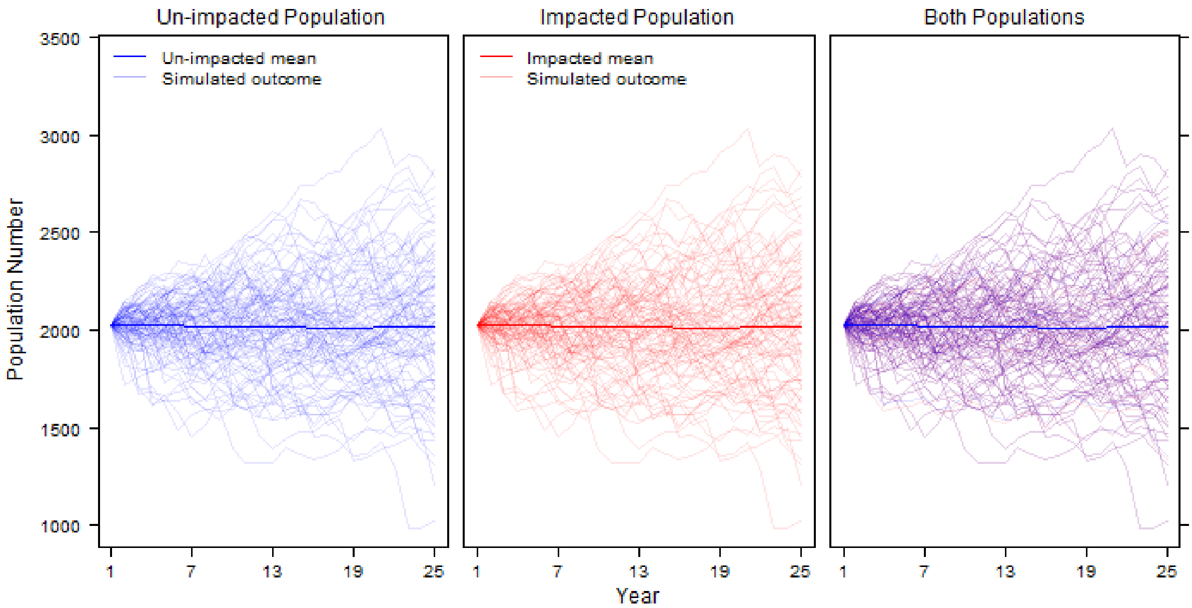

Figure 7: Results of the bottlenose dolphin iPCoD simulations for monopile foundations.

5.3 Minke whale

24. Table 8, Figure 8 and Figure 9 show the results for the iPCoD simulations for minke whales. The counter-factual metric indicates that the impacted population size remains at 100% of the unimpacted population size, and the population continues on a stable trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 8: Results of the minke whale iPCoD simulations.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	20,120	20,120	100%
End Year 1 piling	20,128	20,128	100%
End year 2 piling	20,140	20,140	100%
1 year after pilings ends	20,125	20,125	100%
6 years after piling ends	20,036	20,036	100%
12 years after piling ends	20,038	20,038	100%
18 years after piling ends	19,943	19,943	100%
Monopiles			
Before piling	20,120	20,120	100%
End Year 1 piling	20,105	20,105	100%
End year 2 piling	20,042	20,042	100%
1 year after pilings ends	20,094	20,094	100%
6 years after piling ends	20,097	20,097	100%
12 years after piling ends	20,067	20,067	100%
18 years after piling ends	20,092	20,092	100%

