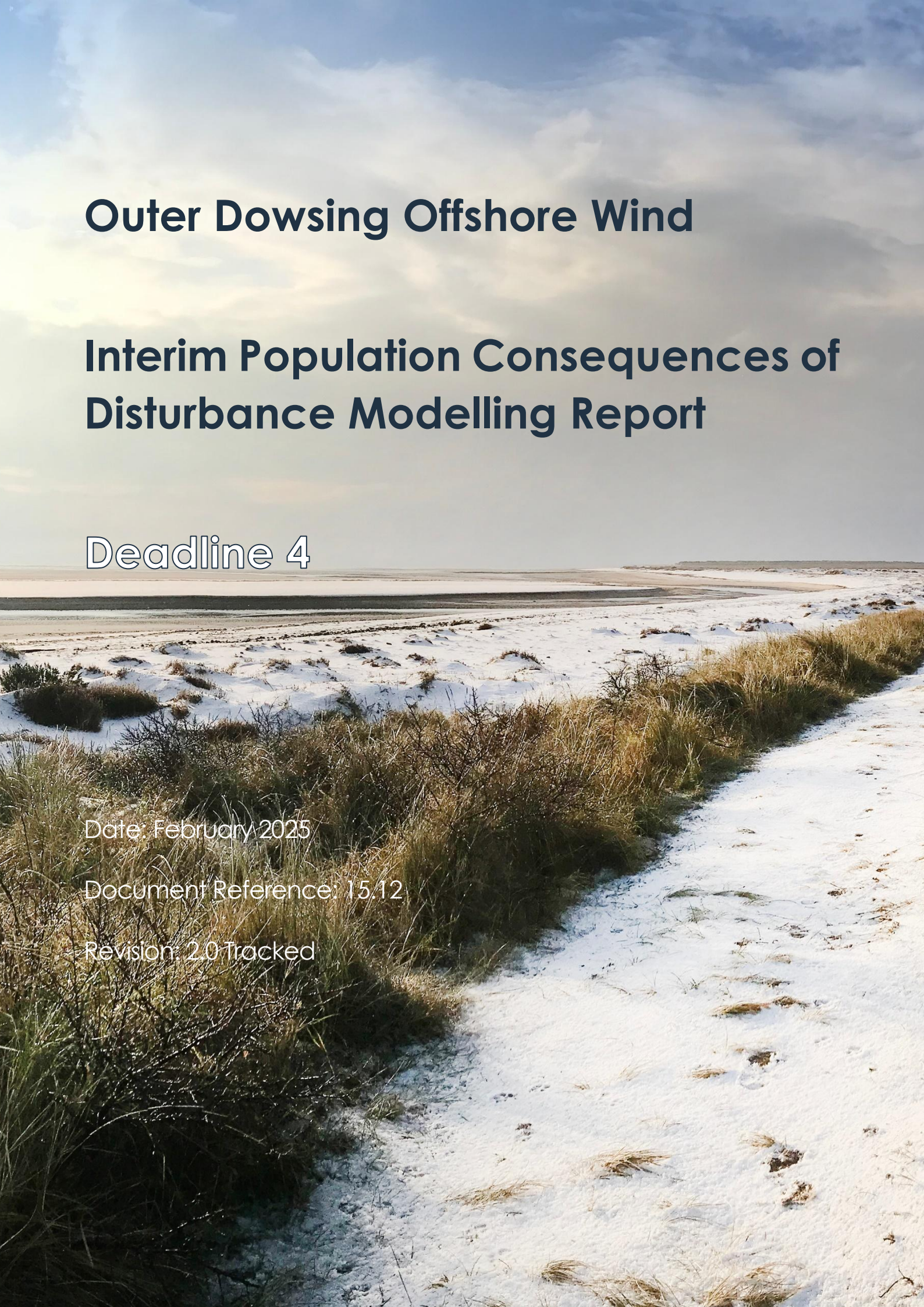
Outer Dowsing Offshore Wind

Interim Population Consequences of Disturbance Modelling Report

Deadline 4



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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).

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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.

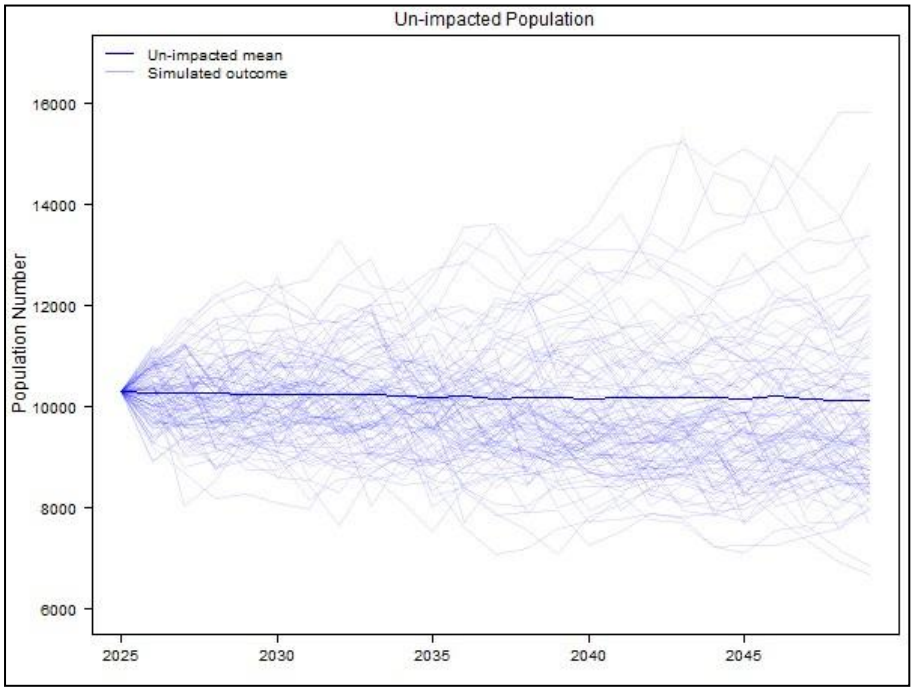

Figure 1: Simulated un-impacted (baseline) population size over the 25 years modelled.

