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Volume 7B Proposed Development (Offshore) Appendices

Appendix 7-4 Marine Mammals Population Modelling (iPCoD)

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Acronyms and Abbreviations

CES	Coastal East Scotland
CGNS	Celtic and Greater North Sea
CIA	Cumulative Impact Assessment
EDR	Effective Deterrence Range
EIA	Environment Impact Assessment
EIAR	Environment Impact Assessment Report
ES	East Scotland
GNS	Greater North Sea
iPCoD	Interim Population Consequences of Disturbance Model
km	Kilometres
MF	Moray Firth
MU	Management Unit
NC&O	North Coast and Orkney
NS	North Sea
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PTS	Permanent Threshold Shift
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SCOS	Special Committee on Seals
SMU	Seal Management Unit
WTG	Wind Turbine Generator

1 Marine Mammals Population Modelling (iPCoD)

1.1 Introduction

1.1.1.1 This appendix of the Environmental Impact Assessment Report (EIAR) provides a full set of results for the assessment of the potential for population level effects from disturbance to marine mammals as a result of the underwater noise during piling at the Caledonia Offshore Wind farm (OWF), hereafter referred to as the 'Proposed Development (Offshore)' This includes results for concurrent and sequential scenarios for phased construction of the Proposed Development (Offshore) alone (see Section 1.4.2), and cumulatively with other projects (see Section 1.4.3).

1.1.1.2 The results presented in Sections 1.5 to 1.9 are used to inform the assessment of magnitude of underwater noise during piling resulting in behavioural disturbance to harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal in Volume 2, Chapter 7: Marine Mammals.

1.2 iPCoD Model

1.2.1 Overview

1.2.1.1 The interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al*., 2014b[1]; King *et al*., 2015[2]) was used to predict the potential population consequences of the predicted amount of Permanent Threshold Shift (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.

1.2.1.2 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.

1.2.1.3 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[3]). 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. Limitations of the iPCoD model are further discussed in Section 1.3.

1.2.2 Precaution in the iPCoD for the Proposed Development (Offshore)

1.2.2.1 It should be noted that the results presented in Sections 1.5 to 1.9 are precautionary as modelling is based on the worst-case scenario parameters used within the Volume 2, Chapter 7: Marine Mammals.

1.2.2.2 The scenarios, further discussed in Section 1.4.2, are based on piling schedules, which assume that only four pin piles for jackets and (an average of) 1.71 pin piles for anchors will be installed per day, resulting in up to 515 piling days. Additionally, it has been assumed that the maximum gap between construction of Caledonia North and Caledonia South may be up to five years, to ensure assessment covers off potential for delayed construction due to external factors outwith the Applicant's control.

1.2.2.3 The iPCoD modelling will be rerun when parameters of the Proposed Development (Offshore) are finalised post-consent and results will be discussed and presented in the Piling Strategy.

1.3 iPCoD Model Limitations

1.3.1 Overview

1.3.1.1 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[4]) 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.

1.3.1.2 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 (see Section 1.3.2),
- The lack of density dependence in the model (meaning the population will not respond to any reduction in population size; see Section 1.3.3),
- The level of environmental and demographic stochasticity in the model (see Section 1.3.5), and
- The estimates of the number of animals disturbed come from noise impact assessments with many levels of precaution (see Volume 7B, Appendix 7-2: Marine Mammals Underwater Noise Assessment Methodology for more details).

1.3.2 Duration of Disturbance: Minke Whales and Bottlenose Dolphins

1.3.2.1 The iPCoD model for minke whale and bottlenose dolphin disturbance was last updated following the expert elicitation in 2013 (Harwood *et al*., 2014[1]). 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 six hours of non-foraging time (Booth *et al*., 2019[3]). 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 one hour of feeding cessation was classified as a mild response, two hours of feeding cessation was classified as a strong response and eight hours of feeding cessation was classified as an extreme response (Czapanskiy *et al*., 2021[5]). 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 Proposed Development (Offshore).

1.3.4 Lack of Density Dependence

1.3.4.1 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[1]). 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.

1.3.4.2 At a recent expert elicitation, conducted for the purpose of modelling population impacts of the Deepwater Horizon oil spill (Schwacke *et al*., 2021[6]), 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).

1.3.5 Environmental and Demographic Stochasticity

1.3.5.1 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[1]). Demographic stochasticity is defined as "variation among individuals in their realised vital rates as a result of random processes" (Harwood *et al*., 2014[1]).

1.3.5.2 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 a Management Unit (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[1]).

1.3.5.3 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 1-1, 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.

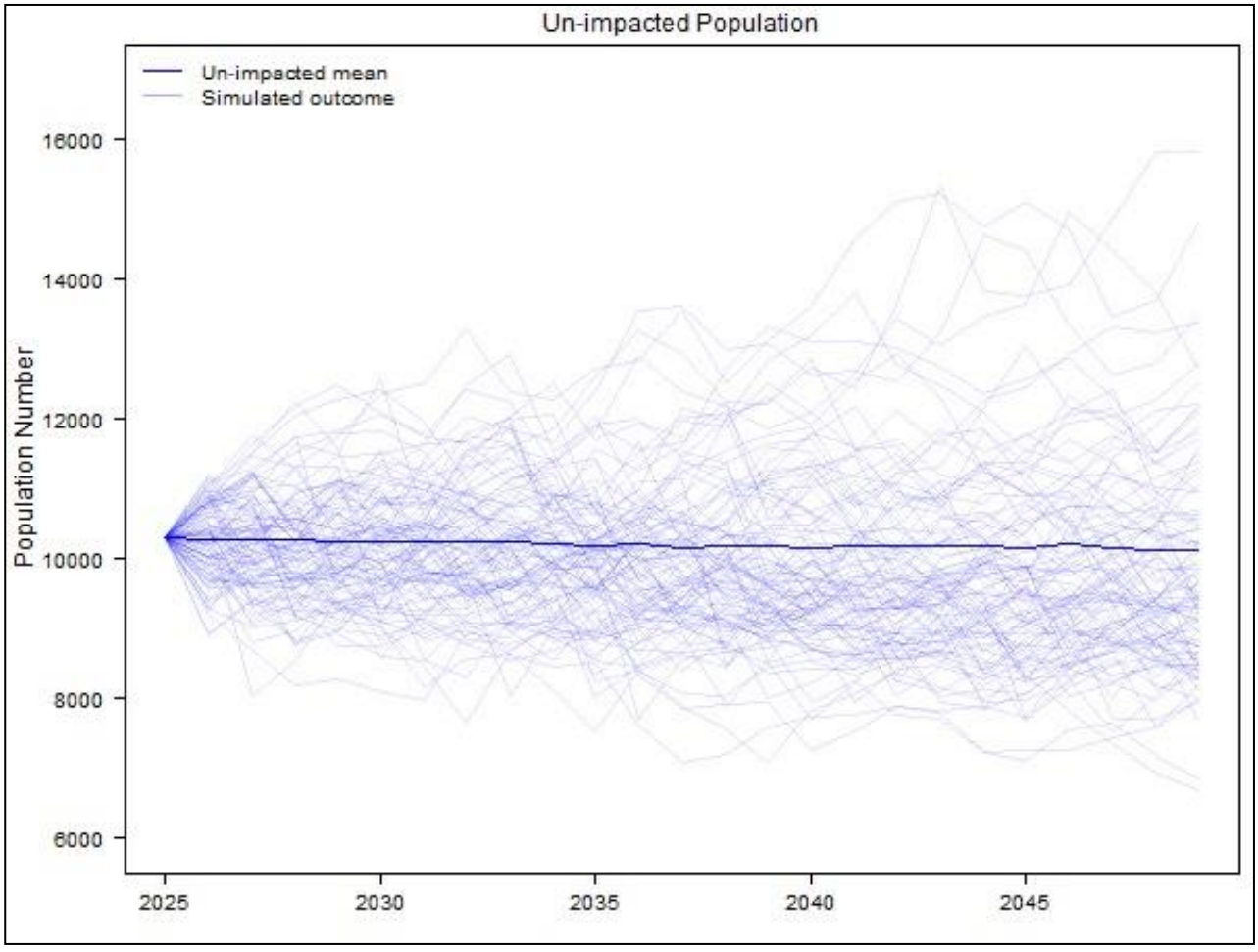

Figure 1-1: Simulated un-impacted (baseline) population size over the 25 years modelled.

1.3.6 Summary

1.3.6.1 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.

1.4 iPCoD Scenarios

1.4.1 Species

1.4.1.1 The population modelling was provided for five species, presented in Table 1-1 alongside their respective MUs.

Table 1-1: Marine mammal reference population taken forward to the iPCoD.

Species	MU
Harbour porpoise	North Sea (NS)
Bottlenose dolphin	Coastal East Scotland (CES)
	Greater North Sea (GNS)
Minke whale	Celtic and Greater North Seas (CGNS)
Harbour seal	East Scotland (ES), Moray Firth (MF), North Coast and Orkney (NC&O)
Grey seal	ES, MF, NC&O

1.4.2 Proposed Development (Offshore) Alone

1.4.2.1 Three foundation designs have been considered in the underwater noise modelling, including monopiles for bottom-fixed foundations, multi-leg foundations for bottom-fixed jacket foundations and anchors for floating foundations. Piling at monopiles represent the worst-case spatial scenario due to the largest hammer energy required for installation (see Volume 7B, Appendix 7-3: Marine Mammals Piling Results (Auditory Injury and Disturbance) for areas and ranges of effect). Considering the minor differences in the spatial extent of underwater noise generated by piling at jackets and anchors compared to monopiles, and, given that the piling process for jackets and anchors (515 days) can take up to seven times longer than for monopiles (72 piling days), only the combination of jackets and anchors has been used to inform the iPCoD modelling as it represents the worst-case temporal scenario. More details regarding the worst-case spatial and temporal scenarios is provided in Volume 2, Chapter 7: Marine Mammals.

1.4.2.2 The assessment provided in Volume 2, Chapter 7: Marine Mammals showed that there is no residual risk of injury as a result of underwater noise during

piling to any of the species. Therefore, across all iPCoD scenarios it was assumed that zero animals will experience auditory injury (PTS).

1.4.2.3 Two phasing scenarios were considered for the construction of the Proposed Development (Offshore) and are described in Table 1-2. All scenarios assume that four pin piles would be installed per day for bottom-fixed foundations (one full substructure jacket per day) and 1.71 anchor piles would be installed per day for floating substructures. It should be noted that the average number of anchors piles to be installed per day was taken forward (1.71) rather than maximum of two per day as it represented worst case scenario. Note, a maximum of two anchor piles per day was assumed in underwater noise modelling for the worst-case spatial scenario in Volume 7, Appendix 6: Underwater Noise Assessment.

1.4.2.4 The concurrent construction scenario assumes that the foundations at the Caledonia North Site and Caledonia South Site of the Proposed Development (Offshore) will be installed within the same overall construction timeframe (Table 1-2). It is important to note that, based on the DE, concurrent piling at two jacket locations is possible during concurrent construction of Caledonia North and Caledonia South; however, applying this assumption would reduce the overall time required for installation. Since the iPCoD scenarios aim to represent the worst-case temporal scenario, the modelling assumes no concurrent piling activities within the Caledonia OWF at any given time, ensuring the maximum possible installation duration is assessed.

1.4.2.5 The sequential construction scenario of the Proposed Development (Offshore) assumes that Caledonia North and Caledonia South will be installed sequentially (in either order) with either no gap or a five year gap between the completion of piling at the North and the commencement of piling in the South (Table 1-2). It should be noted that the iPCoD model is not sensitive to the sequence of construction (e.g., whether Caledonia North is installed first or Caledonia South); therefore, the assumption was made that Caledonia North is going to be constructed first.

Table 1-2: Phased construction scenario descriptions for the concurrent and sequential construction of foundations in the Caledonia North Site and Caledonia South Site (these scenarios were modelled in the iPCoD modelling).

Phasing Scenario	Gap between installation of Caledonia North and Caledonia South	Scenario Description
Concurrent construction*	N/A	Installation of up to 105 bottom-fixed foundations across the Caledonia North Site and Caledonia South Site as well as 39 floating foundations in the Caledonia South Site within the same timeframe, resulting in a total of 515 piling days between October 2028 and September 2030, inclusive. For the purposes of assessing the worst case in iPCoD, no concurrent piling is assumed within this specific scenario (see 1.4.2.4).
Sequential construction**	No gap	The first phase of construction of 65 bottom-fixed jacket foundations at the Caledonia North Site over 65 piling days between October 2028 and February 2030. There would be no gap prior to the commencement of the second phase of construction of 40 bottom-fixed jacket foundations and 39 floating foundations at the Caledonia South Site which could take place over 40 and 410 piling days, respectively, between March 2030 to February 2032.
	Five year gap	The first phase of construction of 65 bottom-fixed jacket foundations at the Caledonia North Site over 65 piling days between October 2028 and February 2030. A maximum of five year gap between construction activities would then occur. The second phase of installation of 40 bottom-fixed jacket foundations and 39 floating foundations at the Caledonia South Site over 40 and 410 piling days, respectively, between March 2035 to February 2037.

* Note, as discussed in paragraph 1.4.2.4, although the foundations at Caledonia North and Caledonia South will be installed within the same overall construction timeframe, in order to reflect the maximum duration of overall installation, the worst-case temporal scenario assessed here assumed that there will be no concurrent piling events within the Caledonia OWF at any one time.

** Note, the iPCoD model is not sensitive to the sequence of construction (e.g., whether Caledonia North is installed first or Caledonia South); therefore, the assumption was made in both models that Caledonia North is going to be installed first

Number of Animals Impacted and Demographic Parameters

1.4.2.6 Given that the iPCoD assessment is based on the worst-case temporal scenario, number of animals impacted is based on single piling to ensure the maximum duration of overall piling. See paragraph 1.4.2.4 for discussion regarding piling assumptions for the concurrent construction scenario.

1.4.2.7 For the concurrent construction scenario of the Proposed Development (Offshore), where the foundations at Caledonia North and Caledonia South will be installed within the same timeframe at random distribution, the disturbance values used in the modelling were based on the worst case single piling across all modelling locations (locations 1 to 8).

1.4.2.8 For the sequential construction scenarios (no gap and five years gap), which assume sequential piling of the foundations in Caledonia North followed by sequential piling in Caledonia South, the number of animals disturbed is based on the locations within the Caledonia North Site and Caledonia South Site. For example, during the first phase of construction of 65 bottom-fixed jacket foundations at the Caledonia North Site, the number of animals disturbed is based on the worst-case for single piling of pin piles at jackets across locations 1, 2, 3 and 4. For the second phase of construction of jacket and floating foundations at the Caledonia South Site, the number of animals disturbed in based on the worst-case for single piling of pin piles at jackets and anchors across locations 3, 4, 5, 6, 7 and 8. The number of animals disturbed taken forward to the iPCoD is described for each species in Sections 1.5 to 1.9; see Volume 7B, Appendix 7-3: Marine Mammals Piling Results (Auditory Injury and Disturbance) for complete set of numbers for each location.

1.4.2.9 The MU specific demographic parameters used in the iPCoD modelling were obtained from Sinclair *et al*. (2020[7]) and are summarised in Table 1-3.

Table 1-3: Demographic parameters used in the iPCoD modelling from Sinclair *et al*. (2020[7]).

Parameters	Harbour Porpoise	Bottlenose Dolphin		Minke Whale	Harbour Seal		Grey Seal	
MU Name	NS	CES	GNS	CGNS	MF	NC&O	MF	MF, NC&O, ES
MU Abundance	346,601	245	2,022	20,118	958	1,951	7,380	52,354
UK MU Abundance	159,632	N/A	N/A	10,288	N/A	N/A	N/A	N/A
Calf/pup survival	0.8455	0.925	0.86	0.7	0.4	0.24	0.222	0.222
Juvenile survival	0.85	0.962	0.94	0.77	0.78	0.86	0.94	0.94
Adult survival	0.925	0.98	0.94	0.96	0.92	0.8	0.94	0.94
Fertility	0.34	0.24	0.25	0.91	0.85	0.9	0.84	0.84
Age at independence	1	3	2	1	1	1	1	1
Age at first birth	5	9	9	9	4	4	6	6

Selected Time Points from iPCoD Simulations

1.4.2.10 For each scenario, selected time points have been used to present the results on population trajectories. These time points have been selected to try and represent as best as possible, a level of periodicity on population estimates following piling. The time points selected for the presentation of results for each Scenario are provided in Table 1-4.

Table 1-4: Time points selected for the presentation of iPCoD modelling results.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Concurrent construction	2027	Before piling starts
	2028	The end of first year of piling at North and South
	2029	The end of second year of piling at North and South
	2030	The end of third (final) year of piling at North and South
	2031	1-year after piling ends
	2036	6-years after piling ends
	2042	12-years after piling ends
	2048	18-years after piling ends
Sequential construction (no gap)	2027	Before piling starts
	2028	The end of first year of piling at Caledonia North
	2029	The end of second year of piling at Caledonia North
	2030	The end of third (final) year of piling at Caledonia North and the end of the first year of piling at Caledonia South
	2031	The end of first year of piling at Caledonia South
	2032	The end of second (final) year of piling at Caledonia South
	2033	1-year after piling ends at Caledonia South
	2038	6-years after piling ends at Caledonia South
	2044	12-years after piling ends at Caledonia South

Scenario	Time Points Selected (Indicative Year)	Time Point Description
	2050	18-years after piling ends at Caledonia South
Sequential construction (five years gap)	2027	Before piling starts
	2028	The end of first year of piling at Caledonia North
	2029	The end of second year of piling at Caledonia North
	2030	The end of third (final) year of piling at Caledonia North
	2031	1-year after piling ends at Caledonia North
	2034	4-years after piling ends at Caledonia North and before piling starts at Caledonia South
	2035	The end of first year of piling at Caledonia South
	2036	The end of second (final) year of piling at Caledonia South
	2037	The end of third year of piling at Caledonia South
	2038	1-year after piling ends at Caledonia South
	2043	6-years after piling ends at Caledonia South
	2049	12-years after piling ends at Caledonia South
	2052*	15-years after piling ends at Caledonia South
* 2052 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this		

1.4.3 Cumulative Impact Assessment (CIA)

Proposed Development (Offshore) Scenarios

1.4.3.1 Two scenarios were taken forward for the assessment of cumulative effects and iPCoD, concurrent and sequential construction scenarios. Sequential construction scenario with no gap was selected as it overlaps with higher number of projects screened into the Cumulative Impact Assessment (CIA), compared to the scenario with maximum gap of up to five years (see Table 1-5 for project timeframes). The duration of both scenarios is as follows:

- Concurrent construction scenario – 2028 to 2030; and
- Sequential construction scenario (no gap) – 2028 to 2032.

Projects Scoped In or Out of the Assessment

1.4.3.2 For the Proposed Development (Offshore) and marine mammals, the focus of the quantitative population level assessment was on the potential impacts from other Scottish offshore windfarm projects with construction/piling overlapping or happening one year either side of the predicted piling window for the Proposed Development (Offshore) (Table 1-5). Projects with no offshore construction timeline available in the public domain at the time of final CIA long list review (Volume 7A, Appendix 7-1: Cumulative Impact Assessment Methodology) were scoped out. Similarly, for projects without submission documents available in the public domain and where the number of WTG and OSP foundations to be installed was not available, the number of piling days cannot be predicted and therefore these projects were also scoped out. The timeline of the projects screened into the cumulative iPCoD for marine mammals alongside the Proposed Development (Offshore) is shown in Table 1-5. It should be noted that for projects for which indicative piling schedules were provided within the submission documents, these were used in the CIA. For projects with indicative construction timeframes available within the public domain, but without specific details on years when the piling can be anticipated, it has been precautionarily assumed that piling may take place throughout the construction years.

1.4.3.3 It should be noted that the time window for projects considered in the cumulative iPCoD (2026 to 2038) is wider when compared to the CIA provided in the Volume 2, Chapter 7: Marine Mammals (2027 to 2033). This is to reflect the baseline conditions before any piling has started (end 2025) and account for the whole duration of piling at projects with temporal overlap with the Proposed Development (Offshore) (Table 1-5).

Table 1-5: List of projects and developments considered in the marine mammal cumulative iPCoD along with the construction and anticipated piling timeframes.

Project	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Proposed Development (Offshore) (Concurrent Construction)			P	P	P								
Proposed Development (Offshore) (Sequential Construction, no gap)			P	P	P	P	P						
Berwick Bank	P	P				P							
Green Volt		P											
Ossian						P	P	P	P	P	P	P	P
Salamander			P										
West of Orkney			P	P	P								
Ayre				P	P	P	P	P					
Broadshore			P	P	P	P							
Buchan			P	P	P	P	P						
Cenos				P	P	P	P	P					
Morven	P	P	P	P	P	P	P						
Muir Mhòr		P	P	P	P								

Project	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Sinclair			P	P	P	P							
Bellrock			P	P	P	P							
Havbredey							P	P	P	P	P		
Spiorad na Mara			P	P	P	P							

1.4.3.4 Only projects with physical overlap between the respective array areas and relevant species' MU were screened into the cumulative iPCoD (Table 1-6). The iPCoD for the Proposed Development (Offshore) showed potential population reduction in CES MU bottlenose dolphin population (see Sections 1.6.1 and 1.6.2). As such, precautionarily, the projects located further offshore (without spatial overlap of the array area and the CES MU) but with quantitative assessment against the CES MU population available in the submission documents, were also screened in for the assessment for the CES MU (Berwick Bank, Ossian, Salamander).

Table 1-6: List of projects and information whether these been screened in for species-specific iPCoD.

Project Name	HP (NS MU)	BND (CES MU)	BND (GNS MU)	MW (CGNS MU)	HS (MF SMU)	HS (NC&O SMU)	GS (MF, ES, NC&O SMUs)
Berwick Bank	Yes	Yes	Yes	Yes	No	No	Yes
Ossian	Yes	Yes	No	Yes	No	No	Yes
Salamander	Yes	Yes	No	Yes	No	No	Yes
West of Orkney	No	No	No	Yes	No	Yes	Yes
Ayre	Yes	No	No	Yes	No	Yes	Yes
Broadshore	Yes	No	No	Yes	Yes	No	Yes
Buchan	Yes	No	No	Yes	No	Yes	Yes
Cenos	Yes	No	No	Yes	No	No	Yes
Morven	Yes	No	No	Yes	No	No	Yes
Muir Mhòr	Yes	No	No	Yes	No	No	Yes
Sinclair	Yes	No	No	Yes	Yes	No	Yes
Bellrock	Yes	No	No	Yes	No	No	Yes
Havbredey	No	No	No	Yes	No	No	No
Spiorad na Mara	No	No	No	Yes	No	No	No
Green Volt	Yes	No	Yes	Yes	No	No	Yes

Project-specific Piling Days

1.4.3.5 For projects with indicative piling schedules available in the public domain (Berwick Bank, Ossian, Salamander, West of Orkney) these were used in the modelling.