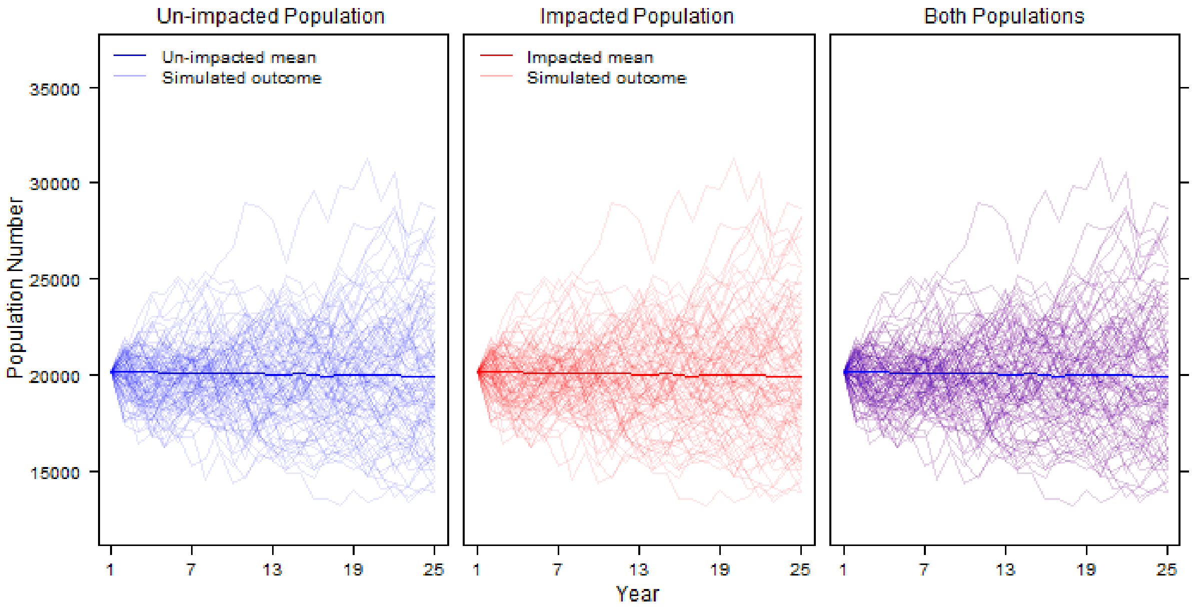

Figure 8: Results of the minke whale iPCoD simulations for jacket foundations.

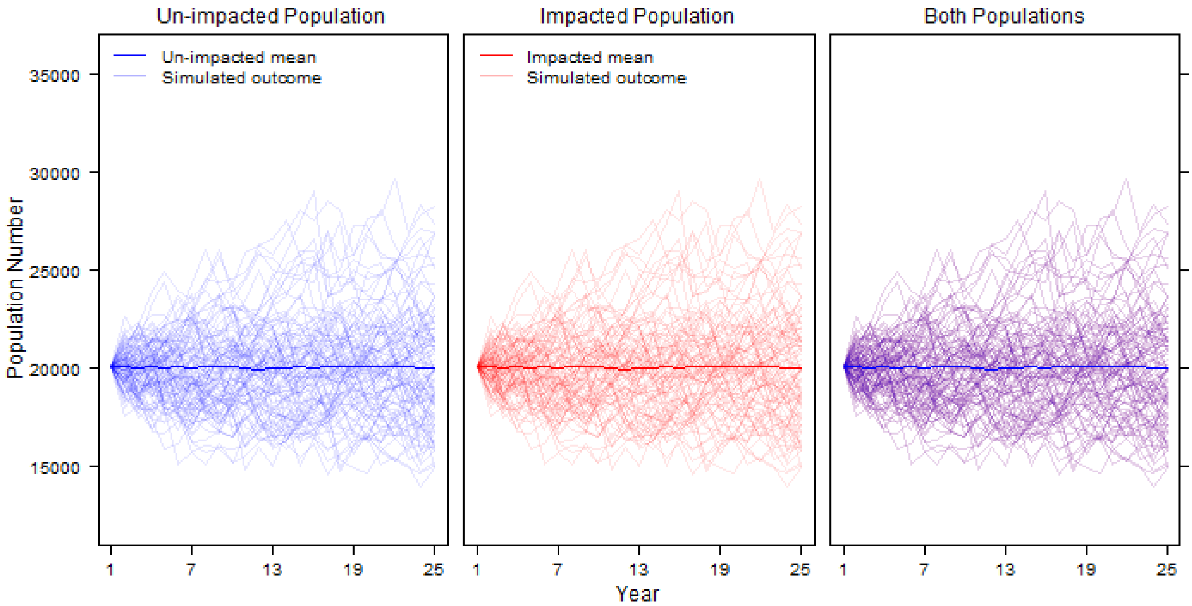

Figure 9: Results of the minke whale iPCoD simulations for monopile foundations.