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					Median		
	~~Mean u~~Un-impacted population size	95% CIs	~~Mean~~ Impacted population size	95% CIs	Impacted as % of un-impacted population size	Un-impacted population size	Impacted population size	Impacted as % of un-impacted population size
Jackets								
Before piling	346,602	N/A	346,602	N/A	100.00%	346,602	346,602	100.00%
End year 1 piling	346,964	318,586 373,099	346,962	318,586 373,099	100.00%	347,699	347,699	100.00%
End year 2 piling	346,849	308,638 382,008	346,752	308,461 382,008	99.97%	347,849	347,812	99.99%
1 year after pilings ends	346,661	305,460 386,388	346,542	305,219 386,388	99.97%	346,654	346,539	99.97%
6 years after piling ends	346,789	286,543 411,225	346,701	286,525 411,225	99.97%	344,641	344,417	99.94%
12 years after piling ends	347,267	270,716 441,671	347,179	270,715 441,178	99.97%	344,207	344,087	99.97%
18 years after piling ends	347,337	255,764 460,571	347,248	255,764 460,571	99.97%	343,649	343,610	99.99%
Monopiles								
Before piling	346,602	N/A	346,602	N/A	100.00%	346,602	346,602	100.00%

	Mean					Median		
End Year 1 piling	346,236	318,597 370,580	346,234	318,597 370,568	100.00%	346,516	346,511	100.00%
End year 2 piling	346,149	308,851 379,965	346,103	308,851 379,963	99.99%	347,426	347,426	100.00%
1 year after pilings ends	346,530	304,323 388,104	346,467	304,322 388,103	99.98%	346,492	346,342	99.96%
6 years after piling ends	346,048	286,140 412,420	346,003	286,140 412,363	99.99%	345,087	345,011	99.98%
12 years after piling ends	348,120	272,039 433,751	348,075	271,918 433,313	99.99%	347,836	347,799	99.99%
18 years after piling ends	347,720	256,663 443,940	347,674	256,596 443,040	99.99%	346,385	346,385	100.00%

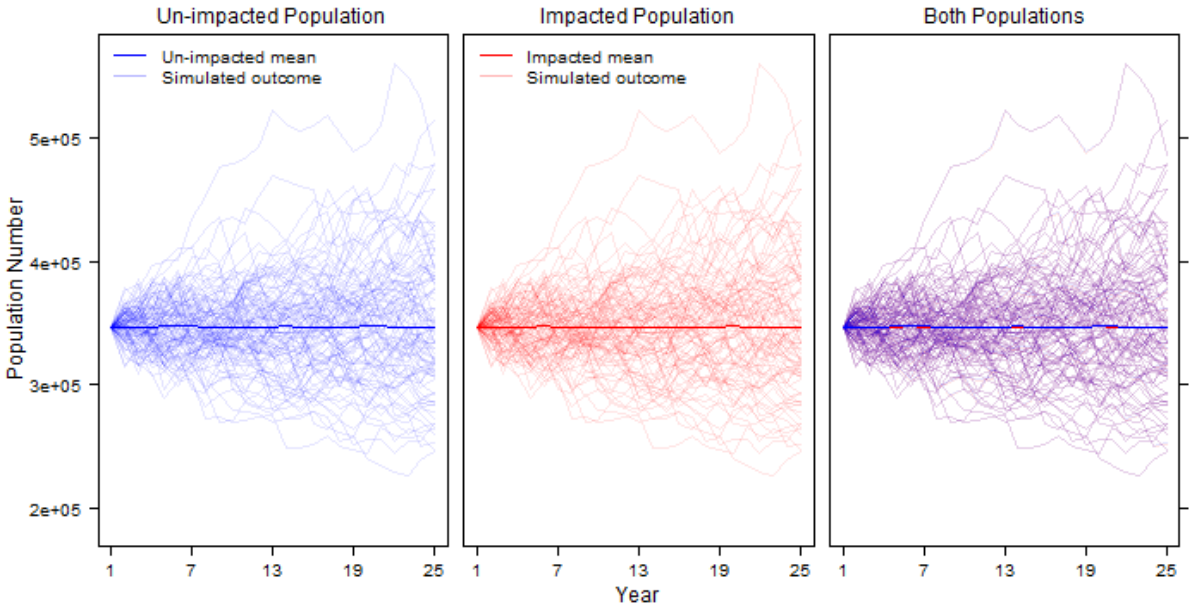

Figure 2: Results of the harbour porpoise iPCoD simulations for jacket foundations using the ES disturbance values.

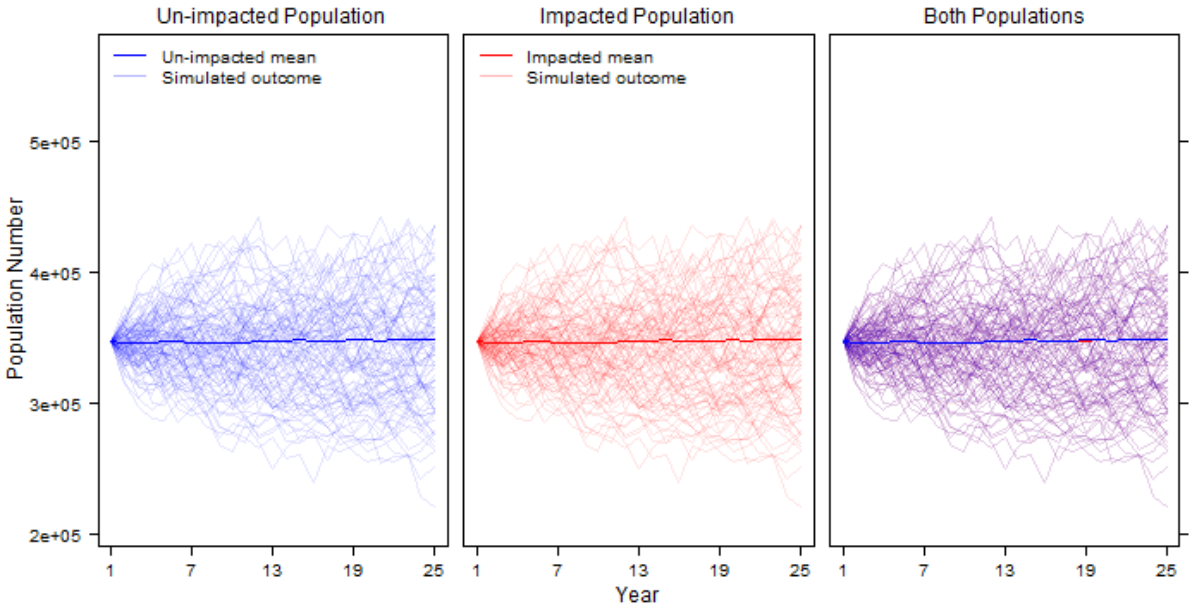

Figure 3: Results of the harbour porpoise iPCoD simulations for monopile foundations using the ES disturbance values.