1.4.3.6 There is a number of projects at early stage of development without submission documents available in the public domain. However, all projects taken forward to the cumulative iPCoD have information about anticipated number of foundations (WTGs, OSPs) and/or number of piles to be installed available in the public domain (in line with screening discussed in paragraph 1.4.3.2). For these projects, the number of piling days was assessed based on the number of piles to be installed and the assumption that there will be up to two piles installed per day (Table 1-7). The number of piling days was evenly distributed throughout the construction years.

Table 1-7: Projects screened into the cumulative iPCoD with parameters used in the model.

Project	Predicted Number of Piled Foundations	Maximum Number of Piles	Total Number of Piling Days
Projects with piling schedules available in the public domain			
Berwick Bank	179 WTGs 8 OSPs	1,432 (WTGs) 64 (OSPs)	372
Ossian	265 WTG 15 OSPs	1,590 (WTGs) 216 (OSP)	602
Salamander	7 WTGs	80	40
West of Orkney	125 WTGs 5 OSPs	580	290
Green Volt	1 OSP	4	4
Projects without piling-specific data available in the public domain			
Ayre	67 WTGs	603	302
Bellrock	80 WTGs	960	480
Broadshore	60 WTGs	720	360
Buchan	70 WTGs	630	315
Cenos	95 WTGs	855	428
Havbredey	108 WTGs	972	486
Morven	191 WTGs	2,292	1,146

Project	Predicted Number of Piled Foundations	Maximum Number of Piles	Total Number of Piling Days
Muir Mhor	67 WTGs	804	402
Sinclair	6 WTGs	72	36
Spiorad na Mara	66 WTGs	528	264

Number of Animals Impacted and Reference Populations

1.4.3.7 For the Proposed Development (Offshore) scenarios taken forward to the cumulative iPCoD (see paragraph 1.4.3.1), the assumptions regarding the number of animals are the same as for the Proposed Development alone iPCoD (see paragraph 1.4.2.6).

1.4.3.8 For the projects listed in Table 1-6and scoped into the assessment, the number of animals predicted to be disturbed were based on either the project-specific values presented in respective EIARs or calculated based on the Effective Deterrence Ranges (EDRs) and Small Cetaceans in European Atlantic waters and the North Sea (SCANS) IV densities (using densities for SCANS IV block where animals are located). These values can be found in each of the species-specific assessments for cumulative impacts (Table 1-11, Table 1-21, Table 1-31, Table 1-41, Table 1-54)

1.4.3.9 The MU specific demographic parameters used in the iPCoD modelling were obtained from Sinclair *et al*. (2020[7]) and are summarised in Table 1-3.

Selected Time Points from iPCoD Simulations

1.4.3.10 For each scenario (see paragraph 1.4.3.1), selected time points have been used to present the results on population trajectories. These time points have been selected to try and represent as best as possible, a level of periodicity on population estimates following piling. For example, before any piling started, end of first year of piling at the Caledonia OWF, final year of piling at the Caledonia OWF, final year of piling at the last project screened in for relevant species as well as six years intervals following the end of piling at the Caledonia OWF.

1.4.3.11 Given that projects screened in for the cumulative iPCoD are different depending on the species, the time points selected for the presentation of results are presented in the species-specific cumulative assessments (Sections 1.5.3, 1.6.3, 1.7.3, 1.8.4 and 1.9.3).

1.5 Harbour Porpoise

1.5.1 Concurrent Construction

1.5.1.1 For the concurrent construction scenario, where Caledonia North and Caledonia South will be installed within the same timeframe at random distribution, the disturbance numbers used in the modelling were based on the worst case (single piling) across all modelling locations:

- Modelling for the whole NS MU:
  - 8,201 harbour porpoise per day for installation of pin piles at jackets; and
  - 6,648 harbour porpoise per day for installation of pin piles at anchors.
- Modelling for the UK proportion of the NS MU:
  - 8,111 harbour porpoise per day for installation of pin piles at jackets; and
  - 6,604 harbour porpoise per day for installation of pin piles at anchors.

1.5.1.2 The impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 98.6 – 99.9% of the size of the un-impacted population. In the year 2030, coinciding with the third and final year of piling at the Caledonia OWF, the impacted population size as a proportion of the unimpacted population size is at its lowest (98.63%) for the UK portion of the North Sea MU, but for the whole North Sea MU this proportion remains higher (99.53%) (Table 1-8 and Figure 1-2).

Table 1-8: Results of iPCoD modelling for harbour porpoise (whole NS MU and the UK portion of the NS MU, Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
NS MU			
2027	346,602	346,602	100.00%
2028	345,962	345,962	100.00%
2029	346,047	345,588	99.87%
2030	346,028	344,401	99.53%
2031	345,907	344,387	99.56%
2036	345,971	344,790	99.66%
2042	344,885	343,712	99.66%
2048	345,636	344,460	99.66%
UK portion of the NS MU			
2027	159,634	159,634	100.00%
2028	159,721	159,721	100.00%
2029	159,524	158,898	99.61%
2030	159,397	157,206	98.63%
2031	159,270	157,260	98.74%
2036	159,558	157,949	98.99%
2042	159,513	157,901	98.99%
2048	159,363	157,743	98.98%
Note, time point descriptions are provided in Table 1-4.			

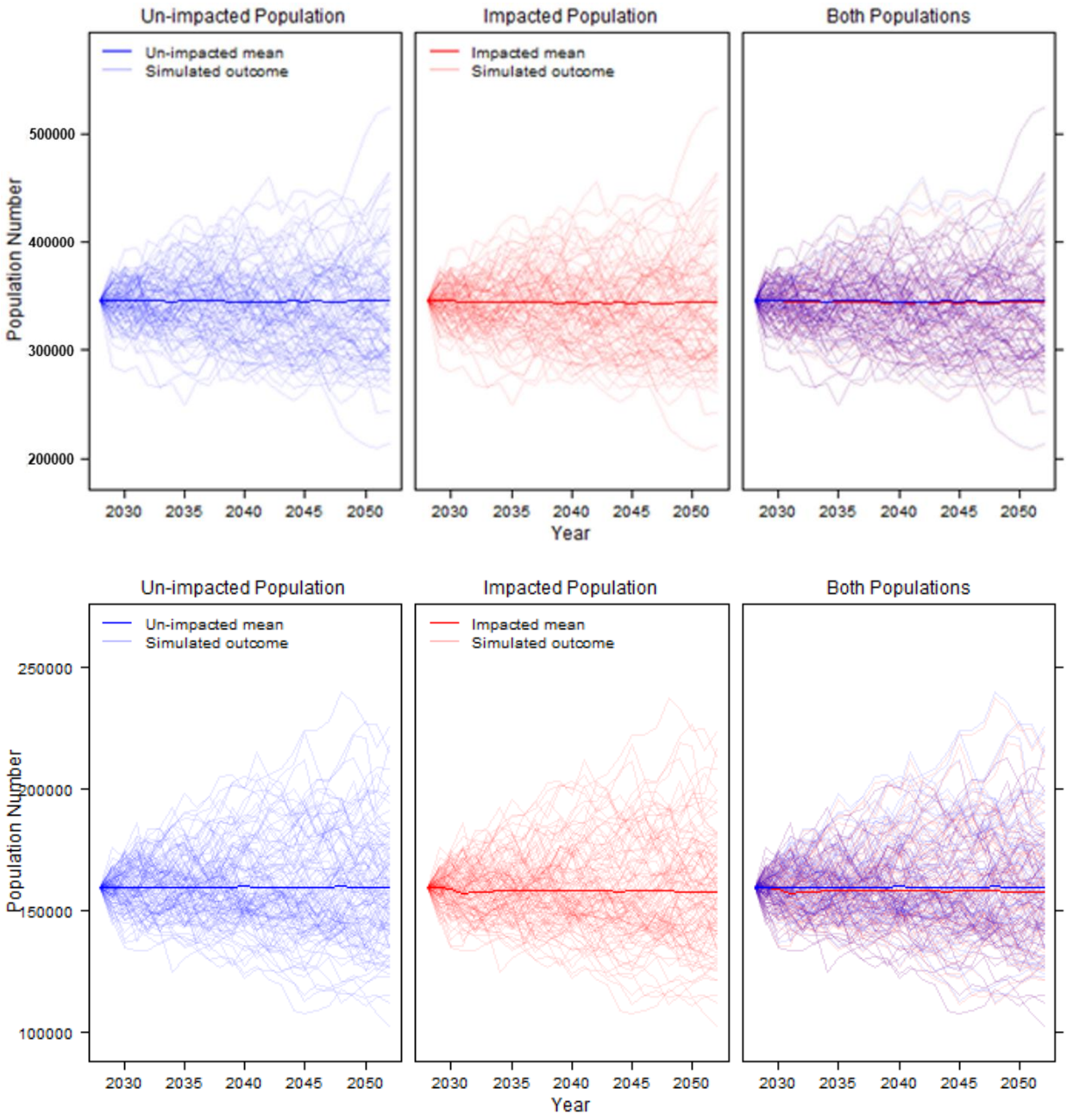

Figure 1-2: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (top graph – NS MU and bottom graph – UK portion of the NS MU; Concurrent Construction Scenario).

1.5.2 Sequential Construction

1.5.2.1 For sequential construction scenario, where Caledonia North and Caledonia South will be installed sequentially with either no gap or five year gap between the completion of installation at the Caledonia North Site and the commencement of installation in the Caledonia South Site, the disturbance values used in the modelling were based on the worst case (single piling) across modelling locations in the Caledonia North Site and modelling locations in the Caledonia South Site, e.g.:

- Modelling for the whole NS MU:
  - 7,274 harbour porpoise per day for installation of pin piles at jackets in the Caledonia North Site;
  - 8,201 harbour porpoise per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 6,648 harbour porpoise per day for installation of pin piles at anchors (Caledonia South Site).
- Modelling for the UK proportion of the NS MU:
  - 7,213 harbour porpoise per day for installation of pin piles at jackets in the Caledonia North Site;
  - 8,111 harbour porpoise per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 6,604 harbour porpoise per day for installation of pin piles at anchors (Caledonia South Site).

No Gap

1.5.2.2 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU, shows that the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 98.78 – 100.0% of the size of the un-impacted population. In the year 2032, a year after the piling finishes at Caledonia South, the impacted population size as a proportion of the unimpacted population size is at its lowest (98.78%) for the UK portion of the North Sea MU, but for the whole North Sea MU this proportion remains higher (99.53%) (Table 1-9 and Figure 1-3).

Table 1-9: Results of iPCoD modelling for harbour porpoise(whole NS MU and the UK portion of the NS MU, Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
NS MU			
2027	346,602	346,602	100.00%
2028	346,248	346,248	100.00%
2029	345,749	345,697	99.98%
2030	346,317	346,047	99.92%
2031	346,201	344,918	99.63%
2032	346,359	344,741	99.53%
2033	346,761	345,373	99.60%
2038	346,688	345,442	99.64%
2044	347,293	346,052	99.64%
2050	347,891	346,648	99.64%
UK portion of the NS MU			
2027	159,634	159,634	100.00%
2028	159,396	159,396	100.00%
2029	159,679	159,617	99.96%
2030	159,704	159,402	99.81%
2031	159,929	158,388	99.04%
2032	160,024	158,070	98.78%
2033	159,713	158,041	98.95%
2038	158,702	157,246	99.08%
2044	158,336	156,897	99.09%
2050	159,025	157,575	99.09%
Note, time point descriptions are provided in Table 1-4.			

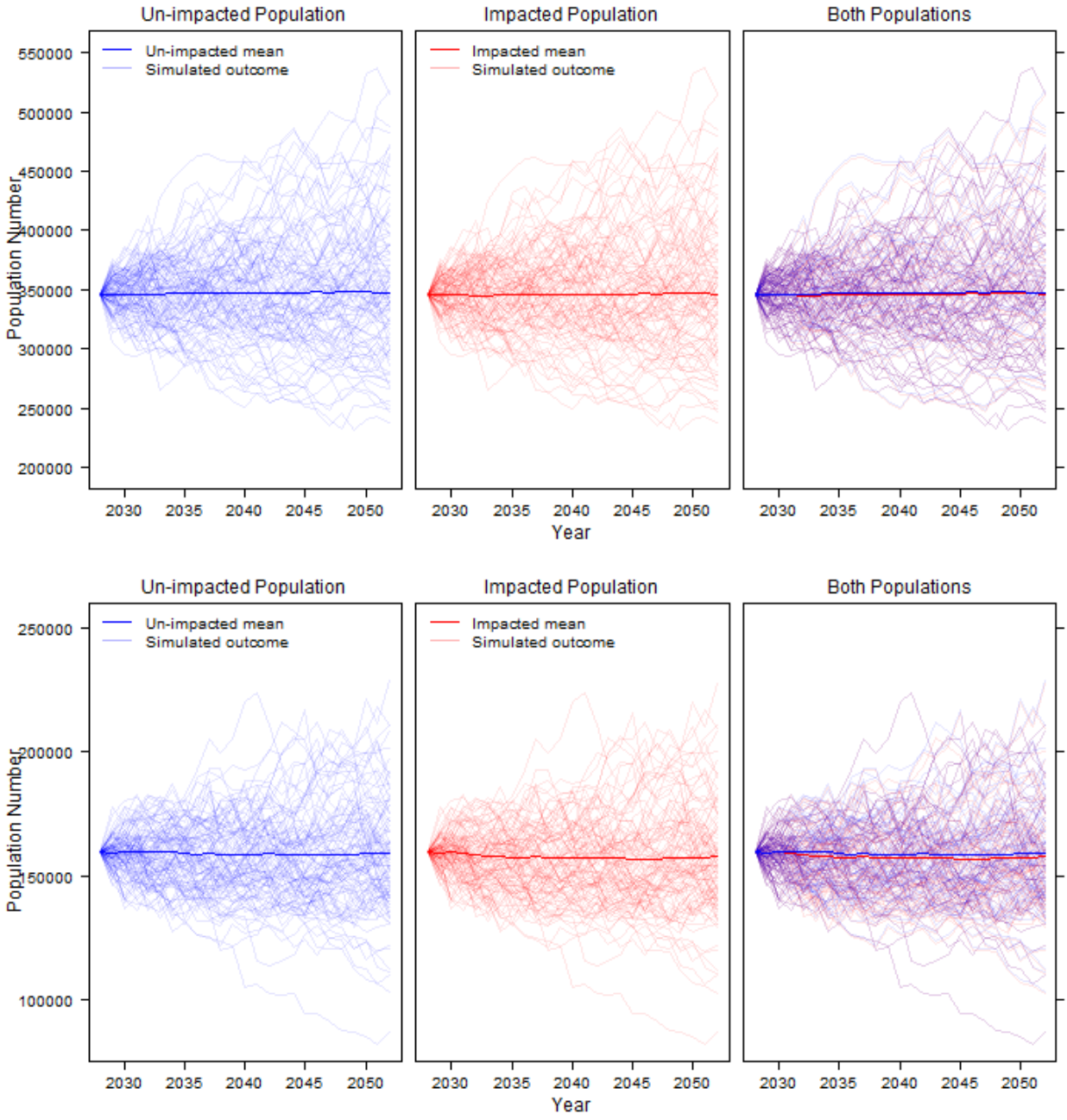

Figure 1-3: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (top graph – NS MU and bottom graph – UK portion of the NS MU; Sequential Construction Scenario with no gap)

Maximum Gap (Five Years)

1.5.2.3 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU, shows that the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 98.74 – 100.0% of the size of the un-impacted population. In the year 2037, a year after the piling finishes at the Caledonia South Site, the impacted population size as a proportion of the unimpacted population size is at its lowest (98.74%) for the UK portion of the North Sea MU, but for the whole North Sea MU this proportion remains higher (99.57%) (Table 1-10 and Figure 1-4).

Table 1-10: Results of iPCoD modelling for harbour porpoise (whole NS MU and the UK portion of the NS MU, Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
NS MU			
2027	346,602	346,602	100.00%
2028	346,560	346,560	100.00%
2029	346,388	346,341	99.99%
2030	346,447	346,320	99.96%
2031	347,204	347,095	99.97%
2034	347,592	347,510	99.98%
2035	347,483	347,318	99.95%
2036	347,480	346,319	99.67%
2037	347,372	345,868	99.57%
2038	347,382	346,094	99.63%
2043	346,121	344,977	99.67%
2049	345,809	344,668	99.67%
2052	345,904	344,763	99.67%
UK portion of the NS MU			
2027	159,634	159,634	100.00%
2028	159,669	159,669	100.00%

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2029	159,991	159,915	99.95%
2030	160,546	160,363	99.89%
2031	160,412	160,258	99.90%
2034	160,310	160,190	99.93%
2035	159,982	159,746	99.85%
2036	159,883	158,333	99.03%
2037	160,126	158,101	98.74%
2038	160,129	158,392	98.92%
2043	159,375	157,851	99.04%
2049	159,244	157,731	99.05%
2052	158,978	157,465	99.05%
Note, time point descriptions are provided in Table 1-4.			

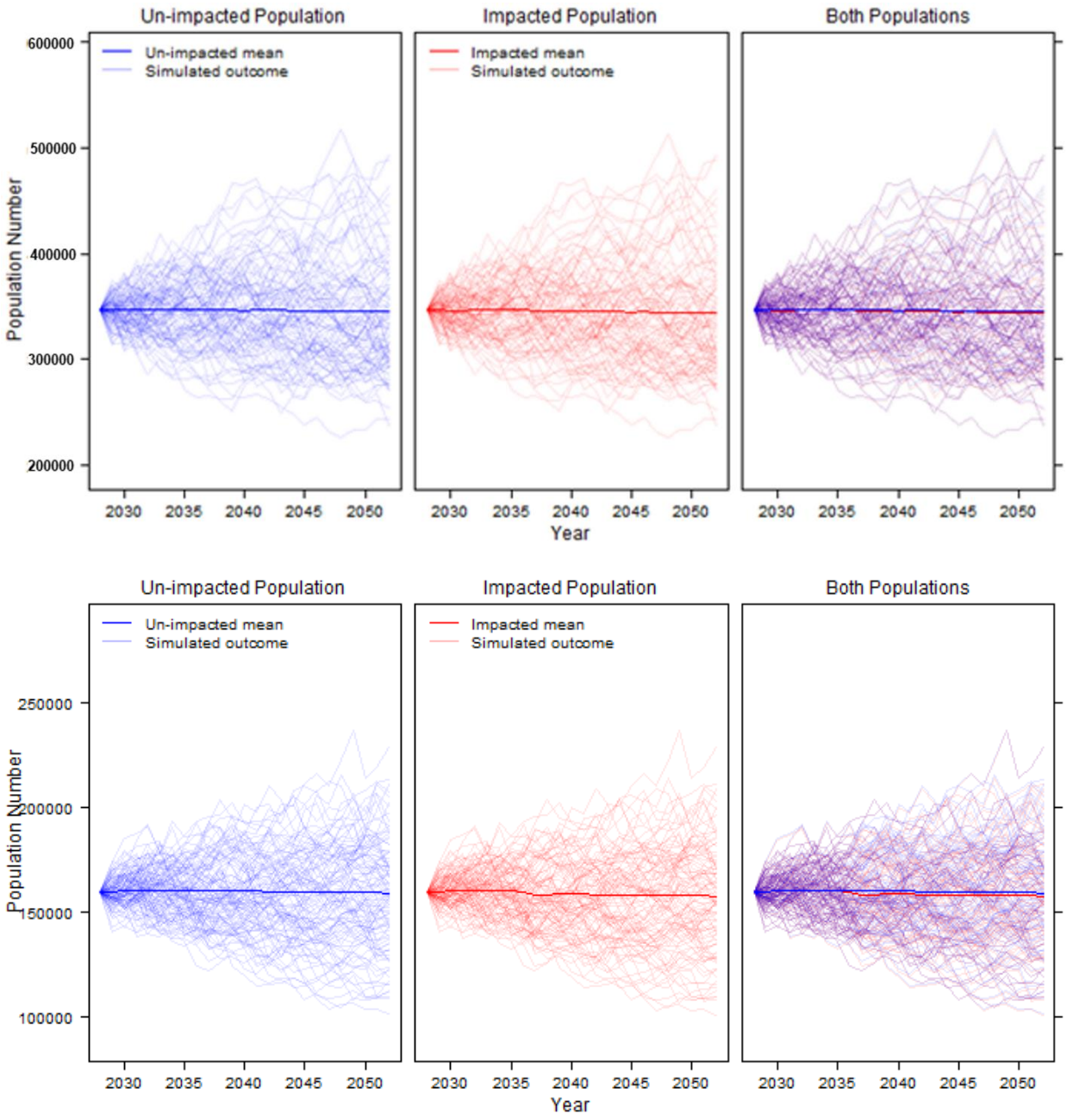

Figure 1-4: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (top graph – NS MU and bottom graph – UK portion of the NS MU; Sequential Construction Scenario with five year gap).

1.5.3 Cumulative Impact

Number of Animals Impacted

1.5.3.1 For the cumulative concurrent and sequential construction scenarios, the disturbance numbers for harbour porpoise used in the modelling are presented in Table 1-11.

Table 1-11: The number of harbour porpoise predicted to be disturbed for each project, based on either the project-specific values presented in respective EIARs or calculated based on the EDRs and SCANS IV densities.

Project	Number Animals Impacted	Data Source
Projects with piling schedules available in the public domain		
Berwick Bank	2,822 (WTG) / 1,754 (OSP)	EIA (RPS, 2022[8])
Ossian	3,856 (WTG) / 7,309 (OSP)	EIA (RPS, 2024[9])
Salamander	12,366	EIA (Salamander Offshore Wind Farm, 2023[10])
Green Volt	5,208	EIA (Royal HaskoningDHV, 2023[11])
Projects without piling schedules available in the public domain		
Ayre	199	SCANS IV & EDR
Broadshore	364	SCANS IV & EDR
Buchan	364	SCANS IV & EDR
Cenos	735	SCANS IV & EDR
Morven	1,271	SCANS IV & EDR
Muir Mhòr	423	SCANS IV & EDR
Sinclair	364	SCANS IV & EDR
Bellrock	423	SCANS IV & EDR

Time Points

1.5.3.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-12.