5.4 Harbour seal

25. Table 9, Figure 10 and Figure 11 show the results for the iPCoD simulations for harbour seals assuming a stable population. The counter-factual metric indicates that the impacted population size remains at 100% of the unimpacted population size, and the population continues on a stable trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 9: Results of the harbour seal iPCoD simulations assuming a stable population.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	4,866	4,866	100%
End Year 1 piling	4,855	4,855	100%
End year 2 piling	4,862	4,862	100%
1 year after pilings ends	4,854	4,854	100%
6 years after piling ends	4,870	4,870	100%
12 years after piling ends	4,910	4,910	100%
18 years after piling ends	4,929	4,929	100%
Monopiles			
Before piling	4,866	4,866	100%
End Year 1 piling	4,870	4,870	100%
End year 2 piling	4,870	4,870	100%
1 year after pilings ends	4,869	4,869	100%
6 years after piling ends	4,857	4,857	100%
12 years after piling ends	4,869	4,869	100%
18 years after piling ends	4,900	4,900	100%

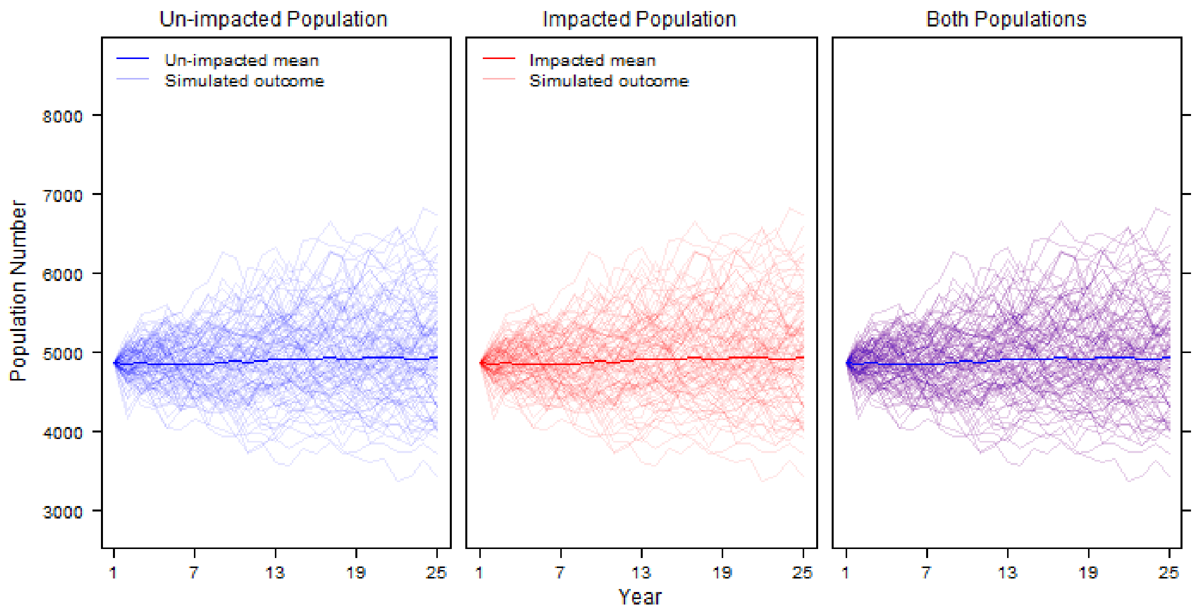

Figure 10: Results of the harbour seal iPCoD simulations for jacket foundations, assuming a stable population.