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 ~~u~~Un-impacted population size	95% CIs	Mean ~~i~~Impacted population size	95% CIs	Impacted as % of un-impacted population size	Median Un-impacted population size	Median Impacted population size	Median Impacted as % of un-impacted population size
Jackets								
Before piling	346,602	N/A	346,602	N/A	100.00%	346,602	346,602	100.00%
End Year 1 piling	345,993	315,426 369,434	345,988	315,426 369,434	100.00%	346,953	346,953	100.00%
End year 2 piling	346,242	309,347 379,209	346,004	309,305 379,090	99.93%	346,464	346,101	99.90%
1 year after pilings ends	346,920	307,362 385,678	346,615	307,170 385,678	99.91%	347,473	346,878	99.83%
6 years after piling ends	347,060	282,456 410,095	346,839	282,445 410,095	99.94%	347,135	346,888	99.93%
12 years after	348,453	272,464 430,372	348,229	271,624 430,372	99.94%	346,173	345,941	99.93%

	Mean					Median		
piling ends								
18 years after piling ends	347,592	255,285 453,363	347,368	255,285 453,363	99.94%	345,091	345,083	100.00%
Monopiles								
Before piling	346,602	N/A	346,602	N/A	100.00%	346,602	346,602	100.00%
End Year 1 piling	346,728	317,968 373,388	346,725	317,968 373,384	100.00%	347,531	347,531	100.00%
End year 2 piling	346,796	309,116 379,559	346,671	309,044 379,559	99.96%	347,335	347,229	99.97%
1 year after pilings ends	346,399	303,468 386,552	346,250	303,455 386,144	99.96%	346,926	346,926	100.00%
6 years after piling ends	346,203	281,342 411,802	346,093	281,341 411,210	99.97%	345,798	345,622	99.95%
12 years after piling ends	344,786	267,725 433,337	344,676	267,609 433,337	99.97%	343,798	343,739	99.98%
18 years after	344,828	255,587 456,581	344,718	255,581 456,581	99.97%	342,758	342,740	99.99%

	Mean					Median		
piling ends								

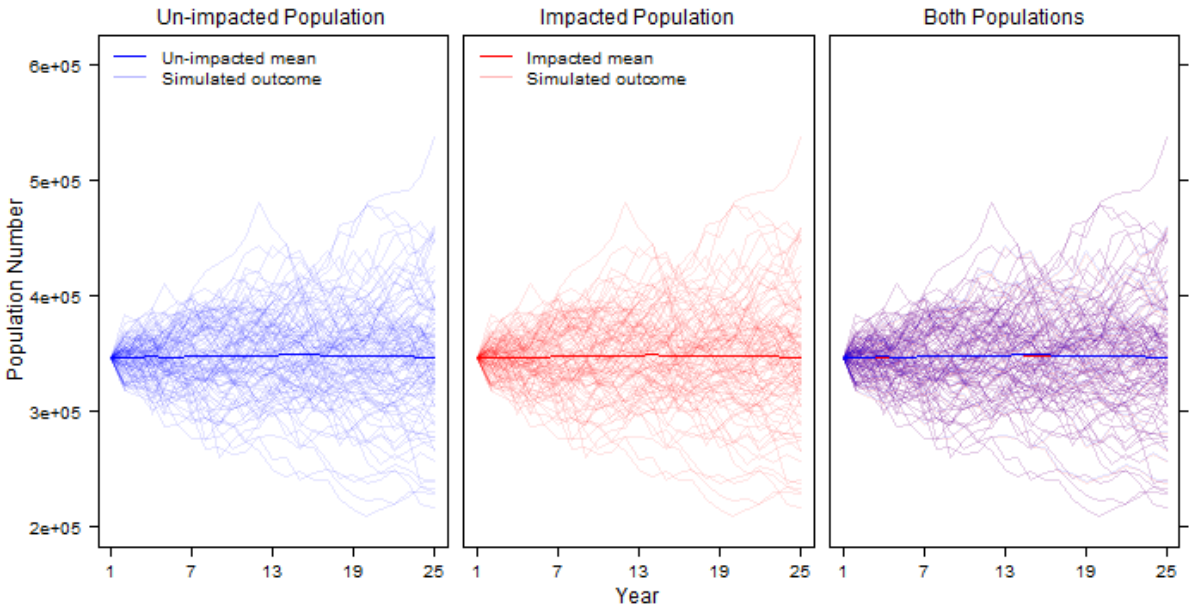

Figure 4: Results of the harbour porpoise iPCoD simulations for jacket foundations using the new disturbance values.

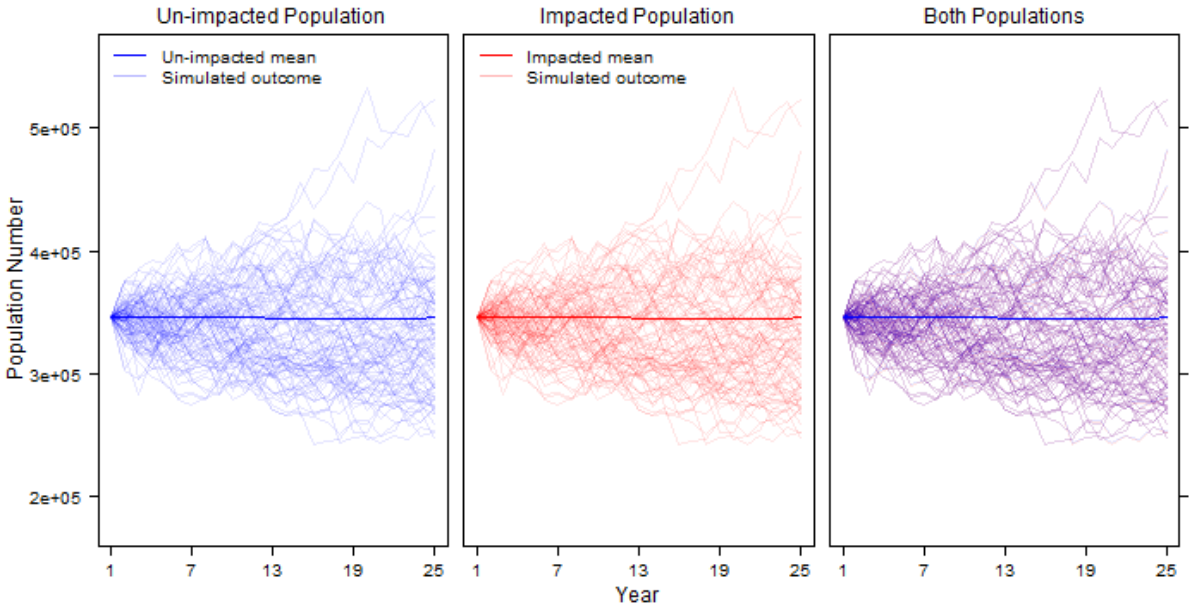

Figure 5: Results of the harbour porpoise iPCoD simulations for monopile foundations using the new disturbance values.