Table 1-12: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the NS MU for harbour porpoise.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for harbour porpoise within the NS MU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for harbour porpoise within the NS MU
	2036	6-years after piling ends at the Proposed Development (Offshore), piling at projects considered for harbour porpoise within the NS MU
	2038	8-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for harbour porpoise within the NS MU
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 4-years after piling has ended at all projects considered for harbour porpoise within the NS MU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 10-years after piling has ended at all projects considered for harbour porpoise within the NS MU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for harbour porpoise within the NS MU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for harbour porpoise within the NS MU
	2032	End of final year of piling at the Proposed Development (Offshore), piling at projects

Scenario	Time Points Selected (Indicative Year)	Time Point Description
		considered for harbour porpoise within the NS MU
	2038	6-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for harbour porpoise within the NS MU
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 6-years after piling has ended at all projects considered for harbour porpoise within the NS MU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for harbour porpoise within the NS MU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Cumulative Concurrent Construction Scenario

1.5.3.3 The results of cumulative iPCoD modelling show that impacted NS MU population is predicted to continue at a stable trajectory and at 98.3 – 99.9% of the size of the un-impacted population. In the year 2038, 8-years after piling at the Caledonia OWF ends, the impacted population size as a proportion of the unimpacted population size reaches its lowest (98.28%), which coincides with the end of piling at projects screened in for the cumulative iPCoD for this MU (Figure 1-5 and Table 1-13).

Table 1-13: Results of cumulative iPCoD modelling for harbour porpoise (NS MU, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	346,602	346,602	100.00%
2028	346,410	345,279	99.67%
2030	345,925	341,603	98.75%
2036	345,418	339,614	98.32%
2038	345,812	339,879	98.28%
2042	345,560	339,708	98.31%
2048	346,665	340,773	98.30%
2050	346,557	340,679	98.30%
Note, time point descriptions are provided in Table 1-12.			

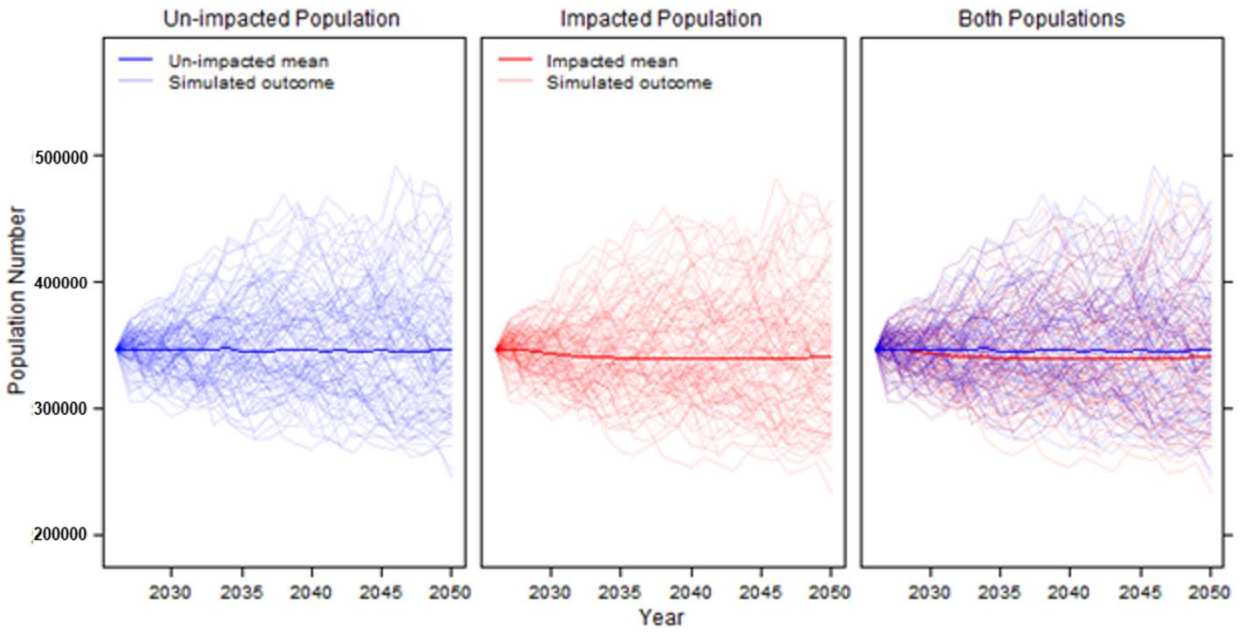

Figure 1-5: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations (NS MU, Cumulative Concurrent Construction Scenario).

Cumulative Sequential Construction Scenario (no gap)

1.5.3.4 The results of cumulative iPCoD modelling show that the impacted NS MU population is predicted to continue at a stable trajectory and at 98.3 – 99.9% of the size of the un-impacted population. In the year 2038, 6-years after piling at the Proposed Development (Offshore) ends, the impacted population size as a proportion of the unimpacted population size reaches its lowest, which coincides with the end of piling at projects screened in for the cumulative iPCoD for this MU (98.36%). The population then continues on a stable trajectory thereafter at a proportion of 98.37% of the unimpacted population size into the year 2044 and 2050 (Table 1-14 and Figure 1-6).

Table 1-14: Results of cumulative iPCoD modelling for harbour porpoise for the whole NS MU (Cumulative Sequential Construction Scenario with no gap). Time point descriptions are provided in Table 1-12.

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	346,602	346,602	100.00%
2028	347,009	345,938	99.69%
2032	347,070	341,412	98.37%
2038	348,858	343,125	98.36%
2044	348,627	342,942	98.37%
2050	348,693	342,995	98.37%

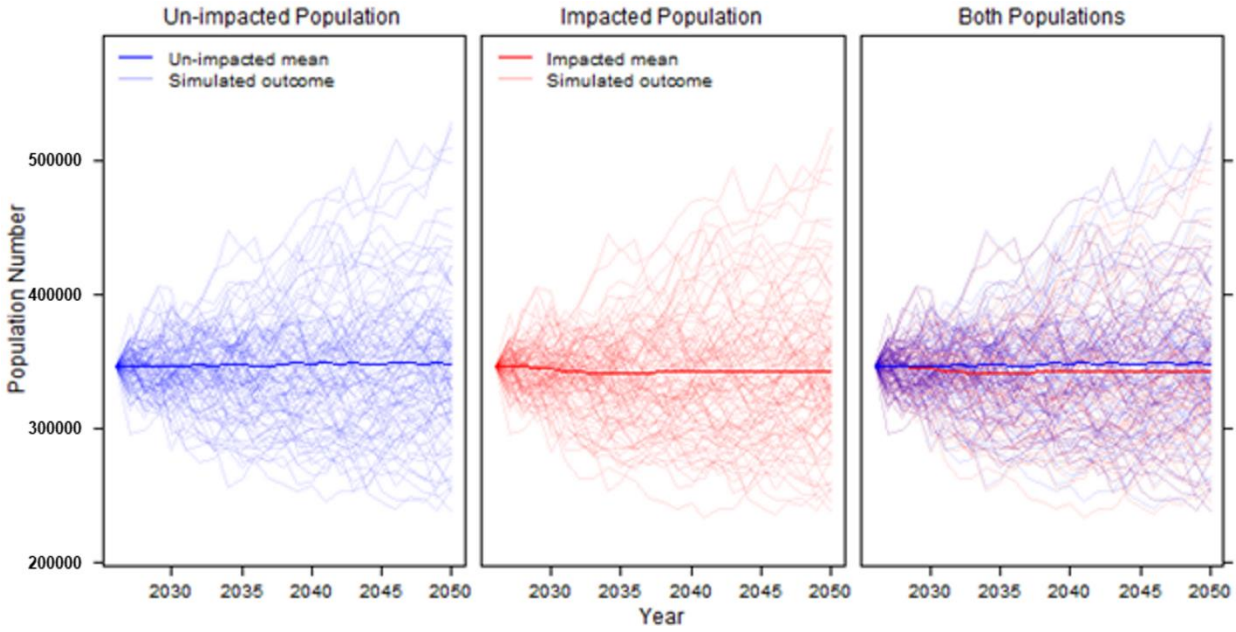

Figure 1-6: Predicted population trajectories for the un-impacted (baseline) and impacted harbour porpoise iPCoD simulations for the whole NS MU (Cumulative Sequential Construction Scenario no gap).

1.6 Bottlenose Dolphin

1.6.1 Concurrent Construction

1.6.1.1 For the concurrent construction scenario, where both Caledonia North and Caledonia South will be installed within the same timeframe at random distribution, the disturbance numbers used in the modelling were based on the worst case (single piling) across all modelling locations:

- Modelling for the CES MU:
  - 52 bottlenose dolphin per day for installation of pin piles at jackets; and
  - 46 bottlenose dolphin per day for installation of pin piles at anchors.
- Modelling for the GNS MU:
  - 35 bottlenose dolphin per day for installation of pin piles at jackets; and
  - 27 bottlenose dolphin per day for installation of pin piles at anchors.

CES MU

1.6.1.2 The results of the iPCoD modelling show that for CES MU, although the level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, and at 92.3 – 96.6% of the size of the un-impacted population (Table 1-15 and Figure 1-7).

1.6.1.3 In the year 2030, coinciding with the third and last year of piling at the Caledonia OWF, the impacted population size as a proportion of the unimpacted population size is at its lowest (92.28%) for the CES MU, before increasing back up to 93.89% by 2048.

Table 1-15: Results of iPCoD modelling for bottlenose dolphin for the CES MU (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	244	244	100.00%
2028	253	253	100.00%
2029	262	253	96.56%
2030	272	251	92.28%
2031	282	260	92.81%
2036	349	329	94.27%
2042	435	408	93.79%
2048	540	507	93.89%
Note, time point descriptions are provided in Table 1-4.			

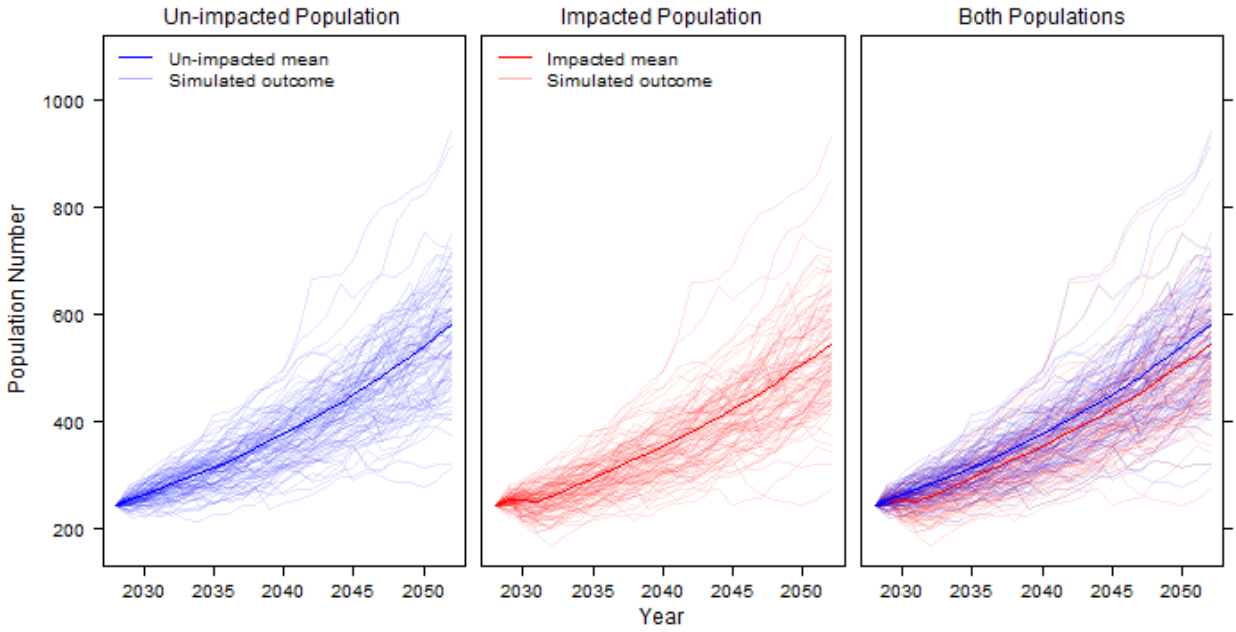

Figure 1-7: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU (Concurrent Construction Scenario).

GNS MU

1.6.1.4 The results of the iPCoD modelling show that for the GNS MU, the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.1 – 99.8% of the size of the un-impacted population (Table 1-16 and Figure 1-8).

Table 1-16: Results of iPCoD modelling for bottlenose dolphin for the GNS MU (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	2,024	2,024	100.00%
2028	2,023	2,023	100.00%
2029	2,015	2,010	99.75%
2030	2,016	1,998	99.11%
2031	2,017	2,001	99.21%
2036	2,025	2,014	99.46%
2042	2.029	2,016	99.36%
2048	2,024	2,011	99.36%
Note, time point descriptions are provided in Table 1-4.			

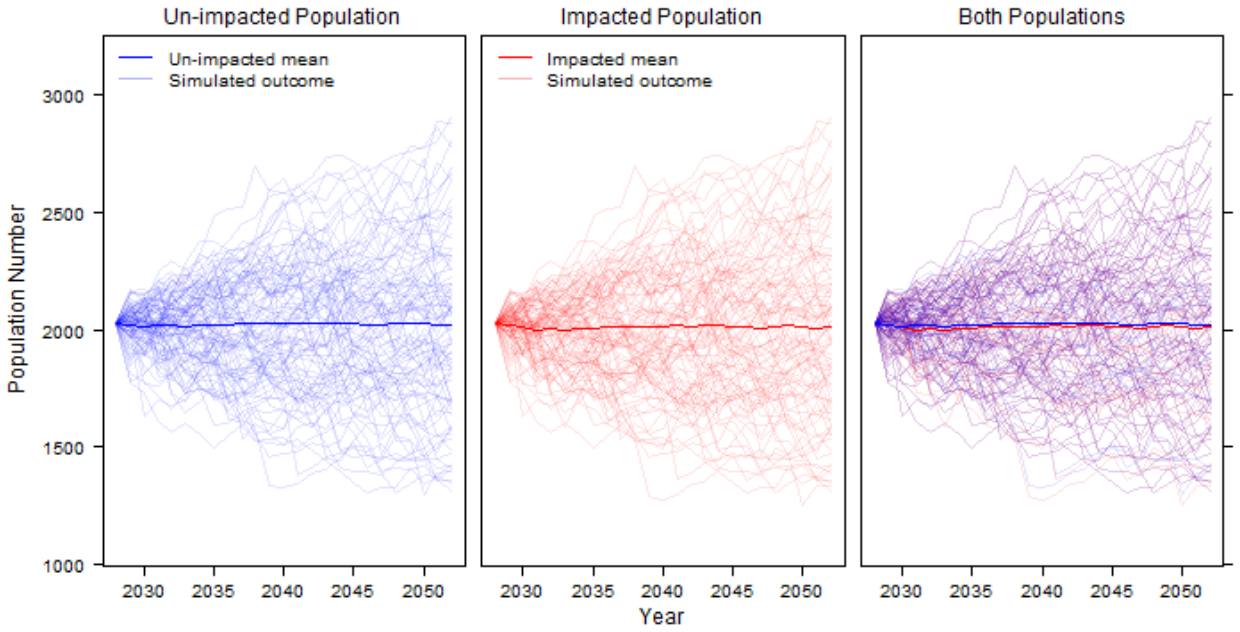

Figure 1-8: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU (Concurrent Construction Scenario).

1.6.2 Sequential Construction

1.6.2.1 For sequential construction scenario, where Caledonia North and Caledonia South will be installed sequentially with either with no gap or a five year gap, between the completion of installation in the Caledonia North Site and the commencement of installation in the Caledonia South Site, the disturbance values used in the modelling were based on the worst case (single piling) across modelling locations in the Caledonia North Site and modelling locations in the Caledonia South Site, e.g.:

- Modelling for the CES MU:
  - 48 bottlenose dolphin per day for installation of pin piles at jackets in the Caledonia North Site;
  - 52 bottlenose dolphin per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 46 bottlenose dolphin per day for installation of pin piles at anchors (Caledonia South Site).
- Modelling for the GNS MU:
  - 30 bottlenose dolphin per day for installation of pin piles at jackets in the Caledonia North Site;
  - 35 bottlenose dolphin per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 27 bottlenose dolphin per day for installation of pin piles at anchors (Caledonia South Site).

No Gap

CES MU

1.6.2.2 The results of the iPCoD modelling show that for CES MU, during the first phase of construction at Caledonia North (2028 to 2030), the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, and at 97.0 – 100.00% of the size of the un-impacted population. During the second phase of construction at Caledonia South (2030 to 2032), the impacted population is predicted to reduce in size when compared to the un-impacted population (e.g., the impacted population size is 91.47% of the size of the unimpacted population in 2032).

1.6.2.3 Although the overall level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, and at 92.3 – 93.8% of the size of the un-impacted population between 2033 – 2050 (Table 1-17 and Figure 1-9).

Table 1-17: Results of iPCoD modelling for bottlenose dolphin for the CES MU (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	244	244	100.00%
2028	253	253	100.00%
2029	263	260	98.86%
2030	273	265	97.07%
2031	283	263	92.92%
2032	293	268	91.47%
2033	303	280	92.41%
2038	364	342	93.96%
2044	451	423	93.79%
2050	559	524	93.74%
Note, time point descriptions are provided in Table 1-4.			

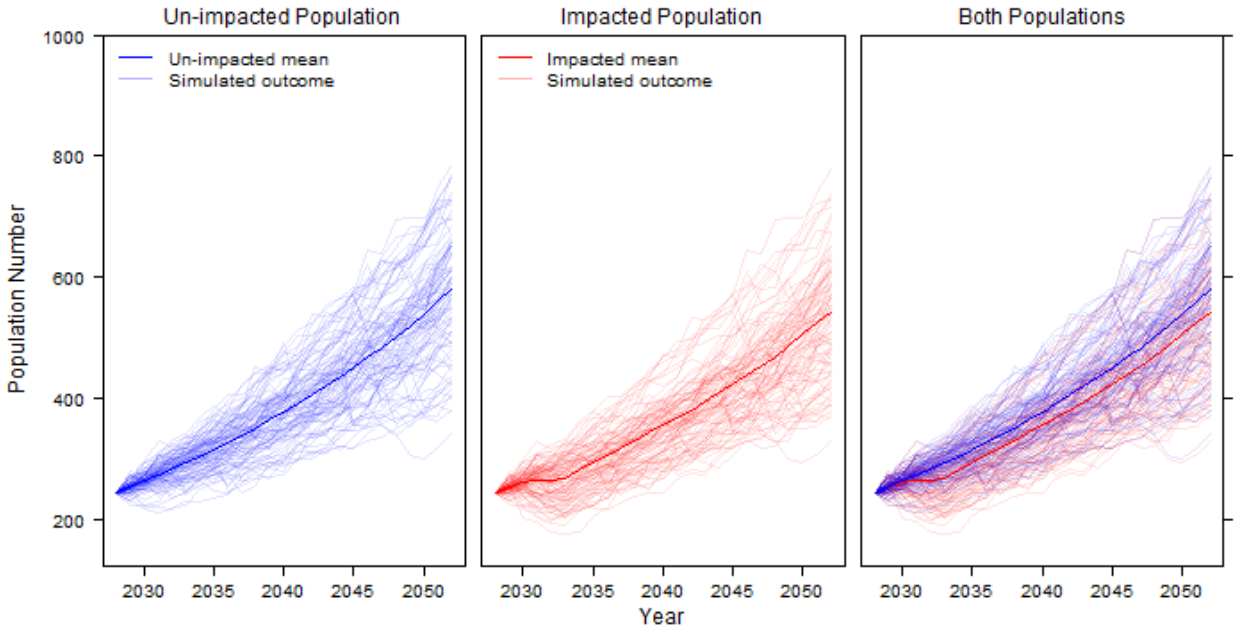

Figure 1-9: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU (Sequential Construction Scenario with no gap).

GNS MU

1.6.2.4 The results of the iPCoD modelling show that for the GNS MU, the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.3 – 100.0% of the size of the un-impacted population (Table 1-18 and Figure 1-10).

Table 1-18: Results of iPCoD modelling for bottlenose dolphin for the GNS MU (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	2,024	2,024	100.00%
2028	2,022	2,022	100.00%
2029	2,026	2,023	100.00%
2030	2,029	2,028	99.95%
2031	2,024	2,013	99.46%
2032	2,020	2,007	99.36%
2033	2,019	2,007	99.41%
2038	2,017	2,008	99.55%
2044	2,024	2,013	99.46%
2050	2,027	2,016	99.46%
Note, time point descriptions are provided in Table 1-4.			

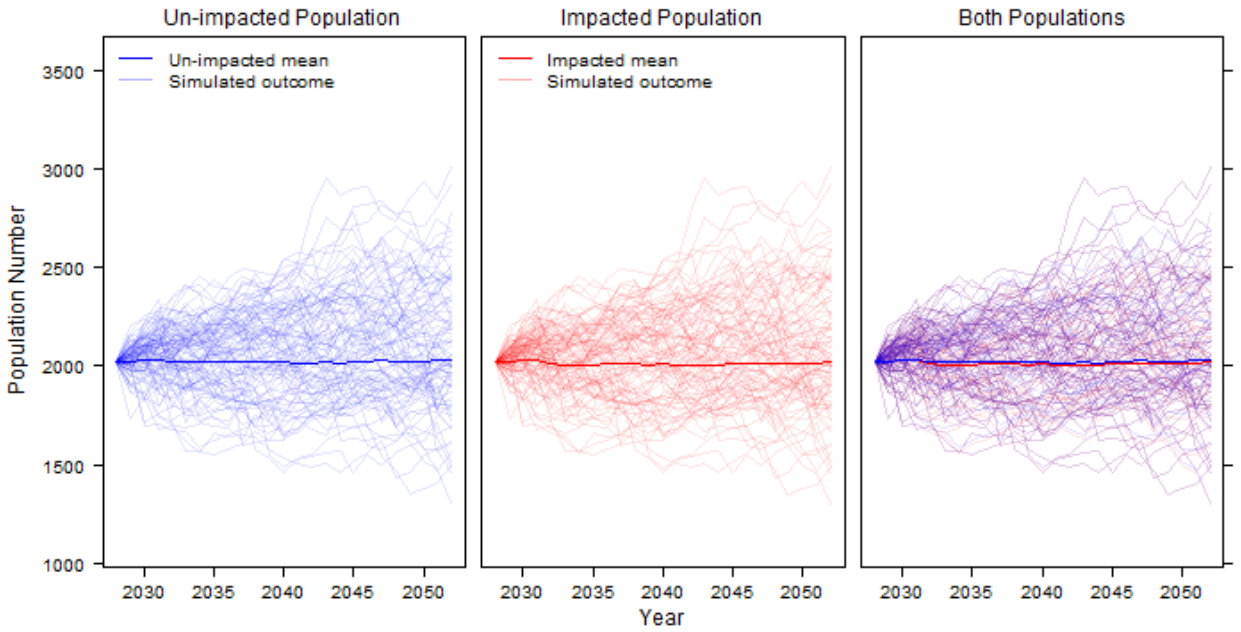

Figure 1-10: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU (Sequential Construction Scenario with no gap).