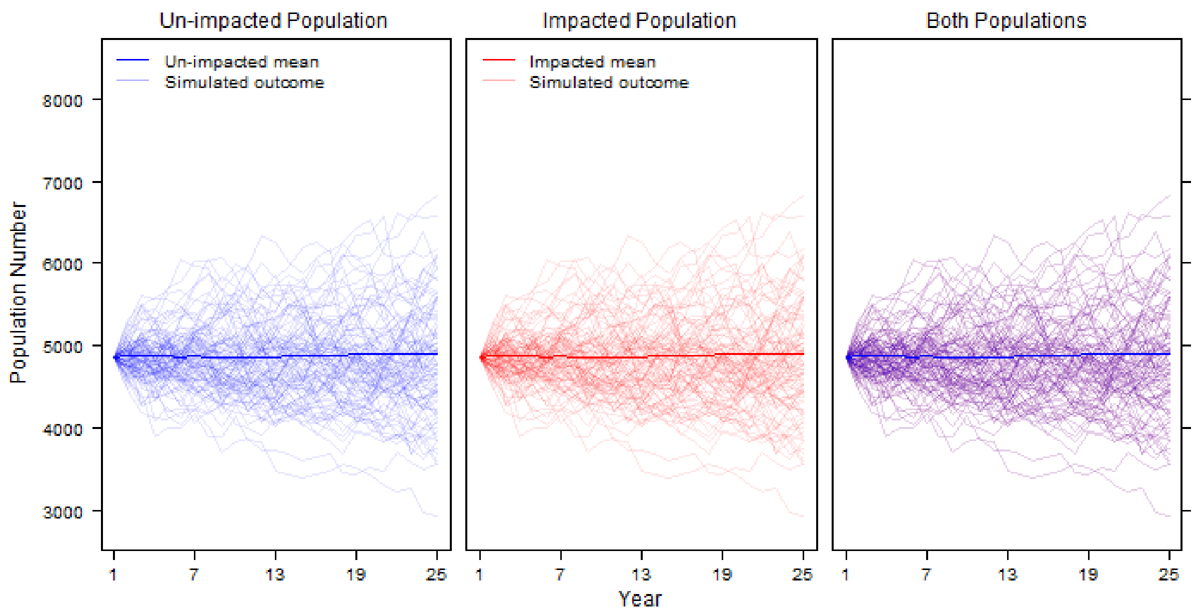

Figure 11: Results of the harbour seal iPCoD simulations for monopile foundations, assuming a stable population.

26. Because the southeast England MU has shown a decline in recent years, the modelling was also conducted assuming a declining harbour seal population. Table 10, Figure 12 and Figure 13 show the results for the iPCoD simulations for harbour seals assuming a declining population. The counter-factual metric indicates that the impacted population size remains at 100% of the unimpacted population size, and the population continues on the same declining trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 10: Results of the harbour seal iPCoD simulations assuming a declining population.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	4,868	4,868	100%
End Year 1 piling	4,365	4,365	100%
End year 2 piling	3,908	3,908	100%
1 year after pilings ends	3,515	3,515	100%
6 years after piling ends	2,022	2,022	100%
12 years after piling ends	1,037	1,037	100%
18 years after piling ends	534	534	100%
Monopiles			
Before piling	4,868	4,868	100%
End Year 1 piling	4,360	4,360	100%
End year 2 piling	3,904	3,904	100%
1 year after pilings ends	3,501	3,501	100%
6 years after piling ends	2,012	2,012	100%
12 years after piling ends	1,040	1,040	100%
18 years after piling ends	533	533	100%