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	95% CIs	Mean ~~Mean~~ Impacted population size	95% CIs	Impacted as % of un-impacted population size	Un-impacted population size	Median Impacted population size	Impacted as % of un-impacted population size
Jackets								
Before piling	2,024	N/A	2,024	N/A	100.00%	2,024	2,024	100.00%
End Year 1 piling	2,025	1,834 2,158	2,025	1,834 2,158	100.00%	2,034	2,034	100.00%
End year 2 piling	2,027	1,784 2,206	2,024	1,784 2,194	99.85%	2,038	2,036	99.90%
1 year after pilings ends	2,024	1,730 2,238	2,021	1,724 2,238	99.85%	2,040	2,038	99.90%
6 years after piling ends	2,032	1,596 2,416	2,029	1,594 2,408	99.85%	2,052	2,049	99.85%
12 years after piling ends	2,032	1,516 2,568	2,030	1,512 2,556	99.90%	2,048	2,046	99.90%

		Mean				Median		
18 years after piling ends	2,036	1,460 2,618	2,034	1,436 2,668	99.90%	2,036	2,034	99.90%
Monopiles								
Before piling	2,024	N/A	2,024	N/A	100.00%	2,024	2,024	100.00%
End Year 1 piling	2,023	1,804 2,152	2,023	1,804 2,152	100.00%	2,034	2,034	100.00%
End year 2 piling	2,024	1,748 2,204	2,023	1,748 2,204	99.95%	2,036	2,036	100.00%
1 year after pilings ends	2,025	1,702 2,246	2,024	1,700 2,246	99.95%	2,038	2,037	99.95%
6 years after piling ends	2,015	1,588 2,378	2,015	1,586 2,376	100.00%	2,028	2,028	100.00%
12 years after piling ends	2,018	1,552 2,470	2,017	1,492 2,546	99.95%	2,026	2,025	99.95%
18 years after piling ends	2,014	1,424 2,580	2,013	1,434 2,650	99.95%	2,001	2,001	100.00%

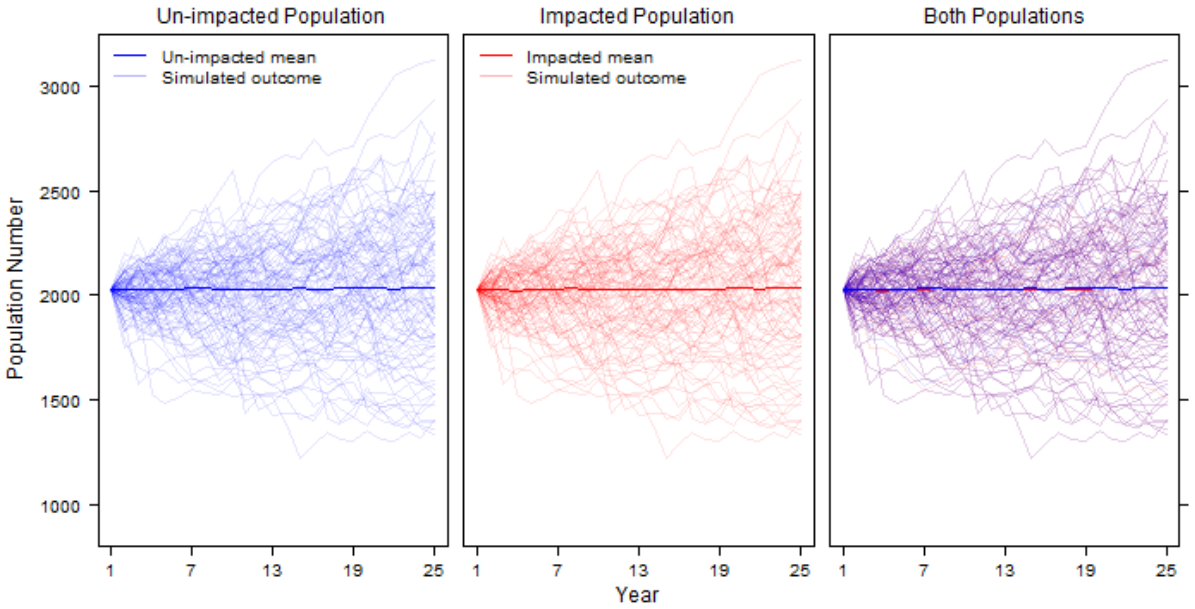

Figure 6: Results of the bottlenose dolphin iPCoD simulations for jacket foundations.

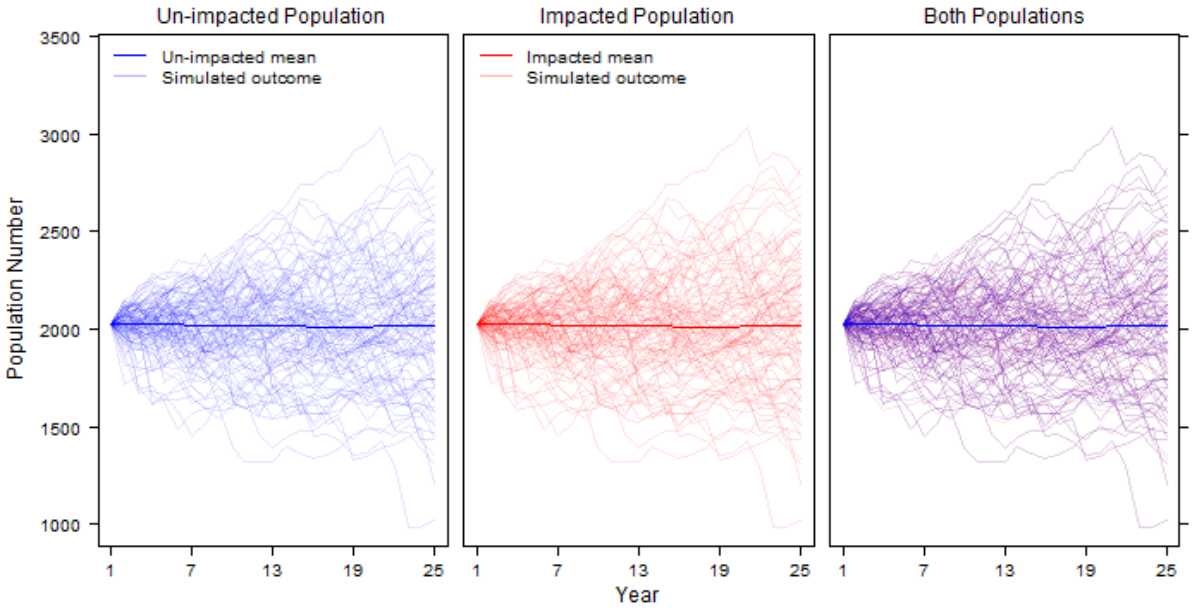

Figure 7: Results of the bottlenose dolphin iPCoD simulations for monopile foundations.