Maximum Gap (Five Years)

CES MU

1.6.2.5 The results of the iPCoD modelling show that for CES MU, during the first phase of construction at Caledonia North (2028 to 2030), the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, and at 97.8 – 100.00% of the size of the un-impacted population. During the second phase of construction at Caledonia South (2035 to 2037), the impacted population is predicted to be reduced in size when compared to the un-impacted population (e.g., the impacted population size is at 90.54% of the size of the unimpacted population in 2037, coinciding with the third and last year of piling at the Caledonia South Site).

1.6.2.6 Although the overall level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, and at 92.5 – 92.8% of the size of the un-impacted population between 2038 – 2052 (Table 1-19 and Figure 1-11).

Table 1-19: Results of iPCoD modelling for bottlenose dolphin for the CES MU (Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	244	244	100.00%
2028	253	253	100.00%
2029	263	259	98.85%
2030	272	265	97.79%
2031	281	276	98.22%
2034	312	307	98.40%
2035	324	313	96.60%
2036	336	309	91.96%
2037	349	316	90.54%
2038	362	330	91.16%
2043	432	401	92.82%
2049	536	496	92.54%
2052	595	551	92.61%
Note, time point descriptions are provided in Table 1-4.			

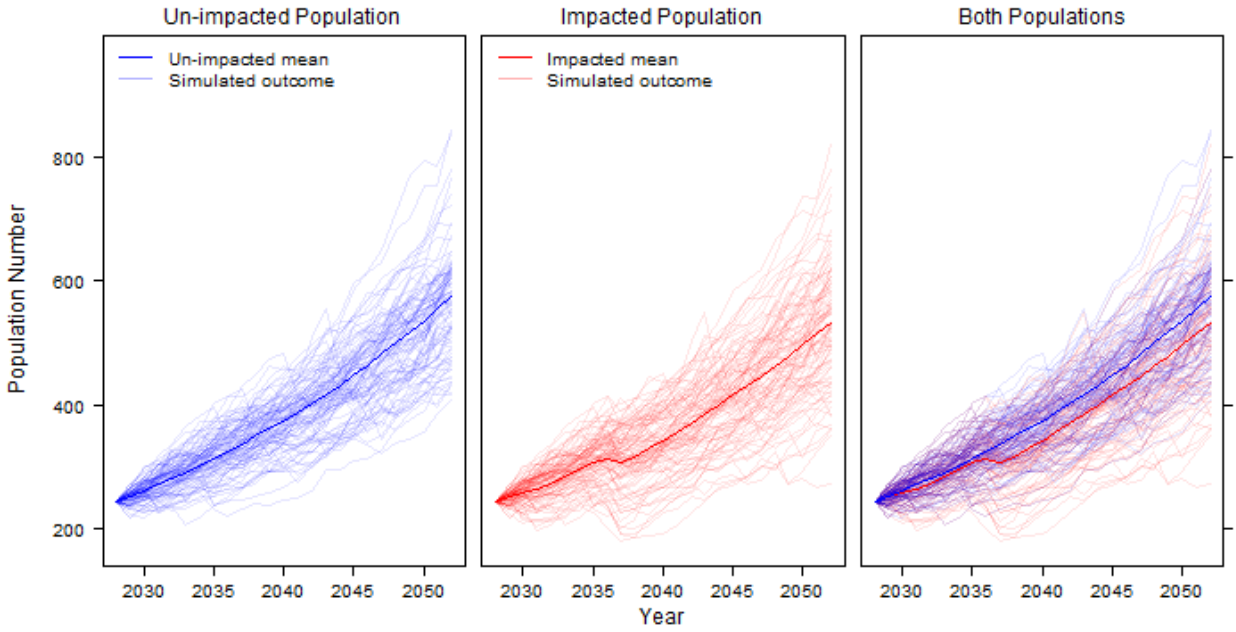

Figure 1-11: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU (Sequential Construction Scenario with five year gap).

GNS MU

1.6.2.7 The results of the iPCoD modelling show that for the GNS MU, the level of disturbance is not sufficient to result in any changes at the population level, since the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.3 – 100.0% of the size of the un-impacted population (Table 1-20 and Figure 1-12).

Table 1-20: Results of iPCoD modelling for bottlenose dolphin for the GNS MU (Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	2,024	2,024	100.00%
2028	2,022	2,022	100.00%
2029	2,023	2,023	100.00%
2030	2,022	2,022	100.00%
2031	2,020	2,020	100.00%
2034	2,032	2,032	100.00%
2035	2,035	2,035	100.00%
2036	2,036	2,024	99.41%
2037	2,039	2,025	99.31%

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2038	2,038	2,025	99.36%
2043	2,035	2,024	99.46%
2049	2,036	2,025	99.46%
2052	2,036	2,025	99.46%
Note, time point descriptions are provided in Table 1-4.			

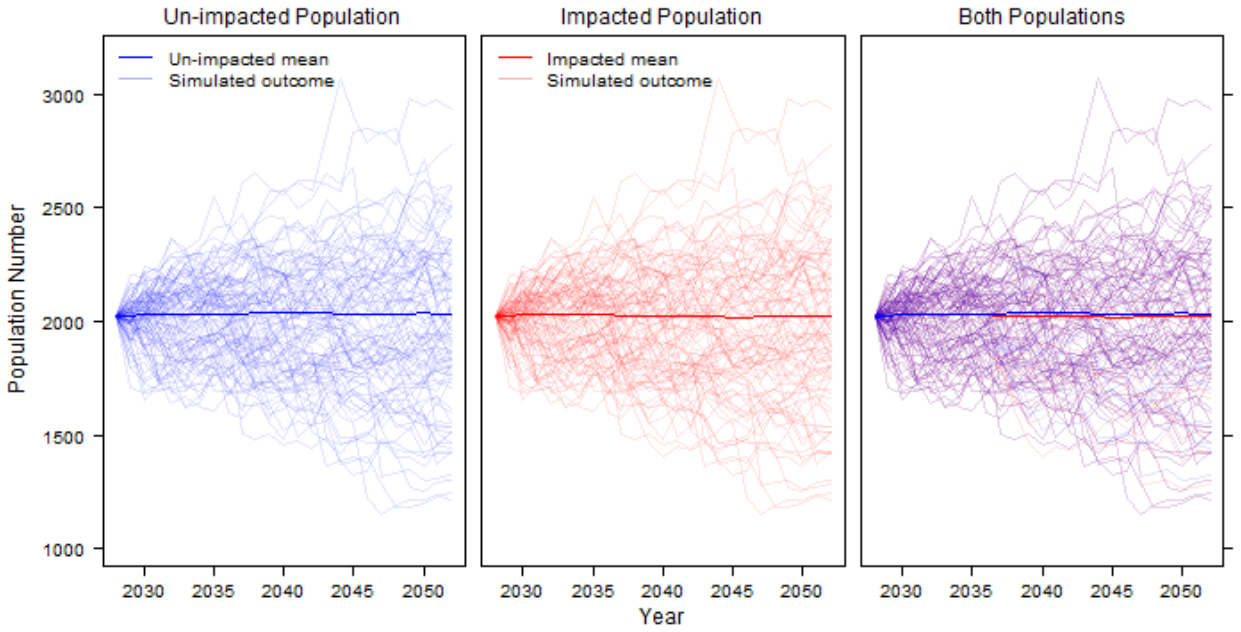

Figure 1-12: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU (Sequential Construction Scenario with five year gap).

1.6.3 Cumulative Impact

Number of Animals Impacted

1.6.3.1 For cumulative concurrent and sequential construction scenarios, the disturbance numbers for bottlenose dolphin used in the modelling are presented in Table 1-21.

Table 1-21: The number of bottlenose dolphin predicted to be disturbed for each project, based on either the project-specific values presented in respective EIARs or calculated based on the EDRs and SCANS IV densities.

Project	Number Animals Impacted	Data Source
CES MU		
Berwick Bank	5 (WTG) / 4 (OSP)	EIAR (RPS, 2022[8])
Ossian	2 (WTG) / 4 (OSP)	EIAR (RPS, 2024[9])
Salamander	27	EIAR (Salamander Offshore Wind Farm, 2023[10])
GNS MU		
Berwick Bank	102 (WTG) / 64 (OSP)	EIAR (RPS, 2022[8])
Green Volt	204	EIAR (Royal HaskoningDHV, 2023[11])

Time Points

1.6.3.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-22 and Table 1-23 for the CES MU and GNS MU, respectively.

Table 1-22: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the CES MU for bottlenose dolphin.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the CES MU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the CES MU
	2036	6-years after piling ends at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the CES MU
	2038	8-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for bottlenose dolphin within the CES MU

Scenario	Time Points Selected (Indicative Year)	Time Point Description
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 4-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 10-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the CES MU
	2032	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the CES MU
	2038	6-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for bottlenose dolphin within the CES MU
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 6-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for bottlenose dolphin within the CES MU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Table 1-23: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the GNS MU for bottlenose dolphin.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the GNS MU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the GNS MU
	2031	1-year after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for bottlenose dolphin within the GNS MU
	2036	6-years after piling ends at the Proposed Development (Offshore) and 5-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 11-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 17-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 19-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for bottlenose dolphin within the GNS MU
	2031	End of 4th year of piling at the Proposed Development (Offshore) and the end of piling at projects considered for bottlenose dolphin within the GNS MU
	2032	End of final year of piling at the Proposed Development (Offshore) and 1-year after piling has ended at all

Scenario	Time Points Selected (Indicative Year)	Time Point Description
		projects considered for bottlenose dolphin within the GNS MU
	2038	6-years after piling ends at the Proposed Development (Offshore) and 7-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 11-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 19-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Cumulative Concurrent Construction Scenario

CES MU

1.6.3.3 The results of the cumulative iPCoD modelling show that for CES MU in the year 2030, the impacted population size as a proportion of the unimpacted population size is at its lowest (91.13%) for the CES MU, which coincides with the final year of piling at the Caledonia OWF, before increasing back up to 93.11% by 2036. Although the overall level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on an increasing trajectory, the same as the un-impacted population, at 92.9 – 93.1% of the size of the un-impacted population through to 2050 (Figure 1-13 and Table 1-24).

Table 1-24: Results of cumulative iPCoD modelling for bottlenose dolphin (CES MU, Cumulative Concurrent Construction Scenario). Time point descriptions are provided in Table 1-22.

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	244	244	100.00%
2028	272	269	98.90%
2030	293	267	91.13%
2036	363	338	93.11%
2038	390	364	93.33%
2042	451	419	92.90%
2048	559	520	93.02%
2050	602	560	93.02%
Note, time point descriptions are provided in Table 1-22.			

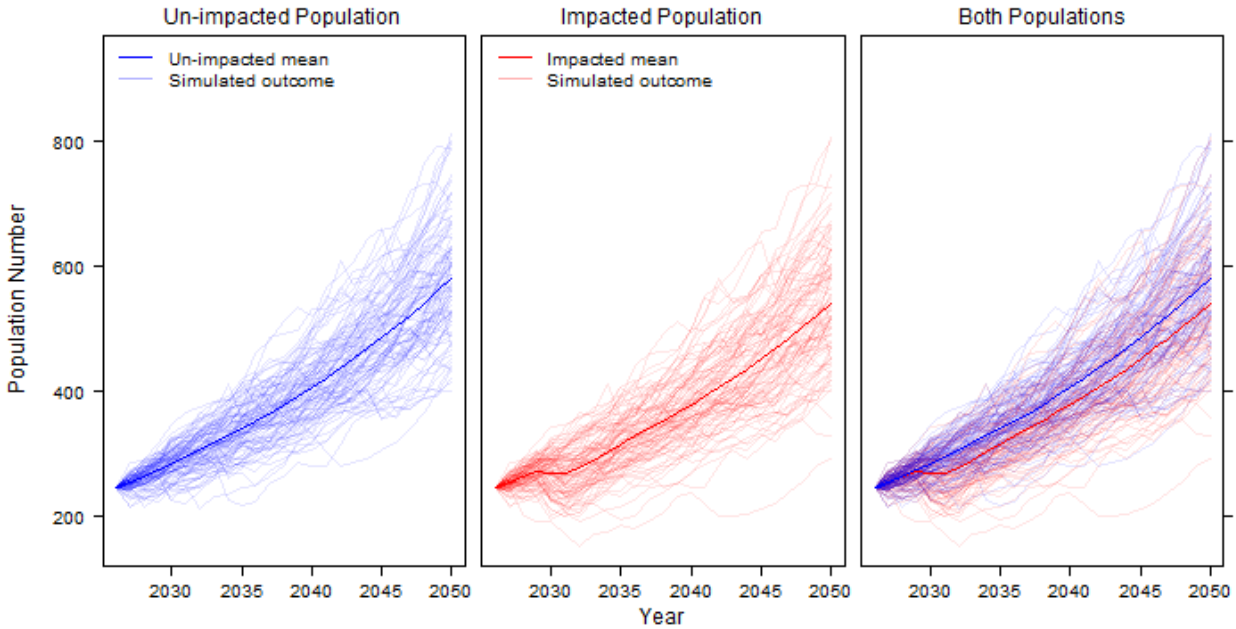

Figure 1-13: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU (Cumulative Concurrent Construction Scenario).

GNS MU

1.6.3.4 The results of the cumulative iPCoD modelling show that for GNS MU, although the level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on a stable trajectory at 97.87 – 97.97% of the size of the un-impacted

population between 2031 – 2050 (Table 1-25 and Figure 1-14). The impacted population size as a proportion of the unimpacted population size reaches its lowest in 2048 (97.87%), 18-years after piling has ended at the Proposed Development (Offshore) and 17-years after piling has ended at all projects considered for bottlenose dolphin within the GNS MU.

Table 1-25: Results of cumulative iPCoD modelling for bottlenose dolphin (GNS MU, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	2,024	2,024	100.00%
2028	2,029	2,001	98.62%
2030	2,028	1,987	97.98%
2031	2,023	1,982	97.97%
2036	2,032	1,989	97.88%
2042	2,026	1,983	97.88%
2048	2,023	1,980	97.87%
2050	2,025	1,983	97.93%
Note, time point descriptions are provided in Table 1-23.			

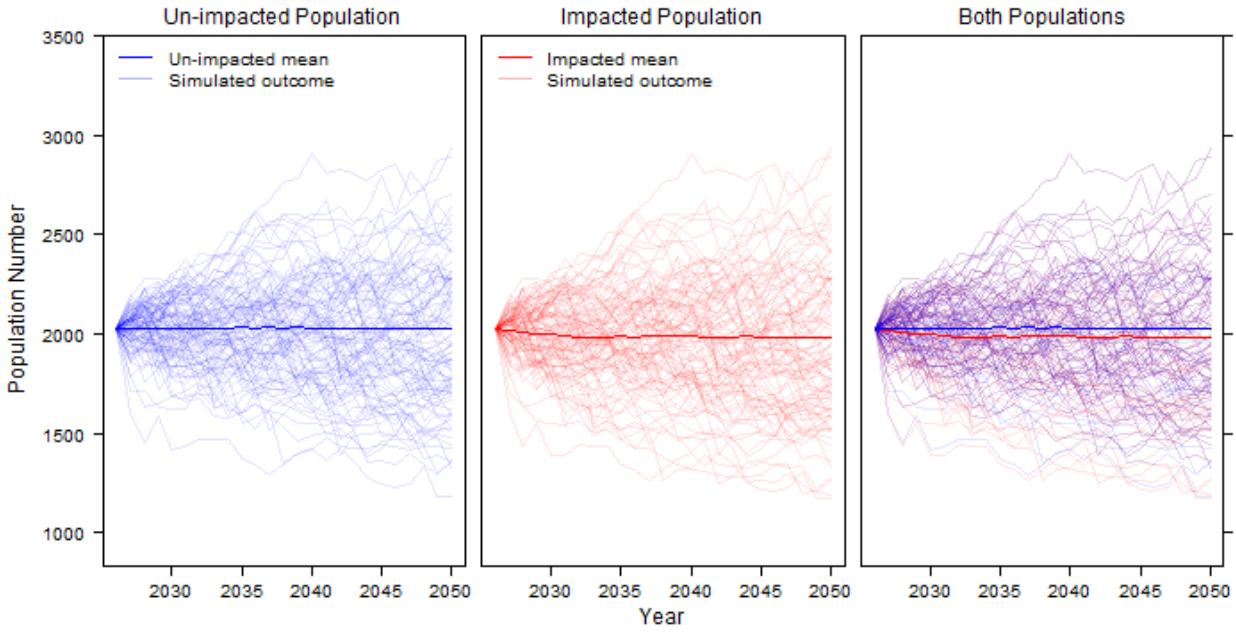

Figure 1-14: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU (Cumulative Concurrent Construction Scenario).

Cumulative Sequential Construction Scenario (No Gap)

CES MU

1.6.3.5 The results of the cumulative iPCoD modelling show that for CES MU in the year 2032, the impacted population size as a proportion of the unimpacted population size is at its lowest (91.08%) for the CES MU, which coincides with final year of piling at the Caledonia OWF, before increasing back up to 93.33% by 2038. The impacted population is then predicted to continue on an increasing trajectory, the same as the un-impacted population, at 92.7 – 93.1% of the size of the un-impacted population through to 2050 (Figure 1-15 and Table 1-26).

Table 1-26: Results of cumulative iPCoD modelling for bottlenose dolphin (CES MU, Cumulative Sequential Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	244	244	100.00%
2028	272	269	98.90%
2032	314	286	91.08%
2038	390	364	93.33%
2044	483	449	92.69%
2050	595	554	93.11%
Note, time point descriptions are provided in Table 1-22.			

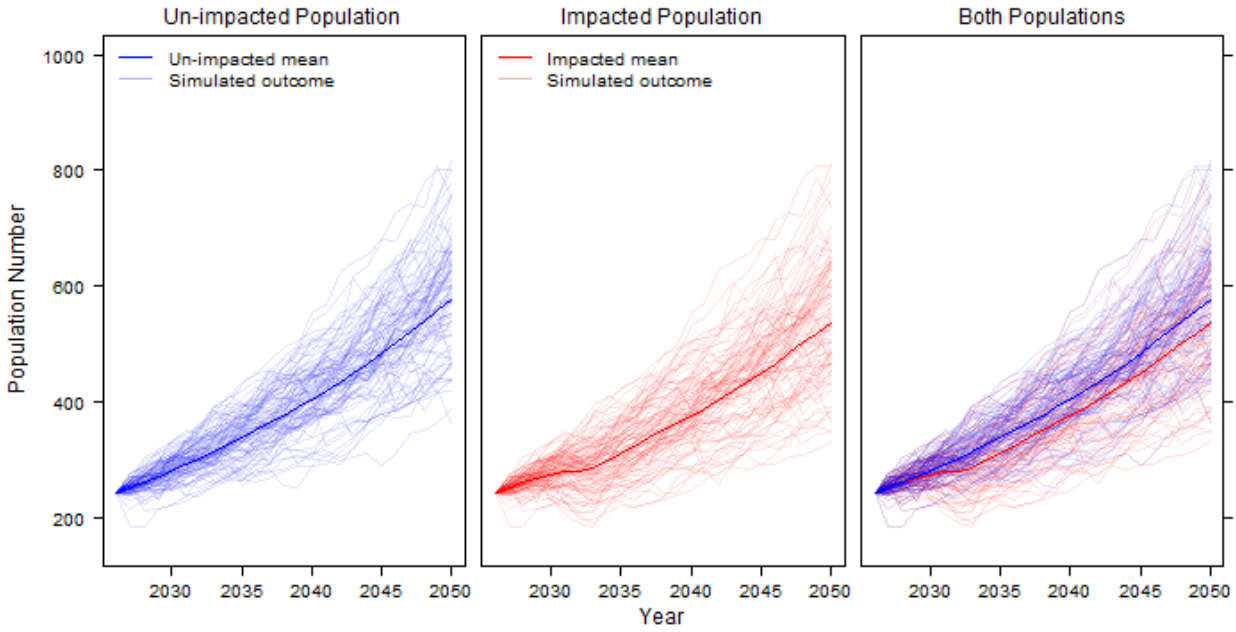

Figure 1-15: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the CES MU (Cumulative Sequential Construction Scenario with no gap).

GNS MU

1.6.3.6 The results of the cumulative iPCoD modelling show that for GNS MU, although the level of disturbance has the potential to result in changes at the population level, the impacted population is predicted to continue on a stable trajectory at 97.49 – 97.78% of the size of the un-impacted population between 2033 – 2050 (Table 1-27 and Figure 1-16). In the year 2032, the impacted population size as a proportion of the unimpacted population size reaches its lowest (97.24%), which coincides with final year of piling at the Caledonia OWF.

Table 1-27: Results of cumulative iPCoD modelling for bottlenose dolphin (GNS MU, Cumulative Sequential Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	2,024	2,024	100.00%
2028	2,022	1,991	98.47%
2031	2,033	1,989	97.84%
2032	2,030	1,974	97.24%
2038	2,029	1,984	97.78%
2044	2,025	1,977	97.63%
2050	2,025	1,977	97.63%
Note, time point descriptions are provided in Table 1-23.			

Figure 1-16: Predicted population trajectories for the un-impacted (baseline) and impacted bottlenose dolphin iPCoD simulations for the GNS MU (Cumulative Sequential Construction Scenario with no gap).