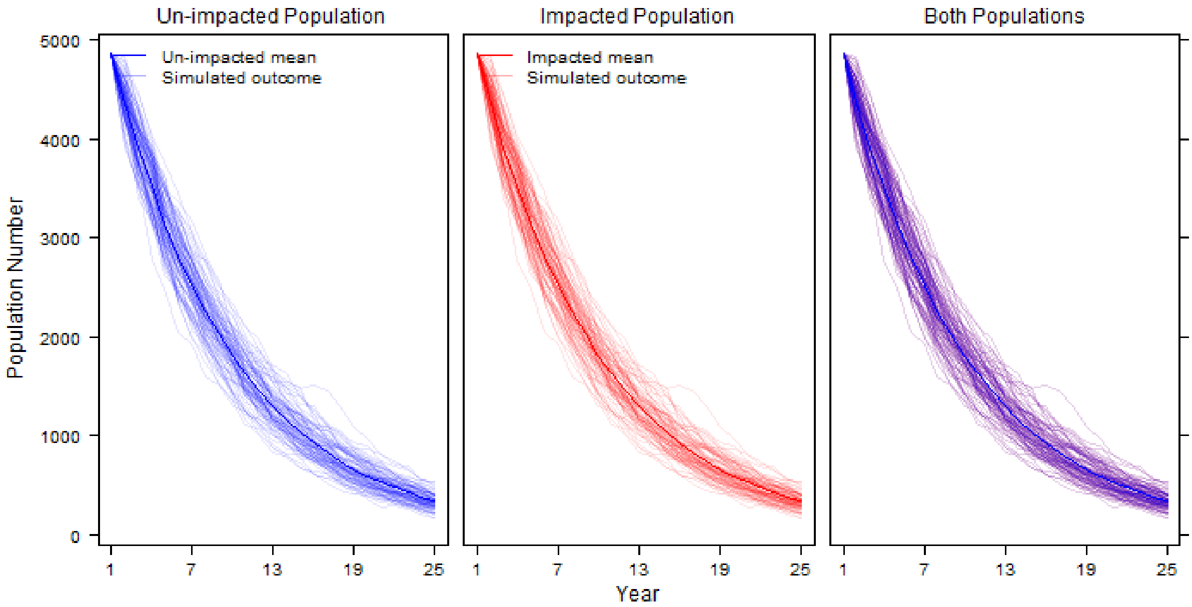

Figure 12: Results of the harbour seal iPCoD simulations for jacket foundations, assuming a declining population.

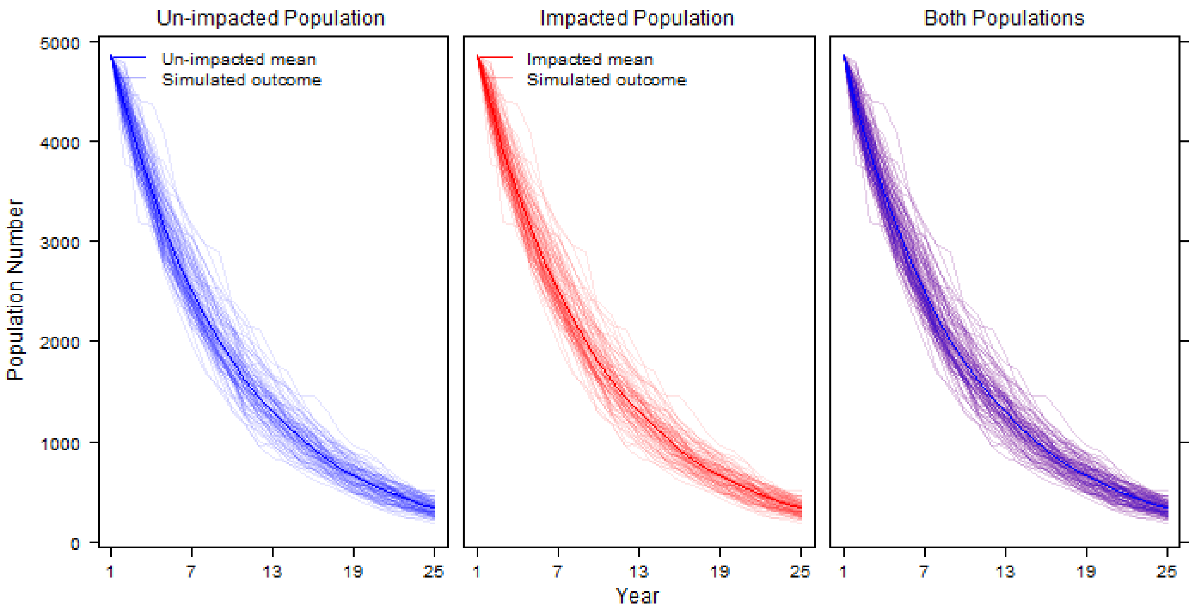

Figure 13: Results of the harbour seal iPCoD simulations for monopile foundations, assuming a declining population.

5.5 Grey seal

27. Table 11, Figure 14 and Figure 15 show the results for the iPCoD simulations for grey seals. The counter-factual metric indicates that the impacted population size remains at 100% of the unimpacted population size, and the population continues on the same increasing trajectory. **Therefore, disturbance from piling at ODOW will not result in a population level effect.**

Table 11: Results of the grey seal iPCoD simulations.