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 u~~Un-impacted population size	95% CIs	Mean ~~Mean il~~ Impacted population size	95% CIs	Impacted as % of un-impacted population size	Un-impacted population size	Median Impacted population size	Impacted as % of un-impacted population size
Jackets								
Before piling	20,120	N/A	20,120	N/A	100%	20,120	20,120	100.00%
End Year 1 piling	20,128	17,881 21,934	20,128	17,881 21,934	100%	20,179	20,179	100.00%
End year 2 piling	20,140	17,662 22,526	20,140	17,662 22,526	100%	20,148	20,148	100.00%
1 year after pilings ends	20,125	17,188 23,093	20,125	17,188 23,093	100%	20,097	20,097	100.00%
6 years after piling ends	20,036	16,386 24,147	20,036	16,386 24,147	100%	19,942	19,942	100.00%
12 years after piling ends	20,038	15,517 25,907	20,038	15,517 25,907	100%	19,843	19,843	100.00%

	Mean					Median		
18 years after piling ends	19,943	15,312 26,029	19,943	14,827 26,581	100%	19,779	19,779	100.00%
Monopiles								
Before piling	20,120	N/A	20,120	N/A	100%	20,120	20,120	100.00%
End Year 1 piling	20,105	17,837 21,860	20,105	17,837 21,860	100%	20,191	20,191	100.00%
End year 2 piling	20,042	17,430 22,538	20,042	17,430 22,538	100%	20,088	20,088	100.00%
1 year after pilings ends	20,094	17,204 22,876	20,094	17,204 22,876	100%	20,074	20,074	100.00%
6 years after piling ends	20,097	16,754 24,077	20,097	16,754 24,077	100%	19,980	19,980	100.00%
12 years after piling ends	20,067	15,923 25,517	20,067	15,923 25,517	100%	19,823	19,823	100.00%
18 years after piling ends	20,092	15,044 26,953	20,092	15,044 26,953	100%	19,885	19,885	100.00%

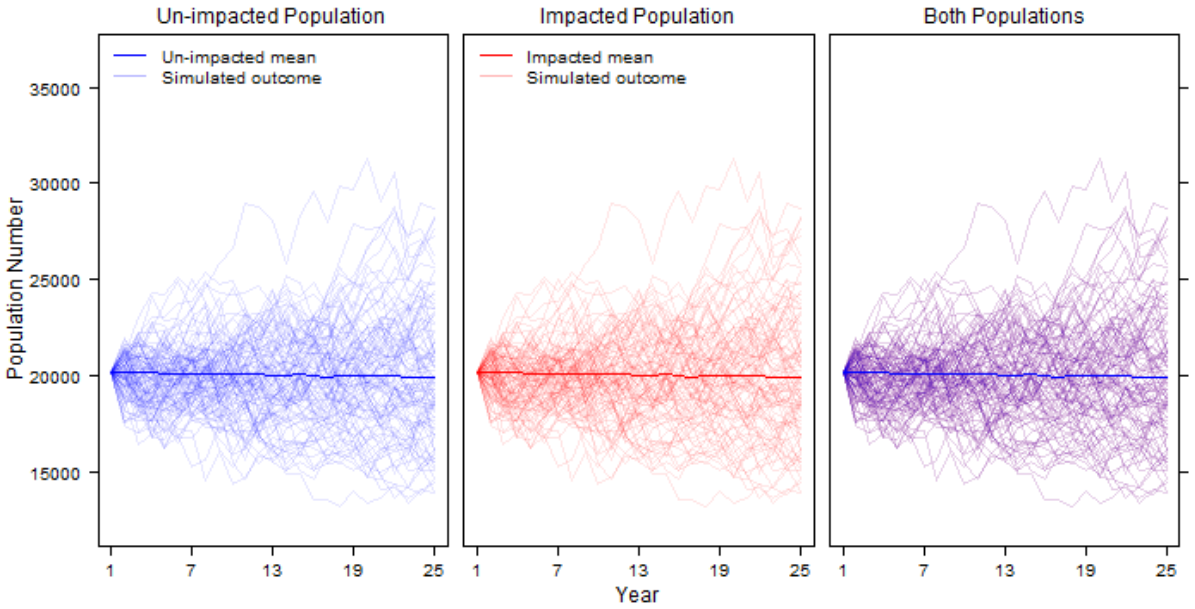

Figure 8: Results of the minke whale iPCoD simulations for jacket foundations.

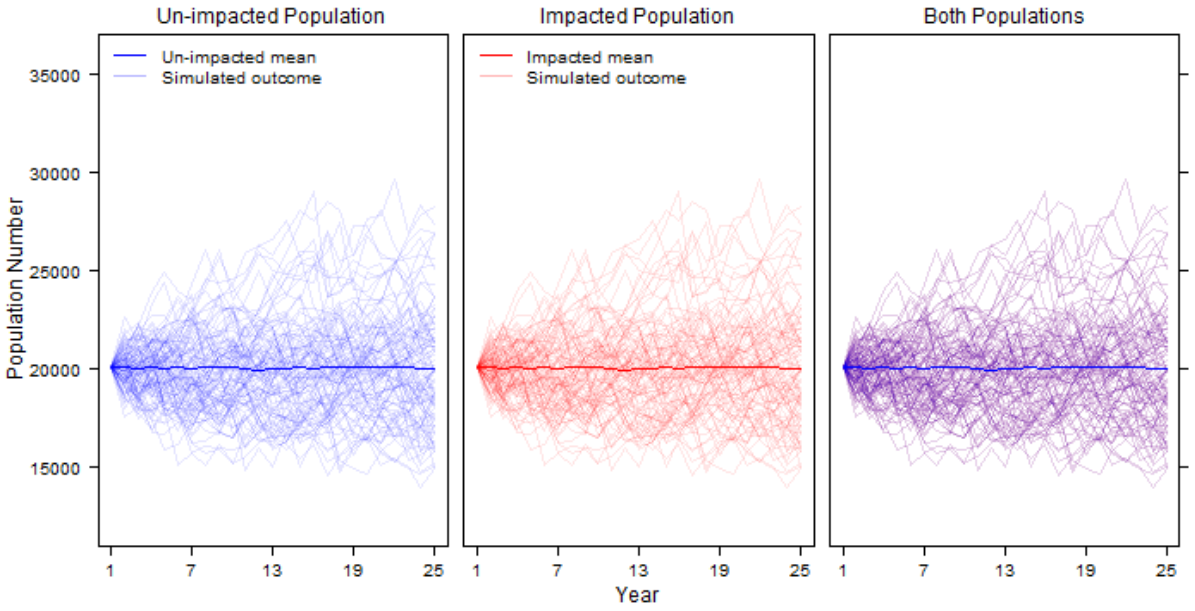

Figure 9: Results of the minke whale iPCoD simulations for monopile foundations.