1.7 Minke Whale

1.7.1 Concurrent Construction

1.7.1.1 For concurrent construction scenario, where both Caledonia North and Caledonia South will be installed within the same timeframe at random distribution, the disturbance numbers used in the modelling were based on the worst case (single piling) across all modelling locations:

- Modelling for the whole NS MU:
  - 502 minke whale per day for installation of pin piles at jackets; and
  - 415 minke whales per day for installation of pin piles at anchors.
- Modelling for the UK proportion of the NS MU:
  - 496 minke whale per day for installation of pin piles at jackets; and
  - 413 minke whales per day for installation of pin piles at anchors.

1.7.1.2 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The results of the iPCoD modelling for both the whole MU and the UK portion of the MU suggest that the impacted population is predicted to continue at a stable trajectory and at 99.9 – 100% of the size of the un-impacted population (Table 1-28 and Figure 1-17).

Table 1-28: Results of iPCoD modelling for minke whale (whole NS MU and the UK portion of the NS MU, Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
CGNS MU			
2027	20,120	20,120	100.00%
2028	20,066	20,066	100.00%
2029	20,030	20,030	100.00%
2030	20,041	20,037	99.98%
2031	20,030	20,027	99.99%
2036	20,024	20,024	100.00%
2042	19,928	19,927	99.99%
2048	19,888	19,887	99.99%
UK portion of the GCNS MU			
2027	10,288	10,288	100.00%
2028	10,257	10,257	100.00%
2029	10,254	10,251	99.97%
2030	10,241	10,231	99.90%
2031	10,254	10,246	99.92%
2036	10,221	10,219	99.98%
2042	10,208	10,206	99.98%
2048	10,165	10,163	99.98%
Note, time point descriptions are provided in Table 1-4.			

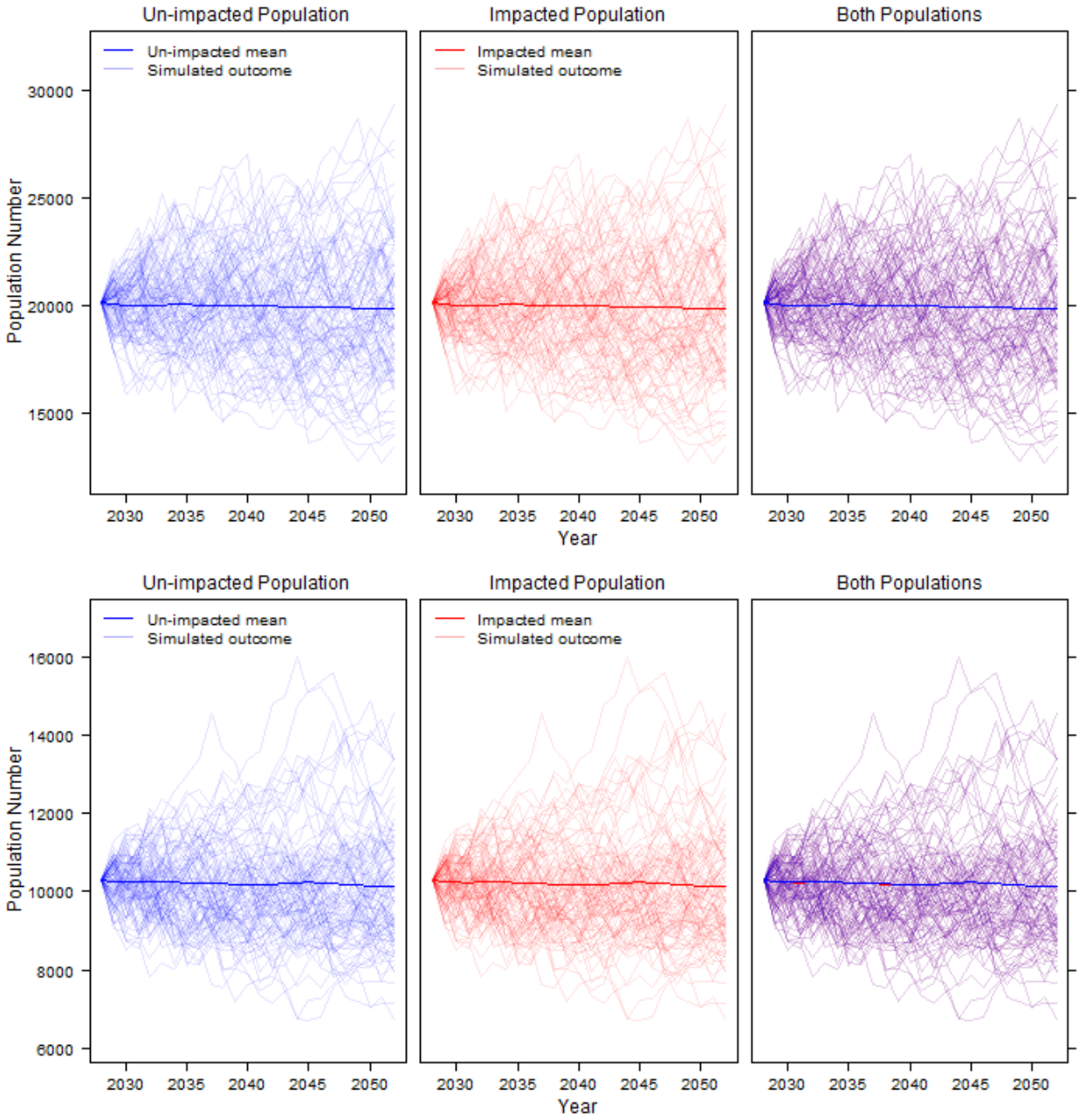

Figure 1-17: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations (whole NS MU and the UK portion of the NS MU, Concurrent Construction Scenario).

1.7.2 Sequential Construction

1.7.2.1 For sequential construction scenario, where Caledonia North and Caledonia South will be constructed sequentially with either with no gap or five year gap between the completion of piling at the Caledonia North Site and the commencement of piling in the Caledonia South Site, the disturbance values used in the modelling were based on the worst case (single piling) across modelling locations in the Caledonia North Site and modelling locations in the Caledonia South Site, i.e.:

- Modelling for the whole NS MU:
  - 458 minke whale per day for installation of pin piles at jackets in the Caledonia North Site;
  - 502 minke whale per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 415 minke whale per day for installation of pin piles at anchors (Caledonia South Site).
- Modelling for the UK proportion of the NS MU:
  - 455 minke whale per day for installation of pin piles at jackets in the Caledonia North Site;
  - 496 minke whale per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 413 minke whale per day for installation of pin piles at anchors (Caledonia South Site).

No Gap

1.7.2.2 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The results of the iPCoD modelling for both the whole MU and the UK portion of the MU suggest that the impacted population is predicted to continue at a stable trajectory and at 99.9-100% of the size of the un-impacted population (Table 1-29 and Figure 1-18).

Table 1-29: Results of iPCoD modelling for minke whale (whole NS MU and the UK portion of the NS MU, Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
CGNS MU			
2027	20,120	20,120	100.00%
2028	20,115	20,115	100.00%
2029	20,097	20,097	100.00%
2030	20,048	20,048	100.00%
2031	20,093	20,092	100.00%
2032	20,084	20,083	100.00%
2033	20,111	20,110	100.00%
2038	20,079	20,079	100.00%
2044	19,912	19,912	100.00%
2050	19,827	19,827	100.00%
UK portion of the GCNS MU			
2027	10,288	10,288	100.00%
2028	10,281	10,281	100.00%
2029	10,290	10,290	100.00%
2030	10,310	10,309	99.99%
2031	10,278	10,272	99.94%
2032	10,264	10,258	99.94%
2033	10,273	10,269	99.96%
2038	10,154	10,153	99.99%
2044	10,104	10,102	99.98%
2050	10,114	10,112	99.98%
Note, time point descriptions are provided in Table 1-4.			

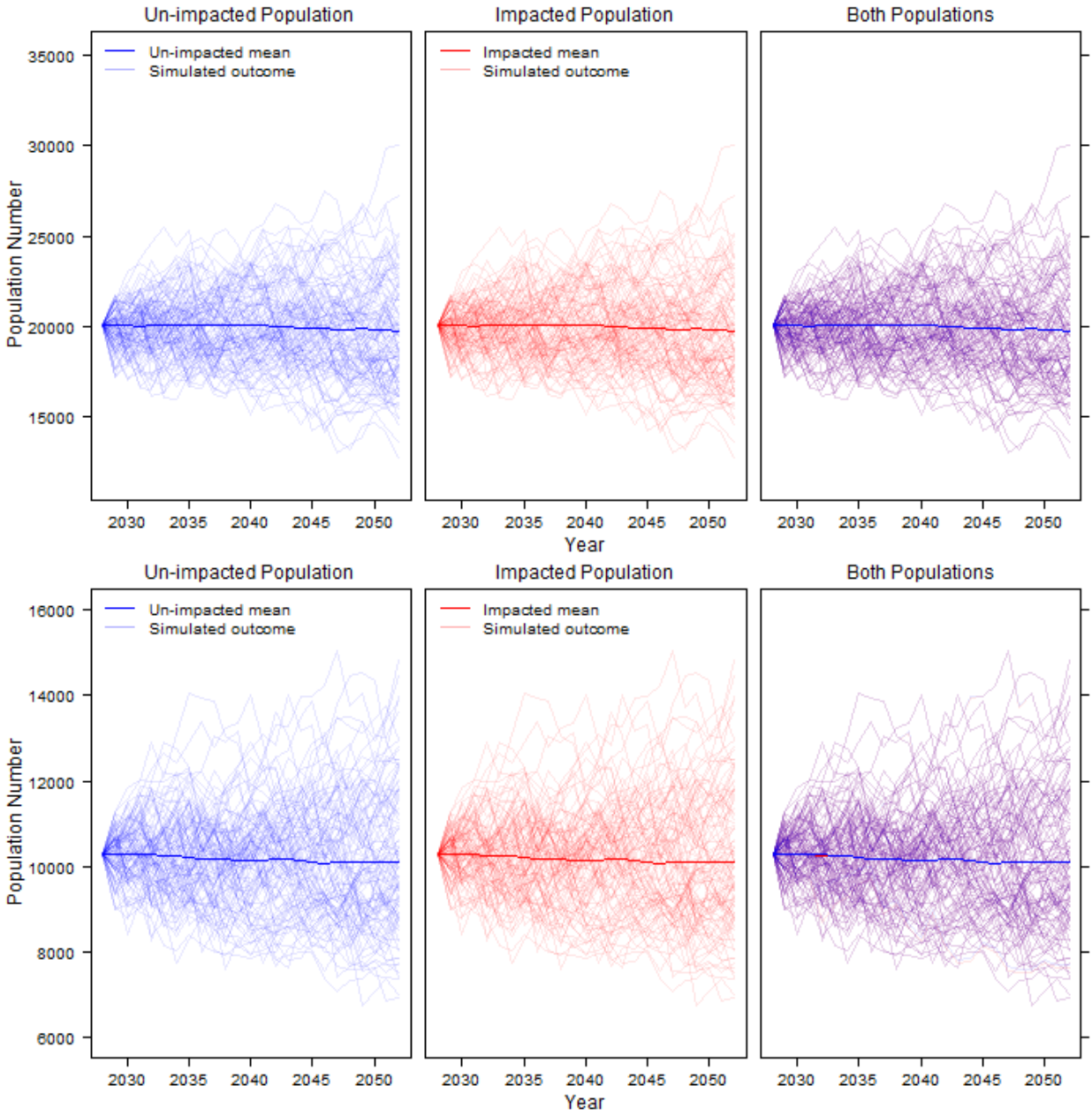

Figure 1-18: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations (top graph – GCNS MU ad bottom graph – UK portion of the GCNS MU; Sequential Construction Scenario with no gap)

Maximum Gap (Five Years)

1.7.2.3 The results of the iPCoD modelling for both the whole MU and the UK portion of the MU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The results of the iPCoD modelling for both the whole MU and the UK portion of the MU suggest that the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.9-100% of the size of the un-impacted population (Table 1-30 and Figure 1-19).

Table 1-30: Results of iPCoD modelling for minke whale (whole NS MU and the UK portion of the NS MU, Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
CGNS MU			
2027	20,120	20,120	100.00%
2028	20,140	20,140	100.00%
2029	20,093	20,093	100.00%
2030	20,080	20,080	100.00%
2031	20,069	20,069	100.00%
2034	20,050	20,050	100.00%
2035	20,034	20,034	100.00%
2036	20,048	20,044	99.98%
2037	20,020	20,015	99.98%
2038	20,039	20,036	99.99%
2043	20,024	20,023	100.00%
2049	19,938	19,937	99.99%
2052	19,872	19,871	99.99%
UK portion of the GCNS MU			
2027	10,288	10,288	100.00%
2028	10,278	10,278	100.00%
2029	10,288	10,288	100.00%

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2030	10,298	10,298	100.00%
2031	10,270	10,270	100.00%
2034	10,321	10,321	100.00%
2035	10,303	10,303	100.00%
2036	10,294	10,288	99.94%
2037	10,303	10,297	99.94%
2038	10,285	10,281	99.96%
2043	10,284	10,283	99.99%
2049	10,269	10,268	99.99%
2052	10,265	10,264	99.99%
Note, time point descriptions are provided in Table 1-4.			

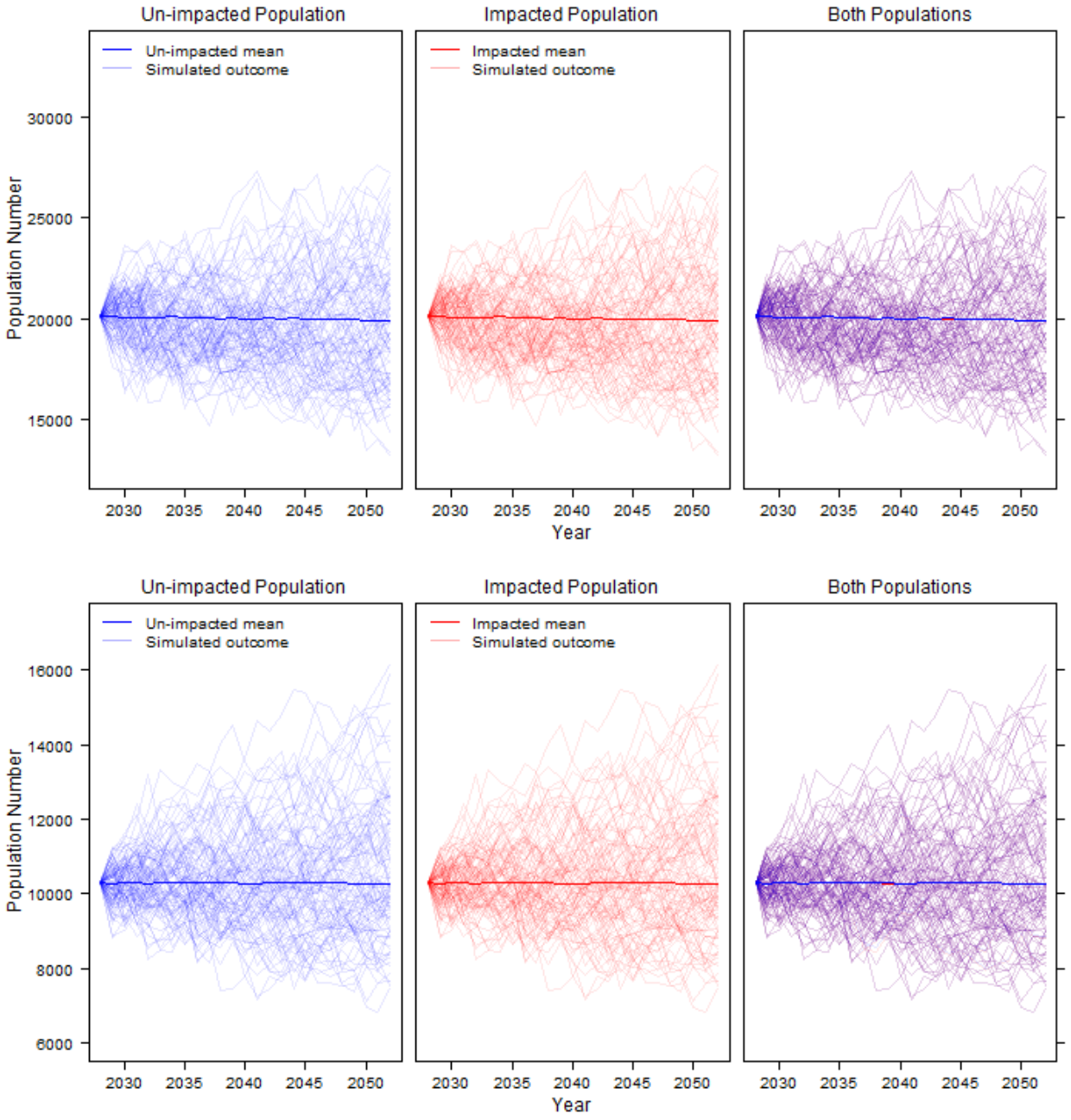

Figure 1-19: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations (top graph – GCNS MU ad bottom graph – UK portion of the GCNS MU; Sequential Construction Scenario with five year gap)

1.7.3 Cumulative Impact

Number of Animals Impacted

1.7.3.1 For cumulative concurrent and sequential construction scenarios, the disturbance numbers for minke whale used in the modelling are presented in Table 1-31.

Table 1-31: The number of minke whale predicted to be disturbed for each project, based on either the project-specific values presented in respective EIARs or calculated based on the EDRs and SCANS IV densities.

Project	Number Animals Impacted	Data Source
Projects with piling schedules available in the public domain		
Berwick Bank	132 (WTG) / 82 (OSP)	EIA (RPS, 2022[8])
Ossian	168 (WTG) / 318 (OSP)	EIA (RPS, 2024[9])
Salamander	1,535	EIA (Salamander Offshore Wind Farm, 2023[10])
West of Orkney	90	EIA (Xodus Group Ltd, 2023[12])
Green Volt	265	EIA (Royal HaskoningDHV, 2023[11])
Projects without piling schedules available in the public domain		
Ayre	8	SCANS IV & EDR
Broadshore	9	SCANS IV & EDR
Buchan	9	SCANS IV & EDR
Cenos	7	SCANS IV & EDR
Morven	89	SCANS IV & EDR
Muir Mhòr	30	SCANS IV & EDR
Sinclair	9	SCANS IV & EDR
Bellrock	30	SCANS IV & EDR
Havbredey	16	SCANS IV & EDR
Spiorad na Mara	63	SCANS IV & EDR

Time Points

1.7.3.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-32.

Table 1-32: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the CGNS MU for minke whale.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for minke whale within the CGNS MU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for minke whale within the CGNS MU
	2036	6-years after piling ends at the Proposed Development (Offshore), piling at projects considered for minke whale within the CGNS MU
	2038	8-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for minke whale within the CGNS MU
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 4-years after piling has ended at all projects considered for minke whale within the CGNS MU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 10-years after piling has ended at all projects considered for minke whale within the CGNS MU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for minke whale within the CGNS MU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for minke whale within the CGNS MU
	2032	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for minke whale within the CGNS MU
	2038	6-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for minke whale within the CGNS MU

Scenario	Time Points Selected (Indicative Year)	Time Point Description
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 6-years after piling has ended at all projects considered for minke whale within the CGNS MU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for minke whale within the CGNS MU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Cumulative Concurrent Construction Scenario

1.7.3.3 The results of the cumulative iPCoD modelling show that the level of disturbance is not sufficient to result in any changes at the population level. The results of the cumulative iPCoD modelling for Celtic and GNS MU suggest that the impacted population is predicted to continue at a stable trajectory and at 99.9 – 100% of the size of the un-impacted population (Table 1-33 and Figure 1-20).

Table 1-33: Results of cumulative iPCoD modelling for minke whale (CGNS MU, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	20,120	20,120	100.00%
2028	20,153	20,151	99.99%
2030	20,117	20,103	99.93%
2036	20,143	20,138	99.98%
2038	20,090	20,085	99.98%
2042	20,016	20,011	99.98%
2048	19,975	19,970	99.97%
2050	19,977	19,973	99.98%
Note, time point descriptions are provided in Table 1-32.			

Figure 1-20: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations for the CGNS MU (Cumulative Concurrent Construction Scenario).

Cumulative Sequential Construction Scenario (No Gap)

1.7.3.4 The results of the cumulative iPCoD modelling show that the level of disturbance is not sufficient to result in any changes at the population level. The results of the cumulative iPCoD modelling for Celtic and GNS MU suggest that the impacted population is predicted to continue at a stable trajectory and at 99.9 – 100% of the size of the un-impacted population (Figure 1-21 and Table 1-34).

Table 1-34: Results of cumulative iPCoD modelling for minke whale (CGNS MU, Cumulative Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	20,120	20,120	100.00%
2026	20,114	20,114	100.00%
2028	19,980	19,980	100.00%
2032	19,902	19,898	99.98%
2033	19,918	19,915	99.98%
2038	19,908	19,907	99.99%
2044	19,748	19,747	99.99%
2050	19,763	19,762	99.99%
Note, time point descriptions are provided in Table 1-32.			

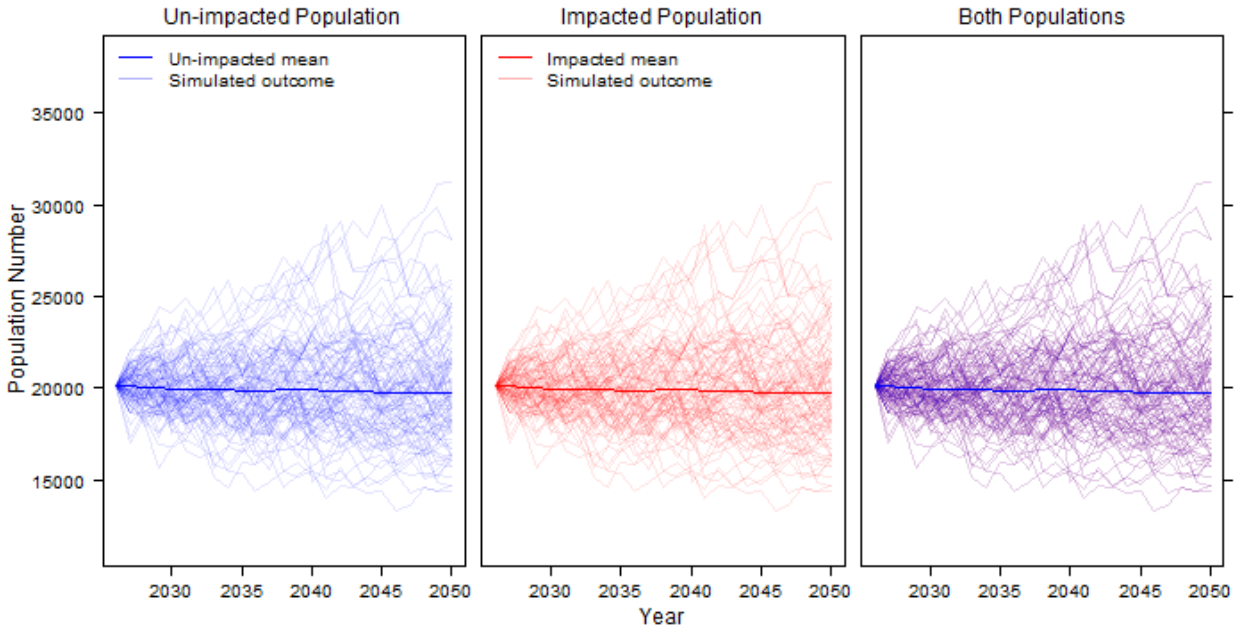

Figure 1-21: Predicted population trajectories for the un-impacted (baseline) and impacted minke whale iPCoD simulations for the CGNS MU (Cumulative Sequential Construction Scenario with no gap).