	Mean un-impacted population size	Mean impacted population size	Impacted as % of un-impacted population size
Jackets			
Before piling	10,788	10,788	100%
End Year 1 piling	10,866	10,866	100%
End year 2 piling	10,912	10,912	100%
1 year after pilings ends	10,996	10,996	100%
6 years after piling ends	11,364	11,364	100%
12 years after piling ends	11,858	11,858	100%
18 years after piling ends	12,275	12,275	100%
Monopiles			
Before piling	10,788	10,788	100%
End Year 1 piling	10,868	10,868	100%
End year 2 piling	10,937	10,937	100%
1 year after pilings ends	11,020	11,020	100%
6 years after piling ends	11,354	11,354	100%
12 years after piling ends	11,820	11,820	100%
18 years after piling ends	12,238	12,238	100%

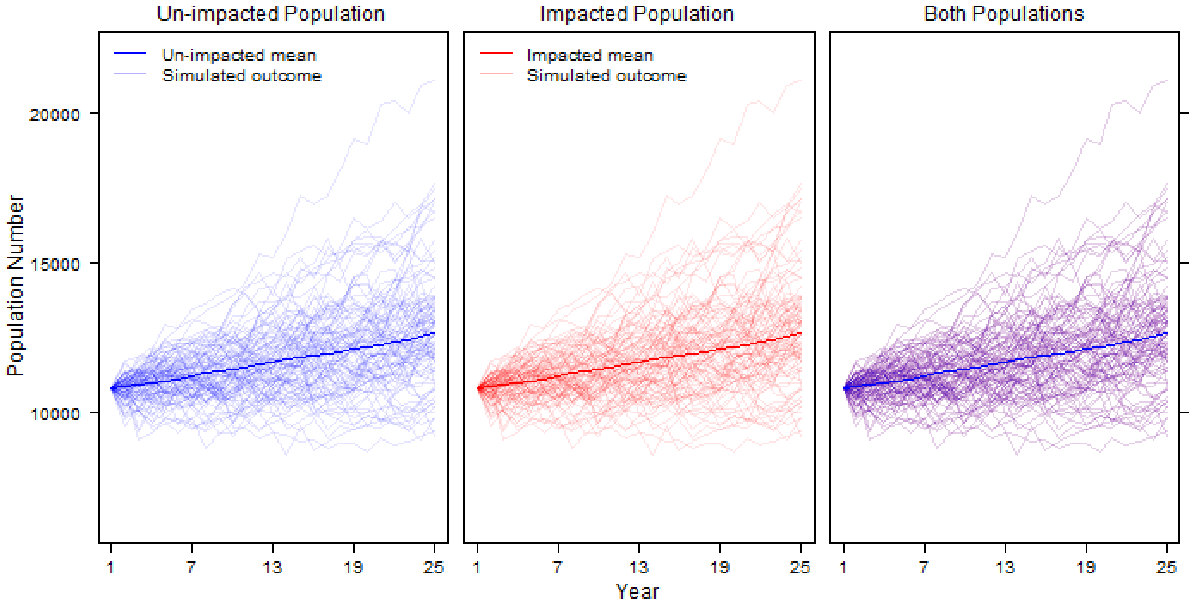

Figure 14: Results of the grey seal iPCoD simulations for jacket foundations.