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	95% CIs	Mean ~~Mean~~ Impacted population size	95% CIs	Impacted as % of un-impacted population size	Un-impacted population size	Median Impacted population size	Impacted as % of un-impacted population size
Jackets								
Before piling	4,866	N/A	4,866	N/A	100%	4,866	4,866	100.00%
End Year 1 piling	4,855	4,424 5,202	4,855	4,424 5,202	100%	4,864	4,864	100.00%
End year 2 piling	4,862	4,364 5,290	4,862	4,364 5,290	100%	4,883	4,883	100.00%
1 year after pilings ends	4,854	4,298 5,370	4,854	4,298 5,370	100%	4,863	4,863	100.00%
6 years after piling ends	4,870	4,082 5,734	4,870	4,082 5,734	100%	4,870	4,870	100.00%
12 years after piling ends	4,910	3,896 6,026	4,910	3,896 6,026	100%	4,862	4,862	100.00%

		Mean				Median		
18 years after piling ends	4,929	3,758 6,338	4,929	3,758 6,338	100%	4,900	4,900	100.00%
Monopiles								
Before piling	4,866	N/A	4,866	N/A	100%	4,866	4,866	100.00%
End Year 1 piling	4,870	4,472 5,206	4,870	4,472 5,206	100%	4,876	4,876	100.00%
End year 2 piling	4,870	4,376 5,338	4,870	4,376 5,338	100%	4,870	4,870	100.00%
1 year after pilings ends	4,869	4,308 5,430	4,869	4,308 5,430	100%	4,852	4,852	100.00%
6 years after piling ends	4,857	4,042 5,810	4,857	4,042 5,810	100%	4,824	4,824	100.00%
12 years after piling ends	4,869	3,842 5,990	4,869	3,842 5,990	100%	4,829	4,829	100.00%
18 years after piling ends	4,900	3,750 6,236	4,900	3,632 6,408	100%	4,804	4,804	100.00%

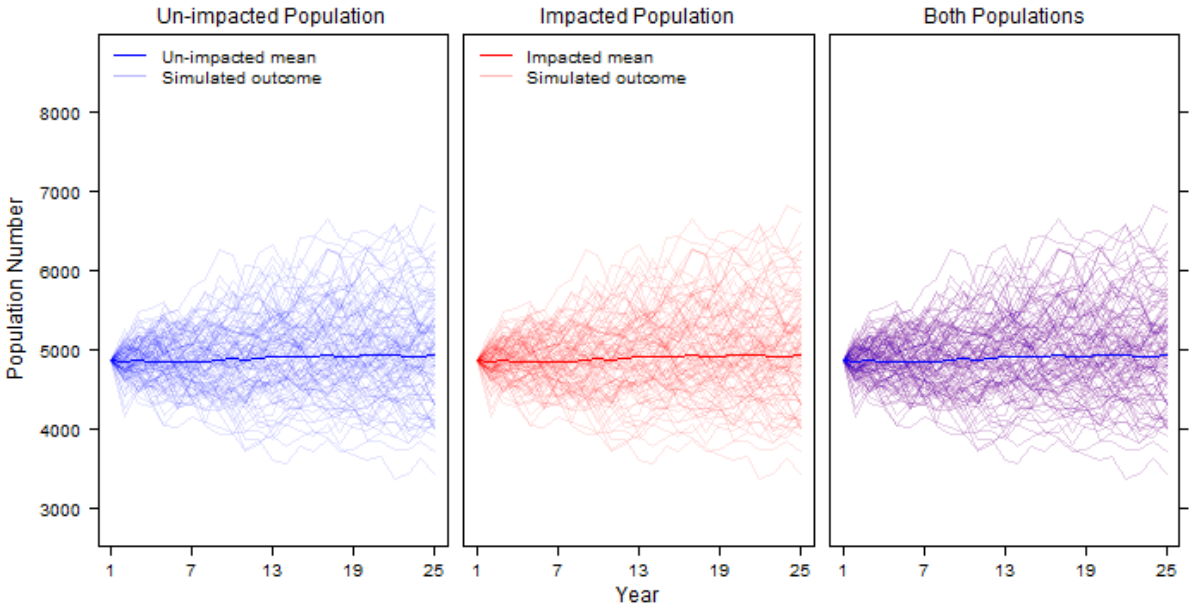

Figure 10: Results of the harbour seal iPCoD simulations for jacket foundations, assuming a stable population.

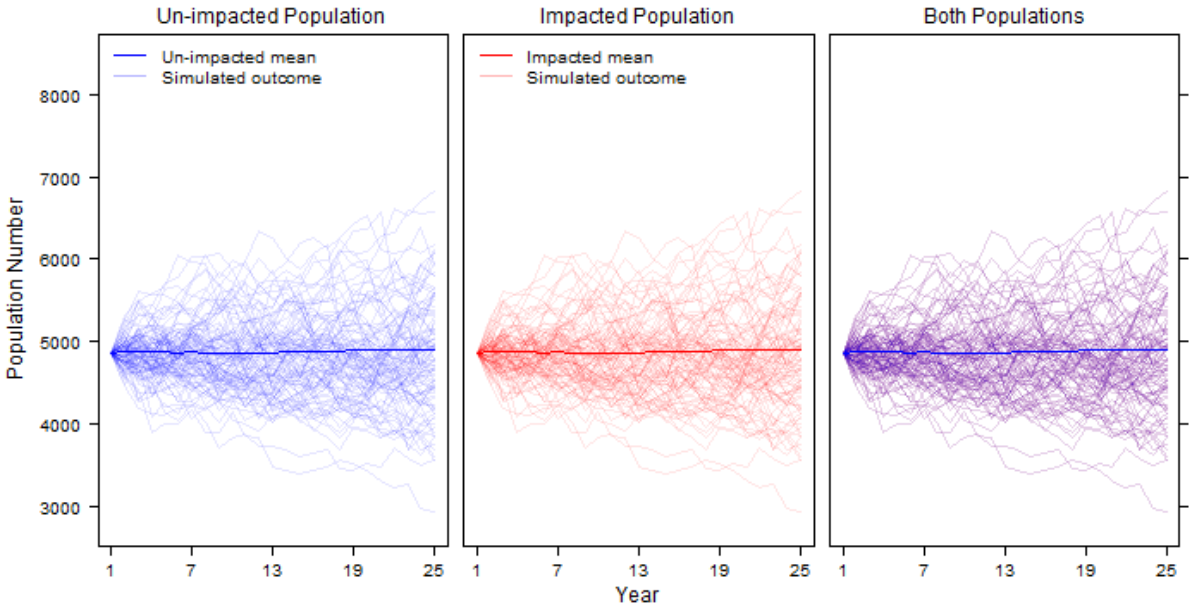

Figure 11: Results of the harbour seal iPCoD simulations for monopile foundations, assuming a stable population.