1.8 Harbour Seal

1.8.1 Overview

1.8.1.1 It is important to note when considering the iPCoD results for harbour seals, that the NC&O Seal Management Unit (SMU) is currently in decline with an average rate of decrease over the last five years of ~8.5% per (SCOS, 2022[13]). It is noted in SCOS (2022[13]) that the 2019 count was similar to the 2016 count, which could indicate that the decline has slowed, but more counts are required to confirm this. When interpreting the iPCoD results for the NC&O SMU, it is therefore necessary to understand that the un-impacted baseline MU is predicted to significantly decline in the absence of any impacts.

1.8.2 Concurrent Construction

1.8.2.1 For concurrent construction scenario, where both Caledonia North and Caledonia South will be installed within the same timeframe at random distribution, the disturbance numbers used in the modelling were based on the worst case (single piling) across all modelling locations:

- MF SMU:
  - 58 harbour seals per day for installation of pin piles at jackets; and
  - 39 harbour seals per day for installation of pin piles at anchors.
- NC&O SMU:
  - 86 harbour seals per day for installation of pin piles at jackets; and
  - 6 harbour seals per day for installation of pin piles at anchors.

MF SMU

1.8.2.2 The results of the iPCoD modelling for the MF SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-35 and Figure 1-22).

Table 1-35: Results of iPCoD modelling for harbour seal for the MF SMU (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	956	956	100.00%
2028	957	957	100.00%
2029	957	957	100.00%
2030	956	956	100.00%
2031	957	956	99.90%
2036	961	961	100.00%
2042	965	965	100.00%
2048	972	971	99.90%
Note, time point descriptions are provided in Table 1-4.			

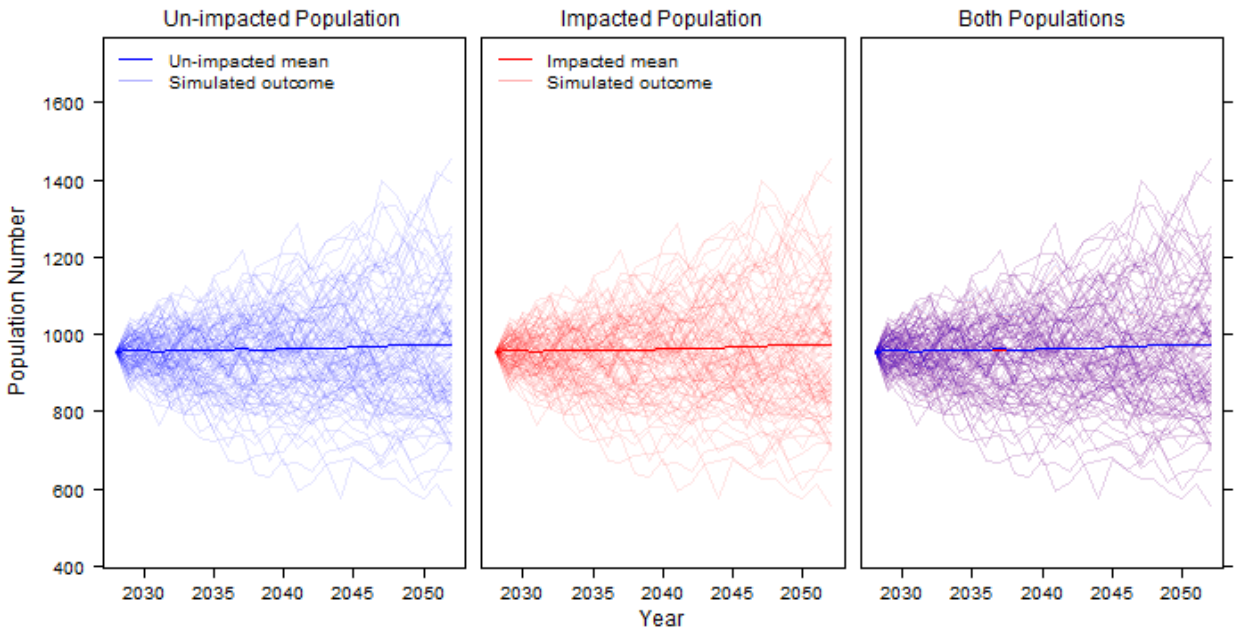

Figure 1-22: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the MF SMU iPCoD simulations (Concurrent Construction Scenario).

NC&O SMU

1.8.2.3 The results of the iPCoD modelling for the NC&O SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue declining at the

same rate as the un-impacted population, at 100% of the size of the un-impacted population (Table 1-36 and Figure 1-23).

Table 1-36: Results of iPCoD modelling for harbour seal for the NC&O SMU (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	1,950	1,950	100%
2028	1,747	1,747	100%
2029	1,566	1,566	100%
2030	1,400	1,400	100%
2031	1,252	1,252	100%
2036	717	717	100%
2042	370	370	100%
2048	190	190	100%
Note, time point descriptions are provided in Table 1-4.			

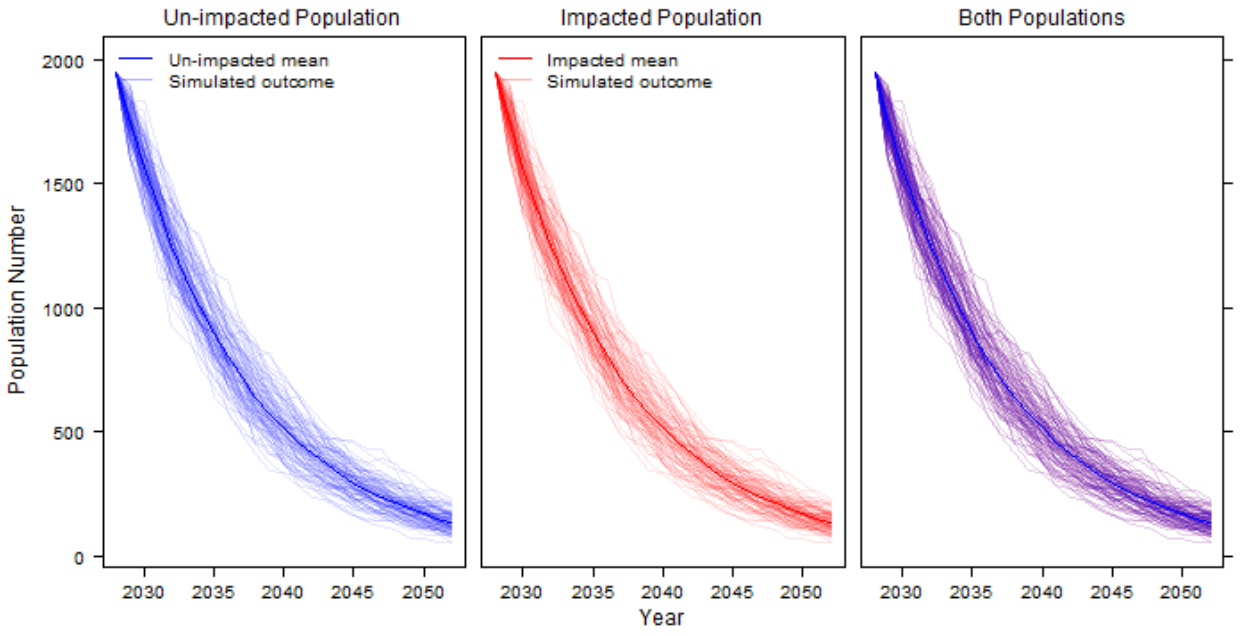

Figure 1-23: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the NC&O SMU iPCoD simulations (Concurrent Construction Scenario).

1.8.3 Sequential Construction

1.8.3.1 For sequential construction scenario, where Caledonia North and Caledonia South will be installed sequentially with either no gap or five year gap between the completion of piling at the Caledonia North Site and the commencement of piling in the Caledonia South Site, the disturbance values used in the modelling were based on the worst case (single piling) across modelling locations in the Caledonia North Site and modelling locations in the Caledonia South Site, i.e.:

- MF SMU:
  - 53 harbour seals per day for installation of pin piles at jackets in the Caledonia North Site;
  - 58 harbour seals per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 39 harbour seals per day for installation of pin piles at anchors (Caledonia South Site).
- NC&O SMU:
  - 86 harbour seals per day for installation of pin piles at jackets in the Caledonia North Site;
  - 43 harbour seals per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 6 harbour seals per day for installation of pin piles at anchors (Caledonia South Site).

No Gap

MF SMU

1.8.3.2 The results of the iPCoD modelling for the MF SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-37 and Figure 1-24).

Table 1-37: Results of iPCoD modelling for harbour seal for the MF SMU (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	956	956	100.00%
2028	956	956	100.00%
2029	955	955	100.00%
2030	956	956	100.00%
2031	955	955	100.00%
2032	956	956	100.00%
2033	958	958	100.00%
2038	960	960	100.00%
2044	963	963	100.00%
2050	964	964	100.00%
Note, time point descriptions are provided in Table 1-4.			

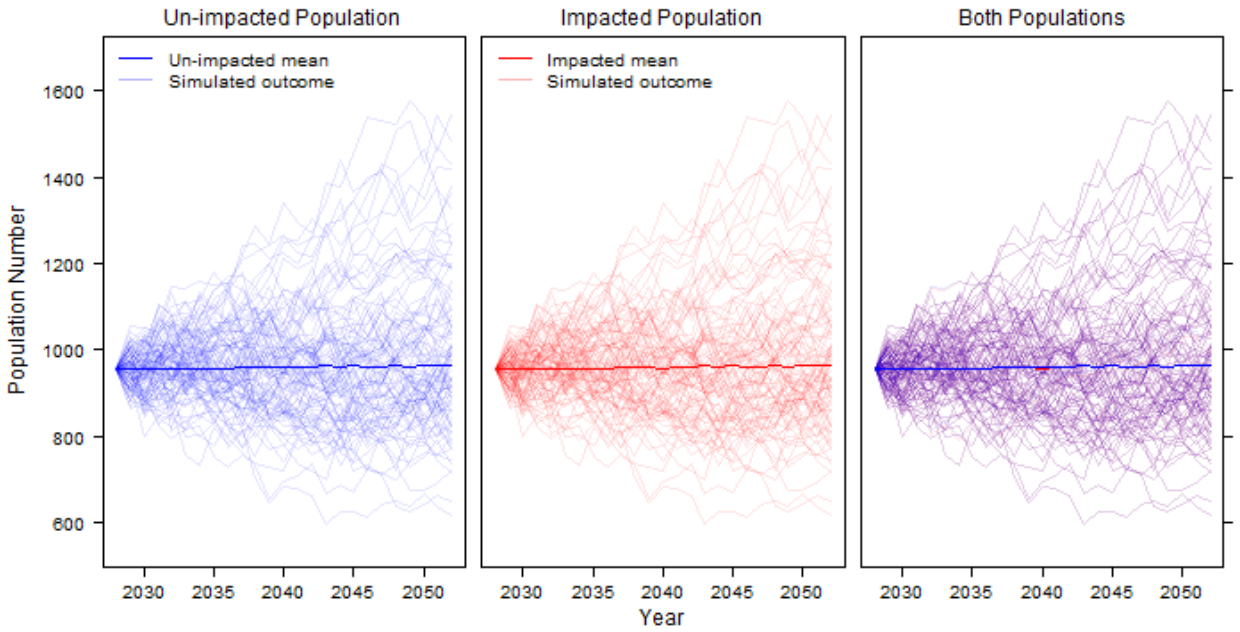

Figure 1-24: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the MF SMU iPCoD simulations (Sequential Construction Scenario with no gap).

NC&O SMU

1.8.3.3 The results of the iPCoD modelling for the NC&O SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue declining at the same rate as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-38 and Figure 1-25).

Table 1-38: Results of iPCoD modelling for harbour seal for the NC&O SMU (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	1,950	1,950	100.00%
2028	1,745	1,745	100.00%
2029	1,560	1,560	100.00%
2030	1,399	1,399	100.00%
2031	1,252	1,252	100.00%
2032	1,122	1,122	100.00%
2033	1,004	1,004	100.00%
2038	578	578	100.00%
2044	296	296	100.00%
2050	152	152	100.00%
Note, time point descriptions are provided in Table 1-4.			

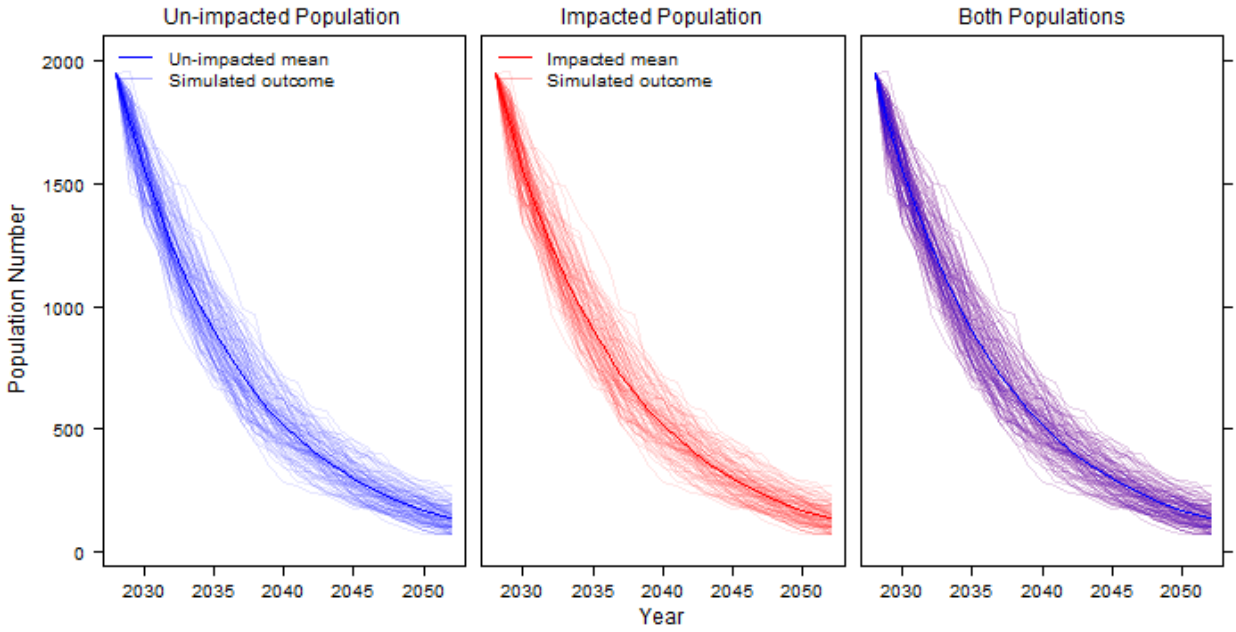

Figure 1-25: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the NC&O SMU iPCoD simulations (Sequential Construction Scenario with no gap).

Maximum Gap (Five Years)

MF SMU

1.8.3.4 The results of the iPCoD modelling for the MF SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-39 and Figure 1-26).

Table 1-39: Results of iPCoD modelling for harbour seal for the MF SMU (Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	956	956	100.00%
2028	958	958	100.00%
2029	958	958	100.00%
2030	960	960	100.00%
2031	958	958	100.00%
2034	957	957	100.00%
2035	958	958	100.00%
2036	960	960	100.00%
2037	962	962	100.00%
2038	964	964	100.00%
2043	969	969	100.00%
2049	975	975	100.00%
2052	977	977	100.00%
Note, time point descriptions are provided in Table 1-4.			

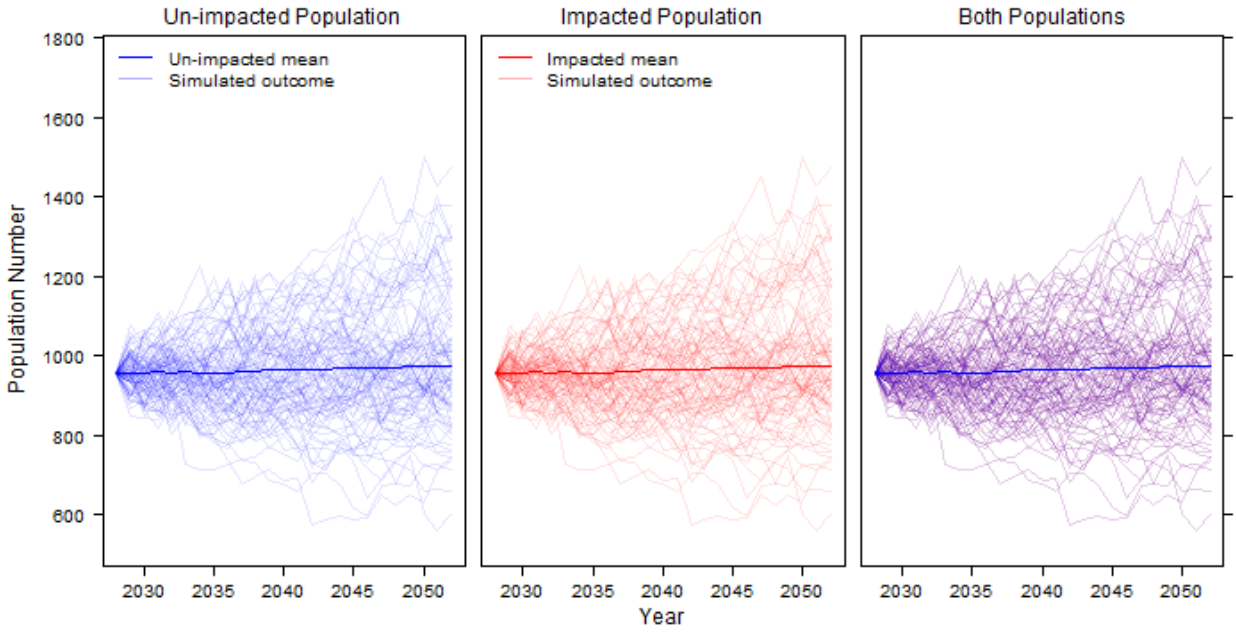

Figure 1-26: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the MF SMU iPCoD simulations (Sequential Construction Scenario with five year gap).

NC&O SMU

1.8.3.5 The results of the iPCoD modelling for the NC&O SMU, shows that the level of disturbance is not sufficient to result in any changes at the population level. The impacted population is predicted to continue declining at the same rate as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-40 and Figure 1-27).

Table 1-40: Results of iPCoD modelling for harbour seal for the NC&O SMU (Sequential Construction Scenario with five year gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	1,950	1,950	100.00%
2028	1,747	1,747	100.00%
2029	1,562	1,562	100.00%
2030	1,397	1,397	100.00%
2031	1,249	1,249	100.00%
2034	896	896	100.00%
2035	805	805	100.00%
2036	718	718	100.00%
2037	642	642	100.00%
2038	574	574	100.00%
2043	328	328	100.00%
2049	171	171	100.00%
2052	122	122	100.00%
Note, time point descriptions are provided in Table 1-4.			

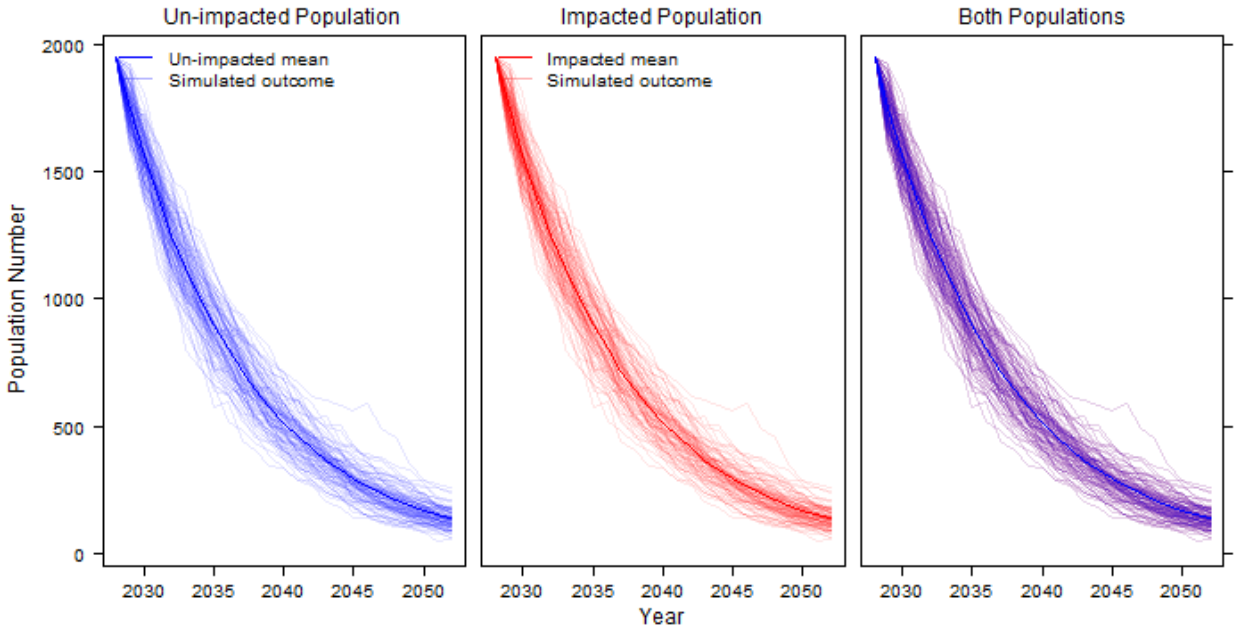

Figure 1-27: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal for the NC&O SMU iPCoD simulations (Sequential Construction Scenario with five year gap).