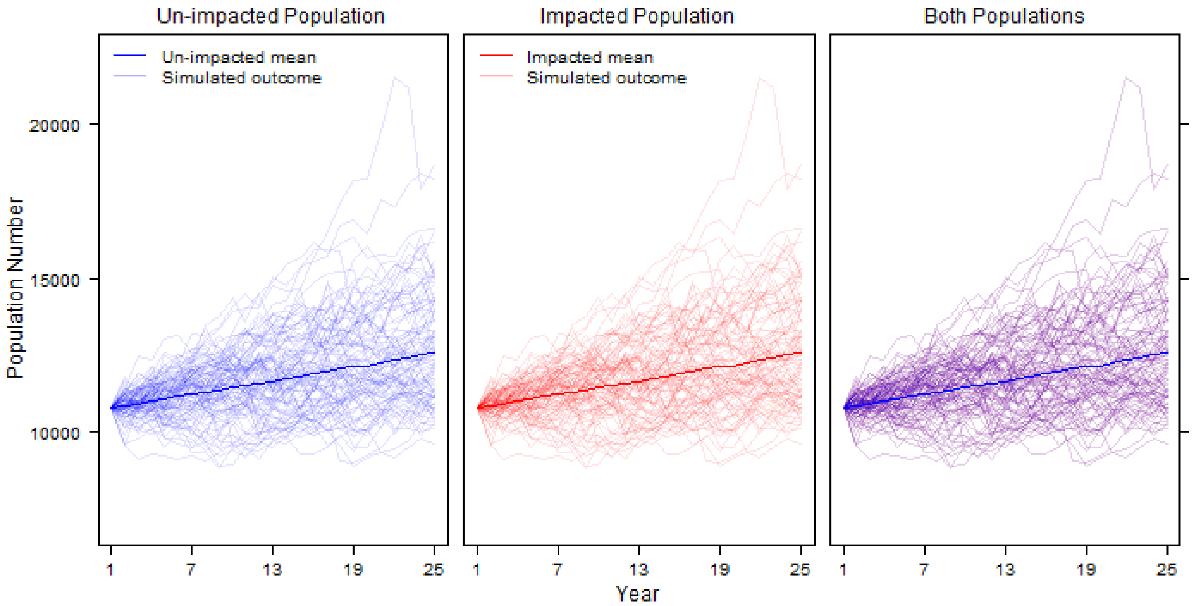

Figure 15: Results of the grey seal iPCoD simulations for monopile foundations.

6 Conclusion

28. The iPCoD modelling shows that for disturbance from piling of ANS and WTGs at the Project, the magnitude score is Low for all species, whereby there is short-term and/or intermittent and temporary behavioural effects in a small proportion of the population, where survival and reproductive rates are very unlikely to be impacted to the extent that the population trajectory would be altered. This aligns with the magnitude scores assigned in the ES chapter (APP-066) (Table 12).

Table 12: Magnitude score assigned in the ES chapter (APP-066) compared to those assigned given the iPCoD modelling.

Species	Magnitude conclusion in ES	Magnitude conclusion from iPCoD
Harbour porpoise	Low	Low – no population level impact
Bottlenose dolphin	Low	Low – no population level impact
Minke whale	Low	Low – no population level impact
Harbour seal	Low	Low – no population level impact
Grey seal	Low	Low – no population level impact

7 References

Booth, C. G., F. Heinis, and H. J. (2019). Updating the Interim PCoD Model: Workshop Report - New transfer functions for the effects of disturbance on vital rates in marine mammal species. Report Code SMRUC-BEI-2018-011, submitted to the Department for Business, Energy and Industrial Strategy (BEIS), February 2019 (unpublished).

Czapanskiy, M. F., M. S. Savoca, W. T. Gough, P. S. Segre, D. M. Wisniewska, D. E. Cade, and J. A. Goldbogen. (2021). Modelling short-term energetic costs of sonar disturbance to cetaceans using high-resolution foraging data. Journal of Applied Ecology **58**:1643-1657.

Donovan, C., J. Harwood, S. King, C. Booth, B. Caneco, and C. Walker. (2016). Expert elicitation methods in quantifying the consequences of acoustic disturbance from offshore renewable energy developments. Advances in Experimental Medicine and Biology.

Harwood, J., S. King, R. Schick, C. Donovan, and C. Booth. (2014). A protocol for Implementing the Interim Population Consequences of Disturbance (PCoD) approach: Quantifying and assessing the effects of UK offshore renewable energy developments on marine mammal populations. Report Number SMRUL-TCE-2013-014. Scottish Marine And Freshwater Science, 5(2).

King, S. L., R. S. Schick, C. Donovan, C. G. Booth, M. Burgman, L. Thomas, and J. Harwood. (2015). An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution **6**:1150-1158.

Schwacke, L. H., T. A. Marques, L. Thomas, C. Booth, B. C. Balmer, A. Barratclough, K. Colegrove, S. De Guise, L. P. Garrison, and F. M. Gomez. (2021). Modeling population impacts of the Deepwater Horizon oil spill on a long-lived species with implications and recommendations for future environmental disasters. Conservation Biology.

SCOS. (2023). Scientific Advice on Matters Related to the Management of Seal Populations: 2022.

Sinclair, R., J. Harwood, and C. Sparling. (2020). Review of demographic parameters and sensitivity analysis to inform inputs and outputs of population consequences of disturbance assessments for marine mammals. **11**:74.