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 ~~Mean u~~Un-impacted population size	95% CIs	~~Mean~~ Impacted population size	95% CIs	Impacted as % of un-impacted population size	Impacted population size	Median Un-impacted population size	Impacted as % of un- impacted Population size
Jackets								
Before piling	4,868	N/A	4,868	N/A	100%	4,868	4,868	100.00%
End Year 1 piling	4,365	3,986 4,692	4,365	3,986 4,692	100%	4,376	4,376	100.00%
End year 2 piling	3,908	3,484 4,320	3,908	3,484 4,320	100%	3,906	3,906	100.00%
1 year after pilings ends	3,515	3,090 3,956	3,515	3,090 3,956	100%	3,504	3,504	100.00%
6 years after piling ends	2,022	1,588 2,494	2,022	1,588 2,494	100%	2,017	2,017	100.00%
12 years after piling ends	1,037	736 1,408	1,037	736 1,408	100%	1,020	1,020	100.00%

	Mean					Median		
18 years after piling ends	534	340 788	534	340 788	100%	527	527	100.00%
Monopiles								
Before piling	4,868	N/A	4,868	N/A	100%	4,868	4,868	100.00%
End Year 1 piling	4,360	3,976 4,678	4,360	3,976 4,678	100%	4,368	4,368	100.00%
End year 2 piling	3,904	3,464 4,308	3,904	3,464 4,308	100%	3,914	3,914	100.00%
1 year after pilings ends	3,501	3,044 3,962	3,501	3,044 3,962	100%	3,498	3,498	100.00%
6 years after piling ends	2,012	2,376 3,330	2,012	1,592 2,514	100%	2,000	2,000	100.00%
12 years after piling ends	1,040	7,48 1,396	1,040	7,48 1,396	100%	1,030	1,030	100.00%
18 years after piling ends	533	340 758	533	340 758	100%	528	528	100.00%

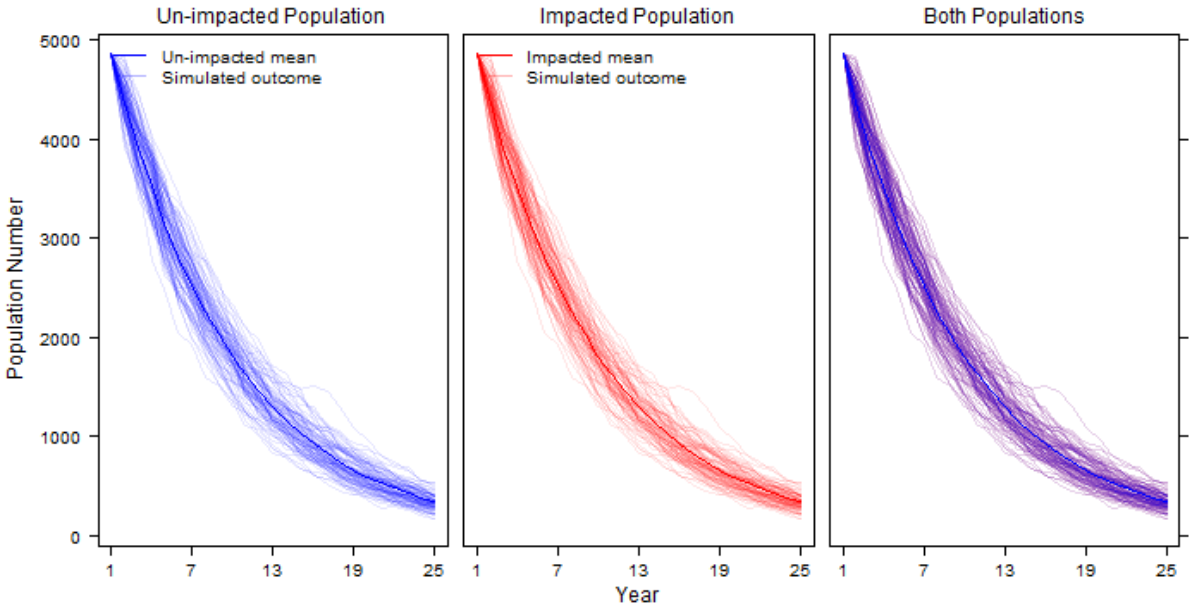

Figure 12: Results of the harbour seal iPCoD simulations for jacket foundations, assuming a declining population.

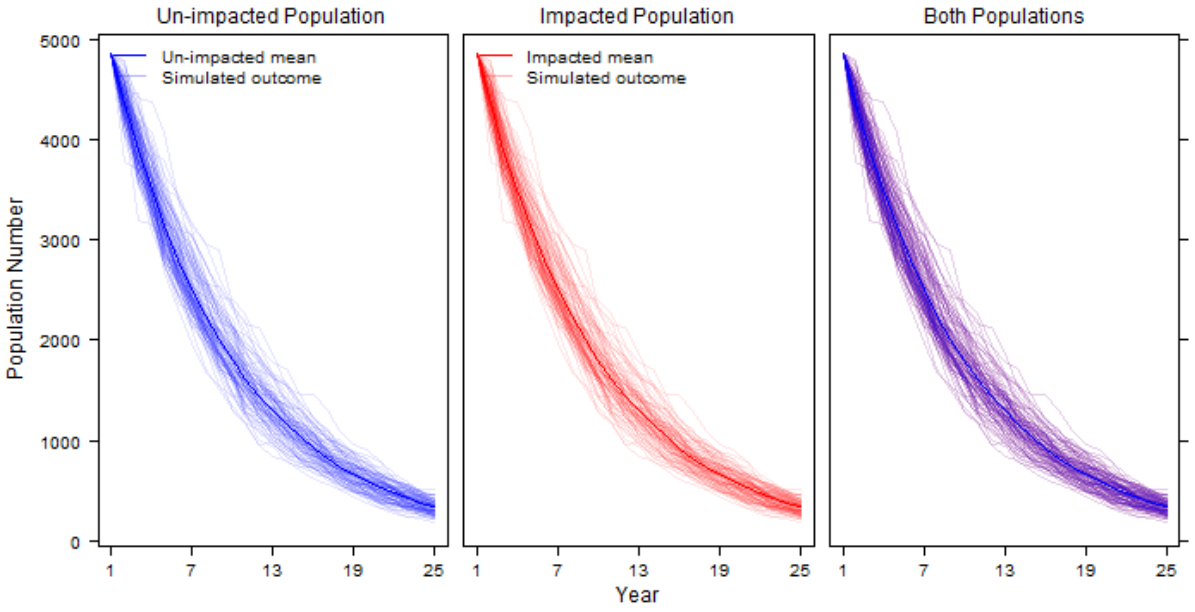

Figure 13: Results of the harbour seal iPCoD simulations for monopile foundations, assuming a declining population.