1.8.4 Cumulative Impact

Number of Animals Impacted

1.8.4.1 For cumulative concurrent and sequential construction scenarios, the disturbance numbers for harbour seal used in the modelling are presented in Table 1-41.

Table 1-41: The number of harbour seal predicted to be disturbed for each project, based on either the project-specific values presented in respective EIARs or calculated based on the EDRs and SCANS IV densities.

Project	Number Animals Impacted	Data Source
MF SMU		
Broadshore	1	SCANS IV & EDR
Sinclair	1	SCANS IV & EDR
NC&O SMU		
West of Orkney	176	EIA (Xodus Group Ltd, 2023[12])
Ayre	13	SCANS IV & EDR
Buchan	1	SCANS IV & EDR

Time Points

1.8.4.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-42 and Table 1-43.

Table 1-42: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the MF SMU for harbour seals

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the MF SMU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the MF SMU
	2031	1-year after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for harbour seal within the MF SMU
	2036	6-years after piling ends at the Proposed Development (Offshore) and 5-years after piling has ended at all projects considered for harbour seal within the MF SMU

Scenario	Time Points Selected (Indicative Year)	Time Point Description
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 11-years after piling has ended at all projects considered for harbour seal within the MF SMU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 17-years after piling has ended at all projects considered for harbour seal within the MF SMU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 19-years after piling has ended at all projects considered for harbour seal within the MF SMU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the MF SMU
	2031	End of fourth year of piling at the Proposed Development (Offshore) and the end of piling at projects considered for harbour seal within the MF SMU
	2032	End of final year of piling at the Proposed Development (Offshore) and 1-year after piling has ended at all projects considered for harbour seal within the MF SMU
	2038	6-years after piling ends at the Proposed Development (Offshore) and 7-years after piling has ended at all projects considered for harbour seal within the MF SMU
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 13-years after piling has ended at all projects considered for harbour seal within the MF SMU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 19-years after piling has ended at all projects considered for harbour seal within the MF SMU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Table 1-43: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the NC&O SMU for harbour seals.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the NC&O SMU
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the NC&O SMU
	2033	3-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for harbour seal within the NC&O SMU
	2036	6-years after piling ends at the Proposed Development (Offshore) and 3-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 9-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 15-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 17-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the NC&O SMU
	2032	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for harbour seal within the NC&O SMU
	2033	1-year after piling ends at the Proposed Development (Offshore) and the end of piling at

Scenario	Time Points Selected (Indicative Year)	Time Point Description
		projects considered for harbour seal within the NC&O SMU
	2038	6-years after piling ends at the Proposed Development (Offshore) and 5-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 11-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
	2050*	18-years after piling has ended at the Proposed Development (Offshore) and 17-years after piling has ended at all projects considered for harbour seal within the NC&O SMU
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Cumulative Concurrent Construction Scenario

MF SMU

1.8.4.3 The results of the cumulative iPCoD modelling show that for the MF SMU the level of cumulative disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-44 and Figure 1-28).

Table 1-44: Results of cumulative iPCoD modelling for harbour seals (MF SMU, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	956	956	100.00%
2028	960	960	100.00%
2030	962	962	100.00%
2031	962	962	100.00%
2036	965	965	100.00%
2042	972	972	100.00%
2048	974	974	100.00%
2050	976	976	100.00%
Note, time point descriptions are provided in Table 1-42.			

Figure 1-28: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the MF SMU (Cumulative Concurrent Construction Scenario).

NC&O SMU

1.8.4.4 The results of the cumulative iPCoD modelling show that for the NC&O SMU the level of cumulative disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue

declining at the same rate as the un-impacted population, at 100% of the size of the un-impacted population (Figure 1-29 and Table 1-45).

Table 1-45: Results of cumulative iPCoD modelling for harbour seals (NC&O SMU, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	1,950	1,950	100.00%
2028	1,405	1,405	100.00%
2030	1,126	1,126	100.00%
2033	965	965	100.00%
2036	581	581	100.00%
2042	298	298	100.00%
2048	154	154	100.00%
2050	124	124	100.00%
Note, time point descriptions are provided in Table 1-43.			

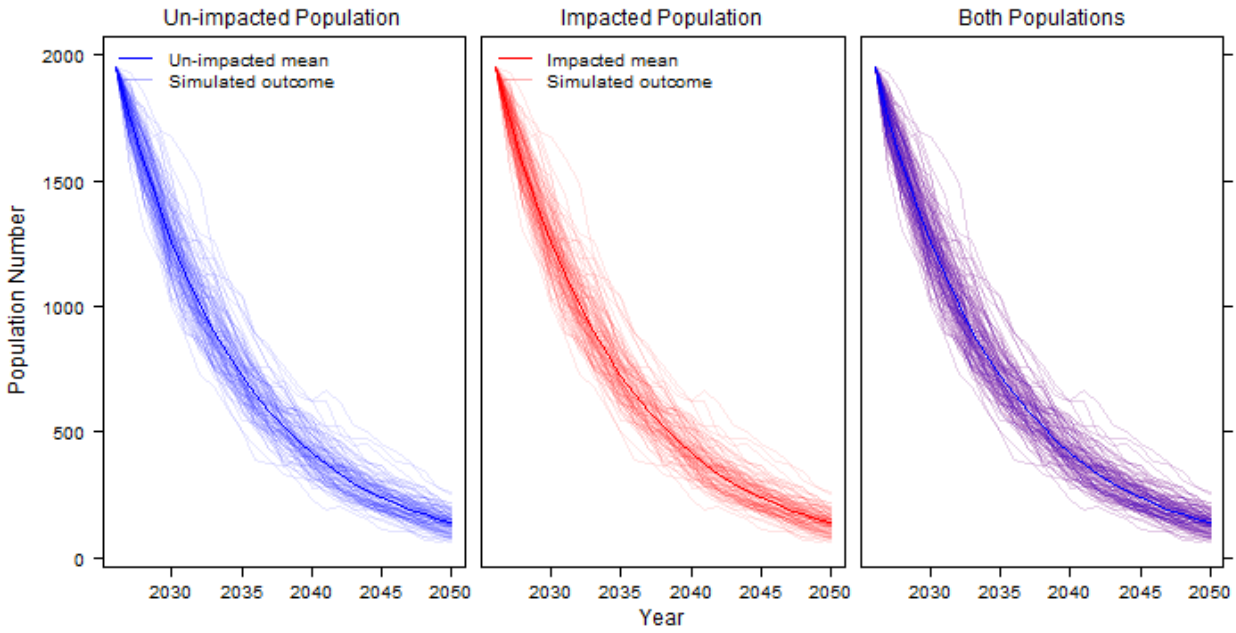

Figure 1-29: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the NC&O SMU (Cumulative Concurrent Construction Scenario).

Cumulative Sequential Construction Scenario (No Gap)

MF SMU

1.8.4.5 The results of the cumulative iPCoD modelling show that for the MF SMU the level of cumulative disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 100% of the size of the un-impacted population (Table 1-46 and Figure 1-30).

Table 1-46: Results of cumulative iPCoD modelling for harbour seals (MF SMU, Cumulative Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	956	956	100.00%
2028	960	960	100.00%
2031	960	960	100.00%
2032	957	957	100.00%
2038	963	963	100.00%
2044	967	967	100.00%
2050	970	970	100.00%
Note, time point descriptions are provided in Table 1-42.			

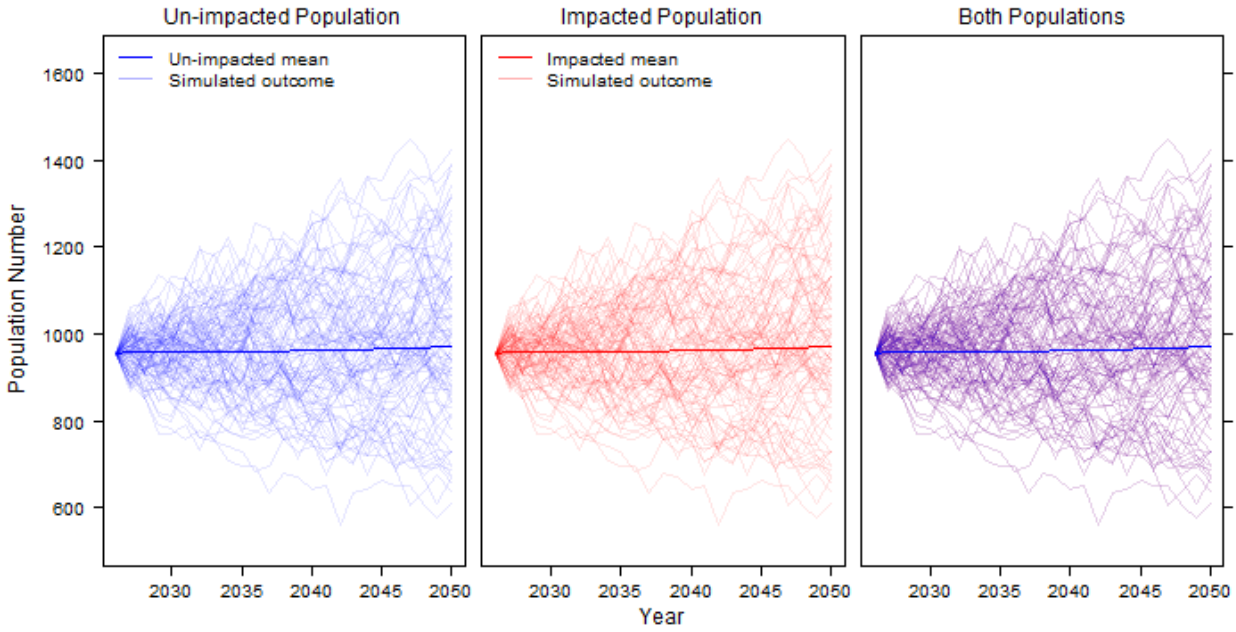

Figure 1-30: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the MF SMU (Cumulative Sequential Construction Scenario with no gap).

NC&O SMU

1.8.4.6 The results of the cumulative iPCoD modelling show that for the NC&O SMU the level of cumulative disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue declining at the same rate as the un-impacted population, at 100% of the size of the un-impacted population (Figure 1-31 and Table 1-47).

Table 1-47: Results of cumulative iPCoD modelling for harbour seals for the (NC&O SMU, Cumulative Sequential Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	1,950	1,950	100%
2028	1,401	1,401	100%
2032	900	900	100%
2033	808	808	100%
2038	466	466	100%
2044	240	240	100%
2050	125	125	100%
Note, time point descriptions are provided in Table 1-43.			

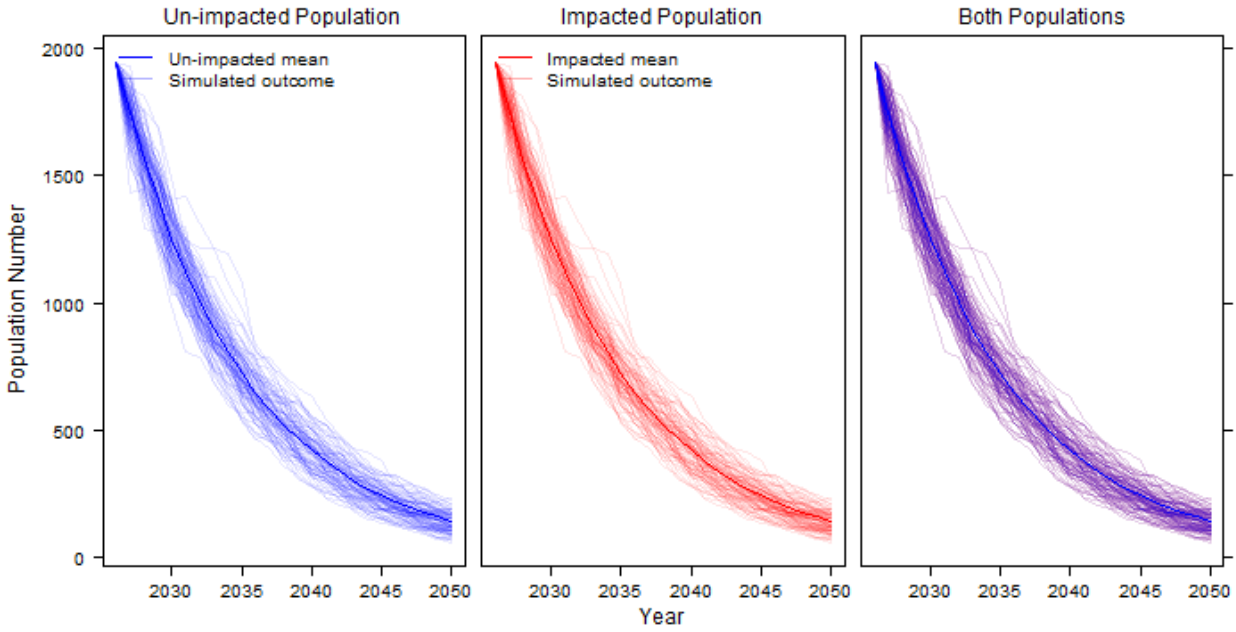

Figure 1-31: Predicted population trajectories for the un-impacted (baseline) and impacted harbour seal iPCoD simulations for the NC&O SMU (Cumulative Sequential Construction Scenario with no gap).

1.9 Grey seal

1.9.1 Concurrent Construction

1.9.1.1 For concurrent construction scenario, where both Caledonia North and Caledonia South of the Proposed Development (Offshore) will be installed within the same timeframe at random distribution, the disturbance numbers used in the modelling were based on the worst case (single piling) across all modelling locations:

- MF SMU:
  - 1,921 grey seals per day for installation of pin piles at jackets; and
  - 1,650 grey seals per day for installation of pin piles at anchors.
- Three SMUs combined:
  - 4,426 grey seals per day for installation of pin piles at jackets; and
  - 2,960 grey seals per day for installation of pin piles at anchors.

MF SMU

1.9.1.2 The results of the iPCoD modelling show that for the MF SMU the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.1 – 100% of the size of the un-impacted population (Table 1-48 and Figure 1-32).

Table 1-48: Results of iPCoD modelling for grey seal for the MF SMU (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	7,380	7,380	100.00%
2028	7,420	7,420	100.00%
2029	7,479	7,466	99.83%
2030	7,529	7,467	99.18%
2031	7,569	7,510	99.22%
2036	7,793	7,727	99.15%
2042	8,132	8,066	99.19%
2048	8,426	8,357	99.18%
Note, time point descriptions are provided in Table 1-4.			

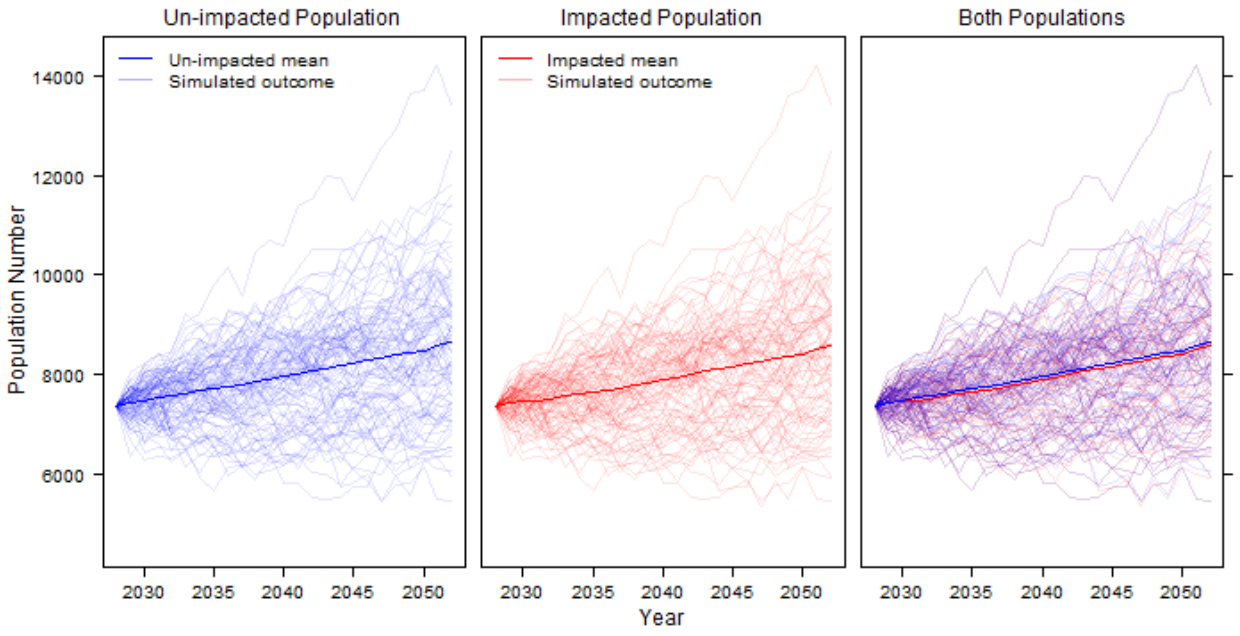

Figure 1-32: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for the MF SMU iPCoD simulations (Concurrent Construction Scenario).

SMUs combined (MF, ES and NC&O)

1.9.1.3 The results of the iPCoD modelling show that for all seal SMUs combined the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.9 – 100% of the size of the un-impacted population (Table 1-49 and Figure 1-33).

Table 1-49: Results of iPCoD modelling for grey seal for MF, ES and NC&O SSMUs combined (Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	52,356	52,356	100.00%
2028	52,763	52,763	100.00%
2029	52,991	52,991	100.00%
2030	53,293	53,279	99.97%
2031	53,614	53,600	99.97%
2036	55,286	55,271	99.97%
2042	57,501	57,487	99.98%
2048	59,719	59,704	99.97%
Note, time point descriptions are provided in Table 1-4.			

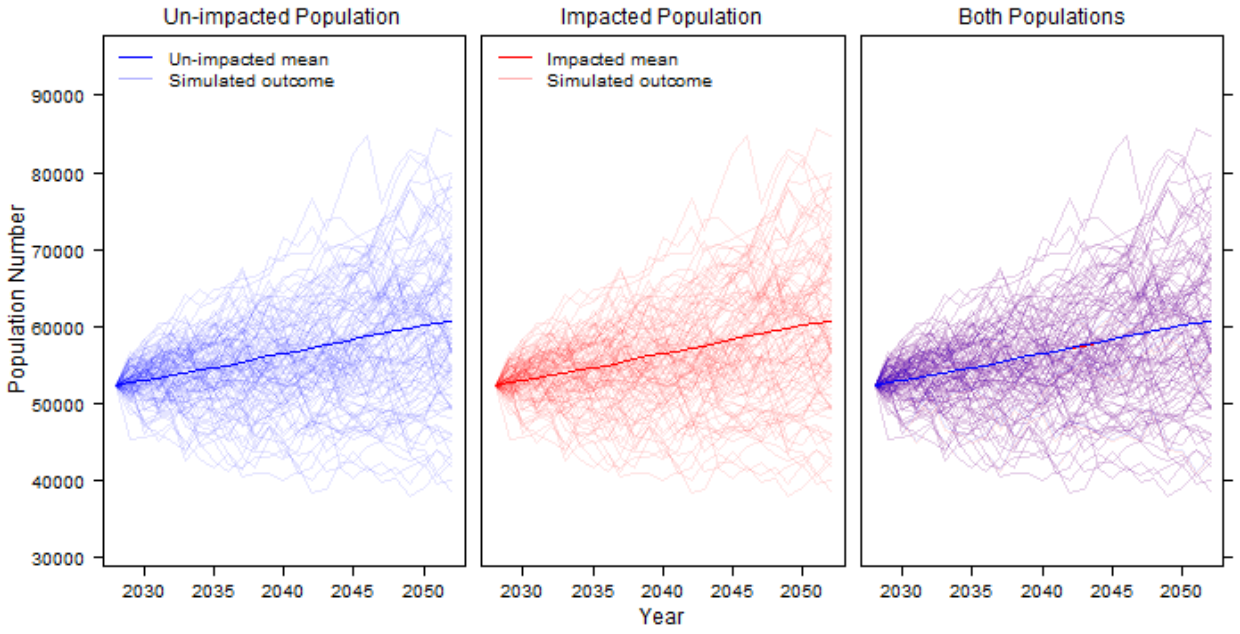

Figure 1-33: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for MF, ES and NC&O SSMUs combined iPCoD simulations (Concurrent Construction Scenario).

1.9.2 Sequential Construction

1.9.2.1 For sequential construction scenario, where Caledonia North and Caledonia South of the Proposed Development (Offshore) will be installed sequentially with no gap or five year gap between the completion of piling at the Caledonia North Site and the commencement of piling in the Caledonia South Site, the disturbance values used in the modelling were based on the worst case (single piling) across modelling locations in the Caledonia North Site and modelling locations in the Caledonia South Site, i.e.:

- MF SMU:
  - 1,921 grey seals per day for installation of pin piles at jackets in the Caledonia North Site;
  - 1,921 grey seals per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 1,650 grey seals per day for installation of pin piles at anchors (Caledonia South Site).
- Three SMUs combined:
  - 4,426 grey seals per day for installation of pin piles at jackets in the Caledonia North Site;
  - 4,225 grey seals per day for installation of pin piles at jackets in the Caledonia South Site; and
  - 2,960 grey seals per day for installation of pin piles at anchors (Caledonia South Site).

No Gap

MF SMU

1.9.2.2 The results of the iPCoD modelling show that for the MF SMU the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.3 – 100.0% of the size of the un-impacted population (Table 1-50 and Figure 1-34).

Table 1-50: Results of iPCoD modelling for grey seal for MF SMU (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	7,380	7,380	100.00%
2028	7,417	7,417	100.00%
2029	7,471	7,471	100.00%
2030	7,514	7,512	99.97%
2031	7,565	7,528	99.51%
2032	7,609	7,561	99.37%
2033	7,658	7,613	99.41%
2038	7,870	7,818	99.34%
2044	8,127	8,074	99.35%
2050	8,463	8,408	99.35%
Note, time point descriptions are provided in Table 1-4.			

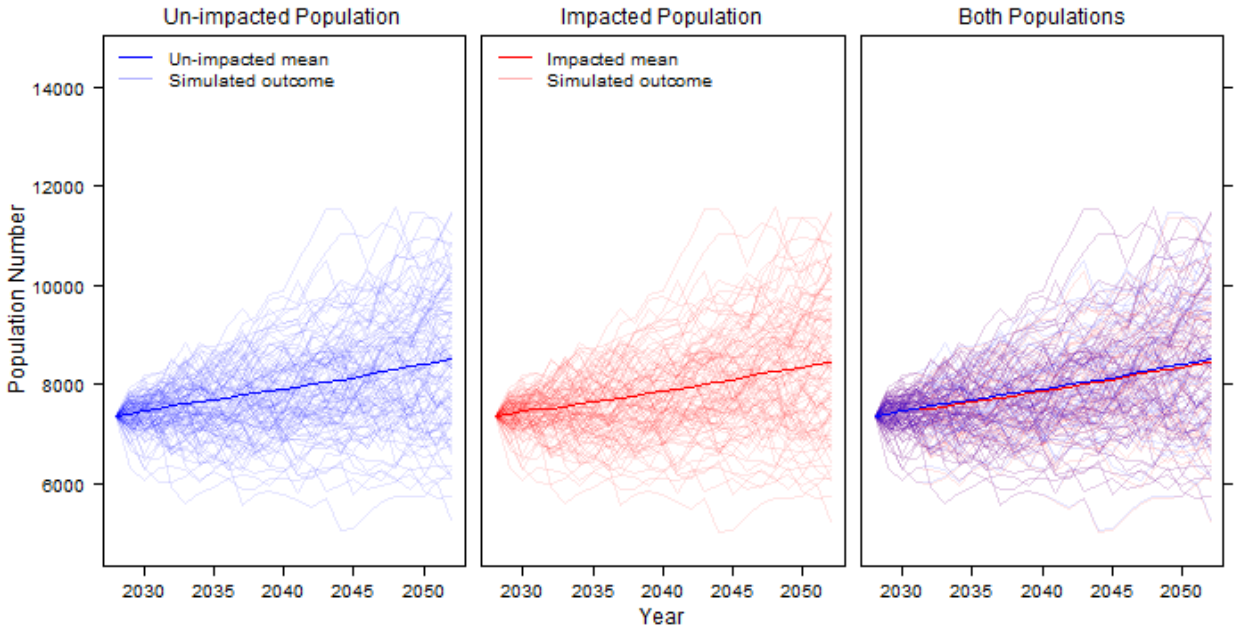

Figure 1-34: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for MF SMU iPCoD simulations (Sequential Construction Scenario with no gap).

SMUs combined (MF, ES and NC&O)

1.9.2.3 The results of the iPCoD modelling show that for all seal SMUs combined the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.9 – 100.0% of the size of the un-impacted population (Table 1-51 and Figure 1-35).

Table 1-51: Results of iPCoD modelling for grey seal for MF, ES and NC&O SSMUs combined (Sequential Construction Scenario with no gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	52,356	52,356	100.00%
2028	52,728	52,728	100.00%
2029	52,994	52,994	100.00%
2030	53,463	53,463	100.00%
2031	53,735	53,730	99.99%
2032	53,987	53,983	99.99%
2033	54,368	54,363	99.99%
2038	56,135	56,130	99.99%
2044	58,417	58,412	99.99%
2050	60,740	60,735	99.99%
Note, time point descriptions are provided in Table 1-4.			

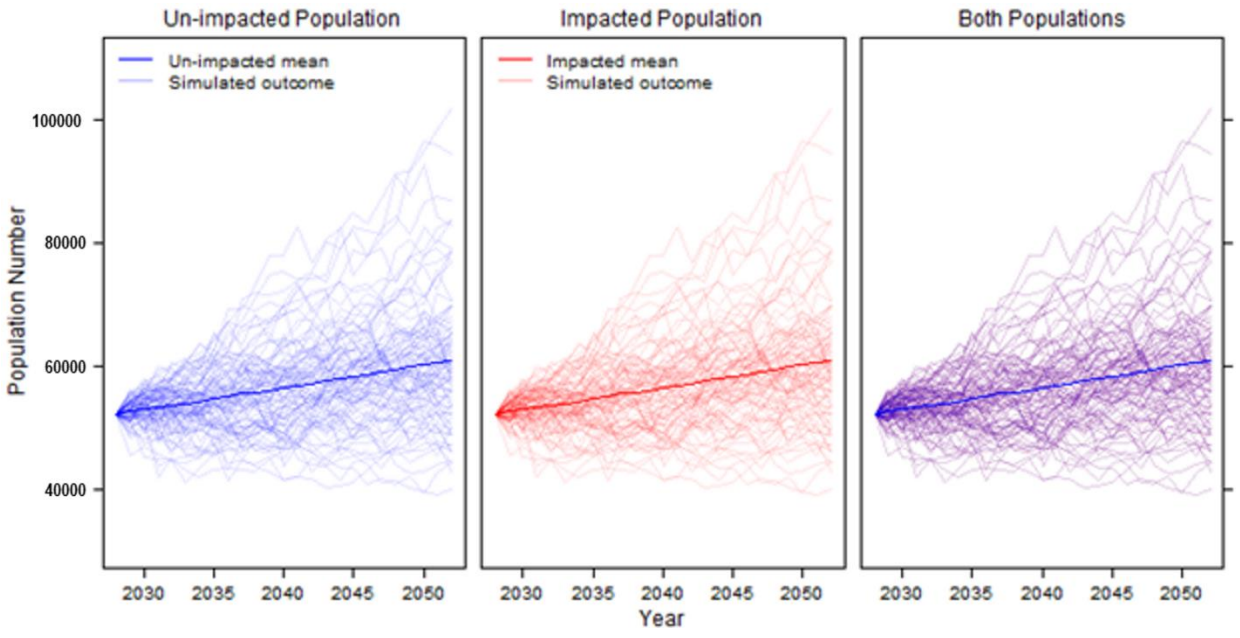

Figure 1-35: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for MF, ES and NC&O SSMUs combined iPCoD simulations (Sequential Construction Scenario with no gap).

Maximum Gap (Five Years)

MF SMU

1.9.2.4 The results of the iPCoD modelling show that for the MF SMU the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.3 – 100.0% of the size of the un-impacted population (Table 1-52 and Figure 1-36).

Table 1-52: Results of iPCoD modelling for grey seal for MF SMU (Sequential Construction Scenario with five years gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	7,380	7,380	100.00%
2028	7,420	7,420	100.00%
2029	7,471	7,471	100.00%
2030	7,524	7,524	100.00%
2031	7,575	7,575	100.00%
2034	7,717	7,717	100.00%
2035	7,767	7,767	100.00%
2036	7,821	7,783	99.51%
2037	7,873	7,826	99.40%
2038	7,922	7,877	99.43%
2043	8,170	8,118	99.36%
2049	8,454	8,403	99.40%
2052	8,617	8,564	99.38%
Note, time point descriptions are provided in Table 1-4.			

Figure 1-36: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for MF SMU iPCoD simulations (Sequential Construction Scenario with five years gap).

SMUs combined (MF, ES and NC&O)

1.9.2.5 The results of the iPCoD modelling show that for all seal SMUs combined the level of disturbance is not sufficient to result in any changes at the population level as the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.9 – 100.0% of the size of the un-impacted population (Table 1-53 and Figure 1-37).

Table 1-53: Results of iPCoD modelling for grey seal for MF, ES and NC&O SSMUs combined Sequential Construction Scenario with five years gap).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2027	52,356	52,356	100.00%
2028	52,755	52,755	100.00%
2029	53,034	53,034	100.00%
2030	53,346	53,346	100.00%
2031	53,734	53,734	100.00%
2034	54,699	54,699	100.00%
2035	54,981	54,981	100.00%
2036	55,362	55,355	99.99%
2037	55,725	55,718	99.99%
2038	56,125	56,119	99.99%
2043	57,811	57,805	99.99%
2049	59,943	59,937	99.99%
2052	61,186	61,180	99.99%
Note, time point descriptions are provided in Table 1-4.			

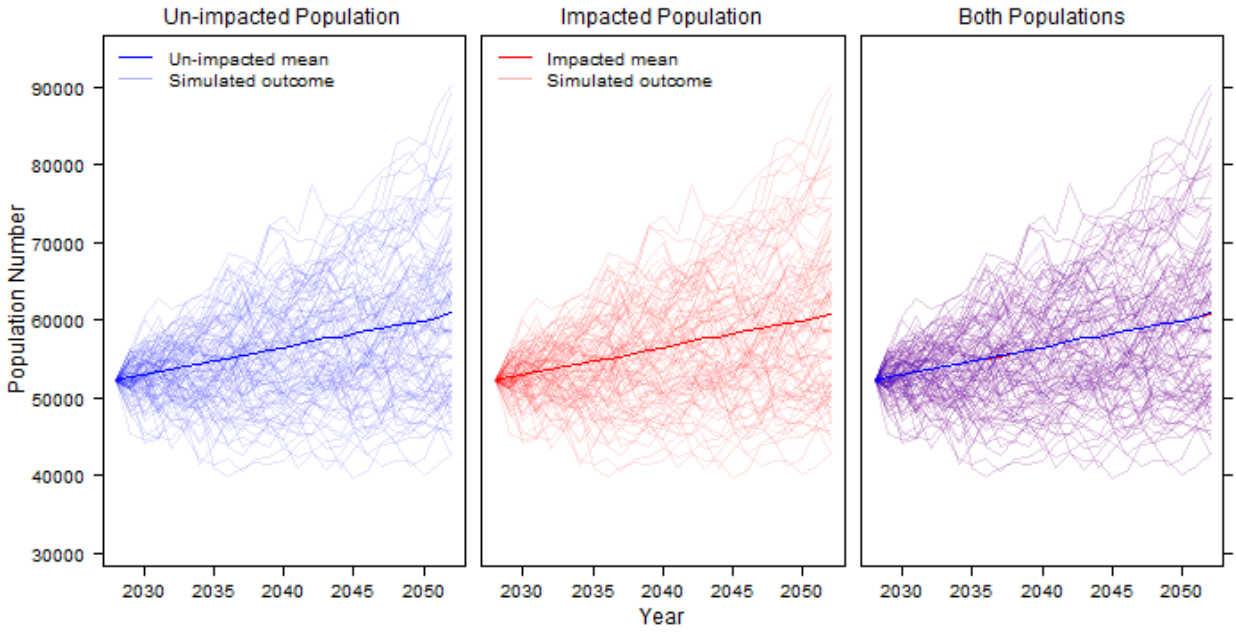

Figure 1-37: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal for MF, ES and NC&O SSMUs combined iPCoD simulations (Sequential Construction Scenario with five years gap).

1.9.3 Cumulative Impact

Number of Animals Impacted

1.9.3.1 For cumulative concurrent and sequential construction scenarios, the disturbance numbers for grey seal used in the modelling are presented in Table 1-54.

Table 1-54: The number of grey seal predicted to be disturbed for each project, based on either the project-specific values presented in respective EIARs or calculated based on the EDRs and SCANS IV densities.

Project Screened Into Assessment	Number Animals Impacted	Data Source
Projects with piling schedules available in the public domain		
Berwick Bank	1,358 (WTG) / 705 (OSP)	EIA (RPS, 2022[8])
Ossian	131 (WTG) / 343 (OSP)	EIA (RPS, 2024[9])
Salamander	73	EIA (Salamander Offshore Wind Farm, 2023[10])
West of Orkney	2887	EIA (Xodus Group Ltd, 2023[12])
Green Volt	336	EIA (Royal HaskoningDHV, 2023[11])
Projects without piling schedules available in the public domain		
Ayre	610	SCANS IV & EDR
Broadshore	138	SCANS IV & EDR
Buchan	232	SCANS IV & EDR
Cenos	6	SCANS IV & EDR
Morven	519	SCANS IV & EDR
Muir Mhòr	160	SCANS IV & EDR
Sinclair	178	SCANS IV & EDR
Bellrock	55	SCANS IV & EDR

Time Points

1.9.3.2 The time points selected for the presentation of cumulative iPCoD modelling results are presented in Table 1-55.

Table 1-55: Time points selected for the presentation of cumulative iPCoD modelling results for cumulative impacts on the SMUs combined for grey seals.

Scenario	Time Points Selected (Indicative Year)	Time Point Description
Cumulative Concurrent Construction	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of first year of piling at the Proposed Development (Offshore), piling at projects considered for grey seal within the SMUs combined
	2030	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for grey seal within the SMUs combined
	2036	6-years after piling ends at the Proposed Development (Offshore), piling at projects considered for grey seal within the SMUs combined
	2038	8-years after piling ends at the Proposed Development (Offshore) and the end of piling at projects considered for grey seal within the SMUs combined
	2042	12-years after piling has ended at the Proposed Development (Offshore) and 4-years after piling has ended at all projects considered for grey seal within the SMUs combined
	2048	18-years after piling has ended at the Proposed Development (Offshore) and 10-years after piling has ended at all projects considered for grey seal within the SMUs combined
	2050*	20-years after piling has ended at the Proposed Development (Offshore) and 12-years after piling has ended at all projects considered for grey seal within the SMUs combined
Cumulative Sequential Construction (no gap)	2025	Population size at the end of the year 2025, before all piling starts
	2028	End of 1st year of piling at the Proposed Development (Offshore), piling at projects considered for grey seal within the SMUs combined
	2032	End of final year of piling at the Proposed Development (Offshore), piling at projects considered for grey seal within the SMUs combined
	2038	6-years after piling ends at the Proposed Development (Offshore) and the end of piling at

Scenario	Time Points Selected (Indicative Year)	Time Point Description
		projects considered for grey seal within the SMUs combined
	2044	12-years after piling has ended at the Proposed Development (Offshore) and 6-years after piling has ended at all projects considered for grey seal within the SMUs combined
	2050*	17-years after piling has ended at the Proposed Development (Offshore) and 11-years after piling has ended at all projects considered for grey seal within the SMUs combined
* 2050 is the maximum extent of the iPCoD model predictions (25-years) and thus population trajectories cannot be predicted beyond this.		

Cumulative Concurrent Construction Scenario

SMUs combined (MF, ES and NC&O)

1.9.3.3 The results of the cumulative iPCoD modelling show that for all seal SMUs combined, the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.8 – 100% of the size of the un-impacted population (Table 1-56 and Figure 1-38).

Table 1-56: Results of cumulative iPCoD modelling for grey seals (combined SMUs, Cumulative Concurrent Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	52,356	52,356	100.00%
2028	53,222	53,222	100.00%
2030	53,964	53,900	99.88%
2036	56,073	56,004	99.88%
2038	56,809	56,741	99.88%
2042	58,161	58,093	99.88%
2048	60,608	60,538	99.88%
2050	61,565	61,493	99.88%
Note, time point descriptions are provided in Table 1-55.			

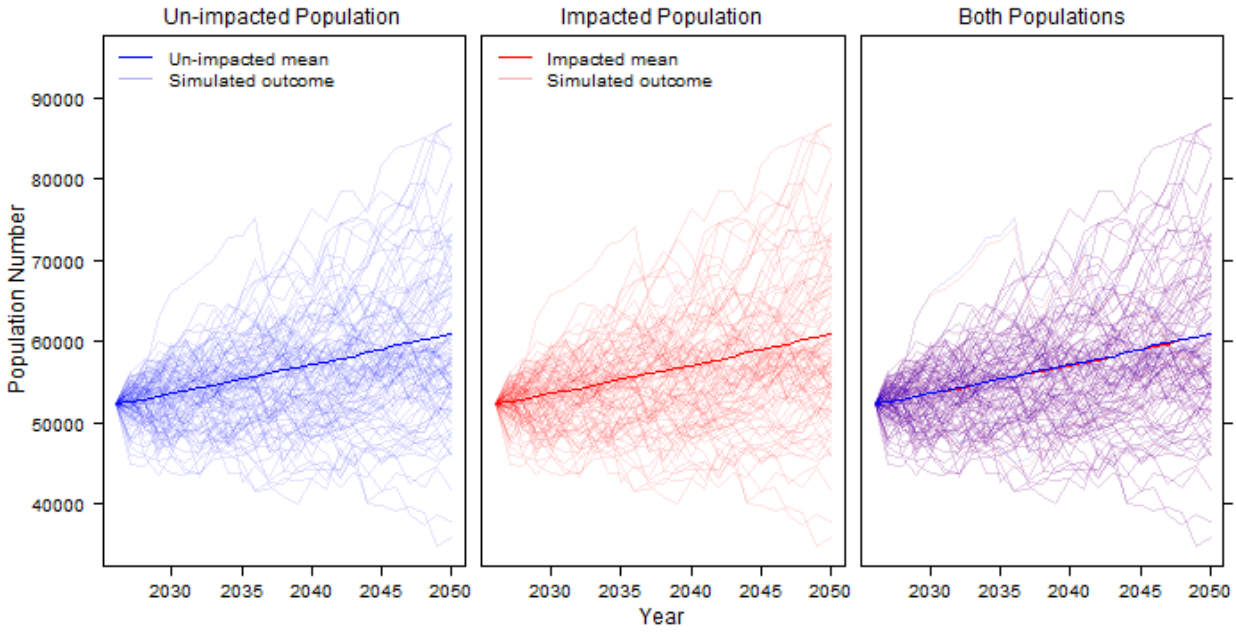

Figure 1-38: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal iPCoD simulations for the combined SMUs (Cumulative Concurrent Construction Scenario).

Cumulative Sequential Construction Scenario (No Gap)

SMUs combined (MF, ES and NC&O)

1.9.3.4 The results of the cumulative iPCoD modelling show that for all seal SMUs combined, the impacted population is predicted to continue at a stable trajectory, the same as the un-impacted population, and at 99.8 – 100% of the size of the un-impacted population (Table 1-57 and Figure 1-39).

Table 1-57: Results of cumulative iPCoD modelling for grey seals (combined SMUs, Cumulative Sequential Construction Scenario).

Time Point	Unimpacted Population Mean Size	Impacted Population Mean Size	Impacted Population as a Proportion of the Unimpacted Population
2025	52,356	52,356	100.00%
2028	53,301	53,301	100.00%
2032	54,571	54,537	99.94%
2038	56,822	56,782	99.93%
2044	59,029	58,988	99.93%
2050	61,343	61,301	99.93%
Note, time point descriptions are provided in Table 1-55.			

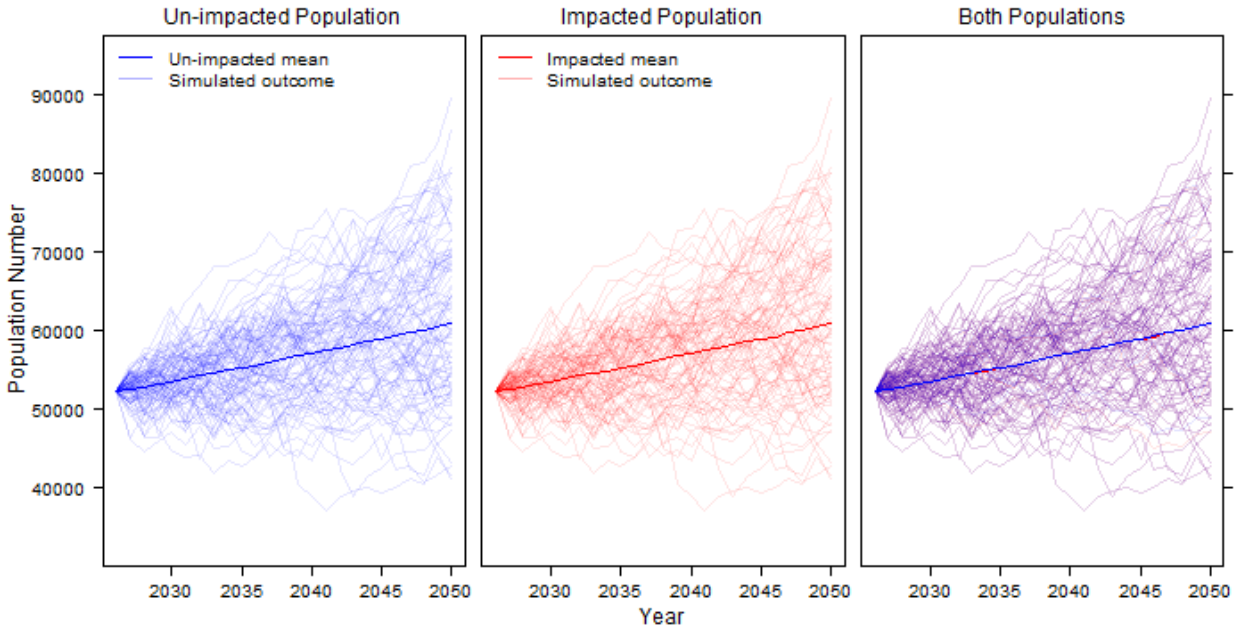

Figure 1-39: Predicted population trajectories for the un-impacted (baseline) and impacted grey seal iPCoD simulations for the combined SMUs (Cumulative Sequential Construction Scenario with no gap).

1.10 References

[1] Harwood, J., King, S., Schick, R., Donovan, C. and Booth, C. (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)

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

[3] Booth, C.G., Heinis, F. and Harwood, 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)

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

[5] Czapanskiy, M.F., Savoca, M.S., Gough, W.T., Segre, P.S., Wisniewska, D.M., Cade, D.E. and Goldbogen, J.A. (2021) 'Modelling short-term energetic costs of sonar disturbance to cetaceans using high-resolution foraging data'. Journal of Applied Ecology 58: 1643-1657

[6] Schwacke, L.H., Marques, T.A., Thomas, L., Booth, C., Balmer, B.C., Barratclough, A., Colegrove, K., De Guise, S., Garrison, L.P. and Gomez, F.M. (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

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

[8] RPS (2022) 'Berwick Bank Wind Farm Environmental Impact Assessment Report Volume 2, Chapter 10: Marine Mammals'. Report to SSE Renewables

[9] RPS (2024) 'Ossian - Chapter 1: Marine Mammals Array EIA Report'

[10] Salamander Offshore Wind Farm (2023) 'Salamander Offshore EIA Report. Volume ER.A.3, Chapter 11: Marine Mammals'

[11] Royal HaskoningDHV (2023) 'Green Volt, Offshore Windfarm EIA Report. Volume 1, Chapter 11 Marine Mammal Ecology'

[12] Xodus Group Ltd (2023) 'West of Orkney Windfarm Offshore EIA Report. Volume 1, Chapter 12 - Marine Mammals and Megafauna'

[13] SCOS (2022) 'Scientific Advice on Matters Related to the Management of Seal Populations: 2021'

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