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 u~~Un-impacted population size	95% CIs	Mean ~~i~~Impacted population size	95% CIs	Impacted as % of un-impacted population size	Impacted population	Median Un-impacted population size	Impacted as % of un-impacted Population size
Jackets								
Before piling	10,788	N/A	10,788	N/A	100%	10,788	10,788	100.00%
End Year 1 piling	10,866	9,912 11,526	10,866	9,912 11,526	100%	10,920	10,920	100.00%
End year 2 piling	10,912	9,698 11,824	10,912	9,698 11,824	100%	10,954	10,954	100.00%
1 year after pilings ends	10,996	9,562 12,072	10,996	9,562 12,072	100%	11,057	11,057	100.00%
6 years after piling ends	11,364	9,139 13,306	11,364	9,139 13,306	100%	11,392	11,392	100.00%
12 years after piling ends	11,858	9,030 14,750	11,858	9,030 14,750	100%	11,809	11,809	100.00%
18 years after piling ends	12,275	9,090 15,901	12,275	9,090 15,901	100%	12,242	12,242	100.00%
Monopiles								

	Mean					Median		
Before piling	10,788	N/A	10,788	N/A	100%	10,788	10,788	100.00%
End Year 1 piling	10,868	9,892 11,560	10,868	9,892 11,560	100%	10,908	10,908	100.00%
End year 2 piling	10,937	9,790 11,888	10,937	9,790 11,888	100%	10,980	10,980	100.00%
1 year after pilings ends	11,020	9,699 12,098	11,020	9,699 12,098	100%	11,082	11,082	100.00%
6 years after piling ends	11,354	9,262 13,302	11,354	9,262 13,302	100%	11,403	11,403	100.00%
12 years after piling ends	11,820	9,261 14,717	11,820	9,261 14,717	100%	11,773	11,773	100.00%
18 years after piling ends	12,238	9,053 15,424	12,238	9,033 15,938	100%	12,054	12,054	100.00%

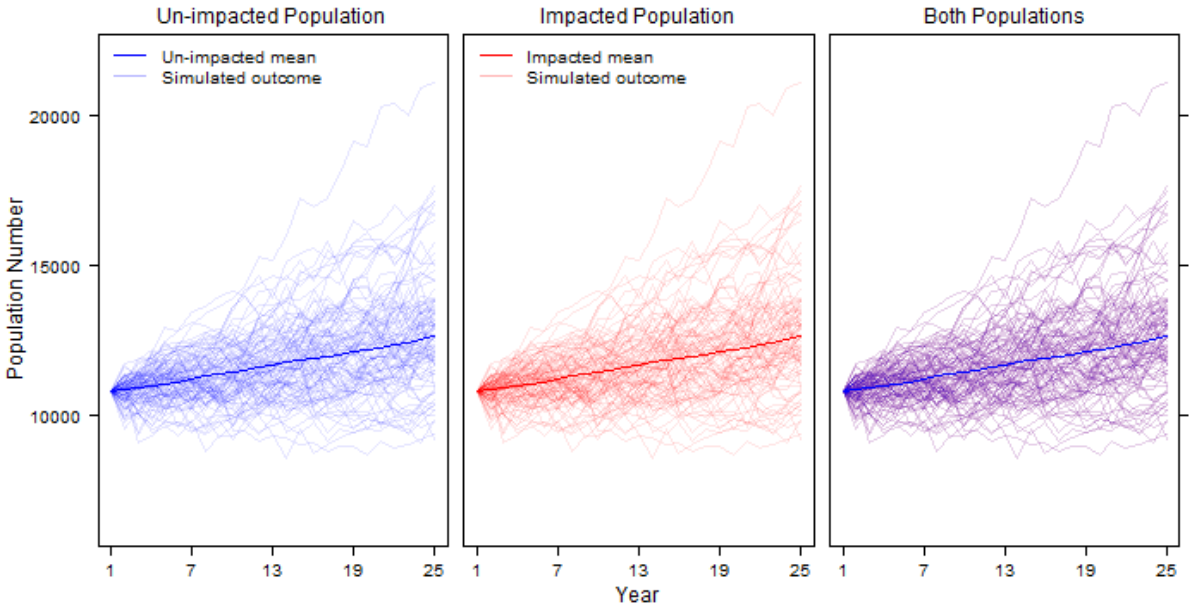

Figure 14: Results of the grey seal iPCoD simulations for jacket foundations.

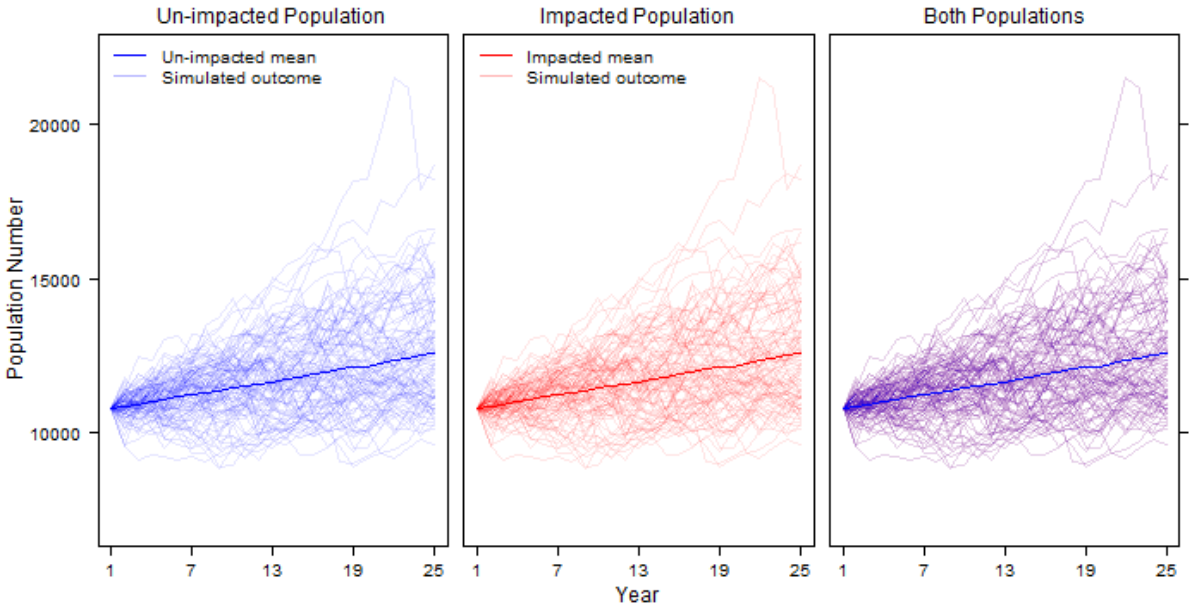

Figure 15: Results of the grey seal iPCoD simulations for monopile foundations.

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

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